

Standard Specifications
For Public Works Construction
1986
Incorporating Update No. 8

Volume 1 of 2
General Conditions and Technical Specifications
January 2011



City of Albuquerque
Planning Department



CITY OF ALBUQUERQUE
STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION

April 5, 2011

UPDATE NUMBER 8

Update number Eight (8) to the City of Albuquerque (COA) Standard Specifications for Public Works Construction is now available for reference and purchase. Specifications may be purchased in bound book format or in CD ROM format from Albuquerque Reprographics.

The cost of the COA Standard Specification for Public Works Construction General Conditions and Technical Specifications bound book format is \$93.00 plus tax, the cost of the Standard Detail Drawings bound book format is \$87.00 plus tax, the cost of the COA Standard Specification for Public Works Construction General Conditions and Technical Specifications including Detail Drawings in binder format is \$165.00 plus tax and CD ROMS are \$50.00 each plus tax.

The cost for Update Number 8, as a supplement to the COA Standard Specification for Public Works Construction including drawings that have been three hole punched for a standard binder is \$25.00 for each set plus tax and CD ROMS are \$10.00 each plus tax.

Prices are based on the reproduction contract prices that Albuquerque Reprographics has with the City of Albuquerque and are subject to change.

The Standard Specifications for Public Works Construction may also be viewed on the City's Web Page at: <http://www.cabq.gov/planning/publications/standardspecs.html>

See attached memo for more information.



April 5, 2011

Mayor Richard J. Berry

TO: All Holders of the City of Albuquerque Standard Specifications for Public Works Construction, 2011

FROM: Richard Dourte, City Engineer, Planning Department

SUBJECT: UPDATE NO. 8 – REVISIONS, DELETIONS, AND ADDITIONS

Attached is a listing of specification sections and/or drawings that have been modified and are hereby made part of the City of Albuquerque's Standard Specifications for PUBLIC Works Construction – 1986 as Update No. 8. The revised text section and drawings should be replaced, deleted, or inserted as indicated. All construction plans and specifications shall incorporate the requirements of Update No. 8 as soon as possible with the following effective dates for full implementation:

1. Plans submitted to DRC for preliminary review shall be in full compliance with Update No. 8 on or after July 1, 2011.
2. Plans submitted to DRC for final review or sign-off shall be in full compliance with Update No. 8 on or after September 1, 2011.
3. Projects with a start of construction date (Work Order or Notice to Proceed Date) on or after November 1, 2011, shall be in full compliance with Update No. 8.

If there are any questions regarding the update of the water/sanitary sewer sections of Update Number 8 of the Standard Specifications please contact Mr. Anthony Montoya, Jr., P.E., Senior Engineer of the ABCWUA at 736-2713 or e-mail him at almontoya@abcwua.org. All other questions concerning Update Number 8 should be directed to Mr. Paul Olson, PE, Senior Engineer at the City of Albuquerque Planning Department at (505) 924-3421 or e-mail him at polson@cabq.gov.

February 10, 2011

To: Richard Dourte, P.E., City Engineer

From: Anthony Montoya , Senior Engineer, ABCWUA

Subject: Update No. 8 – ABCWUA Proposed Revisions, Deletions, and Additions - Summary

The following is a brief summary of the Water Authority's proposed changes to the City of Albuquerque Standard Specifications for Public Works Construction. The section numbers are shown along with a brief description about the proposed changes to the given specification.

General Conditions, Section 18, Utilities:

Changes were made to the Water Shut-Off Procedures with regard to the On-Line submittal and the lead time associated for shut-offs on distribution, transmission, and San Juan Chama lines.

Technical Specifications, Section 121, Plastic Pipe:

121.4.1 – Addition of pvc color designations for potable water, non-potable water, and sanitary sewer pipe applications;

121.4.2 - Minor correction – replace delectable with detectable;

121.5 - Elimination of PVCO from spec;

121.5.1.8 - Addition of new section which limits PVC to 24" diameter (max);

Replacement of 121.5.2.5.1 with 121.5.2.6 for clarity of pipe discussed;

121.5.3.1.1 - New Section – Prohibits HDPE for public water line use;

121.5.3.2.3 – Minor change for clarity of PE pipe;

121.5.3.2.4 – Change to include authorization by Water Authority for tap on HDPE collector line;

121.5.3.3 – Addition of language to emphasize the non-use of plastic water service lines;

Technical Specifications, Section 128, Concrete Cylinder Pipe:

128.1 – Change minimum pipe size from 16" to 24";

Technical Specifications, Section 129, Ductile Iron Pipe:

129.3.6 – Addition of polyethylene encasement on DI pipe installation;

129.3.7 – Addition of Bell and Spigot Joint section;

129.4.3 0 - Addition of polyethylene encasement on DI pipe installation;

Technical Specifications, Section 130, Gray Iron, Ductile Iron, and Steel Fittings:

130 – Change title of section to include Steel Fittings;

130.2.1 – Add reference to AWWA C208, Standard for Fabricated Steel Water Pipe Fittings;

130.2.1 – Add reference to AWWA C226, Standard for Stainless-steel Fittings for Waterworks Service Sizes ½ In. through 72 In.;

130.6.1 – Thrust restraint blocking is to be used only when necessary rather than routine;

130.6.2 – All restrained joints shall be made by mechanical means;

130.7 – NEW section on Steel Fitting use;

130.8 – Moved Pressure Rating section here;

130.9 – Modified measurement and payment to match that of Section 800 and to include fitting insertion;

Technical Specifications, Section 161, Gray Iron Castings:

161.4 – Removed Water and Sanitary Sewer from this section;

161.5 – NEW SAS and Water Manhole Frame and Cover section;

161.6 - NEW Water Valve, Fire Line, and Vacuum Sewer Valve Frame and Cover section;

Technical Specifications, Section 163 – Ductile Iron Castings:

NEW Section in its entirety to include small water meter covers, and 24" Water and SAS Manhole covers;

Technical Specifications, Section 170, Electronic Marker Devices:

EMD's will now be placed at all SAS manholes, SAS taps on the main and at property line, and at all water service taps. This is in addition to the previous locations specified in original specification.

Technical Specifications, Section 801 – Water Transmission, Collector, and Distribution Lines:

801.2.1 – Delete reference to AWWA C909;

801.2.1 – Add reference to Section 161, Gray Iron Castings;

801.2.1 – Add reference to Section 163, Ductile Iron Castings;

801.3.1.1 – Removal of Made in America requirement for pipe and added the reference to Water Authority Approved Product List;

801.3.2.1.1 – Changes to Pipe Type and Size chart; DI will only be used in 4"-64"; Concrete Cylinder will only be used in 24" and larger; Blue C900 will be used in potable water lines 4" – 12"; Blue C905 will be used in potable water lines 14" – 24"; Purple C900 will be used in non-potable water lines 4" – 12"; Purple C905 will be used in non-potable water lines 14" – 24";

801.3.2.3 - Removal of Made in America requirement for pipe;

801.3.3.2 – Gate valve change from AWWA C509 spec to AWWA C515 spec to allow for a reduced wall valve;

801.3.3.4 – Change from C509 to C515 on parts used in gate valve;

801.3.3.6 - Change from C509 to C515 on parts used in gate valve;

801.3.3.7 – Handwheel diameters specified in vault applications;

801.3.3.10 – Elimination of Water Valve Data Cards and replaced with GPS on As Builts;

801.3.4.2 – Addition of 250B Class for Butterfly valves;

801.3.4.6 – Addition of maximum operating torque (80 lb) on handwheel;

801.3.4.8 - Elimination of Water Valve Data Cards and replaced with GPS on As Builts;

801.3.5 – Valve box material will be 12" polymer coated CMP;

801.3.6 – Valves used must comply with WUA Approved Products List;

801.3.7.1 – Hydrants used must comply with WUA Approved Products List;

801.3.7.5 – Hydrant color is to be Safety Yellow;

801.3.7.8.1 – Delete requirement to, "Attach a Water Utility Division approved anti-theft device to the hydrant";

801.3.7.10 – Revised specification so that hydrants will be fully restrained;

801.3.7.11 – Hydrants will now have an isolation valve installed on branch leg;

801.3.7.12 – Addition of max operating torque on hydrant of 200 ft-lbs;

801.3.7.13 – New specification on hydrant removal procedure;

801.3.7.14 – Requirement for GPS on As Builts for hydrants;

801.3.8 – PRVs to be those on WUA Approved Products List;

801.3.8.4 – Requirement to install a stainless steel plate in PRV vault that states elevation and normal downstream pressure setting;

801.3.8.5 - Elimination of Water Valve Data Cards for PRV and replaced with GPS on As Builts;

801.3.9 – Taps greater than 2/3 line size is no longer allowed; Only long body fully gasketed tapping sleeves shall be allowed.

801.4 – Water Valve Data Card section is eliminated. The section is replaced with the NEW Corrosion Monitoring Station specifications.

801.5 – Elimination of all hydrant data cards;

801.8.1 – Addition of 95% compaction requirement to spec;

801.9.1 – Specified the minimum depths of cover for water lines at finished grade;

801.9.5 – Changes allow deflection at joints for PVC pipe as allowed by manufacturer;

801.9.11 – NEW spec on temporary water mains (shoo-fly);

801.10.3 – Minor changes to include C905 and C605 references and compaction to 95%;

801.12.2 – Valves in runs shall now be mechanically restrained;

801.14.4 – Entire section deleted;

801.15 – Entire section deleted;

801.20.1.3 – Add EMD to valve box rehab work;

801.21.1.3 – Elimination of hydrant and valve data cards;

801.22.3 – Elimination of all reference to reusing or relaying pipe;

801.22.5 - Elimination of all reference to reusing or relaying pipe;

801.22.11.1 – Valve box adjustment will include collar, ring, cover, polymer coated cmp, and EMD;

801.22.15 – Include EMD in ARV items;

801.22.16 – Include EMD, ring and cover to valve box rehab;

801.22.20 – NEW spec on payment for corrosion monitoring station adjustments to finished grade;

Technical Specifications, Section 802 – Water Service Lines:

802.3.5.2.1 – Delete section and replace with a reference to the Standard Detail Drawings;

802.3.5.2.2 – Change reference to ASTM A536 (DI Castings);

802.3.5.2.3 – Replace “CITY WATER METER” with “WATER AUTHORITY”;

802.3.5.3.5.7 - Replace “CITY WATER METER” with “WATER AUTHORITY”;

802.3.6 – Add the reference to the WUA Approved Product List rather than specifying details of the corporation stop;

802.3.7 – Added a clarification note that the tailpiece is privately owned infrastructure;

802.3.9.1 – Revised to require a USC approved reduced pressure principal backflow prevention assembly;

802.3.9.2 – Non-potable customers must have a USC RPPBPA;

802.3.9.3 – Fire line services must have a USC RPPBPA;

802.3.9.3.4 – Double check valve may be used on services for specific fire protection systems;

802.7 – NEW specification on service line removal;

802.8.4 – NEW payment specification for service line removal;

STANDARD DETAILS

2109 – NEW DI sas manhole frame and covers;

2110 – NEW storm manhole frame and covers;

2460 – Revised MH and Valve regarding: changes to show EMDs; Pavement not on top of collar;

2461 – Collar detail to show EMD;

2301 – Show old line removed rather than abandon in place; Note added regarding EMDs;

2310 – NEW DI water manhole frame and cover;

2315 – Add note requiring 95% compaction;
2320 – Add note for polyethylene liner; Add note for use of mechanical restraints;
2326 – Revised to show EMD, 12" polymer coated cmp; 4,000 psi concrete collar, and GPS; Note added regarding GPS coordinate requirement;
2328 – Revised to show water on outside ring;
2329 – NEW fire line ring & cover;
2333 – Add note for restraint on both sides of valve; Add note anchor not needed for insertion that does not cut through the pipe; Note added regarding GPS coordinate requirement;
2334 – Revised to show EMD, gooseneck with screen, pvc sleeve through manhole, and gravel;
2335 – NEW ladder detail;
2340 – EMD added to drawing; Note added regarding GPS coordinate requirement;
2344 – Revised to show hydrant connection and EMD;
2350 – Revised to show EMD; Add notes for Schedule 40 fittings; Add note to delete drain pockets when in water table;
2351 – Revised to show handwheel and operating nut profile;
2352 – Revised to show handwheel and operating nut profile;
2353 – Add several general notes (2-5,Z) regarding piping color, bollards, traffic, and drain pockets; addition of a note for EMDs;
2354 – Add several general notes (2-7) regarding piping color, traffic, bollards, vault parts, elevation plate requirement, and drain pockets;
2359 – NEW butterfly valve for direct bury installation;
2360 – NEW butterfly valve for in vault installation;
2362 – The minimum width between the back of curb and the meter box is reduced to 4";
2363 – Removal of notes 1, 2, 4, and 5 and add a note regarding the private tailpiece and construction notes U, V, and W;
2367 – Revised meter lid;
2368 – Revised to show DI meter plate;
2370 – The bypass was moved outside of vault and the meter is now on the straight run; Add general notes 4-7 regarding traffic, maximum depth of vault, bypass in parks, and drain pockets;
2371 – The bypass was moved outside of vault and the meter is now on the straight run; Add general notes 4-7;
2372 – NEW 6" PRV detail;
2373 – NEW 8" PRV detail;
2374 – NEW 10" PRV detail;
2380 – Add general notes 2-3 regarding corrosion monitoring station requirement and pipe restraint;
2381 – NEW line relocation detail;
2387 – Add general note 11 regarding pressure relief devices;
2394 – Revised to show RPBA inside structure in series with water line; Add notes 1-4 regarding taps, location, meter size, and pressure relief devices;
2395 – Add general notes 1-4 regarding taps, tees, hydrant meter use, meter permit, and approved hydrants;
2396 – NEW Corrosion Monitoring Detail – 1;
2397 – NEW Corrosion Monitoring Detail – 2;
2398 – NEW Corrosion Monitoring Detail – 3;

In addition to changes from the Albuquerque Bernalillo County Water Utility Authority, Update 8 includes incorporating Amendment #1 to Update 7 and the following changes to Standard details:

Standard Details for Traffic 2533 and 2534 series for Bus Shelter “A” and “B” were removed and index sheet 2500 updated to reflect these removals.

June 28, 2011

Corrections and Changes to Update 8 January 2011 issued April 5, 2011

Revisions

The January 2011 Update did not include the revised standard detail drawing 2360. The correct standard detail drawing has a revision date of January 2011.

Standard detail drawing 2400 has been updated and has a revision date of 04/26/04. This standard detail drawing was corrected after the release of Update 7. The revised standard detail drawing is now included.

Deletions

The Albuquerque Bernalillo County Water Utility Authority has deleted the following standard detail drawings:

- 2369 Heavyweight Meter Box
- 2391 Landscape Irrigation System
- 2392 Examples of Landscape Irrigation Systems

GENERAL EDITORIAL ITEMS RELATIVE TO TECHNICAL SPECIFICATIONS

The following items have been incorporated into the technical specifications:

- a. The even-hundred numbered Section identifies a major construction function. For example:

Section 100	Materials
Section 200	Earthwork
Section 300	Streets and Related Work
Section 400	Traffic Control
Section 500	Structures
Section 600	Open Channels, Dikes or Dams
Section 700	Trenching and Boring for Utilities
Section 800	Water Transmission Collector, Distribution and Service Lines
Section 900	Sanitary and Storm Sewer Facilities
Section 1000	Landscaping
Section 1500	Miscellaneous Items
Section 2000	Standard Detail Drawings
Section 3000	Bibliography

- b. All subsections are numbered for ease of reference. An example of the subsection numbering system is:

101 = Section number
101.1 = Major Subsection. Title is in capital lettering
with no colon.
101.1.1 = Minor Subsection. Title is in capital lettering
with colon.
101.1.1.1 = Further Subsections to the major or minor
subsections.

For all practical purposes each numbered paragraph will be considered as a subsection

- c. Each Section begins with Subsections titled "GENERAL" which briefly states the contents and/or purpose of the Section, and "REFERENCES" which lists the referenced publications in the Section. "REFERENCES" Subsection without any listing has been retained for possible future use; thereby, the numbering sequence in the Section will not be changed, if a reference is added.
- d. All charts, tables, or sketches are numbered the same as the subsection in which they are referenced or identified. Also these charts, tables, or sketches will be located on the page following the referencing subsection.
- e. All Sections of the technical specification portion contain the most current measurement and payment at the end of each Section.
- f. The Standard Detail Drawings are included as part of the overall specifications.
- g. A bibliography has been added which lists the references contained in the Section texts. The referenced material will be identified by number, title and the Section in which the reference material is used.

CITY OF ALBUQUERQUE
STANDARD SPECIFICATIONS
FOR PUBLIC WORKS CONSTRUCTION

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- 17.12 Ethics and Campaign Practices

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- 18.1 Policy on the Proximity of Water and Sewer Lines
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- 19.2 Street Closures

SECTION 1

DEFINITIONS AND TERMS

1.1 GENERAL

Whenever used in these General Conditions or in the other Contract Documents, the following terms have the meanings indicated which are applicable to both the singular and plural thereof:

1.2 ABBREVIATIONS

Wherever the following abbreviations or symbols are used, they are to be construed the same as the respective expressions represented:

AAS	American Arbitration Association
AASHTO	American Association of State Highway and Transportation Officials
ABC	Aggregate Base Course
AC	Asphalt Concrete
ACI	American Concrete Institute
ACNM	Associated Contractors of New Mexico
ACP	Asbestos Cement Pipe
ACPA	American Concrete Pipe Association
AD	Assessment District
AGC	Associated General Contractors of America, Inc.
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
AMAFCA	Albuquerque Metropolitan Arroyo Flood Control Authority
ANSI	American National Standards Institute
APWA	American Public Works Association
AREA	American Railway Engineers Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
Asph	Asphalt
ASTM	American Society for Testing and Materials
ATSSA	American Traffic Safety Services Association
AWG	American Wire Gauge (Nonferrous Wire)
AWPA	American Wood Preservers Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BC	Beginning of Curve or Back of Curb
BCR	Beginning of Curve Return or Back of Curb Radius
BM	Bench Mark
BTB	Bituminous Treated Base
BWG	Birmingham Wire Gauge (Iron and Steel Wire)
C.C. or C/C	Center to Center
Cem	Cement
CF	Curb Face
CI	Cast Iron
CIP	Cast-Iron Pipe
CIPP	Cast-in-Place Pipe
C.L. or CL	Center Line
CMP	Corrugated Metal Pipe
CMPA	Corrugated Metal Pipe Arch
CO	Clean Out
Col	Column
Conc	Concrete

Const	Construct
cy	Cubic Yard(s)
DF	Douglas Fir
DG	Decomposed Granite
DIA	Diameter
DIP	Ductile Iron Pipe
DMH	Drop Manhole
D/W	Driveway
EA	Each
EC	End of Curve
EL. or Elev.	Elevation
EMD	Electronic Marker Disk
Ex. or Exist.	Existing
F & C	Frame and Cover
f'_c	Design Compressive Strength of Portland Cement Concrete
f_{cr}	Minimum Critical Compressive Strength ($.85f'_c$)
FH	Fire Hydrant
FJ	Flanged Joint
FL	Flow Line
FL. EL	Floor Elevation
FS	Federal Specifications of Finished Surface
FHWA	Federal Highway Administration, Department of Transportation
Galv	Galvanized
GL	Ground Line
Gr	Grade
H	Height or High
HC	House Connection Sewer
hor	Horizontal
id	Inside Diameter
Inv	Invert
IP	Iron Pipe
ITE	Institute of Traffic Engineers
LB	Pound(s)
LF	Linear Feet (Foot)
Lin.	Linear
LL	Liquid Limit
Long	Longitudinal
LS	Lump Sum
M	Thousand
m	meter or middle
max	Maximum
MH	Manhole
MJ	Mechanical Joint
min	Minutes or Minimum
Mon	Monolithic or Monument
MRGCD	Middle Rio Grande Conservancy District
MTD	Multiple Tile Duct
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NGS	National Geodetic Survey
NMSA	New Mexico Statutes Annotated--1978 Compilation as Amended
NMSHD	New Mexico State Highway Department
NMSHTD	New Mexico State Highway and Transportation Department
OC	On Center

od	Outside Diameter
OSHA	Occupational Safety and Health Administration
PC	Point of Curvature
PCC.....	Point of Compound Curve or Portland Cement Concrete
PG	Performance Grade
PI.....	Point of Intersection or Plasticity Index
PL.....	Property Line or Plastic Limit
PP.....	Power Pole
ppm	Parts per Million
PRC.....	Point of Reverse Curve
Prop.....	Proposed or Property
PRV.....	Pressure Reducing Valve
psf	Pounds per Square Foot
psi.....	Pounds per Square Inch
PT.....	Point of Tangency
Pvmt.....	Pavement
PVC.....	Polyvinyl Chloride
PVCO.....	Molecular Oriented Polyvinyl Chloride
PVCP	Polyvinyl Chloride Pipe
Q	Rate of Flow
QAC	Quiet Asphalt Concrete
r.....	Radius
RC	Reinforced Concrete
RCP.....	Reinforced Concrete Pipe
Rdwy.....	Roadway
Ret. Wall.....	Retaining Wall
RGRCP	Rubber Gasket-Reinforced Concrete Pipe
R/W.....	Right-of-Way
s.....	Slope
SAE.....	Society of Automotive Engineers
San.	Sanitary
SCCP.....	Steel Cylinder Concrete Pipe
SD	Storm Drain
Sdl.....	Saddle
Sect	Section
sf	Square Feet (Foot)
Spec.....	Specifications
Sp. MH.....	Special Manhole
San. S	Sanitary Sewer
SP.....	Superpave Aggregate Gradation
ST.....	Street
Sta	Station
Std	Standard
SY	Square Yard(s)
T.....	Tangent Distance
TCS.....	Traffic Control Supervisor
TCT.....	Traffic Control Technician
TH.....	Test Hole
TMH	Trap Manhole
UL	Underwriters' Laboratories, Inc.
USA	United States of America Standards Institute, Inc.
V	Velocity
VC.....	Vertical Curve
VCP.....	Vitrified Clay Pipe
VCPI.....	Vertical Curve Point of Intersection
Vert	Vertical
VF	Vertical Feet (Foot)

VSF..... Vertical Square Feet (Foot)
WI..... Wrought Iron

1.3 AISC ABBREVIATIONS AND SYMBOLS:

All abbreviations and symbols used on plans for structural steel construction shall conform to those given in the Steel Construction Manual of the American Institute of Steel Construction.

1.4 DEFINITIONS

Addenda or Addendum - Any changes, revisions or clarifications of the Contract Documents which have been duly issued by OWNER to prospective Bidders Prior to the time of receiving Bids.

Agreement - The written Agreement between Owner and CONTRACTOR which establishes the terms of the Contract covering the Work and compensation for performance of the Work and incorporates all contract Documents. The Agreement shall be on the form designated as page AG-1 in the Contract documents. No Agreement shall be valid until signed by a person duly authorized to bind the CONTRACTOR and the Chief Administrative Officer of the City of Albuquerque.

Application for Payment - The form which is to be used in requesting progress payments and which is to include the schedule of values required by paragraph 14.1 and an affidavit of CONTRACTOR that progress payments heretofore received on account of the Work have been applied by the CONTRACTOR to discharge in full all of the CONTRACTOR'S obligations reflected in prior Applications for Payment.

Bid - The offer or proposal of the bidder submitted on the prescribed form setting forth the prices for the Work to be performed, also referred to as the Bid Proposal.

Bidder - Any person, firm, or corporation submitting a Bid for the Work.

Bid Proposal - The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed, also referred to as the Bid.

Board - The Governing Body of the OWNER or Contracting Agency.

Bonds - Bid, performance, and payment bonds and other instruments of security, furnished by CONTRACTOR and his surety in accordance with the Contract Documents.

Change Order - A written order to CONTRACTOR signed by OWNER authorizing an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Time issued after execution of the Agreement.

Drawings or Plans - The drawings which show the character and scope of the Work to be performed and which have been

CONSTRUCTION COORDINATOR - The Mayor or the Mayor's designee responsible for the issuance of Barricading Permits and the inspection of traffic control devices in construction work zones.

Contract Document - The Agreement, Addenda, Advertisement for Bids, Instructions to Bidders, Bid Proposal, Bid Bond, Performance Bond, Labor and Material Payment Bond, the Certificates of Insurance, the Notice of Award, the Notice to Proceed, the General Conditions, Supplemental General Conditions, the Special Provisions, the Technical Specifications, the Supplemental Technical Specifications, the Reference Specifications, Plans and Drawings, and all Modifications, also referred to as the contract.

Contract Price - The total monies payable to CONTRACTOR under the Contract Documents.

Contract Time - The number of days stated in the Bid Proposal for the completion of the work, computed as provided in paragraph 17.2

Contracting Agency - (See OWNER).

Contractor - The person, firm, or corporation with whom OWNER has executed the Agreement.

Day - A calendar day of twenty-four hours measured from midnight to the next midnight.

Defective - Defective means an adjective which, when modifying the word Work, refers to Work that is unsatisfactory, faulty, deficient, does not conform to the Contract Documents, or does not meet the requirements of any inspection, reference standard, test, or approval to which contract Documents refer, and specifically includes work that has been damaged prior to the ENGINEER'S recommendation of final payment and acceptance (pursuant paragraph 14.9) unless responsibility for the protection of such Work has been assumed by the OWNER at Substantial Completion (pursuant to paragraph 14.5 or 14.6). The terms Defect and Defective work shall apply to the Work, whether such Work is identified or otherwise discovered at or prior to final payment and acceptance (pursuant to paragraph 14.9) or during any correction period described in paragraph 13.7 of these General Conditions.

Debarment - Debarment of a Contractor means that the City of Albuquerque denies that Contractor the right to bid or offer to enter into a contract, other than a contract for Professional Services, with the City for a specified period of time.

prepared or approved by the ENGINEER and are referred to in the Contract Documents.

Effective Date of Agreement - The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it shall mean the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

ENGINEER - The person, either OWNER'S employee or agent or a licensed professional with whom OWNER has entered into an agreement, who is responsible for the engineering, architectural, and/or landscape architectural design or construction contract administration and inspection or both, acting directly or through duly authorized representatives.

Field Order - A written order issued by ENGINEER which clarifies or interprets the Contract Documents in accordance with paragraph 9.4 or orders minor changes in the Work in accordance with paragraph 10.2.

General Conditions - Conditions which apply to all projects and which can be modified by the Supplemental General Conditions and/or Special Provisions.

General Provisions - A term having the same meaning as the term General Conditions.

Letter of Acceptance - A letter from the City to the Contractor stating the date the work is accepted and states the start date of the correction period.

Modification - (a) A written amendment to the Contract Documents signed by both parties, (b) a Change Order, (c) a written clarification or interpretation issued by ENGINEER in accordance with paragraph 9.4, or (d) a written order for a minor change or alteration in the Work issued by ENGINEER pursuant to paragraph 10.2. A Modification may only be issued after execution of the Agreement.

NMSHTD Standard Specifications - New Mexico State Highway and Transportation Department Standard Specifications for Road and Bridge Construction, latest edition.

Notice of Award - The written Notice by the Owner to the Bidder that it has submitted the apparent low successful Bid and that, upon compliance by the Bidder with the conditions precedent to be fulfilled by the Bidder within the time specified, the OWNER shall prepare and deliver the Agreement to the Bidder in the event the OWNER elects to proceed to execute the Agreement. Issuance of the Notice of Award creates no contractual relationship between OWNER and Bidder.

Specifications, also Technical Specifications - Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction

Notice to Proceed - A written notice given by OWNER to CONTRACTOR (with a copy to ENGINEER) fixing the date on which the Contract Time will commence to run and on which CONTRACTOR shall start to perform his obligations under the Contract Documents.

OWNER - The City of Albuquerque, for whom the Work is to be performed.

Professional Services - means the services of architects, archeologists, engineers, land surveyors, landscape architects, medical arts practitioners, scientists, management, and systems analysts, certified public accountants, registered public accountants, lawyers, psychologists, planners, and researchers and persons and businesses providing similar services.

Project - The entire construction to be performed as provided in the Contract Documents.

Reference Specifications, Test Methods, and Applicable Codes - All standard specifications and test methods of any society, association, or organization herein referred to are hereby made a part of these Contract Documents the same as if written in full. (Any reference to a paragraph or subparagraph within a section shall include all general provisions of the section to which reference is made.) Reference to such standards refer to the latest published issues as of the first date of publication of the Advertisement for Bids. Reference to local or state codes and laws shall mean the latest adopted and published codes as of the date of the Advertisement for Bids.

Schedule of Values - A breakdown of the Material and Labor costs of all major components of a project or a bid item that is bid at Lump Sum unit price.

Service Connections - Service Connections shall be construed to mean all or any portion of the pipe, conduit, cable, or duct which connects a utility main or distribution line to a building, home, residence, or property, also referred to as service line connection.

Shop Drawings - All drawings, diagrams, illustrations, brochures, schedules, and other data which are prepared by CONTRACTOR, a sub-contractor, manufacturer, supplier, or distributor and which illustrate the equipment, material, or some portion of the Work.

Special Provisions - Conditions which are written for a specific project and which may modify the General Conditions.

systems, standards, and workmanship as applied to the Work.

Standard Details - Standard drawings showing City construction methods, materials, and practices, prepared by the City of Albuquerque.

Stop Work Order - A written notice given by OWNER to CONTRACTOR (with a copy to ENGINEER) directing the CONTRACTOR to stop work on the project. The contract time will also stop on that date.

Subcontractor - An individual, firm or corporation having a direct contract with the CONTRACTOR or with any other Subcontractor for the performance of a part of the Work at the Site.

Substantial Completion - the date as certified by ENGINEER when the construction of the Project or a specified part thereof is sufficiently completed, in accordance with the Contract Documents, so that the Project or specified part can be utilized for the purposes for which it was intended; or if there be no such certification, the date when final payment is due in accordance with paragraph 14.9

Supplemental General Conditions - Conditions which are written to modify the General Conditions.

Supplemental Technical Specifications - Specifications which are written to modify the Technical Specifications.

Utility - Overhead or underground wires, pipe lines, conduits, ducts, or structures, operated and maintained in or across a public right-of-way or easement or private easement.

A. Public Utility - Owned and operated by a municipality or another political subdivision of the State

B. Private Utility - Owned and operated by a private company or corporation.

Work - Any and all obligations, duties, and responsibilities necessary to the successful completion of the Project assigned to or undertaken by CONTRACTOR under the Contract Documents, including all labor, materials, equipment, and other incidentals, and the furnishing thereof.

SECTION 2
PRELIMINARY MATTERS

2.1 EXECUTION OF AGREEMENT

2.1.1 Schedule: CONTRACTOR shall deliver to OWNER no less than seven (7) multiple originals of the Agreement between OWNER and CONTRACTOR, along with those Contract Documents specified by OWNER, within ten (10) days of CONTRACTOR'S receipt of the Notice of Award. In the event the OWNER elects to execute the Agreement, it shall do so within fifteen (15) days of its receipt of the Agreement and all required Contract Documents.

2.1.2 Extension of time: In the event the CONTRACTOR, OWNER, or both request an extension of the time in requirements in Section 2.1.1, above, such extension of time shall be agreed upon by OWNER and the Contractor in writing. No such extension of time shall be valid unless the extension includes an extension of the time in which the CONTRACTOR shall not be entitled to withdraw its Bid Proposal by no less than the same number of days of the extension of the Time requirements of section 2.1.1. In the event the OWNER refuses to agree to an extension of the time requirements of Section 2.1.1 or the CONTRACTOR refuses to extend the time in which it shall not be entitled to withdraw its Bid Proposal, as required heretofore, the OWNER shall not be required to execute the Agreement and may cancel the contracting process, rescind the Notice of Award and terminate the procurement of the Work of the Project or award to the next lowest apparent successful Bidder.

2.1.3 Delivery of Agreement: OWNER, CONTRACTOR and ENGINEER shall receive an executed duplicate original of the Agreement and Contract Documents after execution of the Agreement by the Chief Administrative Officer of the City of Albuquerque.

2.2 DELIVERY OF BONDS AND CERTIFICATES OF INSURANCE

CONTRACTOR shall deliver to OWNER executed copies of the Agreement as required in Section 2.1.1 and CONTRACTOR shall deliver at the same time to OWNER the executed Performance Bonds, Labor and Material Payment Bonds, Certificates of Insurance, and any other Bonds and insurance certificates and insurance policies that may be required. Failure of the CONTRACTOR to deliver these documents correctly and fully completed and signed within the time required in Section 2.1.1 shall entitle OWNER to reject the Bid and rescind the Notice of Award. In such event, OWNER shall be entitled to cancel the procurement of the Project, rebid, or award to the apparent next lowest Bidder.

2.3 COPIES OF DOCUMENTS

For use in execution of the Work, OWNER shall furnish to CONTRACTOR not less than seven (7) copies of the Contract Documents, unless otherwise provided in the Special

Provisions. Additional copies will be furnished upon request at the cost of reproduction.

2.4 CONTRACTOR'S PRE-START REPRESENTATIONS

CONTRACTOR represents that he has familiarized himself with and assumes full responsibility for having familiarized himself with the nature and extent of the Contract Documents, Work, locality, and with all local conditions and federal, state, and local laws, ordinances, rules, and regulations that may in any manner affect performance of the Work and represents that he has correlated his study and observations with the requirements of the Contract Documents. CONTRACTOR also represents that he has studied all surveys and investigation reports of subsurface and latent physical conditions referred to in the Specifications and made such additional surveys and investigations as he deems necessary for the performance of the Work at the Contract Price in accordance with the requirements of the Contract Documents and that he has correlated the results of all such data with the requirements of the Contract Documents.

2.5 COMMENCEMENT OF CONTRACT TIME; NOTICE TO PROCEED

2.5.1 The Contract Time will commence to run on the thirtieth (30) day after the Effective Date of the Agreement, or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within thirty (30) days after the Effective Date of the Agreement, provided, however, that the Contract Time shall commence to run on the ninetieth (90) day after the day of Bid opening or the thirtieth (30th) day after the effective date of the Agreement whichever date is earlier, unless otherwise agreed upon by OWNER and CONTRACTOR. Any extensions of time agreed upon, by OWNER and CONTRACTOR pursuant to Sections 2.1.1 through 2.1.3, above, which enlarge the time for execution of the Agreement beyond ninety (90) days after the Bid opening shall automatically and without further Agreement between the OWNER and the CONTRACTOR enlarge the number of days before the Contract time shall commence to run by the same number of days as the extension of time to execute the Agreement.

2.5.2. Fully Executed Contract Required: In the event the OWNER and the CONTRACTOR do not fully execute the Agreement within the time and extensions thereof as required in Sections 2.1.1 through 2.1.3 and 2.5.1, above, the procurement of the work of the Project and contracting execution procedures shall be deemed cancelled and the Notice of Award shall be deemed rescinded.

2.5.3 Damages: The CONTRACTOR shall not be entitled to damages or increases in the Contract Price of any nature whatsoever, including but not limited to damages for such matters as extended home or other

office overhead, delay and impact claims or ripple effect, interruption of schedules, additional Contract Time, and increases in costs of material, labor, supplies, equipment, or other items necessary to perform the Work of the Project, based upon: (1) the extension of time to execute the Agreement or to commence the Contract Time; (2) the refusal of OWNER to agree to extensions of the Contract time or the time to extend execution of the Agreement; (3) the OWNER'S rescission of the Notice of Award. This section shall govern both in the event the Agreement is executed and in the event the Agreement is not executed.

2.6 STARTING THE PROJECT

CONTRACTOR shall start to perform his obligations under the Contract Documents on the date when the Contract Time commences to run. No Work shall be done at the site prior to the date on which the Contract Time commences to run.

2.7. BEFORE STARTING CONSTRUCTION

2.7.1 Before undertaking each part of the Work, CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures shown thereon and all applicable field measurements. He shall at once report in writing to ENGINEER any conflict, error or discrepancy which he may discover; however, he shall not be liable to OWNER or ENGINEER for his failure to discover any conflict, error, or discrepancy in the Drawings or Specifications.

2.7.2 Within ten (10) days after delivery of the executed Agreement by OWNER to CONTRACTOR, CONTRACTOR shall submit to ENGINEER for approval an estimated progress schedule indicating the starting and completion dates of the various stages of the Work and a preliminary schedule of Shop Drawing submissions.

2.7.3 Within twenty (20) days after delivery of the executed Agreement by OWNER to CONTRACTOR, but before starting the Work at the site, a conference will be held to review the above schedules, to establish procedures for handling Shop Drawings and other submissions, for processing Applications for Payment, and to establish a working understanding between the parties as to the Project. Present at the conference will be OWNER or his representative, ENGINEER, CONTRACTOR and his Superintendent.

SECTION 3

CORRELATION, INTERPRETATION, AND INTENT OF CONTRACT DOCUMENTS

3.1 It is the intent of the Specifications and Drawings to describe a complete Project to be constructed in accordance with the Contract Documents. The Contract Documents comprise the entire Agreement between OWNER and CONTRACTOR. They may be altered only by a Modification.

3.2 The Contract Documents are complementary; what is called for by one is as binding as if called for by all. If CONTRACTOR finds a conflict, error, or discrepancy in the Contract Documents, he shall call it to ENGINEER'S attention in writing at once and before proceeding with the Work affected thereby; however, he shall not be liable to OWNER or ENGINEER for his failure to discover any conflict, error, or discrepancy in the Specifications or Drawings. In resolving such conflicts, errors, and discrepancies, the documents shall be given precedence in the following order: Agreement, Modifications, Addenda, Special Provisions, Bid Proposal, Advertisement for Bids, Instructions to Bidders, Supplemental General Conditions, General Conditions, Supplemental Technical Specifications, Specifications, Drawings and Standard Drawings. Dimensions given on plans or which can be calculated will govern over scaled dimensions. Construction detail drawings shall govern over scaled dimensions and over other drawings. Any Work that may reasonably be inferred from the Specifications or Drawings as being required to produce the intended result shall be supplied whether or not it is specifically called for. Work, materials, or equipment described in words which so applied have a wellknown technical or trade meaning shall be deemed to refer to such recognized standards.

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SECTION 4

AVAILABILITY OF LANDS; PHYSICAL CONDITIONS; REFERENCE POINTS

4.1 AVAILABILITY OF LANDS

OWNER shall furnish, as indicated in the Contract Documents and not later than the date when needed by CONTRACTOR, the lands upon which the Work is to be done, right-of-way for access thereto, and such other lands which are designated for the use of CONTRACTOR. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by OWNER, unless otherwise specified in the Contract Documents. If CONTRACTOR believes that any delay in OWNER's furnishing these lands or easements entitles him to an extension of the Contract Time, he may make a claim therefor as provided in Section 12. CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.2 PHYSICAL CONDITIONS--SURVEY AND REPORTS

4.2.1 The OWNER will, upon request, furnish to the CONTRACTOR copies of all boundary surveys, subsurface tests, and other pertinent reports and material which are available in OWNER's office.

4.2.2 GEOTECHNICAL INVESTIGATIONS:

In the event that geotechnical investigations concerning subsurface conditions have been conducted and the results of such investigations have been included in these Contract Documents, they are solely for the information of OWNER; their accuracy and correctness are not guaranteed by OWNER; and in no event is such information to be considered to be a part of the Contract Documents. If this information is used by the Bidder in preparing his Bid Proposal, the Bidder hereby assumes all risks resulting from conditions differing from the information shown. The Bidder, in consideration of the opportunity to review the information, hereby releases OWNER from any responsibility or obligation as to the accuracy or completeness of such information or for any additional compensation for Work performed due to assumptions based on the use of such information. For the purposes of this paragraph, the term "geotechnical investigations" includes, but is not limited to, borings, soundings, test piles and test pits.

4.3 UNFORESEEN PHYSICAL CONDITIONS

CONTRACTOR shall promptly notify OWNER and ENGINEER in writing of any subsurface or latent physical conditions at the site differing materially from those indicated

in the Contract Documents. ENGINEER promptly investigate those conditions and advise OWNER in writing if further surveys or subsurface tests are necessary. Promptly thereafter OWNER shall obtain the necessary additional surveys and tests and furnish copies to ENGINEER and CONTRACTOR. If ENGINEER finds that the results of such surveys or tests indicate that there are subsurface or latent physical conditions which differ materially from those intended in the Contract Documents and which could not reasonably have been anticipated by CONTRACTOR, a Change Order shall be issued incorporating the necessary revisions.

4.4 SURVEYING

4.4.1 PERMANENT SURVEY MONUMENTS:

All permanent survey monuments will be shown on the construction plans. CONTRACTOR shall notify ENGINEER not less than seven (7) days prior to starting work in order that ENGINEER may take necessary measures to ensure the preservation of survey monuments. CONTRACTOR shall not disturb permanent survey monuments without the consent of ENGINEER and shall notify ENGINEER and bear the expense of replacing any that may be disturbed without permission. Replacement shall be done only by ENGINEER. When a change is made in the finished elevation of the pavement of any roadway in which a permanent survey monument is located, CONTRACTOR shall, at his own expense, adjust the monument cover to the new grade unless otherwise specified.

4.4.2 SURVEY STAKES:

4.4.2.1 CONTRACTOR shall carefully preserve temporary bench marks, reference points and property corners and, in case of destruction, he shall bear the expense of replacement and shall be responsible for any mistakes that may be caused by their loss or disturbance.

4.4.2.2 Construction survey stakes and marks will be set sufficiently in advance of the work so as to not interfere with CONTRACTOR's construction progress and will be offset from the construction area. They will show the offset distance, location, and required cut or fill to the grade as indicated on the grade sheet, a copy of which will be furnished to CONTRACTOR.

4.4.2.3 CONTRACTOR shall construct the Work in accordance with the construction survey stakes and marks, making use of them before they are disturbed, and shall be responsible for the conformity and agreement of the Work with the construction plans.

4.4.2.4 Any discrepancies in design or base lines and grades revealed in construction operations shall be brought to ENGINEER's attention immediately for correction or clarification. If CONTRACTOR elects to proceed with construction before such corrections or clarifications are made, he shall do so at his own risk and expense.

4.4.2.5 CONTRACTOR shall be responsible for the preservation of construction survey stakes and marks until inspected by ENGINEER or for the duration of their usefulness during construction and collecting "As-Built" information. If any construction survey stakes or marks are lost or disturbed, and in the opinion of ENGINEER need to be replaced, such replacement shall be by ENGINEER at the expense of CONTRACTOR. The cost of replacing them shall be charged against, and shall be deducted from, the payment to CONTRACTOR for the Work.

4.4.3 SURVEY SERVICES:

Unless otherwise provided in the Special Provisions, OWNER will furnish and set construction stakes establishing lines and grades for curbs and gutters, structures and water and sewer lines, and will furnish CONTRACTOR all the necessary information relative to the lines and grades. CONTRACTOR shall give notice to ENGINEER not less than two (2) working days in advance of when he will require survey services in connection with the laying out of any portion of the Work.

SECTION 5

BONDS AND INSURANCE

5.1 BID, PERFORMANCE, PAYMENT, AND OTHER BONDS

5.1.1 All Bidders shall furnish with their Bid Proposals a bid bond in the amount of five percent (5%) of the total amount of the bid, in such form and with such sureties as are licensed to conduct business in the State of New Mexico and are named in the current list of "Surety Companies Acceptable on Federal Bonds" as published in the Federal Register by the Audit Staff Bureau of Accounts, U. S. Treasury Department.

5.1.2 CONTRACTOR shall furnish Performance and Payment Bonds as security for the faithful performance and payment of all his obligations under the Contract Documents. These Bonds shall be in amounts at least equal to the Contract Price and (except as otherwise provided in the Contract Documents) in such form and with such sureties as are licensed to conduct business in the State of New Mexico and are named in the current list of "Surety Companies Acceptable on Federal Bonds" as published in the Federal Register by the Audit Staff Bureau of Accounts, U.S. Treasury Department. The Performance Bond shall also include coverage for the Guarantee Period (see paragraph 13.7). The Surety on the Performance Bond shall furnish a waiver whereby he consents to the progress or partial payment to CONTRACTOR of amounts for materials under the provisions of paragraph 14.2 of these General Conditions, and acknowledges, in accordance with paragraphs 14.6 and 14.10 that such payment, whether or not in strict compliance with these provisions shall not preclude or stop OWNER from showing the true character and quantity of the materials furnished or from recovering from CONTRACTOR or his sureties such damages as OWNER may sustain by reason of deficiency in quantity of the materials with respect to which a progress payment was made.

5.1.3 If the surety on any Bond furnished by CONTRACTOR is declared bankrupt or becomes insolvent or its right to do business in the State of New Mexico is located is revoked, CONTRACTOR shall within five (5) days thereafter substitute another Bond and surety, both of which shall be acceptable to OWNER.

5.2 INSURANCE

5.2.1 GENERAL CONDITIONS:

CONTRACTOR shall procure and maintain in full force and effect during the life of this Contract, such insurance as is required herein. Policies of insurance shall be written by companies authorized to write such insurance in New Mexico, and they shall be in a form satisfactory to OWNER and properly filed and approved by the Superintendent of Insurance, State of

New Mexico. The pro-rata cost of required insurance shall be included in the prices bid for the Work and no additional compensation will be made therefor. CONTRACTOR shall furnish OWNER a minimum of seven (7) copies of certificates of required insurances (or copies of insurance policies if OWNER calls for them). All certificates of insurance (or policies) shall provide that thirty (30) days' written notice be given to the Director, Risk Management Department, City of Albuquerque, Box 470, Albuquerque, New Mexico 87103, before a policy is cancelled, materially changed or not renewed. Various types of required insurance may be written in one or more policies. The certificates of insurance and endorsements for each policy shall be signed by a person authorized by that insurer to bind coverage on its behalf. The OWNER reserves the right to require complete, certified copies of all required insurance policies at any time.

If part of the Contract is sublet, CONTRACTOR shall:

5.2.1.1 Include any and all subcontractors in his insurance policies; or

5.2.1.2 Require the Subcontractor to secure insurance to protect himself against all hazards enumerated herein which are not covered by CONTRACTOR's policies.

5.2.2 APPROVAL OF INSURANCE:

Even though a "Notice to Proceed" may have been given, no contractor or subcontractor shall begin any work under this Contract until the required insurance has been obtained and the proper certificates (or policies) filed with OWNER. Neither approval nor failure to disapprove certificates, policies or the insurance by OWNER shall relieve CONTRACTOR or any subcontractor of full responsibility to maintain the required insurance in full force and effect.

5.2.3 COMMERCIAL GENERAL LIABILITY INSURANCE INCLUDING AUTOMOBILE:

5.2.3.1 CONTRACTOR shall procure and maintain during the life of this Contract a comprehensive commercial general liability and automobile insurance policy with liability limits in amounts not less than \$1,000,000 combined single limit of liability for bodily injury, including death, and property damage in any one occurrence. Said policies of insurance must include coverage for all operations performed for OWNER by CONTRACTOR, including coverage for collapse (C),

explosion (X), and underground (U) liability coverage, coverage for the user of all owned, nonowned, hired automobiles, vehicles, and other equipment both on and off work, and contractual liability coverage which shall specifically insure the indemnification provisions of this Contract.

5.2.3.2 The above requirements shall include, but shall not be limited to, protection against:

5.2.3.2.1 Damage to, or destruction of, public and private property including telephone conduit, telegraph conduit, power conduit, telephone signal cables, fiber optics cables, television cables, computer cables, fire alarm circuits, gas mains, gas service connections, sanitary sewers, sewer, house or building connections, water mains, water service connections, steam lines, petroleum products pipe lines, storm drains, storm inlet lines, including all appurtenances thereto while located below the surface of the ground, including injury or death, to person or persons caused by CONTRACTOR's operations, including blasting and trenching-backfilling-tamping with or without the use of mechanical equipment; and

5.2.3.2.2 The collapse of, or structural damage to, a building, house or structure, including power-telephone-telegraph-fire alarm-street-light poles, curb and gutter and sidewalk, on public or private property, and destruction of, or damage to, other public and private property resulting therefrom, including injury or death to person or persons and all caused by CONTRACTOR's operations in the removal of other buildings, structures, including their supports, trees and utility poles, or by excavation, including blasting, and trenching-backfilling-tamping with or without use of mechanical equipment. "Other public and private property" as used above shall include lawns, plants, flowers, trees, fences, yards, walls, etc.

5.2.4 OWNER'S PROTECTIVE PUBLIC LIABILITY INSURANCE:

5.2.4.1 CONTRACTOR shall procure and maintain during the life of this Contract, an OWNER's protective public liability insurance policy with liability limits in amounts not less than \$1,000,000 combined single limit of liability for bodily injury, including death, and property damage in any one occurrence.

5.2.4.2 The policy will be written with OWNER and ENGINEER as the named insured and will provide coverage for OWNER's and ENGINEER's officers and employees while acting within the scope of their duties against all claims arising out of or in connection with the work to be performed.

5.2.5 WORKMEN'S COMPENSATION INSURANCE: CONTRACTOR shall comply with the provisions of Workmen's Compensation Act, the Subsequent Injury Act, and the New Mexico Occupational Disease Disablement Law.

CONTRACTOR shall procure and maintain during the life of this Contract, complete Workmen's and Employer's Liability Insurance in accordance with New Mexico law and regulations. Such insurance shall include coverage permitted under Section 52-1-10 NMSA 1978, for safety devices. With respect to Workmen's Compensation Insurance, if CONTRACTOR elects to be self-insured, he shall comply with the applicable requirements of law. If any portion of the Work is to be sublet, CONTRACTOR shall require the Subcontractor similarly to provide such coverage (or qualify as a self insured) for all latter's employees to be engaged in such Work. CONTRACTOR shall save harmless OWNER and ENGINEER, its officers, agents and employees from any claims or actions occasioned by failure of CONTRACTOR to comply with the provisions of this subparagraph. It is agreed that with respect to all Workmen's Compensation Insurance, the CONTRACTOR and its insurer shall waive any right of subrogation it may acquire against the OWNER, ENGINEER, and their officers, agents and employees by reason of any payment made on account of injury, including death resulting therefrom, sustained by any employee of the insured, arising out of the performance of the contract.

5.2.6 ADDITIONAL INSURANCE

5.2.6.1 Builders Risk Insurance: The Contractor shall procure and maintain during the life of the Contract "Builders Risk," installation floater, boiler and machinery and/or property insurance or insurance of an equivalent nature, in an amount equal to the full price of this Contract to cover the Work of the Contract for fire, theft, extended coverage, vandalism, and malicious mischief. Such coverage shall continue until the Work or any part of the work is accepted by the Owner. In the event of partial completion of the Work, the coverage may be reduced proportionally to the value of such work. The amount of insurance procured for the work of this contract in the subsequent Section 5.2.6.2, "Property Insurance" may be deducted from the amount of insurance required under this Section only to the extent that the combined coverage equals the full amount of the Contract Price as shown on the Agreement, Page AG-1 of the contract Documents. The Owner shall be provided a certificate of insurance, (or copies of insurance policies if OWNER calls for them) for all coverage required under this Section and the subsequent Section 5.2.6.2. When applicable, the policy shall provide coverage for the storage and the transport of materials, equipment and supplies of any kind whatsoever to be used on or incidental to the Agreement. The City shall be named as a loss payee with a loss payable clause stating that "loss, if any, shall be payable to the City of Albuquerque as its interest may appear."

5.2.6.2 Property Insurance: If the Contract includes bridge, culvert or channel lining work, either new construction or repair work, CONTRACTOR shall procure and maintain during the life of such work until the work is accepted by OWNER, property insurance upon the entire channel work to the full insurable value thereof. Such insurance shall include the interest of OWNER, CONTRACTOR, and SUBCONTRACTORS and shall be on the "all risk" basis, specifically including the perils of fire, extended coverage, theft, vandalism, malicious mischief, flood and earthquake. The deductible for the flood and earthquake coverage shall not be greater than twenty percent (20%) of the insurable value of the work, except that it shall not be less than Twenty-Five Thousand Dollars (\$25,000.00).

5.2.7 INCREASED LIMITS: If, during the life of this Contract, the legislature of the State of New Mexico increases the maximum limits of liability under the Tort Claims Act (Sections 41-4-1 through 41-4-27 NMSA 1978), OWNER may require CONTRACTOR to increase the maximum limits of any insurance required herein. In the event that CONTRACTOR is so required to increase the limits of such insurance, an appropriate adjustment in the Contract Amount will be made.

5.2.8 CONTRACTOR'S insurer shall have an "A" policyholder's rating and a financial rating of at least Class XI in accordance with the most current Best's rating, unless specifically waived in writing by the Director of Risk Management, City of Albuquerque.

5.3 ADDITIONAL BONDS AND INSURANCE

Prior to delivery of the executed Agreement by OWNER to CONTRACTOR, OWNER may require CONTRACTOR to furnish such other Bonds and such additional insurance, in such form and with such sureties or insurers, as OWNER may require. If such other Bonds or such other insurance are specified by written instructions given prior to opening of Bids, the premiums shall be paid by CONTRACTOR; if subsequent thereto, they shall be paid by OWNER (except as otherwise provided in paragraph 6.3).

SECTION 6

CONTRACTOR'S RESPONSIBILITIES

6.1 SUPERVISION AND SUPERINTENDENCE

6.1.1 CONTRACTOR shall supervise and direct the Work completely and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform work in accordance with the Contract Documents. He shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction; but he shall not be solely responsible for the negligence of others in the design or selection of a specific means, method, technique, sequence, or procedure of construction which is indicated in and required by the Contract Documents. CONTRACTOR shall be responsible to see that the finished Work complies accurately with the Contract Documents.

6.1.2 CONTRACTOR shall keep on the Work at all times during its progress a competent resident superintendent, that has a minimum of three (3) year's experience on the same or similar type of projects, who shall not be replaced without written notice to OWNER and ENGINEER (Written Notice Only, NOT Consent) except under extraordinary circumstances. The superintendent will be CONTRACTOR's representative at the site and shall have authority to act on behalf of CONTRACTOR. All communications given to the superintendent shall be as binding as if given to CONTRACTOR.

6.2 LABOR, MATERIALS AND EQUIPMENT

6.2.1 CONTRACTOR shall provide competent suitably qualified personnel to perform the construction as required by the Contract Documents. He shall at all times maintain good discipline and order at the site.

6.2.2 CONTRACTOR shall furnish and include in his Contract Price the costs of all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water and sanitary facilities, and all other facilities and incidentals necessary for the execution, testing, initial operation, and completion of the Work.

6.2.2.1 CONTRACTOR shall provide, at CONTRACTOR's expense, ample and approved supplies of water of proper quality at convenient points for all operations to be carried on under this Contract. CONTRACTOR may withdraw water from fire hydrants for this Contract in accordance with the most recent "Public Use of Fire Hydrants Ordinance", and "Water and Sewer Rates Ordinance."

6.2.3 All materials and equipment shall be

new, except as otherwise provided in the Contract Documents. If required by ENGINEER, CONTRACTOR shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

6.2.4 All materials and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned in accordance with the instructions of the applicable manufacturer, fabricator, or processors, except as otherwise provided in the Contract Documents.

6.3 SUBSTITUTE MATERIALS OR EQUIPMENT

If the Specifications, laws, ordinances, or applicable rules or regulations permit CONTRACTOR to furnish or use a substitute that is equal to any material or equipment specified, and if CONTRACTOR wishes to furnish or use a proposed substitute, he shall make written application to ENGINEER for approval of such a substitute certifying in writing that the proposed substitute will perform adequately the functions called for by the general design, be similar and of equal substance to that specified, and be suited to the same use and capable of performing the same function as that specified; stating whether or not its incorporation in or use in connection with the Project is subject to the payment of any license fee or royalty; and identifying all variations of the proposed substitute from that specified and indicating available maintenance service. In the written application for substitution the CONTRACTOR shall accept all cost of any redesign of any part of the project required to accommodate the substituted item. No substitute shall be ordered or installed without the written approval of ENGINEER, who will be the judge of equality and may require CONTRACTOR to furnish such other data about the proposed substitute as he considers pertinent. No substitute shall be ordered or installed without such performance guarantee and bonds as OWNER may require which shall be furnished at CONTRACTOR's expense. CONTRACTOR shall not be entitled to extra costs, Contract Time, or home office overhead for the time taken by Engineer to evaluate, approve or deny an application for substitution or redesign any part of the Project required to accommodate the substituted item.

6.4 CONCERNING SUBCONTRACTORS

6.4.1 CONTRACTOR shall not employ any Subcontractor or other person or organization (including those who are to furnish the principal items of materials or equipment), whether initially or as a substitute, against whom OWNER may have

reasonable objection or who has been debarred by the owner. A Subcontractor or other person or organization identified on the SFPA-1 form in the CONTRACTOR'S bid, or in writing to OWNER by CONTRACTOR prior to the Notice of Award and not objected to in writing by OWNER prior to the Notice of Award will be deemed acceptable to OWNER. Acceptance of any Subcontractor, other person, or organization by OWNER shall not constitute a waiver of any right of OWNER to reject defective work or work not in conformance with the Contract Documents.

6.4.2 If OWNER, after due investigation, has reasonable objection to any Subcontractor, other person, or organization proposed by CONTRACTOR after the Notice of Award, CONTRACTOR shall submit an acceptable substitute and the Contract Price shall not be increased but may be decreased by the difference in cost occasioned by such substitution and an appropriate Change Order shall be issued. CONTRACTOR shall not be required to employ any Subcontractor, other person, or organization against whom he has reasonable objection. CONTRACTOR shall not, without the consent of OWNER, make any substitution for any Subcontractor, other person, or organization who has been accepted by OWNER.

6.4.3 If a CONTRACTOR desires to substitute a subcontractor that has been shown on the SFPA-1 form of his bid, the CONTRACTOR must follow the procedures in the SUBCONTRACTORS FAIR PRACTICE ACT if applicable. The CONTRACTOR is not entitled to a delay in the Commencement of the Contract Time or an increase in the Contract Price due to SFPA procedures being implemented, either before or after issuance of the Notice of Award.

6.4.4 CONTRACTOR shall be fully responsible for all acts and omissions of his Subcontractors and of persons and organizations directly or indirectly employed by them and of persons and organizations for whose acts any of them may be liable to the same extent that he is responsible for the acts and omissions of persons directly employed by him. Nothing in the Contract Documents shall create any contractual relationship between OWNER or ENGINEER and any Subcontractor or other person or organization having a direct contract with CONTRACTOR, nor shall it create any obligation on the part of OWNER or ENGINEER to pay or to see to the payment of any monies due any Subcontractor or other person or organization, except as may otherwise be required by law. OWNER or ENGINEER may furnish to any Subcontractor or other person or organization, to the extent practicable, evidence of amounts paid to CONTRACTOR on account of specific Work done in accordance with the schedule of values and/or bid proposal.

6.4.5 The sections of the Specifications and the identifications of any Drawings shall not control CONTRACTOR in dividing the Work among Subcontractors or delineating the Work to be performed by any specific trade.

6.4.6 CONTRACTOR agrees to bind specifically every Subcontractor to the applicable terms and conditions of the Contract Documents for the benefit of OWNER.

6.5 PATENT FEES AND ROYALTIES

CONTRACTOR shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of OWNER or ENGINEER, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by OWNER in the Contract Documents. CONTRACTOR shall indemnify and hold harmless OWNER and ENGINEER and anyone directly or indirectly employed by either of them from and against all claims, damages, losses, and expenses, including attorneys' fees, arising out of any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents and shall defend all such claims in connection with any alleged infringement of such rights.

6.6 PERMITS

CONTRACTOR shall obtain and pay for all construction permits and licenses and shall pay all governmental charges and inspection fees necessary for the prosecution of the Work, which are applicable at the time of his Bid. OWNER shall assist CONTRACTOR, when necessary, in obtaining such permits and licenses. CONTRACTOR shall also pay all public utility charges.

6.7 LAWS AND REGULATIONS

CONTRACTOR shall give all notices and comply with all laws, ordinances, rules, and regulations applicable to the Work, including but not limited to the Americans With Disabilities Act of 1990 (Public Law 101-336, 104 Stat. 327, 42 U.S.C. Section 12101, et seq.). If CONTRACTOR observes that the Specifications or Drawings are at variance therewith, he shall give ENGINEER

prompt written notice thereof; and any necessary changes shall be adjusted by an appropriate Modification. If CONTRACTOR performs any work knowing it to be contrary to such laws, ordinances, rules, and regulations and without such notice to ENGINEER, he shall bear all costs arising therefrom; however, it shall not be his primary responsibility to make certain that the Specifications and Drawings are in accordance with such laws, ordinances, rules, and regulations.

6.8 TAXES

CONTRACTOR shall pay all gross receipts, sales, consumer, use and other similar taxes and assessments and levies required to be paid by him in accordance with the law of the place where the Work is to be performed.

6.9 USE OF PREMISES

6.9.1 CONTRACTOR shall confine his equipment, the storage of materials and equipment, and the operations of his workmen to areas permitted by law, ordinances, permits, or the requirements of the Contract Documents and shall not unreasonably encumber the premises with materials or equipment.

6.9.2 CONTRACTOR shall not load nor permit any part of any structure to be loaded with weights that will endanger the structure, nor shall he subject any part of the Work to stresses or pressures that will endanger it.

6.10 RECORD DRAWINGS

CONTRACTOR shall keep one record copy of all Specifications, Drawings, Addenda, Modifications, and Shop Drawings at the site in good order and annotated to show all changes made during the construction process. These shall be available to ENGINEER and shall be delivered to him for OWNER upon completion of the Project.

6.11 SAFETY AND PROTECTION

6.11.1 CONTRACTOR shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. He shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:

6.11.1.1 All employees on the Work and other persons who may be affected thereby;

6.11.1.2 All the Work and materials or equipment to be incorporated therein,

whether in storage on or off the site; and

6.11.1.3 Other property at the site or adjacent thereto, including but not limited to trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

6.11.2 CONTRACTOR shall conduct his operations in a manner which will minimize interference with the normal use of property adjacent to the construction work and shall give owners of such property at least twenty-four (24) hours notice of the commencement of work in the area abutting their property. CONTRACTOR shall comply with all applicable laws, ordinances, rules, regulations, and orders of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury, or loss. He shall erect and maintain, as required by the conditions and progress of the Work, all necessary safeguards for safety and protection of the property adjacent to the construction work. He shall notify owners of adjacent utilities at least 48 hours in advance when prosecution of the Work may affect them. All damage, injury, or loss to any property referred to in subparagraph 6.11.1.2 or 6.11.1.3 caused, directly or indirectly, in whole or in part, by CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, shall be remedied by CONTRACTOR, except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of OWNER OR ENGINEER or anyone employed by either of them or anyone for whose acts either of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of CONTRACTOR. CONTRACTOR's duties and responsibilities for the safety and protection of the Work shall continue until such time as the Work is completed and ENGINEER has issued a notice to OWNER and CONTRACTOR in accordance with paragraph 14.9 that the Work is acceptable.

6.11.2.1 CONTRACTOR shall assume full responsibility for any damage (1) to the property and improvements thereon at the project site and (2) to other property and improvements thereon used or damaged by the CONTRACTOR in the performance of the Work including damages sustained by the owner or occupant of such land or areas contiguous thereto. Should any claim be made against OWNER by such other property owners or occupants because of the performance of the Work, CONTRACTOR shall promptly attempt to settle with such other party by agreement or otherwise resolve the claim by

arbitration or at law. CONTRACTOR shall, to the fullest extent permitted by Laws and Regulations, defend, indemnify and hold OWNER harmless from and against all claims, damages, losses and expenses (including, but not limited to, fees of engineers, architects, attorneys and other professionals and court and arbitration costs) arising directly, indirectly or consequentially out of any action, legal or equitable, brought by any such other party against OWNER to the extent based on a claim arising out of CONTRACTOR'S performance of the Work. This subsection shall also apply to claims asserted against OWNER based on CONTRACTOR'S alleged trespass on public or private property. This indemnification requirement shall be subject to the provisions of Section 6.15.3, which is incorporated herein as though set forth in full.

6.11.3 CONTRACTOR shall not trespass upon public or private property without proper authority to do so and shall at all times take proper precautions to protect public and private property from damage. Means of ingress and egress shall be provided for all persons living or working on streets in which work is being done. All sidewalks, public walkways and drainage gutters/drainage ways shall be open, and fire hydrants and water system valves shall be left accessible for use at all times.

6.11.4 CONTRACTOR shall designate a responsible member of his organization at the site whose duty shall be the prevention of accidents. This person shall be the CONTRACTOR's superintendent, unless otherwise designated in writing by CONTRACTOR to ENGINEER and OWNER.

6.11.5 WEATHER CONDITIONS

In the event of temporary suspension of the Work or during inclement weather, or whenever ENGINEER shall direct, CONTRACTOR shall, and shall cause his Subcontractors to protect carefully all of the Work and the materials and equipment to be incorporated therein, whether in storage on or off the site, against damage, injury or loss from the weather. If, in the opinion of ENGINEER, any of the Work or materials or equipment to be incorporated therein shall have been damaged or injured or OWNER has suffered any loss by reason of failure on the part of CONTRACTOR or any of his subcontractors so to protect the Work and materials and equipment to be incorporated therein, all such damage, injury or loss shall be promptly remedied at the expense of CONTRACTOR. Until the Project is accepted by OWNER, CONTRACTOR shall be responsible for protecting completed work, work in progress, equipment, materials and property from storm water, wind, erosion, sediment, and related elements. All damage, injury or loss resulting from storm water, wind, erosion, sediment, or related elements shall be promptly corrected at CONTRACTOR'S expense.

6.12 EMERGENCIES

In emergencies affecting the safety of persons or the Work or property at the site or adjacent thereto, CONTRACTOR, without special instruction or authorization from ENGINEER or OWNER, is obligated to act, at his discretion, to prevent threatened damage, injury, or loss. He shall give ENGINEER prompt written notice of any significant changes in the Work or deviations from the Contract Documents caused thereby; and a Change Order may thereupon be issued covering the changes and deviations involved. If CONTRACTOR believes that additional work done by him in an emergency which arose from causes beyond his control entitles him to an increase in the Contract Price or an extension of the Contract Time, he may make a claim therefor as provided in Sections 11 and 12.

6.13 SHOP DRAWINGS AND SAMPLES

6.13.1 After checking and verifying all field measurements, CONTRACTOR shall submit to ENGINEER for review and approval those submittals shown in Section 1502 of the Supplemental Technical Specifications, in accordance with accepted schedule of Shop Drawing submissions nine (9) copies (or, at ENGINEER's option, one reproducible copy) of all Shop Drawings, including the Contractor's proposed trenching systems (if required), which shall have been checked by and stamped with the approval of CONTRACTOR and identified as ENGINEER may require. The purpose of the Shop Drawings is to demonstrate to ENGINEER that CONTRACTOR understands the design concept by indicating which equipment and materials he intends to furnish and install, and by detailing the fabrication and installation scheme he intends to use. All such data submitted shall include type, size, number required, dimensions, specified performance and design criteria, materials and similar data as required by the Contract Documents.

6.13.2 All data shall be submitted to the ENGINEER within thirty (30) days after receipt of the Notice to Proceed in strict accordance with the following procedures:

6.13.2.1 Data shall be provided in not more than four (4) separate submittals. Submittals should be made in groups of items which are related to facilitate cross-checking and coordination. Each submittal shall be in nine (9) copies.

6.13.2.2 Each submittal shall be accompanied by a letter giving CONTRACTOR's name, the Project name and an itemized list of the submitted data.

6.13.3 Should the above procedure not be followed, CONTRACTOR may not make any claim for loss of time or money as a result of delay in receiving approved submittal data. Material fabricated or delivered to

the site before ENGINEER's approval of Shop Drawings has been received by CONTRACTOR shall be subject to rejection by ENGINEER.

6.13.4 CONTRACTOR shall also submit to ENGINEER for review and approval, with such promptness as to cause no delay in Work, all samples required by the Contract Documents. All samples will have been checked by and stamped with the approval of CONTRACTOR, identified clearly as to material, manufacturer, pertinent catalog numbers and the use for which intended.

6.13.5 At the time of each submission, CONTRACTOR shall in writing call ENGINEER's attention to any deviations that the Shop Drawings or sample may have from the requirements of the Contract Documents.

6.13.6 ENGINEER will review and approve with reasonable promptness Shop Drawings and samples, but his review and approval shall be only for conformance with the design concept of the Project and for compliance with the information given in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents) nor to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions. CONTRACTOR shall make any corrections required by ENGINEER and shall return the required number of corrected copies of Shop Drawings and resubmit new samples until approved. CONTRACTOR shall direct specific attention in writing or on resubmitted Shop Drawings to revisions other than the corrections called for by ENGINEER on previous submissions. CONTRACTOR's stamp of approval on any Shop Drawing or sample shall constitute a representation to OWNER and ENGINEER that CONTRACTOR has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or he assumes full responsibility for doing so and that he has reviewed or coordinated each Shop Drawing or sample with the requirements of the Work and the Contract Documents, and/or agrees to pay all cost of re-designing or modifying other items to accommodate the item(s) submitted.

6.13.7 Where a Shop Drawing or sample submission is required by the Specifications, no related Work shall be commenced until the submission has been approved by ENGINEER. A copy of each approved Shop Drawing and each approved sample shall be kept in good order by CONTRACTOR at the site and shall be available to ENGINEER.

6.13.8 ENGINEER's review and approval of Shop Drawings or samples shall not relieve

CONTRACTOR from his responsibility for any deviations from the requirements of the Contract Documents unless CONTRACTOR has in writing called ENGINEER's attention to such deviation at the time of submission and ENGINEER has given written approval to the specific deviation, nor shall any approval by ENGINEER relieve CONTRACTOR from responsibility for errors or omissions in the Shop Drawings. If deviations, discrepancies or conflicts between Shop Drawings and Specifications are discovered either prior to or after Shop Drawing submittals are processed by ENGINEER, the Contract Drawings and Specifications shall govern the Work.

6.14 CLEANING

CONTRACTOR shall keep the premises free from accumulations of waste materials, rubbish, and other debris resulting from the Work; and at the completion of the Work, he shall remove all waste materials, rubbish, and debris from and about the premises, as well as all tools, construction equipment and machinery, and surplus materials and shall leave the site clean and ready for occupancy by OWNER. CONTRACTOR shall restore to their original condition those portions of the site not designated for alteration by the Contract Documents, unless the completion of the work is directly affected by the item in dispute.

6.15 INDEMNIFICATION

6.15.1 CONTRACTOR agrees to defend, indemnify and save harmless OWNER and ENGINEER and their officers, agents, and employees from and against all suits, actions or claims of any character brought because of any injury or damage received or sustained by any person, persons or property arising out of the performance of the Work by CONTRACTOR, or by reason of any act or omission, neglect or misconduct of CONTRACTOR, his agents or employees or any Subcontractor, his agents or employees. This indemnity provision shall equally apply to injuries to CONTRACTOR'S employees. This indemnification provision is subject to the limitations and provisions of Section 56-7-1 NMSA 1978. Claims shall include claims based on contracts of indemnity between the OWNER and a third party that cover liability of the third party for injury or damage received or sustained by any person, persons or property arising out of the performance of the Work by CONTRACTOR, or by reason of any act or omission, neglect or misconduct of CONTRACTOR, his agents or employees, or any Subcontractor, his agents or employees.

6.15.2 In any and all claims against OWNER or ENGINEER or any of their officers, agents or employees by any employees of CONTRACTOR, any Subcontractor, anyone directly or indirectly employed by any of

them or anyone for whose acts any of them may be liable, the indemnification obligation under paragraph 6.15.1 shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for CONTRACTOR or any Subcontractor under Workmen's Compensation acts, disability benefit acts, or other employee benefit acts.

6.15.3 The obligations of CONTRACTOR under paragraphs 6.15.1 and 6.15.2 shall not extend to the liability, claims, damages, losses or expenses, including attorney fees, arising out of the preparation or approval of maps, drawings, opinions, reports, surveys, change orders, designs or specifications by the indemnitee, or the agents or employees of the indemnitee, or the giving of or the failure to give directions or instructions by the indemnitee, or the agents or employees of the indemnitee, where such giving or failure to give directions or instructions is the primary cause of bodily injury to persons or damage to property. CONTRACTOR is not required to indemnify the OWNER and Engineer for the negligence, act or omission of the OWNER and Engineer and their agents and employees or any legal entity for whose negligence, acts or omissions OWNER or Engineer may be liable.

6.16 HAZARDOUS MATERIALS

6.16.1 The Contractor shall, without additional expense to Owner, be responsible for obtaining any necessary licenses and permits required by law or regulation, and comply with all federal, state, municipal law, code, ordinance and regulation applicable to the performance of the Work in connection with hazardous material. The Contractor shall be responsible for all damages to persons or property that occur as a result of Contractor's fault or negligence, and shall take proper safety and health precautions to protect the Work, the workers, and the public, and the property of others. The Contractor shall be responsible for all materials delivered and Work performed until completion and acceptance of the entire Work, except for any completed unit of work which may have been specifically accepted by Owner under the Contract.

SECTION 7

WORK BY OTHERS

7.1 OWNER may perform additional work related to the Project by himself, or he may let other direct contracts therefore which shall contain General Conditions similar to these. CONTRACTOR shall afford the other contractors who are parties to such direct contracts (or OWNER, if he is performing the additional work himself), reasonable opportunity for the introduction and storage of materials and equipment and the execution of work and shall properly connect and coordinate his Work with theirs.

7.2 If any part of CONTRACTOR's Work depends for proper execution or results upon the work of any such other contractor (or OWNER), CONTRACTOR shall inspect and promptly report to ENGINEER in writing any defects or deficiencies in such work that render it unsuitable for such proper execution and results. His failure so to report shall constitute an acceptance of the work as fit and proper for the relationship of his Work except as to defects and deficiencies which may appear in the other work after the execution of his Work.

7.3 CONTRACTOR shall do all cutting, fitting, and patching of his Work that may be required to make its several parts come together properly and fit it to receive or be received by such other work. CONTRACTOR shall not endanger any work of others by cutting, excavating, or otherwise altering their work and will only cut or alter their work with the written consent of ENGINEER and of the other contractors whose work will be affected.

7.4 If the performance of additional work by other contractors or OWNER is not noted in the Contract Documents prior to the execution of the Contract, written notice thereof shall be given to CONTRACTOR prior to starting any such additional work. If CONTRACTOR believes that the performance of such additional work by OWNER or others causes him an additional expense or entitles him to an extension of the Contract Time, he may make a claim therefor as provided in Sections 11 and 12.

7.5 Work by CONTRACTOR and work by others should be coordinated and expedited by OWNER or his representative to minimize time delays and additional cost to CONTRACTOR.

SECTION 8

OWNER'S RESPONSIBILITIES

8.1 OWNER shall issue all communications to CONTRACTOR through ENGINEER.

8.2 In case of termination of the employment, OWNER shall appoint a replacement Engineer and notify CONTRACTOR of the appointment. The replacement Engineer shall have the status of the former Engineer under the Contract Documents. The OWNER'S appointment of a replacement Engineer shall be final. CONTRACTOR shall have no claim for damages, including but not limited to additional Contract Time, home and local office overhead or additional cost based on the OWNER'S substitution or replacement of the Engineer.

8.3 OWNER shall furnish the data required of OWNER under the Contract Documents promptly and shall make payments to CONTRACTOR promptly after they are due as provided in Section 14.

8.4 OWNER's responsibilities in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Section 4. Paragraph 4.2 refers to OWNER's identifying and making available to CONTRACTOR copies of reports of investigations and tests of subsurface and latent physical conditions at the site or otherwise affecting performance of the Work which have been relied upon by ENGINEER in preparing the Drawings and Specifications.

8.5 OWNER's responsibility with respect to certain inspections, tests and approvals is set forth in Section 13.

8.6 In connection with OWNER's right to stop Work or suspend Work, see Sections 13 and 15. Paragraph 15.2 deals with OWNER's right to terminate services of CONTRACTOR under certain circumstances.

SECTION 9

ENGINEER'S STATUS DURING CONSTRUCTION

9.1 OWNER'S REPRESENTATIVE

ENGINEER will be OWNER's representative during the construction period. The duties and responsibilities and the limitations of authority of ENGINEER as OWNER's representative during construction are set forth in the Contract Documents and shall not be extended without written consent of OWNER and ENGINEER.

9.2 VISITS TO SITE

ENGINEER will make visits to the site at intervals appropriate to the various stages of construction to observe the progress and quality of the executed Work and to determine, in general, if the Work is proceeding in accordance with the Contract Documents. ENGINEER's efforts will be directed toward providing assurance for OWNER that the completed Work will conform to the Contract Documents. On the basis of such visits and on-site observations as an experienced and qualified design professional, ENGINEER will keep OWNER informed of the progress of the Work and will endeavor to guard OWNER against defects and deficiencies in the Work.

9.3 PROJECT REPRESENTATION

If OWNER and ENGINEER agree, ENGINEER will furnish a Resident Project Representative to assist ENGINEER in observing the performance of the Work. In such event, the duties, responsibilities and limitations of authority of any such Resident Project Representative and assistants will be as provided in writing by the OWNER to the CONTRACTOR. If OWNER designates another agent to represent OWNER at the site who is not ENGINEER'S agent or employee, the duties, responsibilities and limitations of authority of such other person will be as provided in writing by the OWNER to the CONTRACTOR.

9.4 CLARIFICATIONS AND INTERPRETATIONS

ENGINEER will issue with reasonable promptness such written clarifications or interpretations of the Contract Documents (in the form of Drawings or otherwise) as ENGINEER may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents. If CONTRACTOR believes that a written clarification or interpretation justifies an increase in the Contract Price or Contract Time, CONTRACTOR may make a claim therefor, as provided in Section 11 and Section 12.

9.5 REJECTING DEFECTIVE WORK

ENGINEER will have authority to disapprove or reject Work which is defective, as

provided in Section 13, and will also have authority to require special inspection or testing of the Work whether or not the Work is fabricated, installed or completed.

9.6 SHOP DRAWINGS, CHANGE ORDERS AND PAYMENTS.

9.6.1 In connection with ENGINEER's responsibility for Shop Drawings and samples, see Section 6.

9.6.2 In connection with ENGINEER's responsibilities as to Change Orders, see Sections 10, 11, and 12.

9.6.3 In connection with ENGINEER's responsibilities with respect to Applications for Payment, etc., see Section 14.

9.7 DECISIONS ON DISAGREEMENT

9.7.1 ENGINEER will be the interpreter of the requirements of the Contract Documents and will evaluate the performance thereunder by CONTRACTOR. In his capacity as interpreter and evaluator, he will exercise his best efforts to ensure good faith performance by both OWNER and CONTRACTOR. He will not show partiality to either and will not be liable for the result of any interpretation or decision rendered in good faith. Claims, disputes, and other matters relating to the execution and progress of the work or the interpretation of or performance under the Contract Documents shall be referred to ENGINEER for a decision, which he will render in writing within a reasonable time.

9.7.2 The rendering of a decision by ENGINEER pursuant to paragraph 9.7 with respect to any such claim, dispute or other matter (except any which have been waived by the making or acceptance of final payment as provided in paragraph 14.11) will be a condition precedent to any exercise by OWNER or CONTRACTOR of such rights or remedies as either may otherwise have under the Contract Documents or at law in respect of any such claim, dispute or other matter.

9.7.3 CONTRACTOR shall continue his performance of the Work and adhere to applicable progress schedules during all disputes or disagreements with the OWNER. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted in Section 15 or as CONTRACTOR and OWNER may otherwise agree in writing.

9.8 LIMITATIONS ON ENGINEER'S RESPONSIBILITIES

9.8.1 Neither ENGINEER's authority to act under this SECTION 9 or elsewhere in the Contract Documents nor any decision made by ENGINEER in good faith either to exercise or not exercise such authority shall give rise to any duty or responsibility of ENGINEER to CONTRACTOR, any Subcontractor, any manufacturer, fabricator, supplier or distributor, or any of their agents or employees or any other person performing any of the Work.

9.8.2 Wherever in the Contract Documents the terms "as ordered," "as directed," "as required," "as allowed," or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper," or "satisfactory" or adjectives of like effect or import are used, to describe a requirement, direction, review or judgment of ENGINEER as to the Work, it is intended that such requirement, direction, review or judgment will be solely to evaluate the Work for compliance with the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective never indicates that ENGINEER shall have authority to supervise or direct performance of the Work or authority to undertake responsibility contrary to the provisions of paragraphs 9.8.3 and 9.8.4.

9.8.3 ENGINEER will not be responsible for CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, and ENGINEER will not be responsible for CONTRACTOR's failure to perform the Work in accordance with the Contract Documents.

9.8.4 ENGINEER will not be responsible for the acts or omissions of CONTRACTOR or of any Subcontractor, or of the agents or employees of any CONTRACTOR or Subcontractor, or of any other persons at the site or otherwise performing any of the Work.

SECTION 10

CHANGES IN THE WORK

10.1 Without invalidating the Agreement and without notice to any surety and without releasing any surety, OWNER may, at any time or from time to time, order additions, deletions or revisions in the Work, including such increases or decreases in quantities of Bid Items as OWNER determines to be necessary or desirable; these will be authorized by Change Orders. Upon receipt of a Change Order, CONTRACTOR shall proceed with the Work involved. All such Work shall be executed under the applicable conditions of the Contract Documents. If any Change Order causes an increase or decrease in the Contract Price or an extension or shortening of the Contract Time, an equitable adjustment will be made as provided in Section 11 or Section 12 on the basis of a claim made by either party.

10.2 ENGINEER may authorize minor changes in the Work not involving an adjustment in the Contract Price or the Contract Time, which are consistent with the overall intent of the Contract Documents. These may be accomplished by a Field Order and shall be binding on OWNER, and also on CONTRACTOR who shall perform the change promptly. If CONTRACTOR believes that a Field Order justifies an increase in the Contract Price or Contract Time, CONTRACTOR may make a claim therefor as provided in Section 11 or Section 12.

10.3 ENGINEER with the OWNER'S approval or at the OWNER'S direction may issue a Field Order that will involve an adjustment in the Contract Price or the Contract Time. This type of Field Order is used to authorize changes in the project in a timely manner and allow the CONTRACTOR to proceed with the work without delays. This type of Field Order shall become a Change Order or part of a Change Order as soon as the total change in Contract Price and/or time is established.

10.4 Additional Work performed without authorization of a Field Order/Change Order will not entitle CONTRACTOR to an increase in the Contract Price or an extension of the Contract Time, except in the case of an emergency as provided in paragraph 6.12 and except as provided in paragraphs 10.2 and 13.4.2.

10.5 OWNER shall execute appropriate Change Orders prepared by ENGINEER covering changes in the Work which are covered by a Field Order, or required by OWNER, or required because of unforeseen physical conditions or emergencies, or because of uncovering Work found not to be defective, or as provided in paragraph 11.9, or because of any other claim of CONTRACTOR for a change in the Contract Time or the Contract Price which is recommended by

ENGINEER and accepted by OWNER. When possible and practical the OWNER shall process Change Orders in a timely manner to facilitate payment to the CONTRACTOR for completed authorized changes in the work.

10.6 If notice of any change affecting the general scope of the Work or change in the Contract Price is required by the provisions of any Bond to be given to the Surety, it will be CONTRACTOR'S responsibility to so notify the surety, and the amount of each applicable Bond shall be adjusted accordingly. CONTRACTOR shall furnish proof of such adjustment to OWNER.

CHANGE OF CONTRACT PRICE

11.1 COMPENSATION

The Contract Price constitutes the total compensation payable to CONTRACTOR for performing the Work. All duties, responsibilities, and obligations assigned to or undertaken by CONTRACTOR shall be at his expense without change in the Contract Price.

11.2 CHANGE ORDER

The Contract Price may only be changed by a Change Order. Any claim for an increase in the Contract Price shall be based on written notice delivered to OWNER and ENGINEER within fifteen (15) days of the occurrence of the event giving rise to the claim. Notice of the amount of the claim with supporting data shall be delivered within forty-five (45) days of such occurrence unless ENGINEER, in writing, allows an additional period of time to ascertain accurate cost data. All claims for adjustments in the Contract Price shall be determined by ENGINEER if OWNER and CONTRACTOR cannot otherwise agree on the amount involved. Any change in the Contract Price resulting from any such claim shall be incorporated in a Change Order. No claim for an adjustment in the Contract Price will be valid if not submitted in accordance with this paragraph 11.2.

11.3 VALUE OF WORK

The value of any Work covered by a Change Order or of any claim for an increase or decrease in the Contract Price shall be determined in one of the following ways:

11.3.1 Where the Work involved is covered by unit prices contained in the Contract Documents and the total amount of increase or decrease in quantity of a Bid Item does not vary more than twenty five percent (25%) from the estimated quantity shown in the Bid Proposal for that Bid Item, by application of unit prices to the quantities of the items involved.

11.3.2 By mutual acceptance of a lump sum or unit prices.

11.3.3 On the basis of the Cost of the Work (determined as provided in paragraphs 11.4 and 11.5) plus a CONTRACTOR's Fee for overhead and profit (determined as provided in paragraph 11.6).

11.4 COST OF THE WORK (INCLUSION)

The term Cost of the Work means the sum of all costs necessarily incurred and paid by the CONTRACTOR in the proper performance of the Work. Except as otherwise may be agreed to in writing by OWNER such costs shall be in amounts no higher than those prevailing in the locality of the Project,

shall include only the following items, and shall not include any of the costs itemized in paragraph 11.5:

11.4.1 Payroll costs for employees in the direct employ of CONTRACTOR in the performance of the Work under schedules of job classifications agreed upon by OWNER and CONTRACTOR. Payroll costs for employees not employed full time on the work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include salaries and wages plus the cost of fringe benefits which shall include social security contributions, unemployment, excise and payroll taxes, workmen's compensation, health and retirement benefits, sick leave, vacation and holiday pay applicable thereto. Such employees shall include superintendents and foremen at the site. The expenses of performing work after regular working hours, on Sunday or legal holidays shall be included in the above to the extent authorized by OWNER.

11.4.2 Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and manufacturers' field services required in connection therewith. All cash discounts shall accrue to CONTRACTOR unless OWNER deposits funds with CONTRACTOR with which to make payments, in which case the cash discounts shall accrue to OWNER. All trade discounts, rebates, and refunds and all returns from sale of surplus materials and equipment shall accrue to OWNER; and CONTRACTOR shall make provisions so that they may be obtained.

11.4.3 Payments made by CONTRACTOR to the subcontractors for work performed by Subcontractors. If required by OWNER, CONTRACTOR shall obtain competitive bids from Subcontractors acceptable to him and shall deliver such bids to OWNER who will then determine, with advice of ENGINEER, which bids will be accepted. If a subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work Plus a Fee, the Cost of the Work shall be determined in accordance with paragraphs 11.4 and 11.5. All subcontracts shall be subject to the other conditions of the Contract Documents insofar as applicable.

11.4.4 Costs of special consultants (including, but not limited to, engineers, architects, testing laboratories, surveyors, lawyers, and accountants) employed for services specifically related to the Work.

11.4.5 Supplemental costs including the following:

11.4.5.1 The proportion of necessary transportation, traveling, and subsistence expenses of CONTRACTOR's employees incurred

in discharge of duties connected with the Work.

11.4.5.2 Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office and temporary facilities at the site, and hand tools not owned by the workmen, which are consumed in the performance of the Work; and cost less market value of such items used but not consumed which remain the property of CONTRACTOR.

11.4.5.3 Rentals of all construction equipment, machinery and the parts thereof whether rented from the Contractor or other rental agencies will be authorized by the ENGINEER and approved by the OWNER. The rate for rental equipment, machinery and the parts thereof will be computed and paid by the City of Albuquerque based on the following:

11.4.5.3.1 In cases where the piece of equipment to be used, whether specialized or not, is rented or leased from an outside agency and used in the execution of negotiated or force account work, a reasonable rental rate agreed upon in advance by the CONTRACTOR and the ENGINEER may be allowed upon presentation of the rental agency's quotation. To the approved rental rate, the established Hourly Operating Costs as listed in the current Blue Book (Rental Rate Blue Book in effect at the time of equipment use, published by Equipment Guide Book Co., Palo Alto, California) will be added; to this total an additional 15% will be added for administering this item.

11.4.5.3.2 In cases where the piece of equipment to be used, whether specialized or not, to be used is owned by the contractor, the rental rate will be computed as follows:

City of Albuquerque (COA) Equipment
Rental Rate = Blue Book Hourly Rate X
0.50 + Blue Book Hourly Operating Cost.

The rates shown in the Blue Book have been computed from current costs of ownership and operation related to the average number of hours usage per year. The rates shown do not include operating personnel. The ownership cost represents the total cost of depreciation, interest, insurance, taxes, storage, etc., reduced to an hourly rate. Estimated operating cost/hour includes fuel, lubricants, tires and other operating expendables, such as the percentage of mechanic's wages chargeable to preventive and field maintenance. The current Blue Book as modified above by the City of Albuquerque shall apply for any machinery or special equipment (other than small tools), including fuel, lubricants and transportation costs and the use of which has been authorized by the ENGINEER. COA Equipment Rental Rates will be applied in accordance with the following criteria:

A. Manufacturer's identification plates attached to equipment shall be used insofar as possible to determine identification and capacities of the designated items of equipment. Where the equipment is not provided with such plates, the CONTRACTOR will be required to supply written statements certifying the equipment identification and capacity as shown by his equipment inventory. The ENGINEER'S records shall be completed in full to include type, capacity and horsepower for the equipment used in order to properly correlate the equipment with that described in the Rental Rate Blue Book schedule. The listed Blue Book rates are the maximum for equipment of modern design and in good working condition. Equipment shall be so handled and used to provide normal output and production.

B. Most commonplace items of equipment are listed in the Blue Book. In cases where the piece of equipment to be used is not listed in the Blue Book, the rental rate will be established by requesting a rate from Equipment Guide Book Company or by using the Blue Book Rental Rate for a comparable piece of equipment being used, as determined by the ENGINEER. If the equipment used is of such age that it is not listed, then the most comparable machine shown in the Blue Book, as determined by the ENGINEER, will be used.

C. Standard manufactured items identified by unit weight or section dimensions will be measured utilizing nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

D. "Move-in" and "move-out" charges required by the piece of equipment not available on the job will be included as part of the extra work at actual transportation cost if the particular piece of equipment is not moved onto the specific job under its own power. "Move-in" and "move-out" charges will be paid once each for any particular piece of equipment except in unusual circumstances which must be justified in writing and authorized by the ENGINEER. "Move-in" and "move-out" charges shall include all costs of loading and unloading.

E. Equipment rental rates for standby time, when authorized in writing by the ENGINEER, will be one-half of the computed COA Equipment Rental Rate less the Hourly Operating Cost. Under no circumstances shall it be assumed that idle equipment will be paid for under these standby provisions until after payment for idle equipment is authorized in writing by the ENGINEER.

F. The regional difference percentage as described in Section 1, paragraph 9, of the Blue Book will not be applicable.

G. Overtime as described in Section One of the current Blue Book will not apply. All equipment used on extra work will be paid for at the regular hourly rate as determined by using the formula for City of Albuquerque Equipment Rental Rate.

11.4.5.4 Sales, use, or similar taxes related to the Work and for which CONTRACTOR is liable, imposed by any governmental authority.

11.4.5.5 Deposits lost for causes other than CONTRACTOR's negligence, royalty payments, and fees for permits and licenses.

11.4.5.6 Losses, damages, and expenses not compensated by insurance or otherwise, sustained by CONTRACTOR in connection with the execution of and to the Work, provided they have resulted from causes other than the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of OWNER. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining CONTRACTOR's Fee. If, however, any such loss or damage requires reconstruction and CONTRACTOR is placed in charge thereof, he shall be paid for his services a fee proportionate to that stated in paragraph 11.6.2.

11.4.5.7 The cost of utilities, fuel, and sanitary facilities at the site.

11.4.5.8 Minor expenses such as telegrams, long distance telephone calls, telephone service at the site, expressage and similar petty cash items in connection with the Work.

11.4.5.9 Cost of premiums for bonds and insurance which OWNER is required to pay in accordance with paragraph 5.3.

11.5 COST OF WORK (EXCLUSION)

The term Cost of the Work shall not include any of the following:

11.5.1 Payroll costs and other compensation of CONTRACTOR's officers, executives, principals (of partnership and sole proprietorships), general managers, engineers, architects, estimators, timekeepers, clerks, and other personnel employed by CONTRACTOR whether at the site or in his principal office or a branch office for general administration of the Work and not specifically included in the schedule referred to in paragraph 11.4.1—all of which are to be considered administrative costs covered by the CONTRACTOR's Fee.

11.5.2 Expenses of CONTRACTOR's principal and branch offices other than his office at the site.

11.5.3 Any part of CONTRACTOR's capital

expenses, including interest on CONTRACTOR's capital employed for the Work and charges against CONTRACTOR for delinquent payment.

11.5.4 Cost of premiums for all bonds and for all insurance policies whether or not CONTRACTOR is required by the Contract Documents to purchase and maintain the same (except as otherwise provided in paragraph 11.4.5.9).

11.5.5 Costs due to the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective work, disposal of materials or equipment wrongly supplied and making good any damage to property.

11.5.6 Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in paragraph 11.4.

11.6 CONTRACTOR'S FEE

The CONTRACTOR's Fee which shall be allowed to CONTRACTOR for his overhead and profit shall be determined as follows:

11.6.1 a mutually acceptable fixed fee; or if none can be agreed upon,

11.6.2 A fee based on the following percentages of the various portions of the Cost of the Work:

11.6.2.1 for costs incurred under paragraphs 11.4.1 and 11.4.2, the CONTRACTOR's Fee shall be ten percent (10%),

11.6.2.2 for costs incurred under paragraph 11.4.3, the CONTRACTOR's Fee shall be ten percent (10%); and if a subcontract is on the basis of Cost of the Work Plus a Fee, the maximum allowable to the Subcontractor as a fee for overhead and profit shall be ten percent (10%), and

11.6.2.3 no fee shall be payable on the basis of costs itemized under paragraphs 11.4.4, 11.4.5, and 11.5.

11.7 OVERHEAD AND PROFIT

The amount of credit to be allowed by CONTRACTOR for any change which results in a net increase in cost for the change order OR the amount of credit to be allowed OWNER for any change which results in a net decrease in the cost for such change order shall include the combined overhead and profit of CONTRACTOR, so calculated in this Section 11.

11.8 ITEMIZED COST

11.8 Whenever the cost of any Work is to be determined pursuant to paragraphs 11.4 and 11.5, CONTRACTOR will submit in form prescribed by ENGINEER an itemized cost breakdown together with supporting data.

11.9 CASH ALLOWANCES

11.9.1 It is understood that CONTRACTOR has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be done by such materialmen, suppliers, or Subcontractors and for such sums within the limit of the allowances as ENGINEER may approve.

11.9.2 Upon final payment, the Contract Price shall be adjusted as required and an appropriate Change Order issued. CONTRACTOR agrees that the original Contract Price includes such sums as he deems proper for costs and profit on account of cash allowances. No demand for additional cost or profit in connection therewith will be allowed.

11.10: The CONTRACTOR agrees that, by signing any Change Order, the compensation established in the Change Order shall comprise the total complete compensation due to the CONTRACTOR for the Work and Contract Time defined in the Change Order. The CONTRACTOR agrees that the Change Order is in full accord and satisfaction of all disputed compensation amounts and Contract time including but not limited to compensation amounts and Contract Time for interruption of schedules, extended home or other office overhead, all other overhead, profit, and delay and impact claims or ripple effect, attributable to those matters included within the Change Order, and that CONTRACTOR'S execution of the Change Order is a waiver of any reservation of claim for additional compensation, increase in Contract Price and Contract Time with respect to the Change Order.

SECTION 12

CHANGE OF THE CONTRACT TIME

12.1 The Contract Time may only be changed by a Change Order. Any claim for an extension in the Contract Time shall be based on written notice delivered to OWNER and ENGINEER within fifteen (15) days of the occurrence of the event giving rise to the claim. Notice of the extent of the claim with supporting data shall be delivered within forty-five (45) days of such occurrence unless ENGINEER allows an additional period of time to ascertain more accurate data. All claims for adjustment in the Contract Time shall be determined by ENGINEER if OWNER and CONTRACTOR cannot otherwise agree. Any change in the Contract Time resulting from any such claim shall be incorporated in a Change Order. No claim for adjustment in the Contract Time will be valid if not submitted in accordance with this paragraph 12.1.

12.2 The contract time will be extended in an amount equal to the time lost due to delays beyond the control of the CONTRACTOR if the Contractor makes a claim therefor, as provided in Section 12.1. The CONTRACTOR shall not be entitled to additional time to perform the Agreement beyond the number of days indicated in the Change Order for the matters included within the Change Order and the attachments thereto and the CONTRACTOR shall not be entitled to additional costs, overhead, profit, extended or other office overhead related to any time, interruption of schedules or other delay or impact claim or ripple effect attributable to the matters included in the Change Order and the attachments thereto, except as specifically allowed in the Change Order. Delays that may be the basis for a Change Order include acts of neglect by any separate contractor employed directly by OWNER, abnormal weather conditions, acts of nature, labor disputes, among other similar items not under the control of the CONTRACTOR but shall not include severe weather conditions or acts of nature (acts of God) that are not abnormal, and acts, errors, or omissions caused by any agent, employee, any tier of subcontractors, suppliers, or manufacturers or other person or entity under the control or supervision of the CONTRACTOR or any tier of subcontractors, suppliers or manufacturers who have contracted with the CONTRACTOR. This Section shall also apply to change Orders indicating "no" or "zero" days additional Contract Time.

12.3 All time limits stated in the Contract Documents are of the essence of the Agreement. The conditions of this Section 12 shall not exclude recovery for damages (including compensation for additional professional service) for delay by either party.

Section 13

WARRANTY AND GUARANTEE; TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

13.1: WARRANTY AND GUARANTEE

13.1.1 CONTRACTOR warrants and guarantees to OWNER that all Work will be in accordance with the Contract Documents and shall not be Defective Work. CONTRACTOR further warrants and guarantees to OWNER that all materials and equipment or other elements of the Work shall be new and unused prior to installation, or delivery to OWNER unless otherwise specified in the Contract Documents. Prompt notice of all defects identified by ENGINEER or OWNER shall be given to CONTRACTOR. All Defective Work, whether or not in place, may be rejected, corrected or accepted as provided in this Section 13.

13.1.2 Payment for Defective Work: Whenever CONTRACTOR is required to pay for costs of Defective Work in this Section 13, OWNER shall be entitled to deduct such costs from the Contract Price, including, but not limited to existing retainage held by OWNER in accordance with Section 14 of these General Conditions. In the event the costs of correcting or removing and replacing Defective Work occurs after final acceptance and payment, or should the balance of the Contract Price payable to CONTRACTOR be insufficient to pay OWNER, CONTRACTOR shall pay to OWNER all such costs.

13.2 TESTS AND INSPECTIONS

13.2.1: IN GENERAL

13.2.1.1: CONTRACTOR shall give ENGINEER timely notice of readiness of the Work for all required inspections, tests or approvals.

13.2.1.2: If the Contract Documents, laws, ordinance, rules, regulations, or orders of any public authority having jurisdiction require any Work to specifically be inspected, tested, or approved by some public body, CONTRACTOR shall assume full responsibility therefor, pay all costs in connection therewith and furnish ENGINEER the required certificates of inspection, testing, or approval. CONTRACTOR shall also be responsible for and shall pay all costs in connection with any inspection or testing required in connection with OWNER's or ENGINEER's acceptance of a Supplier of materials or equipment proposed to be incorporated in the Work, or of materials or equipment submitted for approval prior to CONTRACTOR's purchase thereof for incorporation in the Work. All other inspections, tests, and approvals required by the Contract Documents shall be performed by organizations acceptable to OWNER and CONTRACTOR and the costs thereof shall be borne by OWNER unless otherwise specified.

13.2.1.3: Neither observations by ENGINEER nor inspections, tests, or approval by persons other than CONTRACTOR shall relieve CONTRACTOR from CONTRACTOR's obligations to perform the Work in accordance with the requirements of the Contract Documents.

13.2.1.4: All inspections, tests or approvals other than those required by Laws or Regulations or any public body having jurisdiction shall be performed by organizations acceptable to OWNER (or by ENGINEER if so specified).

13.2.2 LABORATORY TESTING

13.2.2.1: Job Mix Formulae and Design Mixes: The preparation of job mix formulae and design mixes together with necessary sampling and testing as required for this Contract shall be at CONTRACTOR's expense. Such sampling and testing shall be performed by an approved testing laboratory under the direct supervision of a New Mexico Registered Professional Engineer. Mix design and job mix formulae submittals shall state the methods used in preparing the design or formulae together with substantiating data and graphic representations as appropriate, shall respond to all pertinent material requirements listed in the technical specifications, and shall give recommendations for job procedures and job mix tolerance limits necessary to give reasonable assurance that the specification requirements will be met in the field, when appropriate. Unless specified otherwise in the Technical Specifications, all job mix formulae and design mixes, and material tests relating thereto shall be based upon tests conducted no more than 12 months prior to the date the mix design is submitted.

13.2.2.2: Materials or Manufactured Items: Testing of materials or manufactured items shall be at CONTRACTOR's expense. Tests for materials or manufactured items shall be certified as meeting contract specifications by an approved testing laboratory under the direct supervision of a professional engineer registered in the state of manufacture or a testing laboratory approved by ENGINEER. Materials or manufactured items that require, as specified herein, either a certificate of compliance or analysis or both, stating that the materials comply in all respects with the requirements of the specifications shall not be installed before the certificates are submitted to the ENGINEER. The certificates shall be signed by a person having legal authority to bind the supplier or manufacturer.

13.2.3 FIELD TESTING

13.2.3.1: The field testing of all locally processed or produced material directly incorporated into the Work, including but not limited to the establishment of density curves representative of materials to be used in the embankment, subgrade and backfilling operations and compliance test will be paid by OWNER. All such field testing required in the Contract Documents shall be paid by OWNER, provided that such payment shall be made by OWNER directly to the testing agency and CONTRACTOR shall not be entitled to any additional fees, markup or percentage of the Contract Price for such payment by OWNER. In the event the initial testing shows Defective Work, materials, supplies or equipment, all subsequent testing shall be at CONTRACTOR'S sole expense. The CONTRACTOR shall pay for such subsequent testing directly to the testing agency. In the event the CONTRACTOR fails to make such payment, the provisions of Section 13.1.1 of this Section shall apply. ENGINEER shall determine the number, type and location of tests. CONTRACTOR shall furnish, incidental to this Contract and at no extra cost to OWNER, necessary equipment, tools and labor, except testing equipment, to assist the testing agency in the performance of field tests. Copies of all laboratory and field tests shall be forwarded to CONTRACTOR, ENGINEER, and OWNER.

13.2.3.2: In the event any Work is covered contrary to the Contract Documents or to the written request of the Engineer, the CONTRACTOR shall give ENGINEER timely notice of readiness of the Work for all inspections, tests, or approvals. If any such Work required to be inspected, tested, or approved is covered without written approval of ENGINEER, it must, if requested by ENGINEER, be uncovered for observation; and such uncovering shall be at CONTRACTOR'S expense unless CONTRACTOR has given ENGINEER timely notice of his intention to cover such Work and ENGINEER has not acted with reasonable promptness in response to such notice.

13.3 ACCESS TO WORK: ENGINEER and his representatives, other representatives of OWNER, testing agencies and governmental agencies with jurisdictional interests shall have access to the Work at reasonable time for their observation, inspecting and testing. CONTRACTOR shall provide proper and safe conditions for such access.

13.4 UNCOVERING THE WORK

13.4.1: In the event any Work is covered contrary to the Contract Documents or to the written request of the Engineer, the CONTRACTOR shall bear or pay all direct, indirect, consequential costs of uncovering (when applicable), exposure, observation, inspection, testing and reconstruction,

including, but not limited to fees, charges and costs of engineers, architects, attorneys and other professionals. OWNER shall be entitled to a decrease in the Contract Price when such inspection or test occurs prior to final payment and acceptance and CONTRACTOR shall pay OWNER for such cost in the event the inspection or test occurs subsequent to final payment and acceptance of the Work. ENGINEER shall determine the number, type and location of tests. CONTRACTOR shall furnish incidental to this contract, at no extra cost to OWNER, necessary equipment, tools and labor, except testing equipment, to assist the testing agency in the performance of field tests. Copies of all laboratory and field tests shall be forwarded to CONTRACTOR, ENGINEER, and OWNER.

13.4.2: In the event any Work has been covered which Engineer has not specifically requested to observe or the Contract Documents do not specifically require to be observed prior to being covered or if ENGINEER considers it necessary or advisable that covered Work be observed by ENGINEER or inspected or tested by others, CONTRACTOR, at ENGINEER'S request, shall uncover, expose or otherwise make available for observation, inspection or testing as ENGINEER may require, that portion of the Work in question, furnishing all necessary labor, material and equipment. If it is found that such Work is Defective, CONTRACTOR shall bear all direct, indirect and consequential costs of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction, (including but not limited to fees and charges of engineers, architects, attorneys and other professionals), and OWNER shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, may make a claim therefor as provided in Section 11. If, however, such Work is not found to be Defective, CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing and reconstruction; and, if the parties are unable to agree as to the amount or extent thereof, CONTRACTOR may make a claim therefor as provided in Sections 11 and 12.

13.5 OWNER MAY STOP THE WORK:

If the Work is Defective, or CONTRACTOR fails to supply sufficient skilled workers or suitable materials or equipment, or fails to pay subcontractors or for labor, materials or equipment, or fails to furnish or perform the Work in such a way that the completed Work shall conform to the Contract Documents, OWNER may order CONTRACTOR to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of OWNER to stop the Work shall not give rise to any duty on the part of OWNER to

exercise this right for the benefit of CONTRACTOR or any other party.

13.6 CORRECTION OR REMOVAL OF DEFECTIVE WORK

If required by ENGINEER, CONTRACTOR shall promptly, as directed by the ENGINEER, either correct all Defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by ENGINEER, remove it from the Site of the Work and replace it with non-Defective Work. CONTRACTOR shall bear and pay for all direct, indirect, and consequential costs of such correction, removal and replacement, including but not limited to fees, charges and costs of engineers, architects, attorneys, and other professionals incurred by OWNER and made necessary by such correction or removal and replacement. In the event CONTRACTOR fails, for any reason, to correct Defective Work or remove and replace rejected Defective Work within the time specified in ENGINEER's written notice to correct or replace Defective Work, OWNER shall be entitled to have such Defective Work corrected or replaced. CONTRACTOR shall bear and pay for all direct, indirect, and consequential cost of such correction or removal and replacement, including but not limited to fees, charges, and costs of engineers, architects and attorneys, and other professionals incurred by OWNER and made necessary by such correction or removal and replacement. OWNER shall be entitled to deduct such costs from the Contract Price, including but not limited to existing retainage held by OWNER pursuant to Section 14 of these General Conditions. Consequential costs shall include, but are not limited to costs of correcting or removing and replacing all Work of others, or personal or real property of OWNER or others, that may be damaged or destroyed directly or indirectly by CONTRACTOR's Defective Work or by the correction or removal and replacement of the Defective Work.

13.7 ONE YEAR CORRECTION PERIOD

If within one year after the date of Substantial Completion as identified in the letter of acceptance issued by the Owner or such longer period of time as may be prescribed by Laws or Regulations or by the terms of any applicable special guarantee required by the Contract Documents or by any specific provision of the Contract Documents, any Work is found to be Defective, CONTRACTOR shall promptly, without cost to OWNER and in accordance with OWNER's written instructions, either correct such Defective Work, or, if it has been rejected by OWNER, remove it from the Site and replace it with non-Defective Work. OWNER shall give CONTRACTOR written notice of OWNER'S discovery of Defective Work. Such notice shall be postmarked no later than thirty days after the expiration

of the one year correction period or such longer correction period as required in the Contract Documents, provided that such notice shall concern only Defective Work identified by OWNER during the applicable correction period. CONTRACTOR shall bear and pay all direct, indirect, and consequential costs of such correction, or removal and replacement as provided in paragraph 13.6, above. If CONTRACTOR does not promptly comply with the terms of such instruction, or, in an emergency where delay would cause serious risk of loss or damage, OWNER may have the Defective Work corrected or the rejected Defective Work removed and replaced, and all direct, indirect and consequential costs of such removal and replacement (including but not limited to fees and charges of engineers, architects, attorneys and other professionals) shall be paid by CONTRACTOR, as provided in paragraph 13.6 above. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Contract Documents. Consequential costs shall include, but are not limited to costs of correcting or removing and replacing all Work of others, or personal or real property of OWNER or others, that may be damaged or destroyed directly or indirectly by CONTRACTOR's Defective Work or by the correction or removal and replacement of Defective Work. OWNER's costs of testing or exploratory Work conducted to verify the existence or extent of Defective Work also be a direct cost of correcting or removing and replacing Defective Work for which CONTRACTOR shall pay OWNER.

13.8 ACCEPTANCE OF DEFECTIVE WORK

In the event of Defective Work identified at any time during the performance of this Agreement, including but not limited to the correction period required in paragraph 13.7, the OWNER, at its sole option, shall be entitled to accept such Defective Work. CONTRACTOR shall bear, or pay to OWNER, all direct, indirect, and consequential costs attributable to OWNER's evaluation of and determination to accept such Defective Work, including but not limited to fees, charges and costs of engineers, architects, attorneys, and other professionals. CONTRACTOR shall also pay to OWNER an amount equal to the loss of value of the Work due to the Defective Work, including, but not limited to diminished productivity, use, function, aesthetics, or life expectancy of the Work. These factors shall be evaluated by the ENGINEER, should such acceptance of Defective Work occur prior to final payment or acceptance. In addition, the ENGINEER shall provide its evaluation and recommendation of the acceptance and the costs associated with the evaluation of acceptance of Defective Work. When acceptance of Defective Work

occurs prior to final payment and acceptance OWNER shall be entitled to a decrease in the Contract Price. Should the acceptance of Defective Work occur after final payment and acceptance, or should the balance of the Contract Price payable to CONTRACTOR be insufficient to pay OWNER, CONTRACTOR shall pay OWNER all costs previously specified in this paragraph.

13.9 WORK NEGLECTED BY CONTRACTOR

If CONTRACTOR fails within the time specified in the written notice of ENGINEER to proceed to correct Defective Work or to remove and replace rejected Defective Work as required by ENGINEER in accordance with paragraph 13.6, or if CONTRACTOR fails to perform the Work in accordance with the Contract Documents, or if CONTRACTOR fails to comply with any other provision of the Contract Documents, OWNER may, after seven days' written notice to CONTRACTOR, correct and remedy any such deficiency. In exercising the rights and remedies under this paragraph OWNER shall proceed expeditiously. To the extent necessary to complete corrective and remedial action, OWNER may exclude CONTRACTOR from all or part of the Site of the Work (the "Site"), take possession of all or part of the Work, suspend CONTRACTOR's services related thereto, take possession of CONTRACTOR's tools, appliances, construction equipment and machinery at the Site and incorporate in the Work all materials and equipment stored at the Site or for which OWNER has paid CONTRACTOR but which are stored elsewhere. CONTRACTOR shall allow OWNER, OWNER's representatives, agents and employees such access to the Site as may be necessary to enable OWNER to exercise the rights and remedies under this paragraph. All direct, indirect and consequential costs of OWNER in exercising such rights and remedies will be charges against CONTRACTOR in an amount approved as to reasonableness by ENGINEER, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and OWNER shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, OWNER may make a claim therefor as provided in Section 11. Such direct, indirect and consequential costs will include but not be limited to fees, charges, and costs of engineers, architects, attorneys and other professionals, all court and arbitration costs and all costs of repair and replacement of Work of others or the real or personal property of OWNER or others destroyed or damaged by correction, removal or replacement of CONTRACTOR's Defective Work. CONTRACTOR shall not be allowed an extension of the Contract Time because of any delay in performance of the Work attributable to the exercise by OWNER of OWNER's rights and remedies hereunder.

PAYMENTS TO CONTRACTORS AND COMPLETION

14.1 SCHEDULES

At least ten (10) days prior to the first Application for Payment, CONTRACTOR shall (except as otherwise specified in the Contract Documents), submit to ENGINEER a progress schedule, a final schedule of Shop Drawing submission and where applicable, a schedule of values of the Work. These schedules shall be satisfactory in form and substance to ENGINEER. The schedule of values shall include quantities and unit prices aggregating to the Contract Price, and shall subdivide the Work into component parts in sufficient detail to serve as the basis for progress payments during construction.

14.2 APPLICATION FOR PROGRESS PAYMENT

Payment to CONTRACTOR will be made from OWNER's funds as follows:

14.2.1 Progress payments will be made monthly, commencing with the month next succeeding the month in which OWNER notifies CONTRACTOR in writing to commence work (Notice to Proceed). ENGINEER will make an approximate estimate of the value of the Work done and the value (based on receipted invoices) of unused materials delivered and stored on the site or stored at a location approved by the ENGINEER for the Work during the previous calendar month which estimate shall be incorporated in an Application for Payment. After each such Application for Payment has been approved by OWNER, OWNER will, within twenty (20) days, make payment to CONTRACTOR in the amount of each such Application for Payment, less retainage.

14.2.2 Five percent (5%) of the amount of each Application for Payment, including materials delivered to the job site but not installed, will be retained until Substantial Completion unless good cause exists for a requirement of a different percentage. Upon Substantial Completion, retainage shall be reduced to two percent (2%) of the total contract price unless good cause exists to retain an amount greater or less than two percent (2%). The determination of good cause as specified heretofore shall be recommended by ENGINEER and approved by OWNER. The retainage defined above shall be held by OWNER until completion and acceptance of the Work, as provided herein. If OWNER fails to make a particular progress payment to CONTRACTOR as specified herein, such failure shall not be held to violate or void this Contract, and no interest or penalty payment shall be owing to CONTRACTOR on such progress payment.

14.3 CONTRACTOR'S WARRANTY OF TITLE

CONTRACTOR warrants and guarantees that

title to all Work, materials and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to OWNER at the time of payment free and clear of all liens, claims, security interests and encumbrances (hereafter in these General Conditions referred to as "Liens").

14.4 REVIEW OF APPLICATIONS FOR PROGRESS PAYMENT

14.4.1 The CONTRACTOR and OWNER shall establish at the pre-construction conference the day of each month which shall be the last day the CONTRACTOR is entitled to include Work for the progress payment for the month. ENGINEER's approval of any payment requested in an Application for Payment will constitute a representation by ENGINEER to OWNER, based on ENGINEER's on-site observations of the Work in progress as an experienced and qualified design professional and on ENGINEER's review of the Application for Payment and the accompanying data and schedules that the Work has progressed to the point indicated; that, to the best of ENGINEER's knowledge, information and belief, the quality of the Work is in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning Project upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents and any qualifications stated in his approval) and that CONTRACTOR is entitled to payment of the amount approved. The ENGINEER shall within seven (7) working days from receipt of the Application for Payment (1) approve and send the Application to the OWNER, or (2) disapprove and return the Application to CONTRACTOR, or (3) respond to CONTRACTOR by making inquiries about the Application such as requiring explanation or documentation in support of the Application. However, by approving any such payment, ENGINEER will not thereby be deemed to have represented that exhaustive or continuous on-site inspections have been made to check the quality or the quantity of the Work, or that the means, methods, techniques, sequences, and procedures of construction have been reviewed or that any examination has been made to ascertain how or for what purpose CONTRACTOR has used the monies paid or to be paid to CONTRACTOR on account of the Contract Price, or that title to any Work, materials or equipment has passed to OWNER free and clear of any liens.

14.4.2 ENGINEER's approval of final payment will constitute an additional representation by ENGINEER to OWNER that the conditions precedent to CONTRACTOR's being entitled to final payment as set forth in paragraph 14.9 have been fulfilled.

14.4.3 ENGINEER may refuse to approve the whole or any part of any payment if, in his opinion, it would be incorrect to make such representations to OWNER. He may also refuse to approve any such payment, or because of subsequently discovered evidence or the results of subsequent inspections or tests, nullify any such payment previously approved to such extent as may be necessary in ENGINEER's opinion to protect OWNER from loss because:

14.4.3.1 the Work is defective, or completed Work has been damaged requiring correction or replacement,

14.4.3.2 written claims have been made against OWNER or liens have been filed in connection with the Work,

14.4.3.3 the Contract Price has been reduced because of Modifications,

14.4.3.4 OWNER has been required to correct defective Work or complete the Work in accordance with paragraph 13.9,

14.4.3.5 of CONTRACTOR's unsatisfactory prosecution of the Work in accordance with the Contract Documents, or

14.4.3.6 of CONTRACTOR's failure to make payment to any subcontractor, or for labor, materials, or equipment.

14.5 SUBSTANTIAL COMPLETION

14.5.1 When CONTRACTOR considers the entire Work ready for its intended use, CONTRACTOR shall, in writing to OWNER and ENGINEER, certify that the entire Work is substantially complete and request that ENGINEER issue a certificate of Substantial Completion. Within a reasonable time thereafter, OWNER, CONTRACTOR and ENGINEER shall make an inspection of the Work to determine the status of completion. If ENGINEER or OWNER does not consider the Work substantially complete, ENGINEER will notify CONTRACTOR in writing giving his reasons therefor. If ENGINEER considers the Work substantially complete, ENGINEER will prepare and deliver to OWNER a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. OWNER shall have seven (7) days after receipt of the tentative certificate during which he may make written objection to ENGINEER as to any provisions of the certificate or attached list. If, after considering such objection, ENGINEER concludes that the Work is not substantially complete, ENGINEER will, within fourteen (14) days after submission of the tentative certificate to OWNER, notify CONTRACTOR in writing, stating his reasons therefor. If, after consideration of OWNER's objections, ENGINEER considers the Work substantially

complete, ENGINEER will, within said fourteen (14) days, execute and deliver to OWNER and CONTRACTOR a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as he believes are justified after consideration of any objections from OWNER. At the time of delivery of the tentative certificate of Substantial Completion ENGINEER will deliver to OWNER and CONTRACTOR a written recommendation as to division of responsibilities pending final payment between OWNER and CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities and insurance. Unless OWNER and CONTRACTOR agree otherwise in writing and so inform ENGINEER prior to his issuing the definitive certificate of Substantial Completion ENGINEER's aforesaid recommendation will be binding on OWNER and CONTRACTOR until final payment.

14.5.2 OWNER shall have the right to exclude CONTRACTOR from the Work after the date of Substantial Completion, but OWNER shall allow CONTRACTOR reasonable access to complete or correct items on the tentative list.

14.6 PARTIAL UTILIZATION

Use by OWNER of a completed portion of the Work may be accomplished prior to Substantial Completion of all the Work subject to the following:

14.6.1 OWNER may at any time request CONTRACTOR in writing to permit OWNER to use any part of the Work which OWNER believes to be substantially complete and which may be so used without significant interference with construction of the other parts of the Work. If CONTRACTOR agrees, CONTRACTOR will certify to OWNER and ENGINEER that said part of the work is substantially complete and request ENGINEER to issue a certificate of Substantial Completion for that part of the Work. Within a reasonable time thereafter OWNER, CONTRACTOR and ENGINEER shall make an inspection of that part of the Work to determine its status of completion. If ENGINEER or OWNER does not consider that part of the Work to be substantially complete, ENGINEER will notify OWNER and CONTRACTOR in writing giving his reasons therefor. If ENGINEER considers that part of the Work to be substantially complete, ENGINEER will execute and deliver to OWNER and CONTRACTOR a certificate to that effect, fixing the date of Substantial Completion as to that part of the Work, attaching thereto a tentative list of items to be completed or corrected before final payment. Prior to issuing a certificate of Substantial Completion as to part of the Work ENGINEER will deliver to OWNER and CONTRACTOR a written recommendation as to the division of responsibilities pending

final payment between OWNER and CONTRACTOR with respect to security, operation, safety, maintenance, utilities and insurance for that part of the Work which shall become binding upon OWNER and CONTRACTOR at the time of issuing the definitive certificate of Substantial Completion as to that part of the Work unless OWNER and CONTRACTOR shall have otherwise agreed in writing and so informed ENGINEER. OWNER shall have the right to exclude CONTRACTOR from any part of the Work which ENGINEER has so certified to be substantially complete, but OWNER shall allow CONTRACTOR reasonable access to complete or correct items on the tentative list.

14.6.2 In lieu of the issuance of a certificate of Substantial Completion as to part of the Work, OWNER may take over operation of a facility constituting part of the Work whether or not it is substantially complete if such facility is functionally and separately usable; provided that prior to any such takeover, OWNER and CONTRACTOR have agreed as to the division of responsibilities between OWNER and CONTRACTOR for security, operation, safety, maintenance, correction period, heat, utilities and insurance with respect to such facility.

14.7 FINAL INSPECTION

Upon written notice from CONTRACTOR that the Project is complete, ENGINEER will make a final inspection with OWNER and CONTRACTOR and will notify CONTRACTOR in writing of all particulars in which this inspection reveals that the Project is incomplete or defective. CONTRACTOR shall immediately take such measures as are necessary to remedy such deficiencies.

14.8 FINAL APPLICATION FOR PAYMENT

After CONTRACTOR has completed all such corrections to the satisfaction of ENGINEER and delivered all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, marked-up record documents and other documents, all as required by the Contract Documents, and after ENGINEER has indicated that the Project is acceptable (subject to the provisions of paragraph 14.11), CONTRACTOR may request final payment. The final Application for Payment shall be accompanied by all documentation called for in the Contract Documents and such other data and schedules as OWNER may reasonably require, together with complete and legally effective releases or waivers (satisfactory to OWNER) of all liens arising out of or filed in connection with the Project. In lieu thereof and as approved by OWNER, CONTRACTOR may furnish receipts or releases in full; an affidavit of CONTRACTOR that the releases and receipts include all labor, services, material and equipment for which a lien could be filed, and that all

payrolls, material and equipment bills, and other indebtedness connected with the Project for which OWNER or his property might in any way be responsible, have been paid or otherwise satisfied; and consent of the Surety, if any, to final payment. If any Subcontractor, manufacturer, fabricator, supplier or distributor fails to furnish a release or receipt in full, CONTRACTOR may furnish a bond or other collateral satisfactory to OWNER to indemnify OWNER against any lien.

14.9 FINAL PAYMENT AND ACCEPTANCE

14.9.1 If, on the basis of ENGINEER's observation of the Work during construction and final inspection, and ENGINEER's review of the documentation to accompany the final Application for Payment—all as required by the Contract Documents, ENGINEER is satisfied that the Project has been completed and CONTRACTOR has fulfilled all of his obligations under the Contract Documents, ENGINEER will, within ten (10) days after receipt of CONTRACTOR's request for final payment, indicate in writing his approval of payment and present the final Application for Payment to OWNER. Thereupon ENGINEER will give written notice to OWNER and CONTRACTOR that the Work is acceptable subject to the provisions of paragraph 14.11. Otherwise ENGINEER will indicate in writing the reasons for refusing to approve final payment, in which case CONTRACTOR shall make the necessary corrections. If the Application and accompanying documentation are appropriate as to form and substance, OWNER shall, within thirty (30) days after receipt thereof, pay CONTRACTOR the amount approved by ENGINEER.

14.9.2 If, through no fault of CONTRACTOR, final completion of the Work is significantly delayed and if ENGINEER so confirms, OWNER shall, upon receipt of the final Application for Payment and recommendation of ENGINEER, and without terminating the Agreement, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by OWNER for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if Bonds have been furnished as required in paragraph 5.1 the written consent of the Surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by CONTRACTOR to ENGINEER with CONTRACTOR's request for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

14.10 CONTRACTOR'S CONTINUING OBLIGATION

CONTRACTOR's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute.

Neither recommendation of any progress or final payment by ENGINEER, nor the issuance of a certificate of Substantial Completion, nor any payment by OWNER to CONTRACTOR under the Contract Documents, nor any use or occupancy of the Work or any part thereof by OWNER, nor any act of acceptance by OWNER nor any failure to do so, nor the issuance of a notice of acceptability by ENGINEER pursuant to paragraph 14.9, nor any correction of defective Work by OWNER shall constitute an acceptance of Work not in accordance with the Contract Documents or a release of CONTRACTOR's obligation to perform the Work in accordance with the Contract Documents.

14.11 WAIVER OF CLAIMS

The making and acceptance of final payment shall constitute:

14.11.1 a waiver of all claims by OWNER against CONTRACTOR, except claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to paragraph 14.7 or from failure to comply with the Contract Documents or the terms of any special guarantees specified therein; however, it shall not constitute a waiver by OWNER of any rights in respect of CONTRACTOR's continuing obligations under the Contract Documents; and

14.11.2 a waiver of all claims by CONTRACTOR against OWNER other than those previously made in writing and still unsettled.

14.12 ITEMS FOR PAYMENT

CONTRACTOR will be required to complete the Work specified herein and as shown on the drawings in accordance with the Contract and at the Contract Unit Price established for each of the payment items listed in the Bid Proposal of these Contract Documents. All work which is subsidiary and pertinent to a particular bid item and is not listed as a separate bid item shall be completed as a part of the bid item to which it applies. In case of dispute as to the bid item to which subsidiary or pertinent work applies, ENGINEER's decision shall govern.

SECTION 15
SUSPENSION OF WORK AND TERMINATION

15.1 OWNER MAY SUSPEND WORK

OWNER may, at any time and without cause, suspend the Work or any portion thereof for a period of not more than ninety (90) days by notice in writing to CONTRACTOR and ENGINEER which shall fix the date on which Work shall be resumed. CONTRACTOR shall resume the Work on the date so fixed. CONTRACTOR will be allowed an extension of the Contract Time directly attributable to any suspension if he makes a claim therefor as provided in Section 12.

15.2 OWNER MAY TERMINATE

15.2.1 The OWNER may terminate this Contract upon the occurrence of any one or more of the following events:

15.2.1.1 If CONTRACTOR commences a voluntary case under any chapter of the Bankruptcy Code, as now or hereafter in effect, or if CONTRACTOR takes any equivalent or similar action by filing a petition or otherwise under any other federal or state law in effect at such time relating to the bankruptcy or insolvency;

15.2.1.2 If CONTRACTOR is adjudged bankrupt or insolvent;

15.2.1.3 If a petition is filed against CONTRACTOR under any chapter of the Bankruptcy Code as now or hereafter in effect at the time of filing, or if a petition is filed seeking any such equivalent or similar relief against CONTRACTOR under any other federal or state law in effect at the time relating to bankruptcy or insolvency;

15.2.1.4 If CONTRACTOR makes a general assignment for the benefit of creditors;

15.2.1.5 If a trustee, receiver, custodian or agent of CONTRACTOR is appointed under applicable law or under contract, whose appointment or authority to take charge of property of CONTRACTOR is for the purpose of enforcing a Lien against such property or for the purpose of general administration of such property for the benefit of CONTRACTOR's creditors;

15.2.1.6 If CONTRACTOR admits in writing an inability to pay its debts generally as they become due;

15.2.1.7 If CONTRACTOR persistently fails to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment);

15.2.1.8 If CONTRACTOR disregards Laws or Regulations of any public body having jurisdiction;

15.2.1.9 If CONTRACTOR disregards the authority of the Engineer;

15.2.1.10 If CONTRACTOR otherwise violates in any material way any provisions of the Contract documents; or

15.2.1.11 If CONTRACTOR repeatedly fails to make prompt payments to Subcontractors or for labor, materials, or equipment.

15.2.2 Should any one or more of the events described in Section 15.2.1 occur then OWNER may, without prejudice to any other right or remedy and after giving CONTRACTOR and his surety a seven (7) day written notice, terminate the services of CONTRACTOR, take possession of all materials, equipment, tools, construction equipment and machinery on the Project site owned by CONTRACTOR and use the same to the full extent they could be used by CONTRACTOR (without liability to CONTRACTOR for trespass or conversion), incorporate in the work all materials and equipment stored at the Project site for which OWNER has paid CONTRACTOR, but are stored elsewhere, and finish the work by whatever method OWNER may deem expedient. In such case CONTRACTOR shall not be entitled to receive any further payment until the work is finished. If the unpaid balance of the Contract Price exceeds the direct, indirect and consequential costs of completing the work (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court and arbitration costs) such excess will be paid to CONTRACTOR. If such costs exceed such unpaid balance, CONTRACTOR shall pay the difference to OWNER. Such costs incurred by OWNER shall be determined by OWNER and incorporated in a Change Order. OWNER shall not be required to obtain the lowest price for Work performed by or through OWNER under the provisions of Section 15.

15.2.2.1 Where CONTRACTOR'S services have been so terminated by OWNER, said terminations shall not affect any rights of OWNER against CONTRACTOR then existing or which may thereafter accrue. Any retention or payment of monies by OWNER due CONTRACTOR will not release CONTRACTOR from liability.

15.2.3 Upon seven (7) days' prior written notice to CONTRACTOR and ENGINEER, OWNER may, without cause and without prejudice to any other right or remedy, elect to abandon the Project and terminate the Agreement. In such case, CONTRACTOR shall be paid for all Work satisfactorily completed and expenses actually incurred and overhead and profit thereon. Profit and overhead shall not exceed the percentages established in Section 11 of the General Conditions. Amounts for local and home office overhead shall not be allowed.

15.3 CONTRACTOR MAY STOP WORK OR TERMINATE

If, through no act or fault of CONTRACTOR, the Work is suspended for a period of more than ninety (90) days by OWNER or under an order of court or other public authority, or ENGINEER fails to act on any Application for Payment within thirty (30) days after it is submitted, or OWNER fails to pay CONTRACTOR any sum approved by ENGINEER within thirty (30) days of its approval and presentation, then CONTRACTOR may, upon seven (7) days' prior written notice to OWNER and ENGINEER, terminate the Agreement and recover from OWNER payment for all Work satisfactorily completed and expenses actually incurred and overhead and profit thereon. Profit and overhead shall not exceed the percentages established in Section 11 of the General Conditions. Amounts for local and home office overhead shall not be allowed. In addition and in lieu of terminating the Agreement, if ENGINEER has failed to act on an application for payment or OWNER has failed to make any payment as aforesaid, CONTRACTOR may, upon seven (7) days' prior written notice to OWNER and ENGINEER, stop the Work until he has been paid all amounts then due.

15.4 TERMINATION FOR CONVENIENCE

Termination for Convenience of the Owner:
The Owner may terminate this Contract, in whole or in part, for the convenience of the Owner at any time by giving at least seven (7) days written notice to the Contractor. In the event this Contract is terminated for the convenience of the Owner, the Contractor shall not be entitled to any damages, including but not limited to loss of anticipated profits, and shall be entitled to compensation for Work satisfactorily completed and expenses actually incurred and overhead and profit thereon. Profit and overhead shall not exceed the percentages established in Section 11 of the General Conditions. Amounts for local or home office overhead shall not be allowed.

SECTION 16
DISPUTE RESOLUTION

16.1 ARBITRATION

Any dispute concerning this Agreement, or the performance, interpretation, or breach thereof, shall be settled by arbitration pursuant to the Construction Industry Arbitration Rules (the "Rules") of the American Arbitration Association (the "AAA") then in effect. The Arbitrator(s) shall have no power to render an award which has the effect of altering or amending or changing in any way any provision of this Agreement. The award of the arbitrator(s) shall be final and binding. Judgment upon any such award shall be rendered only by any state or federal court sitting in Bernalillo County, New Mexico. Any and all arbitration proceedings, including discovery ordered by the arbitrator(s) shall take place in Bernalillo County, New Mexico. In any such arbitration, the arbitrator(s) shall have the powers of a court having jurisdiction as well as all of the powers pursuant to the Rules. Without limiting the generality of the foregoing, the Arbitrators shall have the power to award attorneys' fees and other costs, in their discretion, and shall have the power to issue orders for injunctive relief.

16.2 INJUNCTIVE RELIEF

OWNER and Contractor consent and agree to the issuance of any temporary restraining order or preliminary injunction, by any Court sitting in Bernalillo County having jurisdiction, upon the application of any party to the arbitration. Such authority of a Court to order injunctive relief shall terminate upon completion of the appointment of an arbitrator(s) who will then have jurisdiction to issue orders for injunctive relief. Any party to the arbitration may apply to the Arbitrator(s) for issuance of an injunction or similar relief, and such application shall be heard by the arbitrator(s) within ten (10) days after the application is filed with AAA. Any Court in Bernalillo County, New Mexico having jurisdiction to render an order confirming the award of the arbitrator(s) shall have jurisdiction to enter an order confirming the issuance of such injunction and making it an order of the Court.

16.3 CONSOLIDATION AND JOINDER

OWNER and the Contractor consent to the joinder in arbitration of any party necessary for the complete resolution of all disputes arising out of the performance of contracts pertaining to the Work of the Project, including but not limited to the Engineer or Architect, as applicable, and its subcontractors and subconsultants and the Contractor and its subcontractors and suppliers and any other interested party. The City and the Contractor also consent to the consolidation of any arbitration under this Agreement with any other arbitration involving the performance of contracts pertaining to the Work of the Project.

16.4 ARBITRATION PROVISION REQUIRED

The CONTRACTOR shall require this arbitration provision (with appropriate changes in description of the parties) in all subcontracts of services to be performed to complete this Agreement. OWNER shall require this provision (with appropriate changes in the description of the parties) in its contract with the Engineer, Landscape Architect, Surveyor, or Architect (if any exist) selected for the project.

16.5 NOTICE OF DEMAND

Notice of demand for arbitration must be filed in writing with the other parties to this Dispute Resolution Section and with the AAA. The demand must be made within a reasonable time after the claim, dispute or other matter in question has arisen. In no event may the demand for arbitration be made after the date when institution of legal or equitable proceedings based on such claim, dispute or other matter in question would be barred by the applicable statute of limitations.

16.6 APPLICABILITY OF SECTION

This Section 16 shall be binding on the Contractor and Owner only in the event the Architect/Engineering Services Contract with a private Architect-Engineer firm for the Project contains a provision substantially similar to Section 16.1 through 16.5 provided, however, that such sections shall be binding if arbitration is required by any other general conditions required for the Project by any state or federal government agency, regardless of the Architect-Engineer Services Contract with Owner. In the event the Architect-Engineer is an employee of Owner, this section shall be binding on the Owner and Contractor.

SECTION 17
MISCELLANEOUS

17.1 GIVING NOTICE

Whenever any provision of the Contract Documents requires the giving of written notice it shall be deemed to have been validly given if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended or sent by certified or registered mail, return receipt requested, postage prepaid, to the last business address known to him who gives the notice.

17.2 COMPUTATION OF TIME

When any period of time is referred to in the Contract Documents by a certain number of days, such number of days shall be computed to include the first day of such period. Response time to notice given shall begin to run on the day the notice is delivered to the party that is required to respond.

17.3 GENERAL

17.3.1 CONTRACTOR shall not be entitled to interest on any periodic payment or final payment because of a delay in payment by OWNER.

17.3.2 All specifications, drawings, and other Contract Documents or copies thereof furnished by Owner or Engineer to Contractor are the property of Owner and shall not be used in any manner by Contractor on any other Project.

17.3.3 The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder and, in particular but without limitation, the warranties, guarantees, and obligations imposed upon CONTRACTOR by paragraphs 6.15, 13.1, 13.7, and 14.3 and the rights and remedies available to OWNER thereunder shall be in addition to and shall not be construed in any way as a limitation of any rights and remedies available to OWNER which are otherwise imposed or available by law, by special guarantee or by other provisions of the Contract Documents. All representations, warranties, and guarantees made in the Contract Documents will survive final payment and termination or completion of the Agreement.

17.3.4 Should OWNER or CONTRACTOR suffer injury or damage to his person or property because of any error, omission, or act of the other or of any of his employees or agents or others for whose acts he is legally liable, claim shall be made in writing to the other party within reasonable time of the first observance of such injury or damage.

17.3.5 The Contract Documents shall be governed by the laws of the State of New Mexico.

17.4 MINIMUM WAGES

17.4.1 CONTRACTOR and any Subcontractor performing Work under this Contract shall comply fully with the "Public Works Minimum Wage Act", Sections 13-4-11 through 13-4-17 NMSA 1978 and all amendments thereto, which provides in part that "the contractor, subcontractor, employer or any person acting as a contractor shall pay all mechanics and laborers employed on the site of the project unconditionally and not less often than once a week, and without subsequent unlawful deduction or rebate on any account, the full amounts accrued at time of payment, computed at wage rates not less than those stated in the minimum wage rates issued for the project."

17.4.2 The minimum hourly rate of wage which may be paid to workmen in each trade or occupation required for the Work under the Contract employed in the performance of the Contract either by CONTRACTOR or Subcontractor or by other persons doing or contracting to do the whole or part of the Work contemplated by the Contract shall be as set forth in the schedule of Minimum Wage Rates appearing in the Special Provisions, and the workmen employed in the performance of the Contract shall be paid not less than the applicable specified minimum hourly rate of wage as such is set forth in said schedule.

17.4.3 The scale of wages to be paid shall be posted by CONTRACTOR in a prominent and easily accessible place at the site of the Work; and it is further provided that there may be withheld from CONTRACTOR so much of accrued payments as may be considered necessary by OWNER to pay laborers and mechanics employed by CONTRACTOR or Subcontractor on the Work, the difference between the rates of wages required by the Contract to be paid laborers and mechanics on the Work and the rates of wages received by such laborers and mechanics and not refunded to CONTRACTOR, Subcontractors, or their agents.

17.4.4 The attention of CONTRACTOR and any Subcontractor performing Work under this Contract is directed to Section 13-4-12 NMSA 1978, which reads in part as follows:

A. As used in Section 13-4-11 NMSA 1978, 'wages,' 'scale of wages,' 'wage rates,' 'minimum wages,' and 'prevailing wages' include:

- (1) The basic hourly rate of pay, and
- (2) The amount of:

(a) the rate of contribution irrevocably made by a contractor, subcontractor or any person acting as a contractor to a trustee or a third person pursuant to a fund, plan, or program; and

(b) the rate of costs to a contractor, subcontractor, or any person acting as a contractor which reasonably may be anticipated in providing benefits to laborers and mechanics pursuant to an enforceable commitment to carry out a financially responsible plan or program which was communicated in writing to the laborers and mechanics affected for: 1) medical or hospital care, 2) pensions on retirement or death, 3) compensation for injuries or illness resulting from occupational activity, or 4) insurance to provide for any of the foregoing, and for 5) unemployment benefits, 6) life insurance, 7) disability and sickness insurance, 8) accident insurance, 9) vacation and holiday pay, 10) costs of apprenticeship or other similar programs, or for 11) other bona fide fringe benefits; but only where the contractor, subcontractor, employer, or any person acting as a contractor is not required by other federal, state, or local law to provide any of the foregoing or similar benefits.

B. The obligation of a contractor, subcontractor, employer or any person acting as a contractor to make payment in accordance with the prevailing wage determinations of the Director of the Labor and Industrial Division of the Labor Department, insofar as Section 13-4-11 NMSA 1978 or other sections of legislative acts incorporating Section 13-4-11 NMSA 1978 are concerned, may be discharged by:

(1) The making of payments in cash;

(2) The making of contributions of a type referred to in Subparagraph (a) of Paragraph (2) of Subsection A of this section; or

(3) The assumption of an enforceable commitment to bear the costs of a plan or program of a type referred to in Subparagraph (b) of Paragraph (2) of Subsection A of this section, or any combination thereof, where the aggregate of any payments or contributions and costs therefor is not less than the rate of pay described in Section 13-4-11 NMSA 1978, plus the amount referred to in this section."

In the event it is found by the Director of the Labor and Industrial Division of the Labor Department that any laborer or mechanic employed by CONTRACTOR or Subcontractor on the site of the Project covered by the Contract has been or is being paid as a result of a willful violation of a rate of wages less than the rate of wages required by the Contract, OWNER may, by written notice to CONTRACTOR and his Subcontractor, if the violation involves the Subcontractor, terminate their right to proceed with the Work or such part of the work as to which there has been a willful failure to pay the required wages; and OWNER may prosecute the Work to completion by contract or otherwise, and CONTRACTOR and his sureties shall be liable

to the State of New Mexico for any excess costs occasioned thereby. Any party receiving notice of termination of his contract or subcontract under the provisions of this section may appeal the findings of the director of Labor and Industrial Division of the Labor Department as provided in the Public Works Minimum Wage Act.

There is no representation on the part of OWNER that labor can be obtained at the hourly rates shown in the Special Provisions. It is the responsibility of bidders to inform themselves as to local labor conditions and prospective changes or adjustments of wage rates. No increase in the Contract Price shall be allowed or authorized on account of the payment of wage rates in excess of those listed.

The CONTRACTOR and any Subcontractor performing Work under this Contract shall submit certified copies of weekly payrolls to OWNER and the Labor and Industrial Division of the Labor Department not later than five (5) working days after close of the payroll period. Certified copies of payrolls shall also be submitted to ENGINEER if so requested. The scale of wages must be posted by CONTRACTOR at the Project site. The weekly payrolls shall conform to the following:

(1) Form and Content: Any particular form may be used for CONTRACTOR or Subcontractor payrolls, provided all payrolls contain the following information:

(a) The employee's full name, address, and social security number.

(i) The employee's full name and social security number need only appear on the first payroll on which his name appears.

(ii) The employee's address need be shown only on the first submitted payroll on which his name appears, unless a change of address necessitates an additional submittal to reflect the new address.

(b) The employee's classification(s)

(c) The employee's hourly wage rate(s); and, where applicable, his overtime hourly wage rate(s).

(d) The daily and weekly hours worked in each classification, including actual overtime hours worked (not adjusted).

(e) The itemized deductions made.

(f) The net wages paid.

(2) Numbering Payrolls: All payrolls shall be numbered starting with number one (1) for the first payroll at the beginning of the job and continuing in numerical order until the job is completed.

(3) Certification of Payrolls: CONTRACTOR and each of his Subcontractors shall submit

a weekly statement of compliance in the following form: (See Section 17.4.4).

17.4.5 MINIMUM WAGES (FEDERAL)

In the event that any work under this Contract involves Federal Funds, then the prevailing area Wage Rate Decision listed by the U.S. Department of Labor shall be made a part of this Contract. Whenever a conflict exists between the State and Federal Minimum Hourly Wage Rates, the higher of the conflicting wage rates shall govern.

17.5 ARCHAEOLOGICAL SALVAGE AND REPORTS

17.5.1 Where objects of historical, archaeological, and paleontological value, including ruins, sites, buildings, artifacts, fossils, and other objects of antiquity are encountered within the areas on which CONTRACTOR's operations are performed, CONTRACTOR shall postpone operations in the area, preserve such objects from disturbance or damage, and immediately notify OWNER and ENGINEER of their existence and location.

17.5.2 Upon receipt of such notification, OWNER will arrange for the disposition of the objects or for the recording of data relative thereto and will notify CONTRACTOR when it is proper for him to proceed with the Work in the affected area. In this regard, OWNER may consult the Museum of New Mexico or other appropriate agency as to the nature and disposition of such objects. If CONTRACTOR is directed to perform any work in salvaging said objects, CONTRACTOR shall do so in accordance with the "Changes in the Work" provision of Section 10.

17.6 MEASUREMENT

17.6.1 Measurement of Quantities for Unit Price Work

17.6.1.1 Unless otherwise specified, linear or area quantities of work such as grading, landscaping, paving, curb, gutter, walk, and other work of a similar nature shall be determined from measurements or dimensions of such work and computed in horizontal planes. However, linear quantities of underground cable, fencing, piling, and timber shall be considered as being the true length measured along the longitudinal axis thereof. For pipe work, see related sections; but if the method of measurement for pipe work is not stated therein, it shall be measured along the longitudinal axis of the pipe in place from center of manhole to center of manhole. A station when used as a definition or term of measurement will be one hundred (100) linear feet.

17.6.1.2 Volumetric quantities shall be determined by the average end area method unless otherwise specified or agreed in writing between CONTRACTOR and OWNER.

17.7 METHOD OF MEASUREMENT

17.7.1 Materials and items of work which are to be paid for on the basis of measurement shall be measured in accordance with the methods stipulated in the particular sections herein covering materials or types of work.

17.7.2 When material is to be paid for on a volume basis and it would be impracticable to determine a volume by the specified method of measurement or when requested by CONTRACTOR and approved by ENGINEER, the material will be weighed in accordance with the requirements specified for weight measurement and such weights will be converted to volume measurement for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by ENGINEER and shall be agreed to by OWNER and CONTRACTOR before such method of measurement of pay quantities will be adopted.

17.7.3 Unless otherwise provided, when mineral aggregate or roadway material is being paid for by weight, deductions from pay quantities will be made for the weight of water in excess of three percent (3%) if the material is to be treated with bitumen and six percent (6%) if the material is to be waterbound.

17.8 UNITS OF MEASUREMENT

Measurement shall be in accordance with U.S. Standard Measures. A pound shall be avoirdupois. A ton shall be two thousand (2,000) pounds. The unit of liquid measure shall be the U.S. gallon.

17.9 CERTIFIED WEIGHTS

All materials to be paid for at a contract unit price per ton shall be weighed on platform scales furnished by CONTRACTOR or his supplier of materials at CONTRACTOR's expense, or such materials may be weighed on certified public scales at CONTRACTOR's expense. All scales shall be of adequate size to permit the entire vehicle to rest on the scale platform while being weighed and shall have the same accuracy as a certified public scale. Scales furnished by CONTRACTOR shall be installed on beams, piers, or foundations of sufficient strength and bearing to prevent the weighing mechanism supporting the scale platform from settling. The weighing facilities shall include a weatherproof scale house which has a minimum floor area of thirty-two (32) square feet and which is equipped with adequate heat and light.

17.10 ASSIGNMENT

CONTRACTOR shall not assign the Agreement or sublet it as a whole nor assign any monies due or to become due to him hereunder, without the prior written consent of OWNER, and such consent shall

not relieve CONTRACTOR from full responsibility and liability for the Work and for the due performance of all of the terms and conditions of the Contract Documents.

17.11 GENDER, SINGULAR/PLURAL.

Words of any gender used in the Contract Documents shall be held and construed to include any other gender, and words in the singular number shall be held to include plural, unless the context otherwise requires.

17.12 ETHICS AND CAMPAIGN PRACTICES:

The Contractor agrees to provide the Board of Ethics and Campaign Practices of the City of Albuquerque or its investigator (the "Board") with any records or information pertaining in any manner to this Contract, or both, whenever such records or information are within the Contractor's custody, are germane to an investigation authorized by the Board, and are requested by the Board. The Contractor further agrees to appear as a witness before the Board as required by the Board in hearings concerning ethics or campaign practices charges heard by the Board. The Contractor agrees to require that all subcontractors employed by Contractor for services performed for this Contract shall agree to comply with the provisions of this Section. The Contractor and its subcontractors shall not be compensated under this Contract for its time or any costs incurred in complying with this Section.

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18.1 POLICY ON THE PROXIMITY OF WATER AND SEWER LINES

18.1.1 Whenever possible, it is desirable to lay parallel water and sewer lines at least ten (10) feet apart horizontally, and the waterline should be at higher elevation than the sewer. In cases where it is not practical to maintain a ten (10) foot separation, ENGINEER, after consultation with the Water Authority, may allow deviation on a case by case basis. Such deviation may allow installation of the sewer line closer to the waterline, provided the waterline is in a separate trench or on an undisturbed earth shelf located on one side of the sewer at an elevation such that the bottom of the waterline is at least eighteen (18) inches from the top of the sewer.

18.1.2 When water and sewer lines cross each other, the waterline shall be at least eighteen (18) inches above the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the waterline joints.

18.1.3 When it is impractical to obtain proper horizontal and vertical separation, the sewer line should be designed and constructed of pressure rated (125 psi) green plastic pipe (C900 or C905), and should be pressure tested similar to a water line to assure water tightness. When pressure rated pipe is required for a sewer crossing, it shall be installed the entire distance between the adjacent manholes.

18.2 EXISTING BUILDING SEWER SERVICES OR WATER SERVICE CONNECTIONS, AND REPLACEMENT OF MAINS.

18.2.1 Where building service line connections to existing sewer mains and water mains are encountered, CONTRACTOR shall ensure that the service line will not be disturbed or damaged. Should any service line connection be broken during the construction of the new line, it shall be replaced by the CONTRACTOR. In the case of a sewer service, the trench shall not be backfilled until the service line is inspected by OWNER'S Plumbing Inspector. In the case of a water service line, the trench shall not be backfilled until the service line is inspected by the Water Authority. No extra compensation will be allowed to the CONTRACTOR for this item. Unless specifically provided otherwise, OWNER assumes no liability for damage to or replacement of building sewer and water service line connections.

18.2.2 When a new sanitary sewer main is required as a replacement for an existing line, the alignment of the new line coincides with the existing line and the grade of the new line is approximately at the same grade as the existing line or lower, then the existing line shall be removed or dealt with as ordered by ENGINEER. The cost of this Work shall be paid for under the appropriate item in the

Bid Proposal. ENGINEER shall determine if it is necessary to pump sewage around the replacement work, or if it is possible to temporarily plug the sewer line during the replacement operation. In the case of by-pass pumping, it will be paid for as indicated in the Bid Proposal.

18.2.3 All work performed on privately owned sewer line and service lines must be inspected by the City of Albuquerque's Code Administration Division. In order that inspection by the Planning Department, Code Administration Division, Plumbing Section can be efficiently handled, with a minimum loss of time to CONTRACTOR, the following shall be noted:

18.2.3.1 Inspection arrangements for a sewer service line shall be made by the CONTRACTOR calling the City of Albuquerque, Code Administration Division, Plumbing Section.

18.2.3.2 Inspection requests called in between the hours of 8:00 a.m. and 12:00 noon will be inspected the same afternoon. Inspection requests called in between the hours of 1:00 p.m. and 5:00 p.m. will be inspected the following morning, except in cases of emergency.

18.3 WATER SYSTEM SHUT-OFF AND TURN-ON PROCEDURES

18.3.1 No one without written permission or direct supervision from the Water Authority Field Division Supervisor may operate any valve or fire hydrant which will cause water to flow within, into or out of the existing system. This includes new waterlines and extensions to the water system which have not been accepted but are connected to the existing water system.

18.3.2 When new waterline tie-ins to the existing water system are required, an electronic request and a street map for the water shut-off or water turn-on shall be submitted to the Water Authority. Request forms are found in the Water Authority Web Page at the following address:
<http://www.abcwua.org/content/view/471/746>

18.3.2.1 The request for a water shut-off or turn-on for a main designated as a Distribution Line must be submitted at least seven (7) working days before the date of the actual shut-off or turn-on. Request forms received after 8:00 a.m. will be logged in and scheduled on the following working day and the seven (7) working day requirement will commence.

18.3.2.2 The request for a water shut-off or turn-on for a main designated as a Transmission Line, Master Plan Line, Collector, or Well Collector Line must be submitted at least fourteen (14) working days before the date of the actual shut-off or turn-on. Requests received after 8:00 a.m. will be logged in and scheduled on the following working day

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and the fourteen (14) working day requirement will commence.

18.3.2.3 The request for a water shut-off or turn-on for a San Juan Chama designated transmission line or any other water line in the vicinity of San Juan Chama lines will be required to follow the procedures stated in the Water Authority Administrative Instruction No. 9 and must be submitted at least thirty (30) working days before the date of the actual shut-off or turn-on. Requests received after 8:00 a.m. will be logged in and scheduled on the following working day and the thirty (30) working day requirement will commence. CONTRACTOR shall complete the electronic request form, the electronic Request Form for Work Affecting San Juan Chama Transmission Lines, and submit all required design documentation.

18.3.3 - (intentionally left blank)

18.3.4 The reason for the water shut-off or turn-on shall be detailed and descriptive.

18.3.5 Water shut-offs may have to be scheduled at night or on weekends to accommodate water customers and traffic flow.

18.3.6 Water shutoffs involving Transmission, Master Plan, Collector, Well Collector, or San Juan Chama lines may not be permitted during the months of May through September due to the demand on the system. Construction schedules will need to be coordinated with the Water Authority, Plant & Field Divisions when these types of waterlines are impacted. All subsurface work around San Juan Chama transmission lines require special procedures outlined in the Water Authority Administrative Instruction No. 9.

18.3.7 If the water shut-off or turn-on cannot be done on the requested date, the Field Supervisor will notify the CONTRACTOR as soon as possible. The Water Authority shall have the authority to cancel scheduled water shut-offs if the Field Supervisor determines that:

18.3.7.1 CONTRACTOR is not ready to start work and completion of the work will extend beyond the requested time;

18.3.7.2 CONTRACTOR is lacking the necessary equipment, parts, or materials on the job site;

18.3.7.3 Any existing condition giving just cause to show that the scheduled water shut-off will extend beyond the requested time.

18.3.7.4 Field operating conditions have changed which may impact the number of customers or fire hydrants in the shut-off or turn-on request.

18.3.8 EMERGENCY BREAKS:

The Water Authority Field Division shall be notified immediately so that it can perform the shut-off.

18.4 RESPONSIBILITY OF THE CONTRACTOR

18.4.1 CONTRACTOR shall be held responsible for all costs for the repair of any and all damage to the Work or to any utility (which is previously known and disclosed by the utility) as may be caused by their operations. Utilities not shown on the drawings to be relocated or altered shall be protected and maintained by CONTRACTOR. Utilities which are relocated by others in order to avoid interference with structures and which cross the Work shall be maintained in their relocated positions by CONTRACTOR. All costs for such work shall be at CONTRACTOR'S expense without change in the Contract Price.

18.4.2 CONTRACTOR shall never unnecessarily interfere with or interrupt the services of any public or private utility having property within or adjacent to the streets, alleys and easements involved in the Work and shall take all necessary precaution and effort to locate and protect all underground conduit, cables, pipes, waterlines, sewers, structures, gas lines, trees, monuments, power lines, telephone and telegraph lines, traffic control devices and other structures, both below and above ground. CONTRACTOR shall give all public and private utility companies prior written notice, in no event less than forty eight (48) hours, for any work that the CONTRACTOR contemplates, which would interfere in any way whatsoever with the service of any existing public or private utility and Water Authority or City-owned facilities. If such public or private utility does not cooperate for the protection of its services, CONTRACTOR shall notify ENGINEER. Utility lines identified on plans shall be located by CONTRACTOR far enough in advance of construction work in order that the owner of such lines may raise, lower, realign or remove lines and structures, if necessary, and in order that ENGINEER may make any line and grade changes necessary should the existing utility lines conflict with the work under construction, providing such adjustments do not materially affect the Work. In the event an unplanned conflict between an existing, but previously unidentified, utility line and new construction arises, both the owner of such line and the ENGINEER will be notified immediately by CONTRACTOR. CONTRACTOR shall immediately report any damages to public or private property to the owner of the property involved, and to the ENGINEER.

18.4.3 CONTRACTOR shall repair or restore at his own expense any damage to public, Water Authority, City-owned, or private property, for which they are directly or indirectly responsible, to a condition equal to that existing before damage. The CONTRACTOR shall promptly notify

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their insurance carrier of such damage. If CONTRACTOR fails to give such notice to his insurance carrier or refuses to perform such repairs or restoration upon receipt of notice, OWNER may cause such repairs or restoration and deduct the cost thereof from monies due, or which may become due, the CONTRACTOR.

18.4.4 CONTRACTOR shall not remove, realign, or adjust any official City traffic control device including stop signs, warning signs or any other traffic or parking control signs. CONTRACTOR shall give the Construction Coordinator three (3) working days prior notice of any official City traffic control devices that need to be moved. The Construction Coordinator shall take all appropriate actions as soon as practical thereafter.

18.5 LOCATION OF EXISTING UTILITIES

18.5.1 The public and private utility owners shall be responsible to locate their utilities and provide information stating the horizontal alignments of same. If field verification excavations are required, the utility owner will provide same in a timely manner. Utility locations may be obtained by calling the New Mexico One Call System, telephone (811 or 505-260-1990), two (2) working days in advance.

18.5.2 Utilities, which upon exploration are found to interfere with the permanent project work, or if for safety and/or to facilitate construction, it may be necessary to remove exposed lines from the trenching prism, will not be relocated, altered, or reconstructed without the concurrence of the utility owner involved; or ENGINEER may order changes in location, line, or grade of structures being built in order to avoid the utilities. The cost of such changes will be paid for under applicable bid items.

18.5.3 In certain cases where indicated on the drawings, CONTRACTOR shall locate utilities in advance of his construction operations in coordination with the appropriate utility owner. In these cases, CONTRACTOR shall determine the exact locations of utilities, backfill the excavations and construct either temporary or permanent resurfacing over the backfill. The temporary resurfacing shall be constructed when the exploratory excavations are made in an area located within the proposed Project excavations. Permanent resurfacing, when specified, shall be constructed when the exploratory excavations are made in an area located outside the proposed Project excavation and shall be constructed in accordance with the Excavation Ordinance which may require temporary resurfacing or plating. Said permanent resurfacing shall be of the type and thickness specified or as field conditions may otherwise require. In either case, the excavations shall be backfilled by the methods specified and to the relative density specified.

18.5.4 This exploratory excavation work shall be performed as soon as practical, and in any event, a sufficient time in advance of construction to avoid possible delays to CONTRACTOR'S work. All costs for making such exploratory excavations (including the backfilling and the resurfacing as specified herein) shall be at CONTRACTOR'S expense without change in the Contract Price.

18.6 UNKNOWN UTILITIES DISCLOSED DURING THE CONTRACT WORK

18.6.1 In the event that a utility is disclosed subsequent to the award of the Contract, such utility not being indicated on the drawings, or in the event that an existing utility is found to be in a materially different location than shown on the drawings and thus requires additional work on the part of CONTRACTOR for its maintenance, relocation or support, the necessary alteration, relocation, proper support and protection shall be done and paid for as follows:

18.6.1.1 When said utility is found to occupy the space to be occupied by a part of the permanent works to be constructed or when this utility is, in the opinion of ENGINEER, in such close proximity to the new work as to require the relocation or alteration of said utility, CONTRACTOR shall arrange with the utility owner for such relocation or alteration as directed by ENGINEER.

18.6.1.2 When any portion of the utility is in close proximity and more or less parallel to a structure or conduit, CONTRACTOR shall advise owner thereof, and in cooperation with the utility owner, provide and place the necessary support for proper protection to ensure continuous and safe operation of the utility infrastructure. All costs for such work shall be borne by CONTRACTOR.

18.6.2 In the event the CONTRACTOR discovers an unknown line, the CONTRACTOR shall immediately notify the ENGINEER in writing and all public and private utility companies to identify ownership and status. No work shall proceed that shall affect said line until written approval from the ENGINEER is obtained.

18.7 ABANDONED UTILITIES

18.7.1 Unless otherwise specified or directed, CONTRACTOR shall remove all interfering portions of utilities which are shown on the drawings as "abandoned" or "to be abandoned in place" and which interfere with the construction of the Project. All abandoned waterlines shown on the drawings as "abandoned" or "abandoned in place" or found during construction shall be removed or capped at a minimum, unless otherwise specified. All costs involved in said removals shall be included in the prices bid for the various items of Work. All such abandoned utilities

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removed by CONTRACTOR shall be disposed of or recycled.

18.7.2 Where utilities are shown on the drawings as “abandoned” or “to be abandoned in place”, it shall be the CONTRACTOR’S responsibility to contact the utility company involved, within forty eight (48) hours, prior to excavating around such utilities to ascertain that the abandonment of the utility has been completed.

18.8 COORDINATION FOR RELOCATION BY OTHERS

18.8.1 Where removal or relocation of facilities by others is shown on plans or found necessary through exploratory excavations, CONTRACTOR shall coordinate the work with that of the affected owner to minimize the scheduling impact on both parties.

18.8.2 Where parties other than CONTRACTOR are responsible for the relocation of utilities and a delay in CONTRACTOR’S work is caused by the failure on the part of said parties to remove or relocate such utilities in time to prevent such delay, or by any action or lack of action on the part of OWNER, it shall be understood that the CONTRACTOR shall not be entitled, as a result of such delays, to damages or additional payments over and above the Contract Price. If delays in CONTRACTOR’S work are caused by the reasons mentioned herein, CONTRACTOR shall be entitled to an extension of time. The length of such extension of time will be determined by ENGINEER with consideration as to the effect of the delay on the Project as a whole.

18.8.3 In order to minimize delays to the CONTRACTOR caused by the failure of other parties to relocate utilities which interfere with new facilities, CONTRACTOR upon request to ENGINEER may be permitted to temporarily omit the portion of the Work affected by the utility. The portion thus omitted shall be constructed by the CONTRACTOR immediately following the relocation of the utility involved.

SECTION 19

CONSTRUCTION TRAFFIC CONTROL

19.1 TRAFFIC CONTROL REQUIREMENTS

19.1.1 All construction signing, barricading, and channelization shall conform to the Manual on Uniform Traffic Control Devices (MUTCD) latest edition and with applicable regulations adopted by the Manager, Construction Coordination Division, Public Works Department (CONSTRUCTION COORDINATOR), and this Specification. It shall be the responsibility of the CONTRACTOR to ensure that all such signing, striping, barricading and channelization is installed, altered, or removed as required by this Section. The construction traffic control set-up shall be by an American Traffic Safety Services Association (ATSSA), or equivalent, Certified Traffic Control Supervisor (TCS) or Traffic Control Technician (TCT). The CONTRACTOR is responsible for all barricading.

19.1.2 CONTRACTOR shall at all times comply with the following:

- a.) Standards and requirements set forth in the MUTCD, latest edition.
- b.) The City of Albuquerque Traffic Code, latest edition.
- c.) Sections 19, 1200, and 2800 of the City of Albuquerque's Standard Specifications for Public Works Construction, as well as all other sections.
- d.) National Highway Cooperative Research Program (NHCPR), Report 350.

Failure to comply with any of these items will be adequate cause for the City to revoke all permits and to cease all work on any construction project. Work will not resume until all requirements are addressed and approved by the CONSTRUCTION COORDINATOR.

19.1.3 All construction signing, barricading, channelization and traffic control devices shall conform to the Quality Standards for Work Zone Traffic Control Devices, latest edition, as published by ATSSA. All traffic control devices shall be kept in like new and clean condition. The CONTRACTOR shall immediately remove any and all signing and traffic control devices which are deemed "unacceptable" or worse in condition. CONTRACTOR is responsible to maintain and service all traffic control devices 24 hours a day, 7 days a week throughout length and duration of project. Washing of equipment is incidental to the placement, servicing, and maintenance. When requested by the ENGINEER or the CONSTRUCTION COORDINATOR, replacement of unsatisfactory barricades

19.2.4 Five (5) working days prior to commencing construction, CONTRACTOR shall prepare and submit to the CONSTRUCTION COORDINATOR a detailed construction schedule. Two (2) working days prior to the

and traffic control devices shall be completed within four hours or the barricade permit is subject to revocation.

19.1.4 All category II traffic control devices used after January 1, 2004, shall meet current NHCPR Report 350 criteria.

19.2 PERMITTING

19.2.1 CONTRACTOR must obtain from the Construction Coordination Division an excavation and/or barricading permit before engaging in any construction, maintenance, or repair work in any City of Albuquerque right-of-way. Emergency work that would preserve life or property is excluded with the understanding that a permit shall be obtained within 24 hours.

19.2.2 Unless otherwise provided as part of a previously approved set of construction plans, CONTRACTOR shall at the time of permit request, submit for approval by the Construction Coordination Division, a traffic control plan detailing all existing topography such as lane widths, driveways, and business / residential accesses. The traffic control plan shall be prepared by a certified TCS or TCT, and shall include a complete signing, barricading, and detour plan with all phases of work and schedules involved in the construction project. Any separate phases of a construction project shall be given an individual permit. Blanket permits will not be issued. Permit durations shall not exceed thirty (30) days.

19.2.3 The traffic control plan shall be submitted to the CONSTRUCTION COORDINATOR for approval five (5) working days in advance of construction. The typical traffic control plans in the Standard Drawings do not reflect the existing field conditions and topography. A site specific traffic control plan must be submitted and approved when the Standard Drawings do not apply. Construction shall not begin unless a traffic control plan has been approved and verified by the Construction Coordination Division. The Construction Coordination Division shall be notified two (2) working days prior to any traffic control changes needed by contractor, that were not previously approved. These traffic control changes shall be requested in writing accompanied with a traffic control plan reflecting such changes. Any field adjustments shall be approved by the CONSTRUCTION COORDINATOR.

commencement of each phase of construction, CONTRACTOR shall obtain a barricading permit for the next phase from the Construction Coordination Division.

19.2.5 CONTRACTOR shall keep the Construction Coordination Division updated weekly on the construction schedule and/or phase schedule. Construction scheduling and sequencing reports for the following week are due to the Construction Coordination Division by noon on Thursday of the preceding week. Reports can be faxed to the Construction Coordination Division. The Construction Coordination Division shall keep the general public and media informed of the construction operations involving street or lane closures on arterial or collector roadways. The CONTRACTOR shall inform in writing all businesses and residents directly affected by the construction at least two days prior to the start of construction. Such notice shall include a name and telephone number of the CONTRACTOR's representative who is available 24 hours a day, seven (7) days a week.

19.2.6 CONTRACTOR shall not perform any work until all permits, rights-of-way or easements necessary for completion of the work are secured, including all drilling, boring, or jacking operations.

19.2.7 Unless otherwise approved by the CONSTRUCTION COORDINATOR, all work in Arterial roadways shall be on a continuous, 24 hour per day basis until completed. In other instances, depending on the location, type of project, duration of project, or other extenuating circumstances, the CONSTRUCTION COORDINATOR may require extended hour construction or restricted hour construction.

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SECTION 100

MATERIALS

100.01 GENERAL

The contents of Section 100 pertain to materials which are common public works construction items. For convenience selected materials in this section will be referenced in the appropriate construction activity. Materials which are incidental to only one construction activity will be defined in the activity's section.

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SECTION 101

PORTLAND CEMENT CONCRETE

101.1.1 GENERAL: Portland cement concrete, prestressed concrete, post tensioned concrete, shotcrete, gunite, and light weight structural concrete shall consist of a mixture of Portland cement, aggregates, water, and admixtures, proportioned, batched and delivered as specified herein. All materials and design mixes used in Portland cement concrete, either batched at or delivered to a project shall be certified in accordance with the requirements of Section 13 of these specifications. Each design mix submitted and authorized for use under this Specification shall be identified by a design mix number, unique to that design mix. If either a change in material(s) or material supplier(s) from that specified in the authorized design mix occurs during a project, authorized use of the job mix formula on the project may be canceled as directed by the ENGINEER. A concrete design mix shall not be used on a project without written authorization of The ENGINEER. A design mix, upon request by a concrete supplier, may be authorized by the Public Works Department Construction Division for use on City and City-related projects for a period of 14 months from the date of sampling of reference aggregates in the design mix.

101.1.2 For construction and reconstruction projects requiring portland cement concrete continuous placement(s) equal or greater than either 100 cubic yards of concrete per day, the CONTRACTOR shall have a full time portland cement concrete construction supervisor on site to direct the construction operations. The supervisor shall be certified either as an ACI certified Concrete Field Testing Technician Grade I, or the equivalent National Institute for Certification of Engineering Technologies Technician, with Specialty Concrete Work Elements Level I 82001, 82002, and Level II 84002, 84003, 84004, 84010. The supervisor shall be identified by the CONTRACTOR at the preplacement conference and shall be the contact person for the ENGINEER during concrete construction.

101.1.3 Pre-Placement Conference

A Pre-Placement Conference shall be held by the CONTRACTOR, as directed by the ENGINEER, no later than seven (7) calendar days prior to the start of construction for concrete continuous placement(s) equal or greater than either 100 cubic yards of concrete per day. The following meeting agenda/assigned responsibilities shall be accomplished at the conference.

I. ENGINEER/OWNER

- A. Scope of the project.
- B. Identify construction management team and contact telephone numbers.

- C. Review CONTRACT requirements for construction.
- D. Review Quality Assurance Program.

II. CONTRACTOR

- A. Review construction schedules.
 1. Placement schedules.
 2. Proposed construction schedule for duration of the project.
- B. Identify construction personnel and contact telephone numbers.
 1. Contractor Staff
 2. Sub-Contractor (s)
 3. Supplier (s)
 4. Safety Manager
- C. Present construction placement procedure plans.
 1. Equipment Schedule
 2. Concrete Design Mix
 3. Construction methodology
 4. Concrete pumping plan
 5. Traffic Control Plan
 6. Quality Control Plan

III. DISCUSSION AND COMMENT

101.2 REFERENCES

- 101.2.1 American Society for Testing and Materials (Latest Edition) (ASTM)
- C31 Making & Curing of Concrete Test Specimens in the Field
 - C33 Specification for Concrete Aggregates
 - C39 Test for Compressive Strength of Cylindrical Concrete Specimens
 - C42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 - C78 Test for Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
 - C94 Specification for Ready-Mixed Concrete
 - C125 Definition of Terms Relating to Concrete and Concrete Aggregates
 - C138 Air Content (Gravimetric), Unit Weight, and Yield of Concrete
 - C143 Test for Slump of Portland Cement Concrete specification. If required, certification
 - C150 Specification for Portland Cement
 - C172 Sampling Fresh Concrete
 - C173 Test for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - C192 Making & Curing of Concrete Test Specimens in the Laboratory
 - C227 Test for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar Bar Method)

C231 Test for Air Content of Freshly Mixed Concrete by the Pressure Method
 C260 Specification for Air Entraining Admixtures for Concrete
 C330 Specification for Lightweight Aggregates for Structural Concrete
 C441 Test for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to Alkali-Aggregate Reaction
 C494 Specification for Chemical Admixtures in Concrete
 C567 Unit Weight of Structural Lightweight Concrete
 C617 Capping Cylindrical Concrete Specimens
 C618 Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
 C685 Specification for Concrete Made by Volumetric Batching & Continuous Mixing
 C803 Test for Penetration Resistance of Hardened Concrete
 C805 Test for Rebound Number of Hardened Concrete
 D2419 Sand Equivalent Value of Soils and Fine Aggregates

101.2.2 American Concrete Institute (Latest Editions)

ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
 ACI 211.2 Standard Practice for Selecting Proportions for Structural Lightweight Concrete
 ACI 318-89 Building Code Requirements for Reinforced Concrete

101.2.3 This Specification:

SECTION 337 PORTLAND CEMENT CONCRETE PAVEMENT
 SECTION 340 PORTLAND CEMENT CONCRETE CURBS, GUTTERS, WALKS, DRIVEWAYS, ALLEYS, INTERSECTIONS, SLOPE PAVING, AND MEDIAN PAVING
 SECTION 346 TEXTURED CONCRETE
 SECTION 349 CONCRETE CURING
 SECTION 420 TRAFFIC SIGNAL AND STREET LIGHTING CONDUIT, FOUNDATIONS AND PULL BOXES
 SECTION 510 CONCRETE STRUCTURES
 SECTION 512 PRECAST PRESTRESSED MEMBERS
 SECTION 602 PORTLAND CEMENT CONCRETE FOR CHANNEL LINING AND DIKE AND DAM SURFACING

SECTION 701 TRENCHING, EXCAVATION AND BACKFILL

SECTION 800 INSTALLATION OF WATER TRANSMISSION, COLLECTOR AND DISTRIBUTION LINES

SECTION 900 SANITARY AND STORM SEWER FACILITIES

SECTION 915 STORM DRAINAGE APPURTENANCES

SECTION 1500 MONUMENTS

101.3 PORTLAND CEMENT

101.3.1 Portland cement to be used or furnished under this Specification shall comply either with the requirements of ASTM C150, Types I LA, II LA, III LA, and V LA, cements, or as specified herein, in the Supplementary Technical Specifications, Drawings, or as approved by The ENGINEER. The CONTRACTOR shall submit certification of compliance signed by the cement manufacturer, identifying the cement type and source (plant location), stating the Portland cement furnished to the project, and or used in the concrete delivered to the project complies with this Specification. If required, certification of the Portland cement used for each day's concrete placement shall be submitted to The ENGINEER for each type of cement and each design mix used on the project.

101.3.2 Portland cement specified in an authorized design mix shall be of the same source and type for all concrete batched at and/or delivered to a project under the authorized design mix identification number.

101.3.3 When suitable facilities (such as those recommended by the Concrete Plant Manufacturer's Bureau and/or approved by The ENGINEER) are available for handling and weighing bulk cement, such facilities shall be used. Otherwise, the cement shall be delivered in original unopened bags of the Manufacturer and the type of cement plainly marked thereon, each bag to contain 94 pounds (42.6 kg) of cement.

101.3.4 Cement shall be stored in such a manner as to permit ready access for the purpose of inspection and be suitably protected against damage by contamination or moisture. Should any lot of bulk cement delivered to the site show evidence of contamination, The ENGINEER may require that such lot be removed from the site.

101.3.5 Portland cement shall be measured by weight, lbs, (mass, kg) for concrete produced in accordance with the requirements of ASTM C94 and by volume for concrete produced accordance with the requirements of ASTM C685.

101.4 AGGREGATES:

101.4.1 Aggregates shall comply with the requirements of ASTM C33 and as amended herein, or as specified in the Supplementary Technical Specifications and Drawings, or as approved by the ENGINEER. Aggregates shall be certified to comply with the requirements of this Specification and authorized for use by The ENGINEER before the materials may be incorporated in the construction. Prior to delivery of the aggregates or material containing the aggregates, The CONTRACTOR may be required to furnish samples of the aggregates to The ENGINEER for testing. The CONTRACTOR's daily production aggregate gradations used in concrete shall be submitted to The ENGINEER upon request. Aggregates specified in an authorized design mix shall be of the same source and type for all concrete batched and delivered under the authorized design mix identification number.

101.4.2 In placing materials in storage or in moving them from storage to the mixer, no method shall be employed which may cause the segregation, degradation, or the combining of materials of different grading which will result in any stockpile not meeting specified requirements.

101.4.3.1 Aggregates supplied under this Specification shall be assumed to be "alkali-silica reactive", ASR. Variance from this position for a particular aggregate source may be authorized by The CITY ENGINEER. Application for a variance may be made to The CITY ENGINEER.

101.4.3.2 An aggregate may be classified non-alkali-silica reactive if, when tested in accordance with ASTM C227, using low alkali cement typical to the Albuquerque area, demonstrates an expansion at one (1) year not greater than 0.05%, and the rate of expansion is negative decreasing, based on test measurements at 1 month, 3 months, 6 months, 9 months, and 15 months, as authorized by the CITY ENGINEER.

101.4.3.3 Portland cement concrete design mixes using non alkali-silica reactive aggregates complying with 101.4.3.2 will not be required to be proportioned with Class F fly ash.

101.4.4.1 Coarse aggregates shall meet the gradation limits as specified in Table 2 of ASTM C33. Fine aggregates shall comply with the gradation requirements of ASTM C33, Section 4, Grading. The sand equivalent of fine aggregate, when tested in accordance with ASTM D2419, Sand Equivalent Value of Soils and Fine Aggregates, shall be greater than 75.

101.4.4.2 The maximum size aggregate shall comply with either these specifications, or the requirements of Table 101.A, or the Supplementary Technical Specifications, or

the recommendations of ACI 318-89, paragraph 3.3.2, or as required by The ENGINEER.

101.4.5 Aggregates shall be measured by weight (mass) for concrete batched under the requirements of ASTM C94 and by volume for concrete batched in accordance with the requirements of ASTM C685.

TABLE 101.A
MAXIMUM SIZE AGGREGATE

	Application	Size, in
I.	Pavement, Sidewalk, Curb and Gutter, Drive Pads, Wheel Chair Ramps, Slab on grade, Foundations, and Structures,	1
II.	Channels, minimum 5% retained on the 1 in sieve	1-1/2
III.	High Early Release Concrete, minimum 5% retained on the 1/2 in sieve	3/4
IV.	Stamped, Patterned, Stairs and Steps, minimum 5% retained on the 3/8 in sieve	1/2
V.	Formed Concrete	
	A. 1/5 the narrowest dimension between sides of forms,	
	B. 1/3 the depth of slab,	
	C. 3/4 of the minimum clear spacing between individual reinforcing bars or wires, bundles of bars, or prestressing tendons or ducts, or reinforcing and forms.	

101.5 WATER

Water used in Portland cement concrete shall be clean and free from injurious amounts of oil, acids, alkalis, salts, organic materials, or other substances that may be deleterious to the concrete or reinforcement. Non-potable water shall not be used unless the requirements of ACI 318.3.4.3.2 are met. Water shall be measured by weight or volume for concrete batched under the requirements of ASTM C94 and by volume for concrete batched in accordance with the requirements of ASTM C685.

101.6 ADMIXTURES:

101.6.1 Admixtures shall comply with the requirements of this specification. The CONTRACTOR shall submit a certification of compliance signed by the admixture manufacturer, identifying the admixture and its source (plant location), stating the admixture furnished to the project and/or used in the concrete delivered to the project complies with this Specification. Certification laboratory testing of an admixture shall be submitted by the CONTRACTOR to the

ENGINEER upon request. Admixtures specified in an authorized design mix shall be of the same source and type for all concrete batched and delivered as defined under a design mix identification number. Admixtures shall be measured accurately by mechanical means into each batch by equipment and in a method approved by the ENGINEER. An admixture shall not be used on a project without authorization by the ENGINEER.

101.6.2 Air-entraining agent, conforming to ASTM C260, shall be measured accurately by mechanical means into each batch by equipment and in a method approved by The ENGINEER. The air-entraining agent used shall not contain more than 0.035% chloride by weight. Air-entrainment content shall comply with the requirements Table 101.B., the Supplementary Technical Specifications, or the recommendations of ACI 318, latest edition.

TABLE 101.B ENTRAINED AIR CONTENT

Nominal Maximum Size Aggregate, in.	Air Content Range, (%)	
	min	max
1 / 2	5.5	8.5
3/4	4.5	7.5
1	4.5	7.5

101.6.3 Chemical admixtures shall conform to either the requirements of ASTM C494, or as specified in the Supplementary Technical Specifications, or as specified by The ENGINEER. Chemical admixtures shall not contain more than 0.035% chloride by weight.

101.6.4.1 Mineral admixtures shall be class "F" fly ash complying with the requirements of ASTM C618 including the requirements of TABLE 4, UNIFORMITY REQUIREMENTS, and the requirements of this Specification.

101.6.4.2 Mineral admixtures, when tested in accordance with ASTM C441, shall conform to the following:

Reduction in expansion @ 14 days, % , min, 100% Reliability	65.0
Mortar expansion @ 14 days, max, %	0.20
Expansion must be less than control sample expansion.	

101.6.4.3 The "Reactivity with Cement Alkalis" shall be determined using new Dow Corning glass rod base for aggregate. If a fly ash does not comply with the above requirement using the specified cement type, it may be authorized if the criteria is met using the low alkali Portland cement typically available to the Albuquerque area, as directed by the ENGINEER.

101.6.4.4 Mineral admixtures used or furnished under this Specification shall be certified quarterly, in a calendar year, to comply with this Specification by the supplier. Certification shall include test results and specifications, source and location.

101.6.4.5 Mineral admixtures shall be measured by weight (mass) for concrete batched under the requirements of ASTM C94 and by volume for concrete batched in accordance with the requirements of ASTM C685.

101.6.5 Accelerating admixtures may be used in Portland cement concrete batched and supplied under this Specification only when approved by The ENGINEER. The accelerating admixture used shall be a non-chloride type. A design mix proportioned with an accelerating admixture shall be submitted as specified in paragraph 101.8.8. and authorized by The ENGINEER, prior to use on a project.

101.7 PROPORTIONING

101.7.1 Portland cement concrete shall be proportioned in accordance with the requirements of ACI 318, latest edition, Chapter 5, either ACI 211.1 or ACI 211.2 (latest editions), and Table 101.C of this Specification, either field experience or trial mixtures, and the construction placement requirements selected by the CONTRACTOR. The CONTRACTOR shall be solely responsible for the portland cement concrete design mix proportions for concrete either batched at, or delivered to, placed and finished at the site. Certification of a design mix and all component materials, including all formulations of a mix and any and all admixtures which may be used under special construction conditions and environments with that mix to include high range water reducers (super-plasticizer), accelerating admixtures and retarders, and any other admixture, shall comply with the requirements of Section 13 of this Specification.

101.7.1.1 Design mix(es) shall be prepared in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, and operated under the direct supervision of a New Mexico registered Professional Engineer.

101.7.1.2 The testing equipment used in the design development testing shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certificates of calibration shall be maintained at the laboratory for review by The ENGINEER. A copy of the certifications shall be submitted to The ENGINEER upon request. A portland cement concrete design mix shall

not be batched at and/or delivered to a job site without written authorization of The ENGINEER.

101.7.1.3 A design mix shall be prepared under the direct supervision of a New Mexico Registered Professional Engineer.

101.7.2 Portland cement shall be proportioned to comply with the requirements specified in Table 101.C, or as specified in the Supplemental Technical Specifications, or Plans, or as authorized by The ENGINEER.

101.7.3 The mineral admixture class F fly ash shall be proportioned by weight of cement to provide a fly ash to portland cement ratio not less than 1:4, not less than 20 per cent of the total cementitious material. Portland cement concrete submitted under this Specification shall be proportioned with Class F fly ash, unless a variance is authorized by the City Engineer.

101.7.4 The water to total cementitious material ratio shall not be greater than specified in Table 101.C, or the maximum determined from a "trial mix" compressive strength vs. water to cementitious ratio curve, defined in accordance with ACI 318, latest edition, Chapter 5. The trial mix compressive strength water to cementitious material ratio curve shall be developed with the target slump at design application maximum, ± 0.75 inches, and the target entrained air content at design application maximum, ± 0.5 per cent, using materials specified in the design submittal. The cementitious material shall be defined as the total weight of portland cement and Class F fly ash in design mix.

101.7.5.1 A design mix submittal shall include but not be limited to the following information, as directed by the ENGINEER.

A. Certification of compliance of the design mix with the requirements of this Specification in accordance with Section 13 of these specifications by the New Mexico Registered Professional Engineer in responsible charge of the design mix development;

B. Certification of compliance of design mix's component materials by a manufacturer/supplier. The certification shall include laboratory test results of companion samples of the component material used in the laboratory prepared design mix, verifying the component materials comply with the specifications. For a mix design based on statistical methods, certification(s) of component materials shall be based on results performed within two (2) months of the submittal date.

C. Plastic characteristics of the design mix to include concrete temperature, slump, entrained air content, wet unit

weight, yield and cement factor, reported in English and metric units;

D. Performance characteristics of the hardened concrete to include the compressive strength of all test cylinders averaged for a respective test and the corresponding average compressive strength reported in English units;

E. Compressive strength test (3 cylinder tests each point) shall be reported for each water to cementitious material ratio design mix proportioned at 3, 7, 14 and 28 days laboratory cure normal concrete; and, 1 day, 3 days, 7 days and 28 days laboratory cure for high early release concrete.

F. The "trial mix" compressive strength vs. water to cementitious ratio curve graphically plotted to include the water to cementitious ratio for the proposed design mix. A proposed design mix water to cementitious ratio outside the limits of a trial mix curve shall be rejected.

G. When a proposed design mix is based on statistical analysis of historical data, certification that the design mix represented by the historical data was batched with the same or similar materials from the same sources as the materials proposed in the design mix shall be included in the submittal. Under this design certification procedure, the proposal shall include a statistical analysis for a period of 12 months prior to sampling aggregates of the characteristics of a) slump, b) entrained air, and c) f'_c @28 day compressive strength test. A compressive strength test shall be the average of two (2) cylinders tested at 28 days. An annual average aggregate gradation analysis may be used if the data represents the 12 month period prior to sampling for a design mix. A minimum of three production gradations per month will be required in the data base, as directed by the ENGINEER.

H. Batch proportions for concrete Made by Volumetric Batching and Continuous Mixing. ASTM C685, shall include 1) component batch weights, 2) component batch volumes, and 3) gate settings for each type of batching equipment the design mix that may be batched.

J. High Range Water Reducing Admixture(s) (hrwra), Superplasticizers

- a. A prescription for use of the hrwra in a design mix shall be provided by the CONTRACTOR to include but not limited to the following
 1. Maximum dosage per cubic yard (meter) by standard measure, ozs/yd³;
 2. Admixture introduction location (plant or Job site);
 3. Minimum mixing after admixture introduction (drum revolution count at mixing speed);
 4. Air entrainment dosage adjustment, if required;
 5. Base mix water reducing admixture (wra) dosage

- adjustment, if required;
- 6. Consistency (slump) targets for before and after admixture introduction;
- 7. Concrete temperature limitations, if required; and,
- b. Laboratory demonstrated performance of the design mix, at the specified maximum admixture dosage, shall be reported, including slump, entrained air content, unit weight, water to cementitious materials ratio, seven (7) and twenty eight (28) day compressive strength (fc), and three (3) days and seven (7) day compressive strength (fc) for high early release concrete. Submittal compressive strength shall be based on the average value of three cylinders required.

K. Accelerating Admixture(s)

- a. A prescription for use of the accelerating admixture in a design mix shall be provided by the contractor to include but not limited to the following:
 - 1. Maximum dosage per cubic yard (meter) by standard measure, ozs/yd³;
 - 2. Concrete temperature limitations, if required;
 - 3. Admixture introduction location, plant or project;
 - 4. Restrictions of use in combination with other admixtures, as applicable; and,
- b. Special considerations for mixing, placing, and curing, as applicable.

L. Color Admixture(s)

- a. A prescription for use of a color admixture in a design mix shall be provided by the CONTRACTOR to include but not limited to the following:
 - 1. Maximum dosage per cubic yare (meter) by standard measure, ozs/yd³;
 - 2. Admixture introduction location, plant or project;
 - 3. Restrictions of use in combination with other admixtures; and
- b. Special considerations for mixing, placing, and curing, as applicable.

M. Submittal Format

- a. A standard design mix submittal may include some or all of the above information as directed by the CONTRACTOR to define use as “optional” admixture(s). The standard design mix code would be the same for applications with and without the optional admixture(s)
- b. A specific design mix submittal can be made to include either color, or accelerating, or high range water reducing admixture for use under a specified application only. Separate design mix submittals will be required to include the information specified above.

101.7.5.2 A submittal shall be rejected if it does not include the specified information and samples. A design mix submittal shall be accepted or rejected within ten (10) days of receipt by the ENGINEER.

TABLE 101.C - DESIGN MIX SPECIFICATIONS-PORTLAND CEMENT CONCRETE (1, 2, 3)

Application	Use In Section(s)	f'c @ 28 days (4) minimum psi	Entrained Air Range [1.1] (%)	Slump, Not To Exceed, nte (5)		Portland Cement Min, lbs./cy	w:(c+fa) max [7]
				Placement	inches Norm HRWRA		
<u>Interior Concrete</u> (heated areas): foundations and slab on grade.	510	3,000	(See par.101.7.2)	Hand Place	4 6	423	0.50
<u>Exterior Concrete</u> structure foundations, slab on grade, sidewalks, drive pads, wheel chair ramps, stamped pattern concrete, steps/stairs, curb & gutter, valley gutter, storm drain drop inlets, manhole bases, retaining walls, and miscellaneous concrete.	340, 346, 420, 510, 511 701, 800, and 1500	3,000	(See par.101.7.2)	Hand Place Slip Formed	4 6 2 3	470	0.45
<u>Pavement</u> For design of PCCP, use MR= 600 psi.	337	4,000	(See par.101.7.2)	Hand Place Slip Formed	4 6 2 3	564	0.40
<u>Hydraulic Structures</u> Storm drain structures and channels, and water reservoirs	510, 512, and 602	3,500	(See par.101.7.2)	Hand Place Slip Formed	4 7 2 3	517	0.40
Sanitary sewer structures and SAS manhole bases	900	4,000	(See par.101.7.2)	Hand Place Slip Formed	4 7 2 3	658 (6)	0.40
<u>Structures</u> - Buildings, bridges/bridge decks, and parking structures (8) (9).	510	4,000	(See par.101.7.2)	Hand Place Slip Formed	4 7 2 3	564	0.40
Sanitary sewer structures and manhole bases (8) (9).	915	4,000	(See par.101.7.2)	Hand Place Slip Formed	4 7 2 3	658 (6)	0.40
High Early Release Concrete fcr= 3,400 psi @ release to service (10)	All applications	4,000 @ 7 days	(See par.101.7.2)	Hand Place Slip Formed	4 7 2 3	Design	Design

1. Use of material(s) not defined by this specification must be approved by the ENGINEER and the COA Materials & Testing Laboratory.

2. Maximum size aggregate shall comply with the requirements of par. 101.4.4.2.

3. Portland cement concrete shall be proportioned with Class F fly ash complying with the requirements of 101.6.4, proportioned 1: 4, minimum, fly ash to portland cement, by weight (mass).

4. MR-Modulus of Rupture, Compressive Strength (f'c) at 28 days.

5. When authorized by the ENGINEER, a high range water reducing admixture (HRWRA), super plasticizer, may be used to increase slump. When a HRWRA is proposed for use on a project. The design mix shall be proportioned to include the HRWRA. The use of a HRWRA in a design mix that was not originally proportioned with a HRWRA is not acceptable under this specification. Higher slump(s) may be used, as directed by the ENGINEER.

6. If portland cement complying with ASTM C150 Type VLA is used, a minimum of 564 lbs/cy may be used.

7. "w : (c+fa)" is defined as water to cementitious materials ratio. Cementitious material is the sum of the portland cement and fly ash, by weight (mass).

8. Lightweight structural concrete for structures, parking decks, and bridge decks shall be proportioned with a minimum compressive strength of f'c= 4,750 psi @ 28 days.

9. Minimum requirements for prestressed/post tensioned concrete. Actual criteria may differ as specified in the plans and supplemental technical specifications.

10. "High Early Release Concrete" is specified where early release of structure to either service or construction loads may be required, as authorized by the ENGINEER. "fcr" is the minimum compressive strength for release, as determined by field cured cylinders. Maximum size aggregate shall be 3/4 inch (19 mm).

11. Designated interior concrete, placed, finished, cured, and maintained by the Contractor in a temperate environment of 40°F or greater, may be constructed with non air entrained concrete complying with all other requirements of this specification for the calendar period after April 30 and before October 1, as authorized by the Engineer. Concrete for wet exposures, showers and wash down areas, vehicle repair and storage floors shall not be included in this variance.

101.8 BATCHING

101.8.1 Portland cement concrete shall be batched in accordance with the requirements of either ASTM C94, or ASTM C685, and the requirements of this Specification, as authorized by the ENGINEER. Batching facilities, mixing, and transporting equipment shall be certified within 12 months prior to batching of a design mix. The plant shall be certified by a NM Registered Professional Engineer, to comply with the requirements of this Specification and Section 13. The certification shall have been completed within 12 months of batching an authorized portland cement concrete design mix. Written certification shall be available for review at the plant by the ENGINEER, and, submitted to the ENGINEER upon request.

101.8.2.1 Ready-mix concrete batch plants shall be certified to comply with the requirements of this Specification. Written certification of compliance shall be available for review at the batch plant by The ENGINEER.

101.8.2.2 Central-Mix Batch Plants shall be certified to comply with this Specification and standards of the National Ready-Mix Concrete Association. The central-mixers rated capacity shall be posted at the batch plant in the operator's area.

101.8.2.3 Portable batch plants shall be certified after erection at a project and prior to batching concrete to be used at the project site. The batch plants rated capacity shall be posted at the batch plant in the operator's area.

101.8.2.4 Ready-mix concrete trucks shall be certified to comply with the requirements of this Specification and the "Standards for Operation of Truck Mixers and Agitators of the National Ready-Mix Concrete Association", and the "Truck Mixer Manufacturer Bureau", latest editions. Written certification of compliance shall be carried in/on the vehicle for verification by The ENGINEER. The manufacturers rated capacity, mixing and agitating speeds shall be posted on the truck mixer. Mixers shall have an operable mixer drum revolution counter and water metering system to measure temper water that may be added to a mixer after batching and prior to discharge of a load.

101.8.2.5 Shrink-mixed concrete batching shall be certified to comply with the requirements of this Specification. Written certification of the program to include a) maximum concrete volume defined for the process/equipment, b) minimum time of mixing in the stationary mixer of materials after the addition of all cementitious material, and, c) minimum supplemental mixing revolutions in the transit mix truck. A copy of the certified procedure shall be available at the batch plant for review by The ENGINEER, and submitted upon request. The ENGINEER shall be notified by the CONTRACTOR in writing which concrete supplied to a project is produced with this procedure. Shrink mixed

batching shall not be used on a project without authorization by the ENGINEER.

101.8.2.6 Volume batching central mix and concrete mobile trucks shall be certified to comply with this Specification. Certification shall include discharge gate settings/material weight batching references for each material carried and a certified water meter and calibration chart to define water settings. Discharge calibration settings shall be established for each production batching rate and authorized design mix batched. The equipment shall be recalibrated if a change in materials or source of materials occurs. Written certification of compliance shall be carried in/on the vehicle for verification by The ENGINEER.

101.8.2.7 On-site batching and mixing equipment for concrete volumes of less than 1 cubic yard shall conform to the requirements of ASTM C192, and shall be approved by The ENGINEER. On-site batched concrete for volumes less than 1 cubic yard shall be either "Redi-2-Mix", "Quikrete", or equal prepackaged concrete mix. The concrete shall be proportioned with water not to exceed a maximum of 1.5 gallons per 60 lbs./bag or equivalent. Concrete batched under this paragraph shall not be used for finished, interior and/or exterior exposed concrete surfaces.

101.9 MIXING

101.9.1 Concrete batched in accordance with ASTM C94, shall be mixed in accordance with the requirements of that Specification and as follows.

101.9.2 Central-Mixed Plants: Concrete mixed in a stationary mixer and transported to the point of delivery shall be mixed from the time all the solid materials are in the drum. The batch shall be so charged with some water in advance of the aggregates and cementitious materials, and all water shall be in the drum by the end of one-fourth the specified mixing time. Mixing time shall be a minimum of 1 minute for the first cubic yard plus 15 seconds for each additional cubic yard, or fraction thereof additional capacity. Where mixer performance tests have been conducted in accordance with ASTM C94, with the mixer to rated capacity, the mixing time may be reduced to the time at which satisfactory mixing defined by the performance tests shall have been accomplished. When the mixing time is so reduced the maximum mixing time shall not exceed this reduced time by more than 60 seconds for air entrained concrete. Certified concrete uniformity tests shall be conducted in accordance with ASTM C94 and Section 13. If the uniformity requirements are not met, that mixer shall not be used until the condition is corrected.

101.9.3 Shrink-Mixed Concrete:

Concrete mixed in a shrink mix production program shall be mixed in accordance with the certified shrink mix program as defined by The CONTRACTOR. Concrete shall be mixed in a stationary mixer not less than the certified

minimum mixing time after all ingredients are batched into the drum, and not less than the minimum mixing revolutions specified for the transit mix truck after the load is transferred into the transit mix truck. Mixing in the transit mix truck shall not exceed the maximum requirements of paragraph 101.9.4. Shrink-mixed concrete procedures shall be certified to provide concrete that complies with the uniformity specifications of ASTM C94 as determined by uniformity tests specified in ASTM C94, for the maximum batch volume of concrete defined by The CONTRACTOR. If uniformity requirements are not met for the combination of stationary plant and transit mixers, the shrink mix program shall not be used. Tempering of shrink mix concrete at the job site shall comply with the requirements of 101.10 and 101.11.

101.9.4 Truck-Mixed Concrete:

Concrete mixed in a truck mixer shall be mixed after all ingredients including water, are in the drum at least 70 revolutions and not more than 100 revolutions at the mixing speed as defined by the Manufacturer. The mixing speed for the mixer shall be identified on the mixer. Certified concrete uniformity tests shall be conducted on transit mixer trucks in accordance with ASTM C94 and Section 13 annually. If the uniformity requirements are not met, that mixer shall not be used until the condition is corrected. Mixing beyond the number of revolutions at mixing speed found to produce the required uniformity of concrete shall be at the agitation speed defined by the mixer manufacturer. The manufacturer's recommended mixing and agitation speeds shall be posted on the truck mixer.

101.9.5 Volume Batched Concrete:

Concrete batched in accordance with ASTM C685, shall be mixed in accordance with the requirements of this Specification and the Manufacturer's recommendations. The continuous mixer shall be an auger type mixer or any other type suitable for mixing concrete to meet the requirements for uniformity specified in ASTM C685,

101.10 TEMPERING BATCHED CONCRETE

101.10.1.1 The slump of a concrete mix sampled at final discharge shall comply with the requirements of TABLE 101.C. Non complying material shall be removed from the structure as directed by the ENGINEER.

101.10.1.2 A load of concrete may only be tempered with water after the mix cycle is complete when, upon arrival at the job site, the slump of the concrete is less than specified, and the time limit and revolution limit specified in 101.9 are not exceeded.. When additional water is required, the total water in the truck shall not exceed the maximum water to cementitious ratio specified in the authorized design mix when the concrete is discharged. When tempering is required and allowed as defined by the water to cementitious ratio for the design mix, the water shall be injected into the mixer and the drum or blades turned a minimum of 30

revolutions at mixing speed before discharge as long as the revolution limit specified in 101.9 is not exceeded.. Additional water shall not be added to the batch after tempering without authorization by The ENGINEER.

101.10.1.3 When the slump of a sample taken within the time limits specified in 101.9 the specification requirements of TABLE 101.C, the mixer truck may be mixed a minimum of 15 revolutions at mixing speed, as long as the revolution limit specified in 101.9 is not exceeded, sampled and tested. If the slump of the second sample exceeds the maximum specified slump by 0.25 in (6 mm), the load may be rejected as directed by the Engineer.

101.10.2.1 The air content in air entrained concrete, when sampled from the transportation unit at the point of discharge, shall comply with the requirements of this specification. Non complying material shall be removed from the structure as directed by the ENGINEER.

101.10.2.2 When a preliminary sample taken within the time limits specified in 101.9 and prior to discharge for placement shows an air content below the minimum specified level, the CONTRACTOR may add additional air entraining admixture to achieve the specified air content, if the revolutions on the drum counter are less than 300, and the total revolutions, after air entrainment addition will not exceed 300 following mixing a minimum of 30 revolutions at mixing speed after dosage with the admixture. Additional air entraining admixture may not be added to the batch after the initial air entraining admixture tempering. Air entraining admixture shall be batched in accordance with 101.7.2. In addition to sampling and testing for compliance after tempering with the air entraining admixture, a sample shall be taken during discharge from the second half of the load to verify slump and entrained air compliance through the load with the specification.

101.10.2.3 When the entrained air exceeds the specified requirements, the load may be mixed a minimum of 15 revolutions, sampled and tested, if the drum revolutions do not exceed 300, and will not exceed 300 following mixing. If the entrained air exceeds the specification by 0.1 %, the load may be rejected as directed by the ENGINEER.

101.10.3 High range water reducing admixtures, superplasticizers shall be batched as recommended by the manufacturer.

101.10.4 Aggregates and cementitious material may not be used to temper a batched load of portland cement concrete.

101.10.5 All samples shall be tested for slump, entrained air, and unit weight after tempering..

101.10.6 The field dosage amounts of admixtures and water shall be reported on the truck ticket.

101.10.7 The OWNER shall pay for quality assurance sampling and testing specified 101.15, or as directed by the ENGINEER.

101.11 DELIVERY & DISCHARGE:

101.11.1 Discharge of the concrete shall be completed within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. These limitations may be waived by The ENGINEER if (1) the concrete is proportioned and certified for use after mixing/agitation time in excess of 1-1/2 hrs, or (2) is of such a slump that it can be placed and finished, without the addition of water to the batch after the time limit noted above is exceeded. In hot weather or under conditions contributing to quick stiffening of the concrete, a time less than 1-1/2 hrs. may be specified by The ENGINEER.

101.11.2 The minimum discharge temperature of concrete in cold weather shall be equal or greater than the temperature specified in Table 101.D.

TABLE 101.D - Cold Weather Construction
Concrete Temperature, min [1]

Ambient Air Temperature	Thin Sections	Heavy Sections & Mass Concrete [2]
30 to 45 °F	60°F	50°F
0 to 30 °F	65°F	55°F
Below 0 °F	70°F	60°F

[1] The maximum concrete discharge temperature of all concrete, except "high early release concrete", produced with heated aggregates, heated water, or both, shall be 70°F. The discharge temperature of "high early release concrete" in cold weather shall be 70 °F - 76 °F.

[2] Sections having dimensions in all directions greater than 2 feet (24 inches)

101.11.3 The discharge temperature of concrete in hot weather should be kept as cool as possible. Concrete supplied to a project site having a discharge temperature greater than 90 °F may be rejected by The ENGINEER if the concrete cannot be placed and finished after a single tempering with water as authorized under 101.10. Retarding admixtures may be used to control setting in hot weather. The discharge temperature of "high early release concrete" in hot weather shall be specified by the CONTRACTOR.

101.11.4 The CONTRACTOR shall provide to The ENGINEER with each batch of concrete batched and/or delivered to the job site, before unloading at the site, a

delivery batch ticket on which the information specified in TABLE 101.E is printed, stamped or written, certifying said concrete. One copy of the ticket shall be available for the ENGINEER and one copy of the ticket shall be available for the quality assurance testing program.

TABLE 101.E
BATCHING TICKET INFORMATION
REQUIREMENTS

- A. Name of Concrete Supplier
- B. Delivery Ticket Number
- C. Date of Delivery
- D. Contractor
- E. Project Name (Optional)
- F. Design Mix Number
- G. Volume of Concrete in Load
- H. Time loaded
- J. Batched Weight (mass) of Cement
- K. Batched Weight (mass) of Fly Ash
- L. Batched Weight (mass) of Fine Aggregate
- M. Batched Weight (mass) of Coarse Aggregate(s)
- N. Batched Weight (mass) or Volume of Each Admixture
- O. Weight or volume of water batched at the plant
- P. Design Mix Target Proportions
- Q. Weight or volume (gal.) of temper water added at the site
- R. Weight or volume of each temper admixture added at the site
- S. Signature and name (printed) of CONTRACTOR'S representative who authorized the tempering, if any, at the site and affiliation to project

101.12 PLACEMENT

101.12.1 Portland cement concrete shall be placed to the lines, sections, grades and elevations, with the procedures specified in the CONTRACT documents. The material shall be consolidated to eliminate all voids, internal rock pockets and defects in the finish concrete. Casting subgrade and formed surfaces shall be damp, at the placement of the concrete. Removable forms shall be treated with a form release agent prior to placement of the forms for ease of removal of the forms without damage to the supported concrete. Forms shall be sealed to prevent leakage. Form release agents shall not stain the adjacent concrete. Placement and finishing shall be completed prior to the start of the initial set of the concrete.

101.12.2.1 The CONTRACTOR shall submit a concrete pumping plan to the ENGINEER for review and authorization one week prior to the start of a pumped

concrete construction program for placements complying with 101.1.1.1. The submittal should identify the pump manufacturer, size and type, rated capacity(s) for the line diameter(s) to be used and distance(s) to be pumped.

101.12.2.2 Pumping shall conform to the recommendations of the pump manufacturer. The pump manufacturer's operation manual shall be available on the pump equipment, and submitted to the ENGINEER, upon request.

101.12.2.3 Concrete shall be pumped in a uniform continuous flow to point of discharge, with all lines kept full, during the pumping operation. The CONTRACTOR shall provide either a system for controlled discharge of the concrete, or the last 5 feet of the pump line, immediately prior to the line discharge opening, shall have a slope equal or less than 10:1, horizontal to vertical, during the pumping of concrete, as authorized by the ENGINEER. The concrete shall not be dropped a vertical distance greater than four feet at discharge from the pump line without a tremey. Concrete placed by pump shall conform to the requirements of this specification after discharge from the pump line. Pumping of concrete shall not commence without authorization by the ENGINEER.

101.13 FINISHING

The CONTRACTOR shall finish Portland cement concrete as required by the CONTRACT documents, Supplemental Technical Specifications, or as directed by the ENGINEER.

101.14 CURING CONCRETE

The CONTRACTOR shall cure concrete as required by the CONTRACT documents, SECTION 349 of this specification, the Supplemental Technical Specifications, or as directed by the ENGINEER. A concrete structure or element shall not be released to service loads until it has achieved a minimum of 85% of the design strength, f'_c , at the time the structure is placed in service, or the curing program specified in SECTION 349 is completed, or as directed by the ENGINEER. Service loads shall include construction loads, design loads and environmental exposure.

101.15 QUALITY ASSURANCE SAMPLING AND TESTING

101.15.1.1 Quality assurance sampling and testing shall be performed in accordance with the requirements of this Specification, the Supplemental Technical Specifications, or as required by The ENGINEER. Concrete shall be sampled and tested by a technician/engineer certified as either an ACI certified Concrete Field Testing Technician Grade I, or the equivalent National Institute for Certification of Engineering Technologies Technician, with Specialty Concrete Work Elements Level I 82001, 82002, and Level II 84002, 84003,

84004, 84010.

101.15.1.2 Quality assurance testing and analysis shall be performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, under the direct supervision of a New Mexico Registered Professional Engineer.

101.15.1.3 Testing equipment used in the performance of specified testing shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certification records shall be maintained at the laboratory for review by The ENGINEER. A copy of the certifications shall be submitted upon request to the ENGINEER. Quality assurance testing shall be directed by the ENGINEER and paid by the OWNER.

101.15.2.1 Samples will be taken in the field by The ENGINEER, in accordance with ASTM C172, at discharge to the structure/application after all tempering at the job site has been completed.

101.15.2.2 A sample shall be taken for each design mix of concrete placed each day, once for each 100 cu yd of concrete, once for each 5000 sq.ft. area of slabs or walls, or fractions thereof, whichever is greater, or as directed by the ENGINEER. Hi-lo thermometers will be provided by the CONTRACTOR to monitor field curing concrete temperatures and companion test specimens while in the field, as directed by the ENGINEER.

101.15.3 Slump tests will be performed on each quality assurance sample in the field in accordance with ASTM C143. Concrete used for slump tests shall not be used in specimens for strength tests. The slump shall not exceed the maximum value defined in TABLE 101.C plus 0.25 in (6 mm). Slumps shall be reported to the nearest 1/4 inch (1 mm).

101.15.4 Entrained air tests will be performed on each quality assurance sample in accordance with the requirements of ASTM C231 for normal weight concrete, and ASTM C173, light weight concrete as specified in TABLE 101.C. Concrete used for entrained air tests shall not be used in specimens for strength tests. The entrained air shall not be less than the minimum nor greater than the maximum entrained air specified plus 0.1 %. Entrained air shall be reported to the nearest one tenth of one percent.

101.15.5.1 The cement content per cubic yard for a load of concrete shall be determined on each quality assurance sample in accordance with ASTM C138. The unit weight shall be reported to the nearest one tenth of a pound per cubic foot (one kilogram per cubic meter). The cement factor shall be reported to the nearest pound per cubic yard

(kilogram per cubic meter).

101.15.5.2 The portland cement content per cubic yard for a load of concrete shall be calculated by dividing the batched weight of the portland cement reported on the truck ticket for the load represented by a quality assurance test sample, by the yield, in cubic yards, determined in 101.15.1. The cement content shall be reported to nearest one pound per cubic yard. The portland cement content shall not be less than the minimum cement content for the application specified in TABLE 101.C.

101.15.5.3 The water to cementitious ratio for a load of concrete sampled and tested under this specification shall be calculated by comparing the total water in a load, by weight, the batched water reported on the load's batch ticket plus any water added in the field, to the sum of the portland cement and fly ash reported on the batch ticket. The weight of the water shall be divided by the weight of the cementitious materials and reported to the nearest one hundredth value (xx.xx). The water to cementitious ratio shall be less than or equal to the water to cementitious ratio for the application specified in TABLE 101.C.

101.15.6 A non complying field test, slump test, entrained air test, cement content, shall be verified by sampling and testing a second sample from the same load represented by the non complying sample/tests. If the second sample/tests determine the material is in compliance, the load may be authorized for placement and the all quality assurance tests required shall be performed. If the second test confirms the initial test results, the concrete load may be rejected as directed by the ENGINEER. If the second test confirms the initial sample non complying test, the second sampling and testing shall be paid by the CONTRACTOR, as specified in SECTION 13. The OWNER shall pay for all complying test.

101.15.7.1 Quality assurance compressive strength concrete specimens/cylinders shall be molded in accordance with ASTM C31. Cylinders shall be sealed metal or plastic molds complying with ASTM C31. The specimens will be submerged in water during the initial field curing at the site when the average ambient temperature is equal or greater than 60 °F, site conditions permitting, as directed by the ENGINEER. If the initial field cure submersion procedure is not used, high-low thermometers shall be used to monitor the initial field cure temperature of the quality assurance specimens, and the recorded temperatures shall be reported in the sampling and testing report. If the curing temperature recorded on the high-low thermometer exceeds 85 °F, concrete compressive test strengths shall be reported as information only, and the lab of record shall revise the initial cure procedure for the assurance specimens to control the curing temperature to less than 85 °F. Cylinders left in the field longer than the maximum specified time shall be so identified and reported "for information only". A sample may be taken to the testing laboratory for testing and casting

provided the cylinders can be molded within 15 minutes after sampling.

101.15.7.2 Strength specimens shall be molded and tested in accordance with ASTM C31, C39, C78 & C93, C192, and this specification. The number and type of compressive strength test cylinders shall be a minimum of four (4) 6"dia. x 12"H cylinders for channel concrete, and normal concrete with nominal maximum size aggregate of 1.5 inch to 2.0 inch. The number and type of compressive strength test cylinders shall be a minimum of four (4) 4" dia x 8" cylinders for normal concrete with nominal maximum size aggregate 1 inch and less. The number and type of cylinders shall be a minimum of six (6) 4" dia x 8" cylinders for high early release concrete compressive strength tests. The number and type of Modulus of Rupture flexure test beams shall be a minimum of three (3) 6"x6"x42" beams or equivalent for Modulus of Rupture Tests, as directed by the ENGINEER. Strength specimens shall be cast using concrete from the same load as the concrete field tests. When 4"dia. x 8" cylinders are used, they shall be cast in two equal lifts, each lift rodded twenty five times with a three eights inch (9.5 mm) diameter rod with a three eights inch (9.5 mm) semi spherical tip. The rodding of a lift placed on a lift of concrete shall penetrate into the top of the preceding lift.

101.15.7.3 When strength tests are required for stripping of forms or release of structure, a minimum of 2 test specimens complying with the specimen type specified in 101.15.7.2 for each test shall be molded and cured at the site under the same conditions as the concrete represented by the specimens. The specimens shall be returned to the Lab at the end of the field curing period and tested in accordance with ASTM C39. The test strength shall be the average of the test strengths of the two specimens. The critical concrete compressive strength (F'_c) shall be a minimum of 85% of the specified design strength.

101.15.7.4 Concrete strength test specimens shall be tested at 7 days and 28 days. One specimen shall be tested at 7 days and 2 specimens shall be tested at 28 days, and reported to The Engineer. The test strength shall be the average of the test strengths of the two specimens tested at either 28 days, or as specified in the Supplemental Specifications, drawings, or by The ENGINEER.

101.15.7.5 High early release concrete strength test specimens shall be tested at 3, 7, and 28 days for concrete. One specimen shall be tested at 3 days and 2 specimens shall be tested at 7 and 28 days, and reported to the Engineer. The test strength for high early release concrete shall be the average of the test strengths of two specimens tested at 7 days, or as specified in the Supplemental Specifications, drawings.

101.15.8. Not Used.

101.15.9.1 Evaluation and acceptance of concrete shall meet the criteria established in Chapter 5, Section 5.6, "Evaluation and acceptance of concrete," ACI 318-89. Each strength test result shall be the average of two cylinders from the same sample tested at 28 days or the specified age. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength tests equal or exceed the required f_c and no individual strength test result falls below the required f_c by more than 500 psi. Quality assurance compressive strength specimens sampled and cast when the average ambient temperature is greater than 60 °F, and cured with an initial field cure procedure other than submersion method specified in

101.15.7.1, shall be evaluated using the highest curing temperature recorded by the high-low thermometer provided for the field cure and Table 101.E. The test compressive strength shall be compared to the estimated strength corresponding to the highest initial cure temperature indicated in Table 101.E. An assurance compressive strength test shall be equal or greater than the compressive strength defined by Table 101.E when the initial field cure temperature is equal or greater than 85 °F and the initial field cure is not the submerged method specified in 101.15.7.1.

TABLE 101.E
MINIMUM COMPRESSIVE STRENGTH, f_c

$f_c \geq P_{Ti} \times f'_c / 100$, psi										
°F [2]	73	80	85	90	95	100	105	110	115	120
Cure Day(s)	P_{Ti} , % of Specified Strength, f'_c [1,3]									
3	100	108	114	120	122	123	125	120	115	110
7	100	101	102	103	100	98	95	91	78	75
28	100	97	95	93	90	88	85	82	78	75

- Notes:
1. Reference ACI 306, 6.6.1
 2. The Non Submerged assurance cylinder cure recorded maximum initial field cure temperature. If a high-low thermometer was not used, the highest ambient temperature recorded for the initial cure period by the national weather service will be used as the initial cure temperature.
 3. f'_c specified compressive strength

101.15.9.2 If individual tests of either laboratory-cured specimens produce strengths more than 500 psi (3.4 MPa) below f_c , or, if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is adequate. If the presence of low-strength concrete is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled from the area in question shall be required in accordance with ASTM C42, as directed by the ENGINEER. Three cores shall be taken for each case of an individual cylinder test more than 500 psi (3.4 MPa) below f_c or where the average of any set of three consecutive strength test results is below f_c . If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 °F and relative humidity less than 60 percent) for seven days before test and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be immersed in water for at least 48 hours and tested wet. If

coring is required a coring plan will be prepared by the ENGINEER no later than 42 calendar days after the placement date. Coring shall be completed and a report submitted no later than 56 calendar days after placement. Core sampling for non complying tests shall be taken at the direction of the ENGINEER and paid by the OWNER. The CONTRACTOR shall be responsible for material replacement of the same design mix in adjacent concrete at no cost to the OWNER where samples are removed.

101.15.9.3 Concrete in the area represented by core tests shall be considered structurally adequate if the average strength of three (3) cores is equal or greater than 85% of the specified design strength (f_c), and no single core has a compressive strength less than 75% of the specified design strength. To check testing accuracy, locations represented by erratic core strength may be retested. If these strength acceptance criteria are not met by the core tests, and if structural adequacy remains in doubt, The OWNER and ENGINEER may order load tests as outlined in Chapter 20,

ACI 318 for the questionable portion of the structure. Load tests shall be paid for by The CONTRACTOR.

101.15.9.4 If the structure under consideration does not satisfy the above strength acceptance criteria or the criteria of Section 20.2 or 20.4, ACI 318 The OWNER may order The Contractor to remove and replace any portion of the structure which is not in compliance with the above. If so

ordered, The CONTRACTOR shall perform such work at his own expense. The CONTRACTOR shall patch all core sample holes with the same or similar materials adjacent to the core hole. The patching concrete shall be placed and cured in accordance with the requirements of this specification.

101.15.10 TEST REPORTS

101.15.10.1 Test reports shall include but not limited to the following, as directed by the ENGINEER.

A. Field Data

- 1 Date of Sampling
- 2 Time of Sampling
- 3 City of Albuquerque Project or
- 4 City of Albuquerque project or Permit Number
- 5 Contract Title
- 6 Portland Cement Concrete Supplier
- 7 Delivery Ticket Number
- 8 Design Mix Number
- 9 Sampling location as defined by the Project Plans and Specifications
- 10 Ambient temperature at time of sampling, °F
- 11 Material temperature at time of sampling, °F
- 12 Mixer drum revolution count at start of discharge of concrete

B. Field Tests Results, with specifications.

	Accuracy	
1 Slump, in (mm)	0.25	1
2 Entrained Air, %	xx.x	
3 Unit Weight, pcf (kg/m ³)	xxx.x	(xxxx)
4 w:(c+fa) ratio	x.xx	x.xx
5 Cement Factor, C.F., lbs/yd ³ (kg/m ³)	xxx	(xxxx)
6 Cement pay factor determined in accordance with 101.16.2		

C. Comments

- 1 Report any addition of water and materials and amounts by either volume or weight, prior to and after sampling.
- 2 Report mixer revolutions count at time of discharge.
- 3 Record number of mixer revolutions after field tempering with water and/or admixtures, and @ what mixer speed, mixing or agitating speed.

D. Laboratory Tests

1 Calendar reference and day count from date of sampling for each strength test sample		
2 fc compressive strength test result reported to psi/ MPa	10	1
3 M.R. Modulus of rupture reported to psi/ MPa	5	0.5

E. Analysis & Certification

The testing laboratory shall provide certification the sampling and testing were performed in compliance with the requirements of the specifications. Certification shall be provided by the New Mexico Registered Professional Engineer in direct responsible charge of the laboratory testing program.

101.15.10.2 Test results shall be reported to The ENGINEER, CONTRACTOR, concrete supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, in writing, within 7 working days of completion of the test, as directed by the ENGINEER. Non-complying tests shall be reported within one working day of completion of the test.

101.16 MEASUREMENT AND PAYMENT

101.16.1 Measurement for Portland cement concrete supplied under this specification shall be by LOTS as the area, volumes, and as specified in the contract documents, as directed by the ENGINEER.

101.16.2 Payment for Portland cement concrete supplied

under this specification shall be for each LOT, at the contract unit price adjusted in accordance with the formula below and TABLE 101.F, as directed by the ENGINEER. A LOT shall be defined as either the volume or area of concrete for each design mix placed on a project in a day as defined in the CONTRACT. The adjusted unit price shall be calculated using the formula below and the pay factor, CF_p , defined in TABLE 101.F. The pay factor shall be defined by the number of samples representing a LOT, and, the % variance of the mean/average (M) portland cement content of the LOT from the minimum cement content specified in TABLE 101.C for the application, as determined by field quality assurance sample test results. Acceptance samples for a LOT shall be sampled and tested in accordance with 101.15. All acceptance samples taken in one day for a type of concrete shall represent a LOT of that type of concrete.

$$UP' = PF \times UP$$

UP', Adjusted Contract Unit Price

PF, Pay Factor, $PF = 0.50 \times (1.00 + CF_p)$

UP, Contracted Unit Price

TABLE 101.F - CEMENT PAY FACTOR CALCULATION, CF_p

n, number of samples	Deficiency, $D = (C - M)/C$	CF_p
3, OR MORE	$D \leq 0.0$	1.00
	$0.0 < D \leq 1.0$	1.00
	$1.0 < D \leq 2.0$	0.95
	$4.0 < D \leq 6.0$	0.90
	$6.0 < D \leq 8.0$	0.85
	$8.0 < D \leq 10.0$	[1]
	$D > 10.0$	Remove and Replace

D, Deficient cement content as % of C, minimum

C, Minimum cement content specified for the application in TABLE 101.C

M, Average or mean (M) cement factor for a LOT. The cement factor shall be calculated as the average of cement factors of all tests taken for a LOT, but not less than three tests, determined in accordance with 101.15.6.

[1] If determined by the ENGINEER to be more practical to accept the material, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR at an assigned pay factor $CF_p = 0.70$.

SECTION 102

STEEL REINFORCEMENT

102.1 GENERAL

The following specifications set forth the requirements for bar reinforcement, wire reinforcement, and wire mesh reinforcement. The reinforcement shall conform accurately to the dimensions and details indicated on the plans or otherwise prescribed; and before being placed in any concrete work shall be cleaned of all rust, mill scale, mortar, oil, dirt, or coating of any character which would be likely to destroy, reduce, or impair its proper bonding with the concrete. No reinforcing steel will be accepted under this specification until it has been approved by the ENGINEER as conforming with requirements prescribed therefor. When required by the ENGINEER, the CONTRACTOR or vendor shall furnish samples thereof for testing and notify the ENGINEER as to when and where they will be available. Such samples shall be furnished at the expense of the CONTRACTOR or vendor, but the cost of any testing that may be required will be borne by the OWNER. Samples shall only be taken in the presence of the ENGINEER. The CONTRACTOR shall furnish a certificate mill test report for each heat or size of steel when required by the ENGINEER.

102.2 REFERENCES

102.2.1 ASTM

A 62	A 615
A 185	A 616

102.2.2 ACI

318

102.3 BAR REINFORCEMENT

102.3.1 Reinforcing steel bars shall be deformed intermediate grade billet steel conforming with ASTM A 615. Rail steel conforming with ASTM A 616 may be permitted by the ENGINEER. The Grade shall be 40 or 60, unless Grade 60 is specified on the standard detail drawings or on the construction plans.

102.3.2 In testing bar reinforcement, only the theoretical cross-sectional area will be used in all computations.

102.3.3 Bending of steel will conform to requirements of ACI 318. The various grades of steel shall not be used interchangeably in structures. If rail steel is used, shop and field bending shall comply with the following provisions:

102.3.3.1 Continuous and uniform application for force throughout the duration of the bending operation.

102.3.3.2 Unrestricted movement of the bar at points of contact with the apparatus.

102.3.3.3 Close wrapping of the specimen around the pin or mandrel during the bending operations.

102.3.4 Bending or straightening of reinforcing steel shall be accomplished in such a manner and by such means as to insure that no damage to the material will result as a consequence thereof. Bars shall not be heated to perform bending of bars. Kinked bars shall not be used.

102.3.5 Cutting reinforcement steel by means of a cutting torch is prohibited.

102.4 WIRE REINFORCEMENT

Wire reinforcement shall, in all respect, fulfill requirements prescribed in ASTM A 82.

102.5 WIRE MESH REINFORCEMENT

Mesh reinforcements shall conform to ASTM A 185. The gauge of the wire and the dimensions of the mesh will be specified in the Supplementary Specifications or shown on the plans. The wire mesh reinforcement shall be so constructed as to retain its original shape and form during the necessary handling. The effective cross-sectional area of the metal shall be equal to that specified or indicated on the plans.

102.6 WIRE TIES

Wire for ties shall be black, annealed, not lighter than 16 gauge.

102.7 MEASUREMENT AND PAYMENT

Steel reinforcement will be included in the measurement for reinforced concrete per cubic yard or square yard in place, unless otherwise stipulated in the Bid Proposal. Payment will be made at the unit price per cubic yard or square yard as defined in the bid proposal.

SECTION 103

EPOXY-COATED STEEL REINFORCING BARS

103.1 GENERAL

This section covers deformed steel reinforcing bars with protective epoxy-coating applied by the electrostatic spray method.

103.2 REFERENCES

- 103.2.1 ASTM
A 615 A 617
A 616 A 775
- 103.2.2 AASHTO
M 284
- 103.2.3 AMERICAN WELDING SOCIETY
AWS D 1.4

103.3 MATERIALS

103.3.1 BAR REINFORCEMENT: Reinforcing bars shall be deformed, intermediate grade, billet steel conforming with ASTM A 615 or rail steel conforming with ASTM A 616. The latter steel shall be bend-tested and shall meet the bend-test requirements for axle-steel reinforcing bars, ASTM A 617, Grade 60; and the bar markings rolled into the surface of the bars shall include the letter "R" to designate rail steel meeting these requirements.

103.3.2 EPOXY-COATED REINFORCING BARS: When specified in the construction plans or required by the ENGINEER, epoxy-coated reinforcing bars shall conform with AASHTO M 284, utilizing the reinforcing bars defined in Subsection 103.3.1.

103.3.3 BAR MATS: Bar mats shall conform with ASTM A 184, utilizing the reinforcing bars defined in Subsection 103.3.1. Mats shall be fabricated from reinforcing bars. Metal clips shall be epoxy-coated. Nonmetallic clips may be substituted. Coating damage at the clipped or welded intersections shall be repaired in accordance with Subsection 103.3.4.

103.3.4 REPAIR OF COATING: When required, damaged epoxy-coating shall be repaired with patching material conforming with ASTM A 775. Repair shall be done in accordance with the patching material manufacturer's recommendations.

103.4 FABRICATION

All reinforcement shall be bent cold unless otherwise approved by the ENGINEER.

103.5 FIELD INSTALLATION

103.5.1 Epoxy-coated reinforcing bars supported formwork shall rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable materials. Wire bar supports shall be coated with dielectric material for a minimum distance of 2 inches from the point of contact with the epoxy-coated reinforcing bars. Reinforcing bars used as support bars shall be epoxy-coated. In walls having epoxy-coated reinforcing bars, spreaders where specified by the plans or ENGINEER shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion resistant material.

103.5.2 Epoxy-coated reinforcing bars shall be fastened with nylon-, epoxy-, or plastic-coated tie wire or other acceptable materials.

103.5.3 Splices of reinforcing bars shall be made only as required or permitted in the construction plans or approved by the ENGINEER.

103.5.4 When required or permitted, all welding of reinforcing bars shall conform to AWS D 1.4. Unless otherwise permitted, welding of crossing bars (tack welding) for assembly of reinforcement is prohibited.

103.5.5 Suitable ventilation shall be provided when welding epoxy-coated reinforcing bars.

103.5.6 After completion of welding on epoxy-coated reinforcing bars, coating damage shall be repaired in accordance with Subsection 103.3.4. All welds, and all steel splice members when used to splice bars, shall be coated with the same material used for repair of coating damage.

103.5.7 When required or permitted, mechanical connections shall be installed in accordance with the splice device manufacturer's recommendations.

103.5.8 After installing mechanical connections on epoxy-coated reinforcing bars, coating damage shall be repaired in accordance with Subsection 103.3.4. All

parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

103.5.9 Reinforcing bars partially embedded in concrete shall not be field bent, except as indicated on the construction plans or approved by the ENGINEER. When heat is used to field bend epoxy-coated reinforcing bars, suitable ventilation shall be provided. When epoxy-coated reinforcing bars are field bent, coating damage shall be repaired in accordance with Subsection 103.3.4.

103.5.10 Unless permitted by the ENGINEER, reinforcing bars shall not be cut in the field. When epoxy-coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage.

103.5.11 Equipment for handling epoxy-coated bars shall have protected contact areas. Bundles of coated bars shall be lifted at multiple pickup points to minimize bar-to-bar abrasion from sags in the bundles. Coated bars or bundles of coated bars shall not be dropped or dragged. Coated bars shall be stored in protective cribbing. Fading of the color of the coating shall not be cause for rejection of epoxy-coated reinforcing bars. Coating damage due to handling, shipment and placing need not be repaired in cases where the damaged area is 0.1 square inch or smaller. Damaged areas larger than 0.1 square inches shall be repaired in accordance with Subsection 103.3.4. The maximum amount of damage including repaired and unrepaired areas shall not exceed 2 percent of the surface area of each bar.

103.6 MEASUREMENT AND PAYMENT

Epoxy-coated steel reinforcement will be included in the measurement for this special type of reinforced concrete. Payment will be made at the reinforced concrete's unit price per cubic yard or square yard as defined in the Bid Proposal.

SECTION 105
CONCRETE CURING COMPOUND

105.1 GENERAL

This section shall govern the type of concrete curing compound used, in curing fresh concrete. The curing compound shall consist of a liquid which, when applied to fresh concrete by means of a spray gun, will form an impervious membrane over the exposed surfaces of the concrete.

105.2 REFERENCES

- 105.2.1 American Society for Testing and Materials (Latest Editions)(ASTM)
C-156 Test Method for Water Retention by Concrete Curing Materials
C-309 Specifications for Liquid Membrane - Forming Compounds for Curing Concrete
E-97 Test Method for 45-deg., 0-deg. Directional Reflectance Factor of Opaque Specimens by Broad-Bond Filter Reflectometry

- 105.2.2 This Publication
Section 111 Colored Portland Cement Concrete

105.3 MATERIALS

105.3.1 Curing compound shall be Type 2, White Pigmented as specified in ASTM C-309, unless modified on the plans or the Supplemental Technical Specification, or as approved by the ENGINEER.

105.3.2 When required, the curing compound manufacturer shall supply certification, to the ENGINEER that his product has been tested and complies with ASTM C-309 and for Type 2 compounds, ASTM E-97.

105.3.3 EXCEPTION: Type 2, White Pigmented curing compound shall not be used on colored concrete. The curing compound used on colored concrete shall be as specified in Section 111.

105.4 APPLICATION

The curing compound shall be applied so as to form a uniform, continuous, unbroken film over the concrete surface. The rate of application shall be per the manufacturer's recommendations but in no case greater than 250 square feet per gallon.

105.5 MEASUREMENT AND PAYMENT

No separate measurement or payment will be made for curing compound. The cost of the curing compound and its application shall be included in the cost of the work it is applied too.

SECTION 106

CEMENT MORTAR AND GROUT

106.1 GENERAL

Cement mortar prepared under this specification shall consist of a mixture of cementitious materials, aggregate, and water.

106.2 REFERENCES

106.2.1	ASTM	
	C 5	C 207
	C 91	C 266
	C144	C 270

106.2.2 This publication
SECTION 101

106.3 DESIGNATIONS

106.3.1 The designation of cement mortar according to type listed in the following tabulation indicates the proportions of materials to be used in the preparation thereof; the proportions indicated are on a volume basis. The type of mortar to be used shall be as specified in Tables 106.3.1.1, 106.3.1.2, as shown on the plans, or as approved by the ENGINEER.

106.3.2 Grout shall be Type M mortar, unless otherwise approved by the ENGINEER. Neat cement grout shall consist of cement mixed with water as necessary to obtain a fluid and workable mix.

106.4 CEMENT AND LIME

Cement to be used shall conform with the requirements in Section 101. Masonry cement shall conform to ASTM C 91. Quicklime shall conform to ASTM C 5. Hydrated lime shall conform to ASTM C 207.

106.5 AGGREGATES

Aggregates to be used shall conform with ASTM C 144.

106.6 WATER

Water shall be clean and free of deleterious amounts of acids, alkalis, or organic materials.

106.7 ADMIXTURES OR MORTAR COLORS

Admixtures or mortar colors shall not be added to the mortar at the time of mixing unless approved by the ENGINEER and, after the materials are so added, the mortar shall conform to the requirements of this specification.

106.8 ANTIFREEZE COMPOUNDS

No antifreeze liquid, salts, or other substances shall be used in mortar to lower the freezing point.

106.9 MORTAR FOR REPAIRING SPALLED AREAS AND FOR NOSING GROUT.

Mortar shall have a fast setting Portland cement base, no metallic additives, and shall mix, place and finish similar to regular concrete. It shall develop minimum compressive strengths (psi) of 3200 @ 24 hr. and 4500 @ 7 days. The mortar shall meet the resistance to the action of freeze-thaw cycles as ascertained using the rapid method outlined in ASTM C-266 and shall show no excessive spalling after 300 cycles of rapid freezing and thawing in water.

106.10 MEASURING AND MIXING OF MATERIALS

106.10.1 The method of measuring materials for the mortar used in construction shall be such that the specified portions of the mortar materials can be controlled and accurately maintained.

106.10.2 All cementitious materials and aggregate shall be mixed for a least 3 minutes with the maximum amount of water to produce a workable consistency in a mechanical batch mixer.

106.10.3 Mortars that have stiffened because of evaporation of water from the mortar shall be retempered by adding water as frequently as needed to restore the required consistency. Mortars shall be used and placed in final position within 2 1/2 hours after initial mixing.

106.11 TESTS

The mortar shall be designed and the laboratory mix tested in accordance with ASTM C 270.

106.12 MEASUREMENT AND PAYMENT

106.12.1 Measurement and payment for mortar and grout used in repair of spalled areas and for joint nosing material in drainage channels shall be by the square foot and shall include all chipping, sawing, sandblasting, and materials and work required for the completion of the repair.

TABLE 106.3.1.1
MORTAR TYPES

Mortar Type	Portland Cement	Masonry Cement	Hydrated Lime or Lime Putty	Aggregate, Measured In A Damp, Loose, Condition
M	1	1 (type II)	0	Not less than 2 1/4 and not more than 3 times the sum of the volumes of the cement and lime used.
M	1	0	1/4	
S	1/2	1 (type II)	0	
S	1	0	Over 1/4 to 1/2	
N	0	1 (type II)	0	
N	1	0	Over 1/2 to 1 1/4	
O	0	1 (type I or II)	0	
O	1	0	Over 1 1/4 to 2 1/2	
K	1	0	Over 2 1/2 to 4	

TABLE 106.3.1.2
MORTAR TYPE VS STRENGTH

Mortar Type	Average Compressive Strength at 28 days, psi
M	2,500
S	1,800
N	750
O	350
K	75

106.12.2 No separate measurement and payment will be made for mortar and grout in other applications unless designated by the ENGINEER.

SECTION 107

JOINT FILLER AND SEALANTS

107.1 GENERAL

This section specifies the joint fillers and sealants that are applicable to concrete pavements, concrete channel linings, sidewalks, driveways, and other concrete surfacing applications.

107.2 REFERENCES

107.2.1 ASTM:

C 719	D 994
D 881	D 1751
D 217	D 1752
D 297	D 2007
D 412	D 2240
D 794	

107.2.2 AASHTO:

M 153	T 72
T 59	T 132

107.2.3 Federal Specifications:

LP-590
TT-S-0022 7E

107.3 JOINT FILLERS

107.3.1 PREMOLDED JOINT FILLER:

107.3.1.1 Expansion joint filler material shall consist of premolded strips of a durable resilient compound.

107.3.1.2 Where stiffness is lacking in premolded expansion joint filler, the strips shall be encased in saturated felt, asphalt impregnated cotton webbing, or other satisfactory material. Any material or fabric used for encasement shall be firmly sealed to the body of the joint filler and shall not be detached therefrom after immersion in water for a period of forty-eight hours.

107.3.1.3 Unless otherwise specified, premolded joint filler may be either Premolded Expansion Joint Filler (nonextruding and Resilient Bituminous types) conforming to the requirements of ASTM C 1751 or Preformed Expansion Joint Filler (Bituminous Type) conforming to the requirements of ASTM D 994.

107.3.1.4 Expansion joint filler material shall be manufactured in a workmanlike manner; and when ten percent or more of any lot or shipment is of nonuniform or improper construction, the entire lot or shipment may be rejected.

107.3.2 ASPHALT-LATEX JOINT FILLER:

107.3.2.1 Asphalt-latex joint filler shall consist of asphalt-latex emulsion

and sodium fluosilicate furnished in separate containers and mixed on the site. The emulsion shall consist by volume of 60 parts 200-300 asphalt conforming to the requirements of Section 112, 40 parts of synthetic latex (GRS Type 4 and 5) to 10 parts of sodium fluosilicate, half strength. The emulsion and sodium fluosilicate shall not be mixed until the joint is ready to be filled. The amount of sodium fluosilicate to be mixed with the emulsion shall be approximately 3 percent to 5 percent by weight of the emulsion. The joint to be filled shall be thoroughly cleaned and surface dry.

107.3.2.2 The sealing compound shall consist of paving asphalt, Grade 200-300, conforming to the provisions of Section 112 of these specifications, emulsified with rubber latex in the presence of a suitable emulsifying agent; rubber latex designated as GRS Type 4; or any other approved type containing approximately 40 percent solids.

107.3.2.3 The resulting emulsion shall consist of a minimum of 55 percent of paving asphalt and a minimum of 36 percent of rubber latex and shall conform to the requirements set forth in the Table 107.3.2.3.

107.3.2.4 Test Report and Shipment Certificate for Asphalt-Latex Joint Fillers: Each shipment shall be accompanied by a certificate from the vendor that the material will comply with the above specifications and such certificate shall be delivered to the ENGINEER. The certificate shall show the shipment number for the entire lot of material contained in the shipment and shall also show a list which will enable the ENGINEER to identify each individual container by the vendor's batch number, with which each container shall be plainly marked.

107.3.2.5 Application for Asphalt-Latex Joint Filler:

107.3.2.5.1 At no time shall the emulsion be subjected to a temperature below 4 degrees F. Prior to application, the material may be warmed, if necessary, to permit proper pouring of the joints. The method of heating shall be carefully controlled to avoid overheating of any part of the container or mixture and under no circumstances shall the emulsion

TABLE 107.3.2.3

ASPHALT-LATEX EMULSION JOINT SEALING COMPOUND

Specification Designation	Test Method	Limits	
Furol Viscosity at 77°F	AASHTO T 72	50-250 Seconds	Before adding gelling agent.
Sieve Test	AASHTO T 59	1% Max.	Before adding gelling agent.
Penetration at 77°F	ASTM D 217	50-250	The penetration test is made on a specimen prepared by stirring 5 percent of sodium fluosilicate into the asphalt-latex emulsion in a 6-ounce deep ointment can. The specimen is then allowed to stand in the air at a temperature of 77 degrees F \pm 2 degrees F for a period of 30 minutes and is then penetrated with a grease cone under a total load of 150 grams in accordance with ASTM D 217.
Elasticity		70% Min.	After addition of 5 percent of sodium fluosilicate and curing for 24 hours at 100 degrees F \pm 2 degrees F the specimen shall have an elastic recovery of not less than 70 percent.
Dehydration Loss		30% Max.	Twenty-five grams of emulsion, prior to adding the gelling agent, is placed in an 8-ounce flat ointment can and dehydrated in a suitable oven maintained at a temperature of 200 degrees F \pm 2 degrees F for a period of 24 hours. Weight loss from dehydration shall not exceed 30% of sample tested.
Time of "Set"		15 to 60	After mixing the emulsion with 1 percent to 4 percent by weight powdered sodium fluosilicate, the emulsion shall harden or develop a "set" in from 15 to 60 minutes, under field conditions.

be heated to a temperature greater than 130 degrees F.

107.3.2.5.2 Joints and cracks shall be thoroughly cleaned by hand or mechanical means immediately in advance of pouring the filler material. When new pavement has been cured by the Pigmented Sealing Compound Method, the joints and cracks shall be thoroughly scrubbed by means of a wire brush or a cloth mop saturated with gasoline or by other approved means.

107.3.2.5.3 All joints and cracks shall be surface dry before application of the joint sealer. No sealer shall be placed during unsuitable weather or when the atmospheric temperature is below 50 degrees F or when weather conditions indicate that the temperature may fall to 32 degrees F within 24 hours. Immediately before pouring joints and cracks, the emulsion shall be mixed with from 1 percent to 4 percent by weight of powdered sodium fluosilicate.

107.3.2.5.4 The joints and cracks shall be filled in a neat and workmanlike manner by means of cornucopia pot or other approved method.

107.3.3 POLYETHYLENE FOAM JOINT FILLER:

107.3.3.1 Material: Polyethylene foam filler material shall conform to specification ASTM D 1751 and ASTM D 1752 and shall have a density of 2.5 to 3.0 pounds per cubic ft. It shall be constructed of closed cell, cross linked, polyethylene foam.

107.3.3.2 Installation: The closed cell polyethylene filler shall be cut to size and shape of the joint to be filled as shown on the plans and the Standard Details. The filler shall be held in place against previously poured concrete with metal or wood stakes or forms which shall be removed as newly placed concrete holds the filler in place. Nails or other fasteners are not to be driven into concrete mortar or nosing material for the purpose of holding filler material in place.

107.4 JOINT SEALANT

107.4.1 ETHYLENE VINYL ACETATE FOAM SEALANT (EVA FOAM):

107.4.1.1 Material:

107.4.1.1.1 EVA foam to be used to seal joints shall be preformed foam sealant per AASHTO M 153, Type II or III, ultra-violet resistant. It shall be a non-extruding expansion/contraction, water-proof material, closed cell, cross

linked, with a density range of 2.5 to 3.5 pounds per cubic foot. EVA foam shall be used to seal joints where the width of joint to be sealed is 1 inch or greater. EVA foam sealants shall be 25 percent wider than the joint width and compressed into the joint per the manufacturer's recommendations.

107.4.1.1.2 The bonding agent to be used to bond EVA foam to concrete or mortar shall be a 100 percent solid 2 part epoxy which meets ASTM C 881, Type II, Grade 2, Class B and C as approved by the ENGINEER. The bonding agent shall be used according to the manufacturer's recommendations. Care shall be taken to assure that the bonding agent does not adhere to the exposed surface of the EVA foam sealant.

107.4.1.2 Preparation and Application:

107.4.1.2.1 Immediately prior to application joints shall be sand-blast-cleaned to remove laitance, curing compound, and other bond inhibitors. At the time of application, concrete must be cured at least 7 days and attain at least 80 percent of design strength. The vertical sides of the joint area to be sealed shall be clean, dry, smooth, sound, and free of any foreign material. The bottom of the area to be sealed, if concrete, shall be covered with a polyethylene bondbreaker, minimum 1/16 inch thick, before applying the bonding agent to the vertical sides. The bonding agents shall be applied to completely cover both the nosing and the sealant surfaces which are to be bonded and to no other surface.

107.4.1.2.2 Sealant shall be extruded to the bottom of the joint groove and tooled to work the sealant into close contact with the joint surfaces to eliminate air bubbles. Any sealant that does not cure properly, fails to establish a satisfactory bond, protrudes more than one half inch above the finished concrete surface adjacent to the joint, does not completely adhere to the sides of the joint, is damaged by the CONTRACTOR'S operations, or is not satisfactory in the opinion of the ENGINEER must be removed and the joint recleaned and resealed.

107.4.1.2.3 After the bonding agent has set, sealant that protrudes 1/8 to 1/2 inches shall be cut with a power sander to the concrete surface. The sealant will then be coated with two coats of ultra-violet proofing, opaque, vinyl coating, which will produce approximately 6 mils thickness, as approved by the ENGINEER.

107.4.2 TWO COMPONENT URETHANE SEALANT:

107.4.2.1 Materials:

107.4.2.1.1 Two Component Urethane Sealant to be used to seal joints shall meet Federal Specifications No. TT-S-0022 7E, Type I Class A (Pour Grade) or No. TT-S-0022 7E, Type II, Class A (Non-Sag). Two Component Urethane Sealant shall be used to seal expansion joints less than 1 inch in width.

107.4.2.1.2 The bonding agent to be used to bond the Two Component Urethane Sealant to the concrete or mortar nosing shall be a one-component solvent based system, as furnished by the sealant manufacturer.

107.4.2.1.3 Urethane sealants shall not be placed when the temperature of the concrete or air is below 40 degrees F. The non-sag sealant shall be used in joints other than horizontal. Dimensions of urethane sealants shall be as shown on the drawings.

107.4.2.2 Preparation and Application: Two Component Urethane Sealants and Bonding Agents shall be installed in accordance with the manufacturer's recommendations and Subsection 107.4.1.2 of this specification.

107.4.3 ASPHALT RUBBER SEALANT:

107.4.3.1 Materials and Mixing (Method A)

107.4.3.1.1 Bituminous Material. The bituminous material shall be asphalt cement, having a maximum penetration of 120-150, complying with the requirements of Section 112.

107.4.3.1.2 The granulated crumb rubber (100 percent Vulcanized) shall meet the following requirements:

<u>PASSING SIEVE</u>	<u>PERCENT</u>
#8	100
#10	98 - 100
#30	0 - 10
#40	0 - 4

NOTE: The granulated crumb rubber shall be accepted if accompanied by the certificate of compliance from the supplier that the material has been tested during the grinding process and meets the gradation specified.

107.4.3.1.2.1 The specific gravity of the granulated rubber shall be 1.15 + 0.02. The rubber material shall be free

of fabric, wire, or other contaminating materials except that up to 4 percent of calcium carbonate may be included to prevent the particles from sticking together.

107.4.3.1.3 Diluent for diluting the asphalt cement and granulated crumb rubber mixture shall have a boiling point of not less than 350 F., and the temperature of the hot asphalt-rubber shall not exceed 350 F., at the time the diluent is added.

107.4.3.1.4 Mixing. The percentage of the granulated crumb rubber shall be 33 1/3 percent \pm 2 percent of the asphalt weight.

107.4.3.1.4.1 The materials shall be combined as rapidly as possible for such a time and at such a temperature that the consistency of the mix approaches that of a semi-fluid material. The temperature of the asphalt cement shall be between 350 and 395 degrees F.

107.4.3.1.4.2 After the full reaction between the asphalt cement and the granulated rubber has occurred and before application, the mix may be cut back with diluent. The maximum amount of diluent used shall not exceed 7 1/2 percent by volume of the hot asphalt cement-granulated crumb rubber composition required for adjusting the viscosity for spraying.

107.4.3.1.4.3 In the event that a delay occurs after the full reaction has taken place, the material may be slowly reheated to an acceptable spraying temperature with no detrimental effect but, because of the polymer reversion that can occur when the granulated crumb rubber is held at high temperature(s) for a prolonged time, the material shall not be reheated to temperatures above 350 degrees F.

107.4.3.2 Materials and Mixing (Method B):

107.4.3.2.1 Bituminous Material. The bituminous material shall be Asphalt cement, having a maximum penetration of 120, complying with the requirements of Section 112 and shall be fully compatible with the ground rubber.

107.4.3.2.2 Rubber Extender Oil. The extender oil shall be a resinous, high flash point aromatic hydrocarbon meeting the following test requirements:

Viscosity, SSU @ 100 degrees F. 2500 Min.
(ASTM D 88)

Flash Point, C.O.C., degrees F. 392 Min.

Molecular Analysis (ASTM D-2007)

Asphaltenes, percent by weight 0.1 Max.

Aromatics, percent by weight 55 Min.

107.4.3.2.3 Rubber Components. The rubber shall be U.S. Rubber Reclaiming Company designation G 274, or approved equal meeting the following physical requirements:

107.4.3.2.3.1 Composition: The rubber shall be a dry, free flowing blend of 40 percent powdered reclaimed (that is, Devulcanized), rubber and 60 percent ground vulcanized rubber scrap with a high natural rubber content and shall be free from fabric, wire or other contaminants except that up to 4 percent of a dusting agent such as calcium carbonate may be included to prevent cracking of the particles.

107.4.3.2.3.2 Sieve Analysis:

<u>Sieve No.</u>	<u>Percent Passing</u>
8	100
30	60-80
50	15-40
100	0-15

107.4.3.2.3.3 Mill Test: When 40 to 50 grams of rubber retained on the No. 30 sieve are added to a tight set 6-inch rubber mill, the material shall band on the mill roll in one pass. This will indicate the presence of a suitable quantity of reclaimed, devulcanized rubber.

107.4.3.2.3.4 Natural Rubber Content. Minimum 30 percent by weight. (ASTM D-297).

107.4.3.2.4 Mixing. The Asphalt Rubber Blend shall be a combination of the asphalt cement, extender oil, and ground rubber mixed together at an elevated temperature in accordance with the following procedure and proportions:

107.4.3.2.4.1 Preparation of asphalt-extender oil mix. Blend the preheated asphalt cement (250-400 degrees F.) and sufficient rubber extender oil, (usually from 2 to 6 percent), to reduce the viscosity of the asphalt cement to within the range of 600 to 1800 Poises at 140 degrees F., when tested in accordance with the requirements of AASHTO M 266. Mix thoroughly by recirculation, stirring, air agitation or other appropriate means.

107.4.3.2.4.2 Addition of Rubber. Increase the temperature of the asphalt cement-extender oil blend with appropriate heat exchanges to within the range of 350-425 degrees F., and then add an amount of specified ground rubber equal to 20 percent, + 2 percent by weight of the total asphalt-rubber blend. Add the rubber as rapidly as possible and continue recirculating for a period of not less than 30 minutes after the incorporation of all the rubber.

107.4.3.2.4.3 Sufficient recirculation and/or stirring of the total combined material shall be maintained to provide good mixing and dispersion. Temperature of the total blend shall be kept between 350-425 degrees F.

107.4.3.3 Construction Requirements:

107.4.3.3.1 The equipment used for application shall be capable of maintaining a continuous uniform, homogeneous mixture throughout the sealing operation. The method and equipment for heating and preparing the asphalt-rubber mixture for application shall be so designed as to provide a continuous supply of the prepared mixture that will assure sealing operations without delays due to the mixing-heating operation. The equipment shall incorporate a mechanical mixing device within the heating unit such that a continuous mixing of the sealant compound is maintained.

107.4.3.3.2 The ENGINEER shall be satisfied that the material and the mixing process the CONTRACTOR proposes to use has been successfully used in similar circumstances on comparable projects.

107.4.3.3.3 Nozzles shall be of adequate design to provide for uniform application of the asphalt-rubber material without clogging, or other irregularities in distribution.

107.4.3.3.4 Should clogging or irregularities in distribution occur, operations shall cease until corrective action is effected.

107.4.3.3.5 Defective equipment shall be removed from the project.

107.4.3.3.6 Weather Limitations. Asphalt rubber joint sealant shall not be placed during wet or adverse weather, on a wet surface, or unless the atmospheric temperature is at least 40 degrees and rising, or when the wind conditions are such that a satisfactory seal cannot be achieved.

107.4.3.3.7 The ENGINEER will be the sole judge of when the mixed material has reached a consistency for application. Application shall proceed immediately after the proper consistency is attained.

107.4.3.3.8 Immediately prior to placing the sealant, the joints shall be cleaned of all loose particles, dust, and other deleterious substances by means of high velocity compressed air, or any other methods approved by the ENGINEER.

107.4.3.3.9 Only asphalt-rubber sealant shall be used to fill the joints.

107.4.3.3.10 No Vehicular Traffic will be permitted on the asphalt-rubber sealed joints until sufficient time has elapsed for the asphalt-rubber sealant to become non-tacky.

107.4.3.3.11 The ENGINEER shall be the sole judge as to when the joints are properly cleaned and sealed.

107.4.4 SILICONE RUBBER SEALANT: This work shall consist of cleaning the joint, and installation of low modulus silicone sealant in the roadway joints specified on the plans. The plans will designate the type of joint (transverse or longitudinal) and location of joint.

107.4.4.1 Materials: All materials shall meet the requirements of the following:

107.4.4.1.1 Silicone Sealant: Silicone sealant shall be furnished in a one-part silicone formulation. The compound shall be compatible with the surface to which it is applied. Acid cure sealants are not acceptable for use on concrete. Movement capability shall be +100 percent and -50 percent of the joint width. The physical requirements are:

107.4.4.1.1.1 Accessory Items: The backup material shall be compatible with the sealant or any component of the joint sealant system. No bond or adverse reaction shall occur between the backup material, sealant, or primer if primer is specified.

107.4.4.1.1.2 Test Requirements:

Tensile Stress: 150 45 psi maximum
percent Elogation 7
days cure @ 77 F +3°F
and 45-55 percent R.H.

Specific Gravity 1.01 - 1.515

Durometer Hardness, 10-25 (0°F)
Shore A: cured 7 days
@ 77°F +3°F and 45-55
percent R.H.

Shelf Life 6 mo. minimum from
date of manufac-
ture

Ozone and U.V. Resistance No chalking,
cracking, or bond
loss after 5000
hours

Bond to concrete mortar 50 psi minimum
concrete briquets air
cured 7 days @ 77°F +3°F

Tack Free Time 6 Hrs. minimum

Movement Capability and Adhesion No adhesive or
cohesive failure
after 10 cycles at
0°F.

107.4.4.1.1.3 Test Methods:

Tensile Stress ASTM D-412 (DIE C)

Specific Gravity ASTM D-794, Method A

Durometer Hardness ASTM D-2240

Ozone and UV Resistance ASTM D-793

107.4.4.1.1.4 Bond to Concrete Mortar:

Three briquets molded in accordance with AASHTO T-132 and moisture cured for at least 28 days shall be sawed in half, cleaned, and oven dried to a constant weight in an oven at 100 degrees C + 5 degrees. After cooling, they shall be bonded with approximately 10 mils of silicone sealant and tested using clips meeting AASHTO T 132. They shall be tested in tension at a loading rate of .3 inch/minute.

107.4.4.1.1.5 Tack Free Time:

Prepare specimen in a mold with an area larger than the brass weight described below and 1/4 inch thick. Place a 30 gram brass weight 1-5/8 inch by one inch by 1/8 inch on a polyethylene strip applied to the specimen after they have cured for the specified time. After removing the weight, peel the polyethylene strip by pulling it at 90 degrees to the compound at a rate of one inch in 5 seconds. No material should adhere to the polyethylene when it is tack free.

107.4.4.1.1.6 Movement Capability and Adhesion:

Prepare 1 inch x 1 inch x 3 inch concrete blocks in accordance with ASTM C-719. A sawed face shall be used for bond surface. Seal 2 inch of block leaving 1/2 inch on each end of specimen unsealed. The depth of sealant shall be 3/8 inch and the width 1/2 inch. Cure the specimen 7 days in air at 77 degrees F +3 degrees F and then 7 days in water at 77 degrees F +3 degrees F. Subject sealant to movement in accordance with ASTM C 719. The rate of extension or compression shall be 1/8 inch per hour. One cycle is defined as extension to one inch width and return to the initial 1/2 inch width.

107.4.4.1.1.7 Certification: The manufacturer of the joint sealant shall furnish certification test results of each lot of the joint sealant material furnished to the project to meet all of the above requirements except the bond to cement mortar. Certification shall show use of primers where applicable.

107.4.4.1.1.8 Acceptance: Even though a sealant meets all requirements of the specification failure to perform adequately in actual use shall be just cause for rejection.

107.4.4.1.2 Bond-breaking Adhesive Tape shall be polyethylene and Backer-Rod shall be closed cell polyethylene. Backer-rod shall be of circular cross section with a diameter 25 percent greater than the joint width.

107.4.4.2 Construction Requirements:

107.4.4.2.1 Cleaning the Joint: The joints shall be thoroughly cleaned of all foreign material (oil, asphalt, curing compound, sealant adhesive, paint, rust, etc.), including existing sealant, if any. The CONTRACTOR may use any one or combination of methods below in his cleaning operation, except Method 2, sawing is to be used only if Method 1 will not properly clean the joint.

107.4.4.2.1.1 Method 1 - High Pressure Water Jet:

The joint shall be thoroughly cleaned with a high-pressure water jet blaster (3000 psi at the tip) and other tools as necessary. After blasting, the joint shall be blown out with compressed air. This process shall be repeated until the joint is thoroughly cleaned of all foreign material, including old sealant,

and a new, clean concrete face is exposed on the faces of the joint.

107.4.4.2.1.2 Method 2 - Sawing:

If this method of cleaning is selected (and approved as noted previously), the CONTRACTOR shall exercise utmost care to minimize enlarging the existing width of the joint. Sawing shall be limited to only exposed clean, new concrete faces on the joint with a maximum allowable cut of 1/16 inch on each face of the joint. All dust, sawing residue, and other contamination will be removed from the joint faces. If dry sawing with diamond or abrasive blades is used, the sawing residue shall be thoroughly removed by blowing out the joint and immediate area with compressed air. If wet sawing with diamond or abrasive blades is used, the resulting saw latence or slurry shall be completely removed from the joint and immediate area by flushing clean with a high-pressure jet of clean water. After flushing, the joint shall be blown out with compressed air and allowed to dry 4 hours minimum.

107.4.4.2.2 Installing Backer-Rod in Joint: Prior to placing the backer-rod, the joint must be thoroughly dry and clean. Any necessary cleaning, air blasting, or air-drying will be completed before placing backer-rod (and sealant). On joints less than 1 inch wide after cleaning, a round backer-rod of resilient material, compatible with silicone sealant, and slightly oversized to prevent movement during the sealing operation will be installed in the joint at the depth specified on the appropriate joint detail in the plans or as recommended by the sealant manufacturer. (The thickness of the backer-rod will be greater after squeezing it into the joint and some "rebound" may occur--allowance must be made for this to insure placing at correct depth.) On joints larger than 1 inch after cleaning, use a backup material cut from an approved resilient material which is compatible with silicone sealant.

107.4.4.2.3 Installing Silicone Sealant: The installation of the silicone sealant is to be done as soon after placing the backer-rod as reasonably possible to insure that joint is still clean and dry. In the event the joint does become contaminated, damp, or wet, the backer-rod is to be removed, the joint cleaned and dried, and backer-rod reinstalled prior to placing the sealant material. The sealant material used shall be a low modulus silicone sealant

meeting the movement requirements of Section 107.4.4.1.1. The temperature at time of placement must be 35 degrees F or higher. The silicone sealant shall be applied by pumping or manual means. If pumping is used, the pump shall be a sufficient capacity to deliver the necessary volume of material to completely fill the joint to the specified width and height of sealant in one pass. The nozzle shall be of sufficient size and shape to closely fit into the joint and introduce the sealant inside the joint with sufficient pressure to prevent voids occurring in the sealant and to force the sealant into contact with the joint faces. The sealant after being placed shall be tooled to provide the specified recess depth and thickness and shape of sealant as shown on the plans. Sufficient force or pressure shall be applied to the sealant in this tooling operation to force the sealant against the joint faces to insure satisfactory wetting and bonding of the sealant to the joint faces. The silicone sealant is not self-leveling and will not position itself correctly in the joint under its own weight). The sealant shall be placed to reasonably close conformity with the dimensions and shape shown on the plans. Any unreasonable deviation will be cause for rejection and necessary corrective action will be made by the Contractor. See Sketch 107.4.4.2.3 for installation detail

107.4.4.2.4 Cleaning Pavement: After a joint has been sealed, all surplus sealant or other residue on the pavement or structure surfaces shall be promptly removed.

107.4.4.2.5 Opening to Traffic: Traffic shall not be permitted over sealed joints until the sealant is tack free and until debris from traffic does not imbed into the sealant.

107.4.4.2.6 Special Requirements: The following special requirements apply to this work:

107.4.4.2.6.1 Air compressors used for cleaning joints shall be equipped with suitable traps capable of removing all surplus water and oil in the compressed air. The compressed air will be checked daily by the ENGINEER for contamination. No contaminated air shall be used. The compressor shall be capable of delivering compressed air at a continuous pressure of at least 90 psi.

107.4.4.2.6.2 Unless otherwise specified on the plans, the joints are to be re-sealed after any required pavement repair.

107.4.4.2.6.3 Any failure of the sealed joint due to (1) adhesion or cohesion failure of joint material (2) unsatisfactory or improper workmanship by CONTRACTOR (3) damage by CONTRACTOR's operations or public traffic will be cause for rejection, and the joint shall be repaired to ENGINEER's satisfaction at no additional cost to the OWNER.

107.5 POLYETHYLENE SHEET BEARING PLATE AND SLEEPER

107.5.1 MATERIAL: Ultra high molecular weight, high density, or low density polyethylene sheet to be used as a bearing plate or sleeper shall conform to Federal Specification LP-590. This material is only used for concrete channel expansion joints.

107.5.2 INSTALLATION: The polyethylene sheet shall be cut to size and shape of the horizontal surfaces to be covered. The concrete surface to be covered with polyethylene sheet shall be smooth and flat to within $\pm 1/8$ inch when checked with a 10 foot straightedge. The subgrade upon which the polyethylene sheet is to be placed shall not vary more than $1/4$ inch from the specified grade when checked with a 10 foot straightedge.

107.6 PRECAUTION

The manufacturer's recommendation for clearance between surface of sealant to top of concrete or joint shall be closely observed. Certain sealants will fail if the joint is over filled and sealant is allowed to spread onto the concrete surface. All joint material that does not comply with the manufacturer's installation recommendations or these specifications shall be removed, joint cleaned and material correctly installed by the CONTRACTOR at no cost to the OWNER.

107.7 MEASUREMENT AND PAYMENT

Filler materials and sealants shall be considered as incidental to concrete joint treatment and no measurement or payment will be made for these materials and installation thereof.

SECTION 108

BRICK

108.1 GENERAL

Brick shall be whole, sound, and hard burned and shall give a clear ringing sound when struck together. They shall be uniform in quality and shall be culled or sorted before delivery to the work site.

108.2 REFERENCES

108.2.1 ASTM:

- C 32
- C 62
- C 216
- C 902
- C 1028

108.3 MANHOLE BRICK

108.3.1 Sewer manhole brick shall conform, except for dimensional tolerances, to the requirements of ASTM C 32.

108.3.2 Manhole brick shall conform to the following standard size dimensions: length = 7-5/8 inches, width = 3-5/8 inches and depth = 2-1/4 inches.

108.4 BUILDING BRICK

Building brick shall conform to the requirements of ASTM C 62, Grade MW. The size and texture shall be specified on the plans or as approved by the ENGINEER.

108.5 FACING BRICK

Facing brick shall conform to the requirements of ASTM C 216, Grade SW, Type FBS. The size, color, and texture shall be as specified on the plans or as approved by the ENGINEER.

108.6 PEDESTRIAN AND TRAFFIC PAVING BRICK

108.6.1 Brick used for sidewalks, drive pads, or street surfacing shall conform to the requirements of ASTM C 902, Class SX, Type I. The size of the brick shall be: length = 8 inches, width = 3 3/4 inches and depth = 2 1/4 inches. The surface texture shall be smooth and the color shall be as specified on the plans or as approved by the ENGINEER.

108.6.2 Depending on the size of shipment or order, the ENGINEER may request a random selection of the brick for determining the static coefficient of friction for the dry brick. Tests shall be conducted by an independent testing laboratory and shall be conducted in

accordance with ASTM C 1028. All tested brick must have a coefficient of friction greater than 0.65. Test results shall be included in the require certification of the brick, as per Section 348.

108.7 MEASUREMENT AND PAYMENT

No separate measurement or payment shall be made for brick, unless otherwise stipulated in the Bid Proposal.

SECTION 109
RIPRAP STONE

109.1 GENERAL

The riprap stone provided and installed under this specification shall be angular rock, stone or recycled Portland cement concrete complying with the requirements of this specification. The material shall be certified to comply with the specification in accordance with the requirements of Section 13. If a change in material and/or source from that authorized occurs during a project, the CONTRACTOR shall resubmit to include the changed material/and or source for authorization by the ENGINEER. A riprap material shall not be used on a project without written authorization of the ENGINEER.

109.2 REFERENCES

- 109.2.1 American Society of Testing and Materials (Latest Edition)(ASTM)
 - C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate Solution
 - C127 Specific Gravity and Absorption of Coarse Aggregate
 - C535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- 109.2.2 American Association of State Highway and Transportation Officials (Latest Edition)(AASHTO)
 - T103 Soundness of Aggregates by Freezing and Thawing
- 109.2.3 This Publication
 - 603 Rip Rap Surface Treatment
 - 610 Gabions

109.3 MATERIAL

109.3.1 Riprap stone shall be stone, rock or recycled Portland cement concrete complying with this specification. The material shall be free of seams, fractures and coatings and of such characteristics that it will not disintegrate when subject to the action of flowing water.

109.3.2 The minimum specific gravity of the stone shall be 2.65 for sizes and gradation specified in TABLE 209.A, as determined in accordance with ASTM C127, latest edition. If the specific gravity of a stone is less than 2.65, the minimum size of the stone and the depth of the riprap shall be increased in accordance with TABLE 109.B.

109.3.3 The maximum resistance to abrasion shall be fifty (50) percent determined in accordance with the requirements of ASTM C535.

109.3.4 The maximum soundness loss shall be twenty (20) percent determine in accordance with ASTM C88.

109.3.5 The maximum loss to freeze thaw shall be ten (10) percent for 12 cycles determined in accordance with the AASHTO T103, Ledge R, Procedure A.

109.4 SHAPE AND GRADATION

109.4.1 Riprap material shall be rectangular in shape having maximum to minimum dimension ratio not more than 3:1.

109.4.2 Riprap stone shall comply with the gradation requirements of TABLES 109.A and 109.B.

109.4.3 Waste Portland cement concrete complying with the requirements of this specification may be used as riprap as specified in the plans and specification, as directed by the ENGINEER.

109.5 PLACEMENT

109.5.1 The placement of riprap stone shall be to the line and grade shown on the plans or as authorized by the ENGINEER. The depth of the riprap shown on the plans shall be adjusted based on Table 109.B for the specific gravity of the material provided. The surface tolerances shall be within the maximum variations shown in Table 109.C.

109.6 MEASUREMENT AND PAYMENT

109.6.1 Riprap shall be measured by the cubic yard (cy) placed to the lines and grades in the plans and specifications complete in place.

109.6.2 Payment for riprap will be made at the contract unit price per cubic yard for the type of riprap required, which payment shall include all material, labor and equipment required in placing riprap stone as specified in Section 603 and/or 610.

TABLE 109.A
CLASSIFICATION GRADATION

DESIGNATION	MAXIMUM DIMENSIONS inches (m)	% SMALLER	Km [1]
A. GABIONS			
TYPE VL	12 (0.30)	100	
	9 (0.25)	50-70	
	6 (0.15)	35-55	6
	3 (0.08)	10	
TYPE L	18 (0.45)	100	
	12 (0.30)	50-70	
	6 (0.15)	30-55	9
	3 (0.08)	10	
B. RIPRAP			
TYPE M	24 (0.60)	100	
	18 (0.45)	50-70	
	12 (0.30)	30-55	12
	6 (0.15)	10	
TYPE H	36 (0.90)	100	
	24 (0.60)	50-70	
	12 (0.30)	30-55	18
TYPE VH	48 (1.20)	100	
	36 (0.90)	50-70	
	18 (0.45)	30-55	24
	9 (0.23)	10	

[1] Km = mean particle size

TABLE 109.B
SPECIFIC GRAVITY MULTIPLIER

SPECIFIC GRAVITY	MULTIPLIER
2.65	1.00
2.60	1.05
2.50	1.15
2.40	1.25
2.30	1.35
< 2.30	REJECT

TABLE 109.C
CONSTRUCTION TOLERANCES

RIPRAP DESIGNATION	MAXIMUM VARIATION FROM SPECIFIED FINISH GRADE inches (meters)
TYPE VL	+/- 3 (0.08)
TYPE L	6 (0.15)
TYPE M	9 (0.25)
TYPE H	12 (0.30)
TYPE VH	+/- 12 (0.30)

SECTION 111
COLORED PORTLAND CEMENT CONCRETE

111.1 GENERAL

The Colored Portland Cement Concrete shall be a portland cement concrete that meets the requirements of Section 101, to which coloring pigments are added that meet the requirement of this Section.

111.2 REFERENCES

111.2.1 American Society for Testing and Materials (Latest Edition)

C-979 Specification for Pigments for Integrally Colored Concrete

111.2.2 This publication
Section 101 Portland Cement Concrete
Section 105 Concrete Curing Compound

111.3 MATERIALS

111.3.1 The portland cement concrete shall conform to the requirements of Section 101 or as modified by the Supplemental Specifications and the approved concrete mix design.

111.3.2 Pigments used in the coloring of portland cement concrete shall be either natural or synthetic iron and mineral oxides in powder form. Pigments shall conform with the requirements of ASTM C-979.

111.4 DOSAGE

The maximum dosage rate shall not exceed the recommendations of the manufacturer, or 10% by weight of portland cement in the design mix. When a combination of pigments is required for a specific color, the total dosage rate of all pigments shall not exceed any of the individual maximum dosage rates of the component pigments, or 10% by weight of portland cement in the design mix.

111.5 BATCHING, MIXING, TRANSPORTATION AND PLACEMENT

Colored concrete shall be batched, mixed, transported and placed in/with equipment that is clean of all residual non-colored concrete prior to the introduction of the colored concrete materials.

111.6 PLACEMENT

111.6.1 Colored portland cement concrete that does not have the color mixed throughout the entire load or has uneven distribution of color in the load shall not be incorporated in the work and shall be rejected.

111.6.2 The finishing of all colored portland cement concrete shall be conducted in such a manner as to not diminish, streak, or in any way lessen the coloring of the concrete.

111.7 CURING

The liquid membrane-forming curing compound used to cure all colored concrete shall be compatible with the colored concrete, having the same color source pigments as those used in the color concrete and shall conform to the requirements of Section 105.

111.8 SUBMITTALS

111.8.1 The CONTRACTOR shall submit a mix design for the Colored Portland cement Concrete to the ENGINEER for review and approval. The mix design shall show the manufacturer of the pigment material, the dosage per cubic yard of the pigment material, and a certification from the pigment manufacturer that pigment(s) complies with the requirements of this Specification in accordance with Section 13. If during the project a change in the pigment material(s) or a change in the pigment manufacturer from the approved mix design is made, a new mix design shall be submitted to the ENGINEER for review and approval before the new material(s) are used on the project. The submittal shall include a curing program for the Colored Portland Cement Concrete.

111.8.2 As part of the ENGINEER'S review of the mix design a sample of the colored concrete may be required. The sample shall be not less than the size of the typical element to the cast with the colored concrete or a four foot (4') by four foot (4') section, whichever is smaller. The sample shall be placed, finished and cured according to the project requirements to produce a true sample of the finished product. The sample shall be placed on the project site in a location where the sample may or may not, as approved by the ENGINEER, be incorporated into the completed work. The sample shall be maintained as the acceptance referenced, once approved for the duration of the project.

111.9 MEASUREMENT AND PAYMENT

Colored Portland Cement Concrete shall be measured and paid for at the unit price per specific construction item as specified herein or as defined in the Bid Proposal.

SECTION 112

PAVING ASPHALT BINDER

112.1 GENERAL: Paving asphalt binder for asphalt concrete (AC), bituminous treated base course construction (BTB), and plant mixed seal coat (PMSC), shall conform to the requirements of this specification. The CONTRACTOR shall be solely responsible for the binder supplied under this specification, its proportions and manufacture. The binder shall be supplied from a single source/supplier and be of a single formulation for the duration of either the authorized period of a job mix formula including the binder, or the project, as directed by the ENGINEER. The CONTRACTOR shall submit his qualifications in writing, and at least three references to whom he has supplied the same or similar binder, as directed by the ENGINEER.

112.2 REFERENCES

- 112.2.1 American Society For Testing and Materials, ASTM
- D 5 Standard Test Method for Penetration of Bituminous Materials
- D 8 Standard Definitions of Terms Relating to Materials for Roads and Pavements
- D 92 Standard Test Method for Flash and Fire Points of Bituminous Materials
- D 113 Standard Test Method for Ductility of Bituminous Materials
- D 946 Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
- D 1754 Standard Test Method for Effect of Heat and Air on Asphaltic Materials (Thin Film Oven Test, TFOT)
- D 2042 Standard Test Method for Solubility of Bituminous Materials in Organic Solvents
- D 2171 Standard Test Method for Viscosity of Asphalt by Vacuum Capillary Viscometer
- D 2170 Standard Test Method for Kinematic Viscosity of Asphalts
- D 2872 Standard Test Method for Effect of Heat and Air on Asphaltic Materials (Rolling Thin Film Oven Test, RTFOT)
- D 3381 Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
- D 4402 Standard Test Method for Viscosity Determinations of Unfilled Asphalt Using the Brookfield Thermosel Apparatus
- 112.2.2 American Association of State Highway and Transportation Officials, AASHTO
- MP1 Standard Specification for Performance Graded

- Asphalt Binder
- MP2 Specification for Superpave™ Volumetric Mix Design
- TP1 Test Method for Determining Flexural Creep Stiffness of Asphalt Binder Using Bending Beam Rheometer (BBR)
- TP3 Test Method for Determining Fracture Properties of Asphalt Binders in Direct Tension (DT)
- TP5 Test Method for Determining Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
- T40 Practice for Sampling Bituminous Materials
- PP1 Accelerated Aging of Asphalt Binder Using Pressure Aging Vessel (PAV)
- PP5 Laboratory Evaluation of Modified Asphalt Systems
- PP6 Grading or Verifying the Performance Grade of an Asphalt Binder
- PP-28 Superpave™ Volumetric Design for HMA

112.2.4 This Publication:

- SECTION 116 ASPHALT CONCRETE CONSTRUCTION
- SECTION 307 PLANT MIXED BITUMINOUS TREATED BASE COURSE CONSTRUCTION
- SECTION 329 PLANT MIXED SEAL COAT
- SECTION 336 ASPHALT CONCRETE PAVEMENT

112.3 MATERIAL

112.3.1 An asphalt binder shall be either an asphalt cement, a blend of asphalt cement(s), or a blend of asphalt cement(s) and admixture(s), to be determined by the CONTRACTOR, complying with the requirements specified in either TABLE 112.A 60-70 PENETRATION GRADE BINDER SPECIFICATION, or TABLE 112.B AC-20 VISCOSITY GRADE BINDER SPECIFICATION, or TABLE 112.C PERFORMANCE GRADE (PG) BINDER SPECIFICATIONS.

112.3.2 The CONTRACTOR shall submit certified test results in writing, with the job mix formula submittal, that a binder complies with the specification. The certification shall include, but not be limited to:

- (a) name of the supplier
- (b) source(s) of base asphalt cement(s)
- (c) type and source(s) of admixture(s)
- (d) proportions of materials

- (e) laboratory test results of the binder
- (f) certification statement that the binder complies with the requirements of this specification.

A certification shall be submitted (1) for a binder used in the design of a job mix formula as a part of the submittal, and, (2) during the life of an authorized job mix formula as scheduled herein.

112.4 SAMPLING AND TESTING

112.4.1.1 Quality assurance sampling and testing of asphalt binders shall be performed by the CONTRACTOR, at no cost to the OWNER, to verify compliance with the specification. A sample shall be taken at random during paving operations from a load(s) of material shipped to any City of Albuquerque asphalt concrete supplier, either at least once a week, or as directed by the ENGINEER. The sample shall be tested by the CONTRACTOR to verify compliance with the specification requirements specified in either TABLE 112.A 60-70 PENETRATION GRADE BINDER SPECIFICATION, or TABLE 112.B AC-20 VISCOSITY GRADE BINDER SPECIFICATION, or TABLE 112.C PERFORMANCE GRADE (PG) BINDER SPECIFICATIONS. Test results shall be reported in writing to the ENGINEER by the CONTRACTOR. Non-complying sample test results shall be reported in to the ENGINEER within 24 hours of completion of the test(s). Complying sample test results shall be reported in writing to the ENGINEER, no later than ten working days after the date of sampling.

112.4.1.2 The binder sample used in the design of a job mix formula(s) shall be tested, and certified to comply with this specification. Written test results of the design sample binder tabulated with specifications with the certification of compliance shall be reported as specified herein and included in a job mix formula submittal.

112.4.2 A test report shall include, but not be limited to, (1) report date, (2) date of sampling, (3) bill of lading number of load sampled, (4) destination of load, (5) report of test results, (6) standard test identifications, (7) specification requirements, (8) statement of compliance, and certification signature. Failure to comply with quality assurance testing may result in rejection of either the binder, and/or the job mix formula, and/or the associated job mix placed on a project, as directed by the ENGINEER.

112.4.3.1 If non-complying material is identified, the paving program may be suspended for 24 hours, as directed by the ENGINEER, during which time the CONTRACTOR and the ENGINEER will meet to determine the impact of the non-compliance, and specify the necessary remedial

action to be taken by the CONTRACTOR. Remedial action shall be either acceptance, or acceptance at a pay adjustment, or removal and replacement at no cost to the OWNER. The paving program may continue upon written authorization by the ENGINEER. The suspension of asphalt concrete construction period due to the identification of non complying binder shall be at no cost to the OWNER.

112.4.3.2 Production binder identified to be in non-compliance shall not be shipped to a project. Asphalt concrete batched and placed with non-complying binder shall be removed and replaced with complying material by the CONTRACTOR at no cost to the OWNER, as directed by the ENGINEER.

112.4.4.1 GRADE CORRELATION: TABLE 112.D defines binder correlation(s). A binder grade to the right of a respective binder grade in the same row may be substituted.

112.4.4.2 A job mix formula using either penetration or viscosity grade binders shall be designed using the Marshall procedure and specifications.

112.4.4.3 A job mix formula using a performance grade, PG, binder shall be designed using the gyratory (SUPERPAVE) procedure and specification.

112.4.4.4 Binder substitution in an authorized job mix formula shall not be allowed.

112.5 TEMPERATURES

112.5.1 The CONTRACTOR shall specify the temperature ranges for mixing and compaction of a job mix formula for a binder, minimum and maximum, °F. Temperature ranges for mixing and compaction shall be specified in a job mix formula submittal.

112.5.2 The CONTRACTOR shall specify the “release to traffic” temperature, °F. Release to traffic temperature shall be the maximum temperature at which the viscosity of a binder is greater than 200,000 cps as determined by ASTM D4402. Release to traffic temperature shall be specified in a job mix formula submittal.

112.6 MEASUREMENT AND PAYMENT

112.6.1 Asphalt binder is an ingredient of asphalt concrete (AC), bituminous treated base course construction (BTB), and plant mixed seal coat (PMSC). Binder shall be paid either as incidental to the above materials, or as specified in the CONTRACT, as directed by the ENGINEER.

TABLE 112.A - 60-70 PENETRATION GRADE BINDER SPECIFICATION (ASTM D 946) [1]

CHARACTERISTIC		min	max	ASTM Procedure
I.	Original Binder			
1	Penetration @ 25 °C, 100 g, 5 s, mm	60	70	D 5
2	Flash Point (Cleveland open cup), °C	230		D 92
3	Ductility @ 25 °C, 5 cm/min, cm	100		D 113
4	Solubility in trichloroethylene, %	99.0		D 2042
II.	Asphalt after Thin Film Oven Test, TFOT			
1	Retained penetration @ 25 °C, 100 g, 5 s, mm	52		D 5
2	Ductility @ 25 °C, 5 cm/min, cm	50		D 113

[1] PG64-22 binders shall be used if 60-70 Penetration Grade and AC-20 Viscosity Grade binders are unavailable.

112.B AC-20 VISCOSITY GRADE BINDER (ASTM D 3381, TABLE 2) [1]

CHARACTERISTIC		min	max	Procedure
I.	Original Binder			
1	Viscosity @ 60 °C, poises	1600	2400	ASTM D2171
2	Viscosity @ 135 °C, cSt	300	-	ASTM D2170
3	Penetration @ 25 °C, 100 g, 5 s	60	-	ASTM D5
4	Flash Point, °C (Cleveland open cup)	230	-	ASTM D92
5	Solubility in trichloroethylene, %	99.0	-	ASTM D2042
II.	Tests on Residue From Thin-Film Oven Test			ASTM D1754
1	Viscosity after TFOT @ 60 °C, poises	-	10,000	ASTM D2171
2	Ductility after TFOT @ 25 °C, 5 cm/min, cm	50	-	ASTM D113

[1] PG64-22 binders shall be used if 60-70 Penetration Grade and AC-20 Viscosity Grade binders are unavailable.

TABLE 112.C PERFORMANCE GRADE (PG) BINDER SPECIFICATIONS

	Performance Grade Binder Characteristic	PG70-22	PG76-28	Standard Procedure
A.	Original Binder			
1	Dynamic Shear, 1.0 kPa min, $G^*/\sin \alpha @ 10 \text{ rad/sec}$	70	76	AASHTO TP 5
2	Flash Point, min	230	230	ASTM D48
3	Viscosity, 3 Pa. s (3000 cP) max, @temp	135	135	ASTM D4402 [1]
B.	Rolling Thin Film Oven Test Residue, RTFOT (T 240), 1 minute			
1	Mass loss, 1% max	yes	yes	
2	Dynamic Shear, 2.20 kPa, min, $G^*/\sin \alpha @ 10 \text{ rad/sec}$	70	76	AASHTO TP 5
C.	Pressure Aging Vessel Residue, PAV (PP1), after RTFOT			
1	PAV Temperature	110	110	
2	Dynamic Shear: $G^*/\sin \alpha$, max, 5,000 kPa, @ 10 rad/sec	28	28	AASHTO TP 5
3	Physical Hardening (report) [2]			
a.	Creep Stiffness: S, 300 MPa, max, m-value, 0.300 minimum, @ 60 s	-12	-18	AASHTO TP 1 [3]
b.	Direct Tension: Failure strain, 1.0 % min @ 1.0 mm/min	-12	-18	AASHTO TP 3 [4]

Notes:

- [1] This requirement may be waived if the binder supplier warrants that the supplied binder can be adequately pumped and mixed at temperatures that meet all safety standards.
- [2] Physical Hardening - TP1 is performed on a set of asphalt beams according to Section 13.1 of TP 1, except the conditioning is extended to 24 hrs +10 minutes at 10 °C above the minimum performance temperature. The 24 hour stiffness, S, and the m-value are reported for information purposes only.
- [3] The physical hardening index "h" accounts for the physical hardening of the binder. It shall be determined and reported in the submittal for the proposed binder and each sample tested for compliance with TABLE 112.PG76-28.A. "h" is calculated as follows:

$$h = (S_{24} / S_1)^{m1 / m24}$$

"1" and "24" indicate 1 and 24 hours of conditioning of the tank asphalt. Conditioning and testing is conducted at the designated test temperature. Values should be calculated and reported. "S" is the creep stiffness after 60 sec loading time and "m" is the slope of the log creep stiffness versus the log time curve after 60 sec loading time.

- [4] If the creep stiffness $S < 300$ MPa, the direct tension test is not required. If $300 < S < 600$ MPa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

TABLE 112.D - ASPHALT BINDER CORRELATION(S)

Pen. Grade [1]	Visc. Grade[1]	Performance Grade [2]	
60-70	-	PG70-22	-
-	AC-20	PG70-22	-
-	-	PG70-22	PG76-28
-	-	-	PG76-28

[1] Marshall analysis/design

[2] Gyratory analysis/design

SECTION 113

EMULSIFIED ASPHALTS

113.1 GENERAL: Emulsified asphalts shall be a homogeneous mixture of paving asphalt base, water, and an emulsifying or stabilizing agent complying with the requirements of this specification. Emulsified asphalt shall be classified as quick-setting, rapid-setting, medium-setting, or slow-setting type in either anionic or cationic emulsions.

113.2 REFERENCES:

113.2.1 American Society for Testing and Materials, ASTM:

- D5 Standard Test Method for Penetration of Bituminous Materials
- D70 Standard Test Method for Specific Gravity and Density of Semi-Solid Bituminous Materials
- D88 Standard Test Method for Saybolt Viscosity
- D113 Standard Test Method for Ductility of Bituminous Materials
- D244 Standard Test Methods for Emulsified Asphalts
- D977 Standard Specification for Emulsified Asphalt
- D2042 Standard Test Method for Solubility of Asphalt Materials in Trichloroethylene
- D2397 Standard Specification for Cationic Emulsified Asphalt
- D3628 Standard Practice for Selection and Use of Emulsified Asphalt
- E70 Standard Test Method for pH of Aqueous Solutions with the Glass Electrode

113.2.2 American Association of State Highway and Transportation Officials, AASHTO:

- 0 Solubility of Asphalt Materials in Trichloroethylene
- T49 Standard Test Method for Penetration of Bituminous Materials
- T51 Standard Test Method for Ductility of Bituminous Materials
- T59 Standard Test Methods for Emulsified Asphalts
- T200 Standard Test Method for pH of Aqueous Solutions with the Glass Electrode

113.2.3 This Specification:

SECTION 112 PAVING ASPHALT BINDER

SECTION 116 ASPHALT CONCRETE

SECTION 302 AGGREGATE BASE COURSE CONSTRUCTION

SECTION 305 CEMENT TREATED BASE COURSE CONSTRUCTION

SECTION 336 ASPHALT CONCRETE CONSTRUCTION

SECTION 337 PORTLAND CEMENT CONCRETE CONSTRUCTION

113.3 TESTING REQUIREMENTS: The emulsified asphalt shall conform to the requirements set forth in the Tables 113.3.1, 113.3.2, 113.3.3, or TABLE 113.5.3.

113.4 TEST REPORT AND CERTIFICATION: Quality assurance sampling and testing of emulsified asphalt shall be performed by the CONTRACTOR to verify compliance with the specification. A sample will be taken at random during paving operations from a load(s) of material shipped to any City of Albuquerque project, either at least once a week, or as directed by the ENGINEER. Non-complying sample test results shall be reported to the ENGINEER within 24 hours of completion of the test(s). Complying sample test results shall be reported in writing to the ENGINEER no later than ten working days after the date of sampling. Emulsified asphalt sampling and testing shall be incidental to the cost of the material and placement costs.

113.5 TEMPERATURES:

113.5.1 Emulsified asphalt shall be heated in such a manner that steam or hot oils will not be introduced directly into the emulsified asphalt during heating. The CONTRACTOR shall furnish and keep on the site at all times an accurate thermometer suitable for determining the temperature of the emulsified asphalt.

113.5.2 Unless otherwise specified, the various grades of emulsified asphalt shall be applied at temperatures within the limits specified in Table 113.5.2, the exact temperature to be determined by The ENGINEER. Emulsified asphalt shall be reheated, if necessary, but at no time after loading into a tank car or truck for transportation from the refinery to the purchaser shall the temperature of the emulsion be raised above 185 °F. During all reheating operations the emulsified asphalt shall be agitated to prevent localized

overheating. Emulsified asphalt shall not be permitted to cool to a temperature of less than 40 °F.

113.6 MEASUREMENT AND PAYMENT: The unit of volumetric measurement shall be the U.S. gallon at a

temperature of 60°F. If this material is to be part of a surface treatment the measurement may be in square yards of area covered. All approved quantities shall be paid at the unit price per defined unit of measurement as specified in the Bid Proposal.

TABLE 113.3.1 SPECIFICATIONS FOR ANIONIC EMULSIFIED ASPHALT

Type			Rapid Setting				Slow Setting			
Grade			RS-1		RS-2		SS-1		SS-1h	
Test on Emulsions:	AASHTO	ASTM	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity SSF@77°F (25°C) , sec		D88	20	100	-	-	20	100	20	100
Viscosity SSF@122°F (50°C) , sec		D88	-	-	75	400	-	-	-	-
Settlement, 5 days, %			-	-	-	5	-	5	-	5
Storage Stability 1 day ^[2]			-	1	-	1	-	1	-	1
Demulsibility in 35 ml of .02N Calcium Chloride ^[3]			60	-	60	-	-	-	-	-
Cement Mixing Test, %			-	-	-	-	-	2.0	-	2.0
Sieve Test, %			-	0.10	-	0.10	-	0.10	-	0.10
Residue by distillation, %			55	-	63	-	57	-	57	-
Tests on Residue from Distillation										
Test:		D244		(4)		(4)				
Penetration @77°F(25°C)	T49	D5	100	200	100	200	100	200	40	90
Ductility, 77°F(25°C)5 cm/min, cm	T51	D113	40	-	40	-	40	-	40	-
Solubility in Trichloroethylene, %	T44	D2042	97.5	-	97.5	-	97.5	-	97.5	-

Notes

:

- 1 The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days time; or the purchaser may require the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.
- 2 The 24 hour (1 day) storage stability test may be used instead of the 5 day settlement test.
- 3 The demulsibility test shall be made within 30 days from date of shipment.
- 4 A harder base asphalt meeting current paving asphalt specifications may be specified with the provision that the test requirements on the Residue from Distillation be waived.

TABLE 113.3.2 SPECIFICATIONS FOR CATIONIC EMULSIFIED ASPHALT

Type	Test Method		Rapid Setting				Medium Setting						Slow Setting			
			CRS-1		CRS-2		CMS-2S		CMS-2		CMS-2h		CCS-1		CSS-1h	
Grade	AASHTO	ASTM	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Tests on Emulsions:																
Viscosity SSF @ 77°F. (25°C.) sec.		D88	20	100	100	400	50	450	50	450	50	450	20	100	100	100
Viscosity SSF @ 122°F. (50°C.) sec.		D88	-	5	-	5	-	5	-	5	-	5	-	5	-	5
Settlement 5 days, %			-	1	-	1	-	1	-	1	-	1	-	1	-	1
Storage Stability Test 1 day ^[2] Demulsibility 35 ml 0.8% sodium dioctyl sulfosuccinate, % ^[3]			40	-	40	-	-	-	-	-	-	-	-	-	-	-
Coating ability s water resistance:																
Coating, dry aggregate			-	-	-	-	Good	-	Good	-	Good	-	-	-	-	-
Coating, after spraying			-	-	-	-	Fair	-	Fair	-	Fair	-	-	-	-	-
Coating, wet aggregate			-	-	-	-	Fair	-	Fair	-	Fair	-	-	-	-	-
Coating, after spraying			-	-	-	-	Fair	-	Fair	-	Fair	-	-	-	-	-
Particle charge test			Positive		Positive		Positive		Positive		Positive		Positive		Positive	
Sieve test, %			-	0.10	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10
Cement mixing test, %			-	-	-	-	-	-	-	-	-	-	-	2.0	-	2.0
Distillation:																
oil distillate by volume of emulsion %		0	-	3	-	3	-	20	-	12	-	12	-	-	-	-
Residue, %			60	-	65	-	60	-	65	-	65	-	57	-	57	-
Tests on residue from distillation test			-	(4)	-	(4)	-	-	-	-	-	-	-	-	-	-
Penetration, 77°F. (25°C.)	T49	D5	100	250	100	250	100	250	100	250	40	90	100	250	40	90
Ductility, 77°F. (25°C.), 5 cm/min., cm.	T51	D113	40	-	40	-	40	-	40	-	40	-	40	-	40	-
Solubility in Trichloroethylene, %	0	D2042	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-

Notes:

1. The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days time; or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.
2. The 24 hour (1 day) storage stability test may be used instead of the 5 day settlement test.
3. The Demulsibility test shall be made within 30 days from date of shipment.
4. Must meet a pH requirement of 6.7 maximum (ASTM E-70) if the Particle Charge Test result is inconclusive.

TABLE 113.3.3 EMULSIFIED ASPHALT SLURRY SEAL MIXING GRADES

BITUMULS CLASS			ANIONIC				CATIONIC			
Bitumuls Type			Dense Aggregate Mixing		Quick-Set Slurry Seal		Dense Aggregate Mixing		Quick-Set Slurry Seal	
Bitumuls Grade Designation			DM-h		QS-h		DM-Kh		QS-Kh	
ASTM Grade Designation (Closest)			(SS-lh)		(None)		(CSS-lh)		(None)	
Test on	Emulsion (a)	Test Method	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol at 77°F (25°C) sec.		AASHTO T-59 ASTM D244	-	100	-	100	-	100	-	100
Storage Stability Test, 1 day, per cent		ASTM D244	-	1.0	-	1.0	-	1.0	-	1.0
Cement Mixing Test, per cent		AASHTO T-59 ASTM D244	-	2.0	-	-	-	2.0	-	-
Sieve Test, per cent		AASHTO T-59 ASTM D244	-	0.10	-	0.10	-	0.10	-	0.10
Particle charge Test (b)		AASHTO T-59 ASTM D244	Negative		Negative		Positive		Positive	
pH (b)		AASHTO T-200 ASTM E70	7.3	-	-	-	-	6.7	-	-
Dehydration, ratio			0.5	-	-	-	0.7	-	-	-
Adhesion			Pass	-	-	-	Pass	-	-	-
Slurry Seal Tests (Standard Reference Aggregate ©)										
Mixing, seconds			-	-	60	-	-	-	120	-
Setting, minutes			-	-	-	60	-	-	-	60
Water Resistance, after 30 minutes cure			-	-	-	Pass	-	-	-	Pass
Residue by Distillation, per cent		AASHTO T-59 ASTM D244	57	-	57	-	57	-	57	-
Tests on Residue from Distillation Test										
Penetration at 77°F (25°C), 1130 gm, 5 sec.		AASHTO T-49	40	100	40	100	60	110	40	110
Ductility at 77°F (25°C), cm,		AASHTO T-51 ASTM D113	40	-	40	-	40	-	40	-
Solubility in Trichloroethylene, per cent		AASHTO T-44 ASTM D2042	97	-	97	-	97	-	97	-

Notes:

- a) All tests shall be performed within 30 days from the date of emulsified asphalt shipment.
- b) Must meet pH Test if inconclusive Particle Charge Test.
- c) ASTM C778, Specification for Standard Sand

TABLE 113.5.2 - APPLICATION TEMPERATURE OF EMULSIFIED ASPHALT

Grade	Mixing	Spraying
RS-1	Not Used	70-140 °F
CRS-1, RS-2, CRS-2	Not Used	125-185 °F
SS-1, CSS-1	50-160 °F	70-140 °F
SS-1h , CSS-1h	50-160 °F	70-140 °F
CMS-2S, CMS-2, CMS-2h	50-160 °F	125-185 °F
QS-KH, QS-H	50-120 °F	70-120 °F

TABLE 113.5.3 - PRIME COAT SPECIFICATION

I. Material Type		AE-P [1]		PE-P [2]	
II. Test		Min	Max	Min	Max
A.	Viscosity, Saybolt Furol, @ 122 degF, sec	15	150	-	75
B.	Storage Stability @ 24 hr , %	-	1.0	-	-
C.	Sieve Test No. 20, %	-	-	-	0.10
III. Distillation Test					
A.	Residue from Distillation Test To 500 degF, %	65	-	35	-
B.	Oil by Distillate, % by Volume	-	25	-	4.0
C.	Solubility in Trichloroethylene, %	97.5	-	-	-

Notes:

[1] AE-P, asphalt emulsified prime

[2] PE-P, penetrating emulsified prime

SECTION 114

ASPHALT PAVEMENT HOT RECYCLING

114.1 GENERAL

Asphalt pavement hot recycling shall consist of removing an existing asphalt pavement, sizing the removed materials, furnishing additional materials if required by the ENGINEER, mixing the materials with a recycling agent in either a dryer-drum or batch plant and placing the recycled asphalt mixture on the roadway or street.

114.2 REFERENCES

114.2.1 ASTM

D 70	D 1160
D 92	D 2170
D 244	

114.2.2 AASHTO

T 48	T 202
T 201	T 240

114.2.3 This publication:

SECTION 116
SECTION 336

114.3 REMOVAL AND SIZING OF EXISTING PAVEMENT: The asphalt pavement removed for recycling shall be crushed and re-screened so that all the material removed from the roadway is prepared for recycling and a uniform mixture of all material is maintained. If determined by the ENGINEER the material removed from the roadway and placed in the stockpile is not uniform in nature, the CONTRACTOR shall blend the material in such a manner that it is uniform throughout the stockpile.

114.4 MATERIAL

114.4.1 RECYCLING AGENTS: The recycling agent to be mixed with the removed pavement shall conform with Table 114.4.1.1, 114.4.1.2, and 114.4.1.3.

114.4.2 VIRGIN AGGREGATE: If a virgin aggregate is specified for blending with the removed asphalt pavement, it shall meet the requirements of aggregates for an asphalt concrete as described in Section 116. The gradation band to be used shall be as designated in the supplemental specifications.

114.5 PROPORTIONING

A job-mix formula for the recycled asphaltic concrete mixture to be supplied

under this contract shall be determined by an approved testing laboratory from representative samples of graded aggregate produced and stockpiled and the reclaimed asphalt pavement stockpiled by the CONTRACTOR. Recycled asphaltic concrete material will not be mixed until the ENGINEER has received and approved the job-mix formula. The job-mix formula shall indicate the definite percentage of the reclaimed pavement and the virgin aggregate, the percentage of recycling agent, and the temperature of the completed mixture as it is to be discharged from the mixer.

114.6 MIXING

The recycled asphalt mixture shall consist of the reclaimed asphalt, the virgin aggregate and a recycling agent. No mixing of these materials shall occur until a job-mix formula has been approved by the City of Albuquerque Materials Testing Laboratory. The recycled mixture can be mixed in either an asphalt batch-plant or a dryer-drum. The CONTRACTOR is to follow the recommendations of the manufacturer of the plant as to mixing procedure. The reclaimed asphalt and virgin aggregate are to be proportioned in the plant through the cold feed bins or to be blended in the stockpile. The CONTRACTOR is to submit to the ENGINEER, for his approval, an outline of the procedures to be used in mixing the asphalt concrete.

114.7 PLACEMENT

The placement of the mixture will follow the requirements for the placement of asphalt concrete as described in Section 336.

114.8 MEASUREMENT AND PAYMENT

Removal of the existing asphalt pavement will be paid for at the contract unit price per square yard. Payment will include removing and delivering the bituminous pavement materials to the plant, and crushing and stockpiling as required. The recycled bituminous pavement mixture will be paid for at the unit price per ton or square yard, with a separate item for the recycling agent which will be paid for at the unit price per ton.

TABLE 114.4.1.1
PROPOSED SPECIFICATIONS FOR HIGH FLASH RECYCLING AGENTS

Tests	AASHTO	Grade					
	Test	H-1		H-2.5		H-5	
	Method	Min.	Max.	Min.	Max.	Min.	Max.
Original Material:							
Viscosity, 60°C (140°F), Poise	T-202	50	200	200	300	400	600
Viscosity, 135°C (275°F), cs	T-201	50	--	80	--	110	--
Flash Point, COC, F	T-48	450	--	450	--	450	--
RTFC Residue:	T-240*						
Weight Loss, %	T-240	--	1.0	--	1.0	--	1.0
Viscosity Ratio**	--	--	3.0	--	3.0	--	3.0

*TFO may be used, but RTFC shall be the preferred method.

**Viscosity Ratio = $\frac{\text{RTFC Viscosity at 60°C (140°F)}}{\text{Original Viscosity at 60°C (140°F)}}$

TABLE 114.4.1.2

INTERIM SPECIFICATIONS FOR CYCLOGEN

PROPERTY	FUNCTION & PURPOSE	TEST METHOD	L*	M*	H*
Viscosity @ 140°F, cS	Asphalt viscosity adjustment in recycled mix	ASTM D 2170	80-500	1000-4000	5000-10000
Flash Point, COC, °F	Handling precaution	ASTM D 92	350 min.	350 min.	350 min.
Volatility, IBP, °F 2%, °F 5%, °F	Avoidance of air pollution and hardening by evaporation	ASTM D 1160, 10 mm	300 min. 375 min. 410 min.	300 min. 375 min. 410 min.	300 min. 375 min. 410 min.
Compatibility, N/P	Avoidance of syneresis		0.5 min.	0.5 min.	0.5 min.
Chemical Composition (N+A ₁)(P+A ₂)	Durability of asphalt in recycled mix	ASTM D 2006	0.2-1.2	0.2-1.2	0.2-1.2
Specific Gravity	Calculations	ASTM D 70	Report	Report	Report

Suitable pumping temperatures are the following: L = 115°F, M = 190°F, and H = 200°F

TABLE 114.4.1.3

INTERIM SPECIFICATIONS FOR EMULSIFIED CYCLOGEN
Designated as LE, ME, and HE¹

PROPERTY	FUNCTION & PURPOSE	TEST METHOD	SPECIFICATIONS
Viscosity @ 77°F, SFS	Ease of handling	ASTM D 244	15-85
Pumping Stability	Prevention of premature breaking	G.B. Method ²	Pass
Emulsion Coarseness, percent	Optimal distribution	Sieve Test, ASTM D 244 (MOD) ³	0.1 max.
Sensitivity to Fines, percent	Adequate mixing life	Cement Mixing, ASTM D 244	2.0 max.
Particle Charge	Preferential affinity to asphalt	ASTM D 244	Positive
Concentration of Oil Phase, percent	Assurance of oil content and for calculations	ASTM D 244 (MOD) ⁴	60 min.

¹Oils used for emulsions must meet specifications listed in Table 1.

²Pumping stability is determined by charging 450 ml of emulsion into a one-liter beaker and circulating the emulsion through a gear pump (Roper 29 B22621) having 1/4" inlet and outlet. The emulsion passes if there is no significant oil separation after circulating ten minutes.

³Test procedure identical with ASTM D 244 except that distilled water shall be used in place of two percent sodium oleate solution.

⁴ASTM D 244 Evaporation Test for percent of residue is modified by heating 50 gram sample to 300°F until foaming ceases, then cooling immediately and calculating results.

SECTION 115

SLURRY SEAL MATERIALS

115.1 GENERAL

Slurry seal coats shall consist of a bituminous material and filler of mineral aggregates in the proportions specified under Section 330.

115.2 REFERENCES

115.2.1 ASTM

C 88	D 242
C 131	D 2419
C 386	

115.2.2 This publication:

SECTION 112
SECTION 113
SECTION 330

115.4.2 Test certificates and reports for bituminous material shall be furnished in accordance with Section 112.

115.4.3 A test report for adhesion of emulsified asphalt as specified in Section 112 is required.

115.5 MEASUREMENT AND PAYMENT

No measurement or payment will be made for separate ingredients of the slurry seal. Payment for asphalt emulsion slurry seal shall be made on the unit price per square yard as per the Bid Proposal.

115.3 MINERAL AGGREGATES

115.3.1 The mineral aggregate shall consist of natural or manufactured sand, slag, crusher fines, or a combination thereof. Smooth textured sand of less than 1.25 percent water absorption shall not exceed 50 percent of the total combined aggregate. The aggregate shall be clean and free from vegetable matter and other deleterious substances. When tested by ASTM D 2419, the aggregate blend shall have a sand equivalent of not less than 45. When tested according to ASTM C 88, the aggregate shall show a loss of not more than 15 percent. When tested according to ASTM C 131, the aggregate shall show a loss of not more than 35 percent.

115.3.2 Mineral fillers such as Portland cement, limestone dust, or fly ash, shall be considered as part of the blended aggregate and shall be used in minimum required amounts. The mineral fillers shall meet the requirements of ASTM D 242. Mineral fillers shall only be used if needed to improve the quality of the mix or gradation of the aggregate.

115.3.3 The combined mineral aggregate shall conform to one of the following gradations on Table 115.3.3 when tested in accordance with ASTM C 386. The type gradation will be as shown on the plans or as specified by the ENGINEER.

115.4 BITUMINOUS MATERIALS

115.4.1 The bituminous material shall be an emulsified asphalt as specified by the ENGINEER or as shown on the plans. The material shall conform to the requirements of Section 113.

TABLE 115.3.3
AGGREGATE GRADING FOR SLURRY SEAL

Sieve Size	Type I Percent Passing	Type II Percent Passing	Type III Percent Passing
3/8	100	100	100
No. 4	100	90-100	70-90
No. 8	90-100	65-90	45-70
No. 16	65-90	45-70	28-50
No. 30	40-60	30-50	19-34
No. 50	25-42	18-30	12-25
No. 100	15-30	10-21	7-18
No. 200	10-20	5-15	5-15
Residual Asphalt Content % Dry Aggregate	10-16	7.5-13.5	6.5-12

Note: Job mix design shall be submitted for ENGINEER'S approval

SECTION 116

ASPHALT CONCRETE

116.1 GENERAL: Asphalt concrete shall consist of a mixture of asphalt binder, aggregates, mineral filler and admixtures, proportioned as required, batched and delivered as specified herein. All materials and job mix formulas used in asphalt concrete, either batched at or delivered to a project, shall be certified in accordance with the requirements of Section 13 of these specifications. The CONTRACTOR shall be solely responsible for asphalt concrete job mix formula supplied under this specification, its proportions and manufacture. Each job mix formula submitted and authorized for use under this Specification shall be identified by a number, unique to that job mix formula. If either a change in material(s) or material supplier(s) from that specified in the job mix formula occurs during a project, authorized use of the job mix formula on the project may be cancelled as directed by the ENGINEER.

A job mix formula shall not be used on a project without written approval of The ENGINEER. A job mix formula, upon request by an asphalt concrete supplier, may be approved by the Public Works Department Construction Division for use on City and City related projects for a period of 14 months from the date of sampling of reference aggregates used in the job mix formula.

116.2 REFERENCES:

116.2.1 American Society For Testing and Materials (ASTM):

C88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C117	Method for Material Finer Than 0.75 μm (No.200) Sieve In Mineral Aggregates by Washing
C131	Test Method for Resistance to Degradation of Small-size Coarse Aggregate by Abrasion and Impact in a Los Angeles Machine
C136	Method for Sieve Analysis of Fine and Coarse Aggregate
D242	Specifications for Mineral Filler for Bituminous Paving Mixtures
D692	Specification for Coarse Aggregate for Bituminous Paving Mixtures
D979	Methods of Sampling Bituminous Paving Mixtures
D995	Specification for Mixing Plants for Hot-Mixed, Hot Laid Bituminous Paving Mixtures
D1073	Specification for Fine Aggregate for Bituminous Paving Mixtures
D1074	Test Method for Compressive Strength of Bituminous Mixtures
D1559	Resistance to Plastic Flow of Bituminous Mixtures

Using Marshall Apparatus

D2041	Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures
D2493	Viscosity-Temperature Chart for Asphalts
D2726	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
D2851	Test for Determining the Percentage of Fractured Particles in Coarse Aggregate
D2950	Density of Bituminous Concrete in Place by Nuclear Methods
D3203	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
D3515	Standard Specification for Hot Mixed, Hot-Laid Bituminous Paving Mixtures
D4791	Test for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

116.2.2 American Association of State Highway and Transportation Officials (AASHTO) (Latest Edition):

MP2	Specification for Superpave™ Volumetric Mix Design
PP-28	Superpave™ Volumetric Design for HMA
TP 4	Preparation of Compacted Specimens of Modified and Unmodified Hot Mix Asphalt by Means of SHRP Gyratory Compactor
PP 2	Short and Long-term Aging of Bituminous Mixes
T53	Quantitative Analysis of Bitumen From Bituminous Paving Mixtures, Ignition Oven Method A
T245	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
T283	Resistance of Bituminous Mixture To Moisture Induced Damage
T304	Uncompacted Void Content of Fine Aggregate

116.2.3 Asphalt Institute

MS-2	Mix Design Methods, Sixth Edition
MS-2	Mix Design Methods, Sixth Edition, Section 5.16, Modified Marshall Method For Large Aggregate

116.2.4 This publication:

SECTION 13 WARRANTY AND GUARANTEE;
TESTS AND INSPECTIONS;
CORRECTIONS, REMOVAL, OR
ACCEPTANCE OF DEFECTIVE WORK

SECTION 101 PORTLAND CEMENT CONCRETE
SECTION 112 ASPHALT BINDER
SECTION 118 HYDRATED LIME
SECTION 336 ASPHALT CONCRETE PAVEMENT

116.3 MATERIALS

116.3.1 Asphalt binder shall comply with the requirements of SECTION 112-ASPHALT BINDER

116.3.2 Aggregates shall be crushed stone, crushed gravel, crushed asphalt concrete pavement, crushed portland cement concrete, and natural or manufactured sand conforming to the quality and crushed particle requirements of this Specification. Coarse aggregates shall comply with the requirements of ASTM D692, Coarse Aggregate for Bituminous Paving Mixtures. Fine aggregates shall comply with the requirements of ASTM D1073, Fine Aggregate for Bituminous Paving Mixtures. The combined aggregates, proportioned as defined by the target gradation, shall comply with the requirements of Table 116.A. Aggregates shall be certified to comply with the requirements of this Specification and authorized for use by The ENGINEER before the materials may be incorporated in the construction. Prior to delivery of the aggregates or material containing the aggregates, The CONTRACTOR may be required to furnish samples of the aggregates to The ENGINEER for testing. Daily production aggregates gradations shall be submitted to the ENGINEER, upon request.

116.3.3 Mineral filler shall comply with the requirements of ASTM D242, Mineral Filler for Bituminous Paving Mixtures and as specified herein. Mineral filler shall be certified to comply with the requirements of this Specification and approved for use by ENGINEER before the materials may be incorporated in the construction. Prior to either delivery of the mineral filler or material containing the mineral filler, The CONTRACTOR may be required to furnish samples of the mineral filler to The ENGINEER for testing.

116.3.4 Asphalt concrete shall comply with the minimum requirements of TABLE 116.C.1.H. Moisture susceptibility, % retained strength at 7% air voids, AASHTO T283, with freeze cycle. Admixtures to reduce moisture susceptibility in an asphalt concrete mix shall be either hydrated lime, portland cement, liquid admixture, or a modified asphalt binder authorized by the ENGINEER.

116.4 PROPORTIONING:

116.4.1.1 The CONTRACTOR shall be solely responsible for the asphalt concrete job mix formula (jmf)

proportions and asphalt concrete either batched at and/or delivered to the site. Asphalt concrete shall be proportioned in accordance with the requirements of this Specification.

116.4.1.2 Asphalt concrete material proportioned with "performance grade binders" shall be proportioned to comply with the requirements of TABLE 116.C.1 of this specification, AASHTO MP2, Specification for Superpave™ Volumetric Mix Design, and PP-28, Superpave™ Volumetric Design for HMA. The job mix formulas shall be designed under the direct supervision of a New Mexico Registered Professional Engineer who has completed a certified "SUPERPAVE Mixture Design & Analysis" Short Course.

116.4.2.1 Asphalt concrete for construction of street classifications of Collector, Minor and Major Arterial, and Controlled Access Roadways submitted to the Design Review Committee (DRC) shall be proportioned with performance grade (PG) binders.

116.4.2.2 Asphalt concrete for construction of classifications of Collector, Minor and Major Arterial, and Controlled Access Roadways shall be proportioned with performance grade (PG) binders.

116.4.2.3 Asphalt concrete for construction of street classifications of Residential, Local, Major Local, and streets with design equivalent single axle loads (Esals) less than 3.0 mil, may be proportioned with a PG70-22 performance grade binder.

116.4.3 Asphalt concrete proportioned with either penetration or viscosity grade binders shall be proportioned to comply with the requirements TABLE 116.C.2. A JMF shall be prepared in a laboratory under the direct supervision of a New Mexico Registered Professional Engineer.

116.4.4 Asphalt concrete design and analysis shall be performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition.

116.4.5.1 An asphalt concrete job mix formula shall be proportioned to comply with the requirements of TABLE 116.B AGGREGATE GRADATION PROPERTIES and either TABLE 116.C.1 ASPHALT CONCRETE DESIGN SPECIFICATIONS PERFORMANCE GRADE BINDERS, or TABLE 116.C.2 ASPHALT CONCRETE DESIGN SPECIFICATIONS PENETRATION AND VISCOSITY GRADED BINDERS.

116.4.5.2.1 Aggregates, mineral filler, and anti-strip admixture if required, shall be proportioned to provide a combined gradation that complies with the requirements specified in Table 116.B, and have the same or similar shape characteristic gradation curve as the specification limits specified therein when graphically plotted on a standard "0.45 POWER" gradation chart. The gradation shall be reported to the nearest whole per cent for material passing sieves above the 0.075 mm (no. 200) sieve, and to the nearest 0.1 per cent for material passing the 0.075 mm (no. 200) sieve. The theoretical maximum density gradation curve shall be the curve represented by a straight line drawn from the intersection of the ordinate and abscissa of the graph to the one hundred percent passing point for the nominal maximum size aggregate.

116.4.5.2.2 The design characteristic shape gradation curve for SP-II asphalt concrete shall be similar to a "S" shape curve, with a convex curve above the maximum density line for aggregate greater than 4.75 mm (No.4) sieve and a concave curve below the maximum density line for aggregate finer than the 4.75 mm (No.4) sieve.

116.4.5.2.3 The design characteristic shape gradation curve for Type SP-III and SP-IV asphalt concretes shall be similar to a "S" shape curve, with a convex curve above the maximum density line for aggregate greater than 2.36 mm (No.8) sieve and a concave curve below the maximum density line for aggregate finer than the 2.36 mm (No.8) sieve.

116.4.5.2.4 The design characteristic shape gradation curves for Types B, C, and D, asphalt concretes shall be similar to two convex curves above the maximum density line, one for aggregate greater than the 2.36 mm (No.8) sieve, and one for aggregate finer than the 2.36 mm (No.8) sieve. The two curves shall intersect each other at the 2.36 mm (No.8) sieve.

116.4.5.2.5 The design characteristic gradation curve shape for Type A asphalt concretes shall be similar to two convex curves above the maximum density line, one for aggregate greater than the 4.75 mm (No.4) sieve, and one for aggregate finer than the 4.75 mm (No.4) sieve. The two curves shall intersect each other at the 4.75 mm (No.4) sieve.

116.4.6 The job mix formula asphalt binder content shall be proportioned to provide a job mix formula that complies with the requirements defined either in TABLE 116.C.1 when proportioned with PG binders, or in TABLE 116.C.2, when proportioned with either penetration or viscosity graded binders. The design asphalt binder content shall be selected, based on laboratory testing, aged binder mix required. The binder content shall include a minimum of 75% virgin binder when a job mix formula is designed with recycled asphalt concrete pavement, RAP. The design % binder content, $\pm 0.3\%$, shall not exceed the binder content at minimum VMA.

TABLE 116.A - COMBINED AGGREGATE DESIGN PROPERTIES

CHARACTERISTIC	AGGREGATE TYPE		PROCEDURE
	Coarse	Fine	
1. Coarse aggregate angularity, material > 4.75 mm	[1]	[2]	ASTM D 5821
ESALs < 3.0 mil	85	80	
3.0 ≤ ESALs < 30.0 mil	95	90	
30.0 mil ≤ ESALs	100	100	
2. Fine aggregate angularity as air voids, %, min	-	45	AASHTO TP 33
3. Flat and elongated particles, 3:1 or greater dimension, material > 4.75 mm, %	20 max		ASTM D 4791
4. Clay content, min %	-	45	ASTM D 2419
5. Deleterious material, max %	1	1	ASTM C 142
6. LA Abrasion, material > 2.36 mm, max loss, %	40	40	ASTM C 131
7. Soundness, max loss after 5 cycles, %	15	15	ASTM C 88

[1] coarse aggregate has one or more fractured faces

[2] coarse aggregate has two or more fractured faces

TABLE 116.B AGGREGATE GRADATION [3]

SIEVE SIZE, in	% PASSING TYPE, Nominal Maximum Size Aggregate [1]												PRODUCTION TOLERANCE (%)
	SP-II/A, 1		SP-III, 3/4		SP-IV, ½		SP-V/D, 3/8		B, 3/4		C, ½		
	min	max	min	max	min	max	min	max	min	max	min	max	
1-1/2	100	100	-	-	-	-	-	-	-	-	-	-	
1.00	86	96	100	100	-	-	-	-	100	100-	-	-	8
3/4	-	90-	89	96	100	100	-	-	88	96	100	100	8
½	62	83	-	90	88	96	100	-	-	90	88	96	8
3/8	-	-	64	85	-	90	91	97	70	85	73	90	8
no.4	31	40	37	47	52	70	-	90	51	69	57	75	7 [2]
8	19	27	23	32	28	39	47	67	35	49	39	58	6
16	10	18	12	22	14	26	38	55	28	40	32	48	6
30	6	14	8	17	8	19	28	43	21	31	24	38	5
50	4	11	5	14	5	16	19	30	14	23	16	27	5
200	3.0	7.0	3.0	8.0	2.0	10.0	3.0	10.0	2.0	8.0	3.0	10.0	3.0

NOTES: [1] SP-II and Type A gradation materials may not be used for the surface course

[2] If recycled asphalt concrete aggregate (RAP) is used, ±8%

[3] A JMF aggregate gradation may pass through the restricted zone if all JMF volumetric design criteria is in compliance. The restricted zone is defined by the material passing the no.8 to no.30 sieves for SP-II and Type A asphalt concretes. The restricted zone is defined by material passing the no.4 to no.30 sieves for all other asphalt concrete.

TABLE 116.C.1 - ASPHALT CONCRETE SUPERPAVE DESIGN SPECIFICATIONS

DESCRIPTION	Local, Major Local, Residential, Intersections [1]		Collector, Minor and Major Arterial, Controlled Access Roadway, and Intersections [1]			
	PG70-22		PG76-28		PG76-28	
A. Binder	< 3		3 ≤ ESALs <30		30 ≤ ESALs [2]	
B. Equiv.. Single Axle Load, ESALs (million)	3.5 - 4.5		3.5 - 4.5		3.5 - 4.5	
C. Voids, %	min max		min max		min max	
D. Voids in Mineral Aggregate, VMA, %	12 14		12 14		12 14	
Type SP-II [3], (1 in.)	- -		13 15		13 15	
Type SP-III, (3/4 in.)	- -		14 16		14 16	
Type SP-IV, (½ in.)	- -		16 18		16 18	
Type SP-V, (3/8 in.)	12 14		- -		- -	
Type A, (1 in.) [3]	13 15		- -		- -	
Type B, (3/4 in.)	14 16		- -		- -	
Type C, (½ in.)	16 18		- -		- -	
Type D, (3/8 in.)	- -		65 75		65 75	
E. Voids filled with binder, %	- -		65 75		65 75	
Type SP-II [3], (1 in.)	- -		65 75		65 75	
Type SP-III, (3/4 in.)	- -		65 75		65 75	
Type SP-IV, (½ in.)	- -		65 75		65 75	
Type SP-V, (3/8 in.)	68 78		- -		- -	
Type A, (1 in.) [3]	68 78		- -		- -	
Type B, (3/4 in.)	68 78		- -		- -	
Type C, (½ in.)	68 78		- -		- -	
Type D, (3/8 in.)	0.6 1.6		0.6 1.6		0.6 1.6	
F. Dust Ratio, -no.200 (0.075mm) : %P _{bc}	N % CMPTN		N % CMPTN		N % CMPTN	
G. Gyratory compaction [4] at binder compaction temp, ± 5 °F	7 91.0		8 89.0		9 89.0	
Gyrations	75 96.0		100 96.0		125 96.0	
N _i (initial)	115 98.0		160 98.0		205 98.0	
N _d (design)	80 min		80 min		80 min	
N _m (max)						
H. Moisture susceptibility, % retained strength @7% air voids, AASHTO T283, with freeze cycle.						

NOTES:

- [1] The intersection area shall be the core area common to all intersecting streets, and, include the distance to the curb return of the approach and departure of the intersecting streets.
- [2] Level II Design Complying with NMSHTD Procedures at Date of Bid, as directed by the City Engineer.
- [3] SP-II and Type A gradations asphalt concrete shall not be used for surface course
- [4] % of maximum theoretical specific gravity / density, G_{mm}

TABLE 116.C.2 - ASPHALT CONCRETE DESIGN SPECIFICATIONS
PENETRATION & VISCOSITY GRADE BINDERS

DESCRIPTION	Residential, Local, Major Local, and Intersections
A. Binder Grade	60-70 Pen, AC-20 Viscosity
B. Equiv. Single Axle Load, ESALs (million)	ESALs < 3.0
C. Voids, %	3.5 - 4.5
D. Voids in Mineral Aggregate, VMA, %	
Type A, (1 in.)	12 - 14
Type B, (3/4 in.)	13 - 15
Type C, (1/2 in.)	14 - 16
Type D, (3/8 in.)	15 - 17
E. Voids filled with binder, %	68 - 78
F. Dust Ratio, -no.200(0.075 mm) : %P _{be}	0.6 - 1.6
G. Marshall Stability Design, Blow counts/ each face	50
Stability, lbs, min	1500
Flow, 0.01 in	10-18
H. Stability to Flow Ratio, minimum @target binder + 0.5%	200
I. Moisture susceptibility, % retained strength, @ 7% air voids, AASHTO T283, with freeze cycle.	80 min

NOTES:

[I] The intersection area shall be the core area common to all intersecting streets and include the distance to the curb return of the approach and departure of the intersecting streets.

116.5.1 A design mix job mix formula submittal shall be include but not be limited to the information specified in TABLE 116.D-SUBMITTAL INFORMATION, as directed by the ENGINEER.

116.5.2 The materials specified in an authorized job mix formula shall be the same source and type for all asphalt concrete batched, delivered, placed and compacted, under

the identification code defined for the authorized job mix formula.

116.5.3 A submittal shall be rejected if it does not include the specified information and samples. A job mix formula submittal shall be accepted or rejected within ten (10) working days of receipt by the ENGINEER.

TABLE 116.D - SUBMITTAL INFORMATION

I. Identification
A. Asphalt concrete supplier
B. Laboratory that performed design/development tests
C. Date of Submittal
D. Unique mix code identification number
E. Aggregate sample date
II. Job Mix Formula (jmf)
A. City type/application of asphalt concrete
B. Component material target proportions to include combined aggregate gradation and asphalt content, specifications, and production tolerances
C. 0.45 power gradation plot of combined aggregate gradation with specification and production limits
D. Temperature viscosity relationship of binder
E. Recommended mixing, compaction, and release to traffic maximum temperatures.

- F. Tabulation of job mix formula performance characteristics defined in either TABLE 116.C.1 or TABLE 116.C.2, as applicable, at the proposed design proportions, with reference specification limits and production limits (if specified), maximum theoretical specific gravity/density (as pcf), and bulk specific gravity/density (pcf).
- G. Reference daily production gradation, see 116.3.2
- III. Certifications of Compliance
 - A. Compliance of job mix formula by NM Registered Professional Engineer in direct charge of design/development;
 - B. Design Laboratory Certification, projects bid after June 30, 2000.
 - C. Component materials testing and certification by supplier/manufacturer with supporting test data for materials used in design development
 - D. Certification and laboratory test results of asphalt binder used in job mix formula design development, see 112.4.1.2.
- IV. Design Development (Tables and graphs, with specifications limits of the following:)
 - A. Marshall Design & Modified Marshall Designs (design development with a minimum of 4 asphalt binder contents required, and the recommended design characteristic bracketed by a minimum of two test points for the design binder content $\pm 0.5\%$)
 - 1. Design hammer blow counts, mold diameter, hammer mass and drop
 - 2. Stability (lbs.) vs. % asphalt content
 - 3. Flow (0.01 in.) vs. % asphalt content
 - 4. Briquette bulk Specific Gravity and Bulk Density (as pcf) vs. % asphalt content
 - 5. % Voids In Mineral Aggregate (% VMA) vs. % asphalt content
 - 6. % Voids (Pa) in asphalt concrete vs. % asphalt content
 - 7. % voids filled in Asphalt Concrete vs. % asphalt content
 - 8. dust ratio vs. % asphalt content
 - B. SUPERPAVE Design (Tables and graphs, with specifications limits of the following)
 - 1. Trial Designs: Aggregate gradations, 3 minimum required, and trial asphalt binder content (%)
 - a) Table of Aggregate Gradations and 0.45 power plot, with specification limits
 - b) Trial design % asphalt content
 - c) Trial designs volumetric analysis for each gradation, VMA, Va, VFA, graph not required
 - d) Trial designs compaction analysis @ Ni, Nd, and Nm, for each gradation
 - e) Dust ratio for each trial design, graph not required
 - 2. Job Mix Formula Design, (design development with a minimum of 4 asphalt binder contents required, and the recommended design characteristic bracketed by a minimum of two test points for the design binder content $\pm 0.5\%$)
 - a) Table of design aggregate gradation and 0.45 power plot, with specification limits and production targets
 - b) Compaction analysis G_{mb} as % G_{mm} at Ni, Nd, and Nm, vs asphalt content (separate graphs for Ni, Nd, and Nm)
 - c) Volumetric analysis of VMA, Va, VFA, and dust ratio at design gyration, @Nd, vs % asphalt content
 - d) Gyratory compaction tables as height of sample versus gyration, for each asphalt content, G_{mb} @ NM, and bulk specific gravity/density correction factor(s) (graphs not required)
 - e) Maximum theoretical specific gravity/density (as pcf), G_{mm} , vs %asphalt content @Nd
 - f) Corrected bulk specific gravity/density (as pcf), G_{mb} , vs % asphalt content
 - e) dust ratio vs. % asphalt content
 - f) Recommended gyratory sample mass(g) for 115 mm sample height at Nm
 - C. Ignition Correction Factor: Correction for material losses during asphalt content ignition oven analysis

The correction factor shall be determined as the average value for three samples, design % asphalt content, design - 1.0%, and design +1.0%, developed in an ignition oven complying with the requirements of AASHTO T53, Method A.

116.6 PRODUCTION:

116.6.1 Asphalt concrete shall be produced in accordance with the requirements of ASTM D3515, the requirements of this Specification, or as authorized by The ENGINEER. Production facilities shall comply with the requirements of ASTM D995, and this Specification. A

plant shall be certified annually, by a New Mexico Registered Professional Engineer, to comply with the requirements of this Specification and Section 13. The production plant shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certification shall be completed within 12 months prior to production of an authorized job mix

formula at the plant. Certificates of calibration and production certifications shall be maintained at the plant for review by The ENGINEER. A copy of the certifications shall be submitted to The ENGINEER upon request.

116.6.2 Asphalt concrete shall be placed at the design proportions specified in the authorized job mix formula within the specified production tolerances for combined aggregate gradation and asphalt binder content. Asphalt concrete placed at a project, sampled and tested in accordance with this specification, shall have a gradation that complies with the authorized design gradation \pm the production tolerance(s) specified in the authorized job mix formula. Asphalt concrete placed at a project, sampled and tested in accordance with this specification, shall have an asphalt content that complies with the design asphalt content \pm 0.5% (laboratory analysis), T53-Quantitative Analysis of Bitumen From Bituminous Paving Mixtures, Ignition Oven Method, Method A (Modified: reference temperature for constant mass, $149 \pm 3^{\circ}\text{C}$ / $300 \pm 7^{\circ}\text{F}$).

116.7 DELIVERY:

116.7.1 Asphalt concrete shall be delivered in trucks free of fluid leaks. Trucks detected to have leaks shall not be allowed on the project. Subgrade, base course, and asphalt concrete surfaces contaminated by uncontrolled equipment fluids shall be removed and replaced with complying material. Contaminated material shall be disposed of as specified. When hauling time from the mixing plant to the job site exceeds two hours or when inclement weather prevails, bituminous mixtures shall be covered with tarpaulins while being hauled. The tarpaulins shall completely cover the load and be firmly tied down. Mixtures shall be delivered to site of the work and placed without segregation of the ingredients and within the temperature range specified in the authorized job mix formula. Diesel fuel or other petroleum based solvents shall not be used in the bed of transport vehicles as a release agent to prevent build up of the asphalt material. Material contaminated with diesel fuel or other petroleum based solvents shall be removed and replaced with complying material by the CONTRACTOR, as directed by the ENGINEER, at no cost to the OWNER.

116.7.2 The CONTRACTOR shall provide with each load of asphalt concrete batched and/or delivered to the job site, before unloading at the site, a delivery ticket on which is printed, stamped or written, the information defined in Table 116.E. One copy of the ticket shall be available for each of the ENGINEER and the quality assurance testing program.

TABLE 116.E - DELIVERY TICKET
INFORMATION

Name of Asphalt Concrete Supplier
Date of Delivery
Delivery Ticket Number Contractor
Project Name (optional)
Job Mix Formula Number
Weight of Load (tons)
Time loaded

116.8 PLACEMENT:

Asphalt concrete shall be placed in uniform layers/lifts in accordance with the requirements of Section 336. The thickness of a layer/lift shall be not less than two (2) times the maximum size aggregate and/or not greater than 4 inches for SP-II aggregate gradations. The thickness of a layer/lift shall be not less than two (2) times the maximum size aggregate of the job mix formula used but not greater than 3 inches, as directed by the ENGINEER. A pavement lift thickness shall be selected to use the maximum size aggregate, as authorized by the ENGINEER. Lift thickness(s) and asphalt concrete type, designating the maximum size aggregate, shall be either specified in the CONTRACT documents, or as directed by the ENGINEER. S-II asphalt concrete shall not be used for a surface course.

116.9 COMPACTION:

116.9.1 Asphalt concrete compaction shall begin when the asphalt concrete temperature is in the compaction temperature range specified in the authorized job mix formula. Compaction shall be completed before the temperature of the material cools to less than 200 $^{\circ}\text{F}$. Compaction may be allowed on material with a temperature less than 200 $^{\circ}\text{F}$ and greater than 185 $^{\circ}\text{F}$, as directed by the ENGINEER. The material shall be compacted to a density of at least 93% but not greater than 97% of the theoretical maximum density as determined by ASTM D2041.

116.9.2 The CONTRACTOR shall be responsible for the development and implementation of the compaction program. The program shall be defined by the CONTRACTOR, to include equipment type and description, and procedures, reported in writing to the ENGINEER for each job mix formula/lift thickness used on a project. Changes in the compaction program shall be reported to the ENGINEER as they may occur.

116.9.3 A CONTRACTOR may construct a test strip, a minimum of 10 feet wide and 250 feet long, to establish the rolling pattern for an asphalt mix and lift thickness to be placed on a project, as directed by the ENGINEER. The test

strip shall be paid for in accordance with the requirements of the CONTRACT, as authorized by The ENGINEER.

116.9.4.1 Compaction equipment shall be steel wheeled, pneumatic wheeled, and hand plate tampers, free of fluid leaks, selected by the CONTRACTOR, and authorized by the ENGINEER. Compaction equipment detected to have leaks shall not be allowed on the project.

116.9.4.2 Compaction may be either static or dynamic (vibratory). All equipment shall be ballasted and operated as recommended by the manufacturer. Motorized wheeled dynamic (vibratory) compaction equipment shall have the frequency rate and amplitude setting readily available for review by the ENGINEER. Frequency rate and amplitude adjustability shall be operable on so equipped motorized wheeled dynamic (vibratory) compaction equipment. Motorized compaction equipment with inoperable frequency rate and amplitude adjustment features shall not be used on the project.

116.9.4.3 Motorized compaction equipment shall be equipped with automatic wheel spray systems to apply release agents to prevent tracking of asphalt concrete. Diesel fuel or other petroleum based solvents shall not be used as a release agent to prevent build up of the asphalt material. Material contaminated with diesel fuel or other petroleum based solvents shall be removed and replaced with complying material by the CONTRACTOR, as directed by the ENGINEER, at no cost to the OWNER.

116.9.4.4 Repair and replacement of damaged adjacent property and structures, resulting from the use of vibratory rolling equipment, shall be the responsibility of the CONTRACTOR, at no cost to the OWNER.

116.10 SAMPLING AND TESTING:

116.10.1.1 Quality assurance asphalt concrete sampling and testing shall be performed in accordance with the requirements of this specification, the Supplemental Technical Specifications, or as directed by The ENGINEER.

116.10.1.2 Quality assurance asphalt concrete analysis shall be (1) performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, and (2) under the direct supervision of a New Mexico Registered Professional Engineer.

116.10.1.3 Testing equipment shall be calibrated annually

with calibration standards traceable to the National Bureau of Standards. Calibration records and certifications shall be maintained at the Laboratory for review by The ENGINEER. A copy of the certifications shall be submitted to The ENGINEER upon request.

116.10.1.4 Quality assurance sampling and testing shall be performed by a technician certified under the New Mexico State Highway and Transportation Department/Associated Contractors of New Mexico Technical Training and Certification Program for ASPHALT and SUPERPAVE™.

116.10.1.5 Quality assurance sampling and testing shall be conducted under the direct supervision of a New Mexico Registered Professional Engineer.

116.10.2 FIELD SAMPLING:

A quality assurance asphalt concrete material field sample shall be taken in accordance with the requirements of ASTM D979 for each job mix delivered. The materials shall be sampled at the greater rate of either one sample for each 250 tons, or one sample per day, for each type of material placed on a project, as directed by the ENGINEER. The sample shall be of such size to provide material for all tests specified and a split sample to perform verification/referee tests for gradation and binder content, if required.

116.10.3 MATERIAL TESTING:

116.10.3.1 Asphalt concrete quality assurance sampling and testing shall be performed in accordance with the requirements of this Specification, the Supplemental Technical Specifications, or as directed by The ENGINEER.

116.10.3.2 The asphalt concrete quality assurance sample shall be tested and the properties reported, with authorized job mix formula production limits, as specified in TABLE 116.F - FIELD SAMPLE LABORATORY TESTS.

TABLE 116.F - FIELD SAMPLE LABORATORY TESTS

-
- I. Marshall Design Analysis
 - A. Energy Reference:
 - 1 briquette mass / mold size;
 - 2 hammer size and drop; and
 - 3 number of blow counts per face;
 - B. Volume characteristics of compacted briquettes, with production specifications, average of three:
 - 1 VMA, voids in mineral aggregate;
 - 2 Va, voids in asphalt concrete;
 - 3 VFA, voids filled with asphalt binder; and,
 - 4 Gmb, bulk specific gravity and density, with authorized jmf target, average of three;
 - C. Gmm, maximum theoretical specific gravity/density with authorized jmf target, one test;
 - D. Strength Characteristics:
 - 1 stability;
 - 2 flow; and,
 - 3 stability : flow ratio.
 - III. SUPERPAVE Analysis (sample aging is not required)

Analysis at authorized jmf gyrations, N_i (initial), N_d (design), and N_m (max). (1) Two briquettes required. (2) Report average of test results of two briquette tests.

 - A. Compaction analysis with authorized design, and specifications (if applicable)
 - 1 Bulk specific gravity/density, G_{mb} , @ N_i , N_d , and N_m
 - 2 Maximum theoretical specific gravity/density, Gmm
 - 3 Compaction: Gmb as % Gmm at N_i , N_d , and N_m
 - 4 Sample height, mm, at N_d
 - B. Volume characteristics of compacted briquettes @ N_d , with design value and specifications
 - 1 VMA, voids in mineral aggregate
 - 2 Va, voids in asphalt concrete
 - 3 VFA, voids filled with asphalt binder
 - IV. Asphalt binder content, with design value and authorized production range, T53-Quantitative Analysis of Bitumen From Bituminous Paving Mixtures, Ignition Oven Method A (Modified: reference temperature for constant mass, $149 \pm 3^\circ \text{C}$ / $300 \pm 7^\circ \text{F}$)
 - V. Dust ratio, % P_{75}
 - VI. Extracted Combined Aggregate, with design value(s) and authorized production range
 - A. Gradation
 - B. Coarse aggregate angularity, material > 4.75 mm, coarse aggregate has two or more fractured faces
 - C. Flat and elongated particles, 3:1 or greater dimension, material > 4.75 mm, %

116.10.3.3 A CONTRACTOR may challenge production material test results, binder content and aggregate gradation, and request that the retained split asphalt concrete sample of record be released to his assigned laboratory and tested for compliance, as authorized by the ENGINEER. Notification of challenge shall be made in writing to the ENGINEER by the CONTRACTOR within 28 calendar days from date of sampling. Challenge test results shall be submitted to the ENGINEER for evaluation no later than 42 calendar days from date of sampling. Challenge test results will be evaluated in accordance with "multi laboratory" precision tolerances specified, T53 for binder content, ASTM C117 and C136 for aggregate gradation. Challenge and record test results that comply with precision tolerances will be

averaged with the companion test results of record and the material pay factor, PF_M , recalculated, as directed by the ENGINEER. Challenge and record test results that do not comply with the precision tolerances will direct the disqualification of the challenged sample, as directed by the ENGINEER. Cut/core sample(s) will be taken from the area(s) represented by the disqualified challenge sample(s) and evaluated by the lab of record under the observation of the CONTRACTOR, in accordance with the requirements of this specification and replace the disqualified sample test results. Analysis of the replacement cut/core sample(s) may not be challenged. The CONTRACTOR will submit challenge test results in writing to the ENGINEER for each split sample released to his assigned laboratory of record.

Challenges filed after the time limitations will not be considered. The OWNER shall pay for all complying tests.

16.10.4 FIELD TESTING:

116.10.4.1 Asphalt concrete quality assurance sampling and testing shall be performed in accordance with the requirements of this Specification, the Supplemental Technical Specifications, or as directed by The ENGINEER.

116.10.4.2 Quality assurance in place field compaction tests shall be conducted in accordance with the requirements of this specification, as directed by the Engineer. A test shall determine the density of a constructed asphalt concrete roadway lift. Compaction shall be calculated as the measured in-place density, divided by the average maximum theoretical density (G_{mm}) of the samples taken for that day's placement, reported to one tenth of a percent, xxx.x.%. Maximum theoretical density (G_{mm}) shall be determined in accordance with ASTM D2041.

116.10.4.2.1 Field density for SP-II and Type A materials shall be measured from field core samples. A minimum of one core sample shall be taken for each lift of 250 tons of a material type, or fraction thereof, placed each day, but not less than 3 cores per day, as directed by the Engineer. The bulk density (G_{mb}) of each core shall be measured in accordance with the requirements of D2726 and reported to the nearest one-tenth pound per cubic foot, (one kilogram per cubic meter). The compaction for the shall be calculated as the average measured density of the cores for a lift of a type of material placed in a day, divided by the average of the maximum theoretical density (G_{MM}) of the samples of the same or similar materials taken for that day's placement, reported to the nearest one tenth of a percent, xxx.x.%. The

maximum theoretical density (G_{MM}) shall be determined in accordance with ASTM D2041, and reported to the nearest one-tenth pound per cubic foot, (one kilogram per cubic meter). The core barrel shall be 6 inches (150mm) o.d. or greater, taken full depth. A lift sample shall be trimmed from the core at the lamination lines between lifts. The CONTRACTOR shall be responsible for material replacement at no cost to the OWNER where samples are removed.

116.10.4.2.2.1 The field density for Types B, C, D, SP-III, SP-IV, and SP-V materials shall be measured in accordance with the requirements of ASTM D2950, at the minimum rate of three tests per lift, per 500 sy of each type of asphalt material placed in a day, as directed by The ENGINEER.

116.10.4.2.2.2 A reference density test of the support material, for the asphalt concrete roadway lift to be construction, shall be taken prior to the placement of the fresh asphalt concrete lift, or defined from previous test results. The density of the support material shall be used as reference in performing the density test of a fresh asphalt concrete lift in accordance with the requirements ASTM D2950, placed over the support material. a density test of the support material shall be taken at the rate of one (1) test for each 500 sy of surface or less to be paved over in a day, as directed by the Engineer. The density of the support material shall be reported as "reference support material density" in the compaction test report of the constructed asphalt concrete pavement over the area represented by the support material compaction test.

116.10.4.2.3.1 Compaction tests shall be taken at random locations on the asphalt being placed, as directed by The ENGINEER. The three (3) general areas in which tests are to be taken are the free edge of the mat, mat interior, and the joints. The number of tests taken in each area will vary but the total number of tests taken on any project shall be in the following approximate proportions.

TABLE 116.G
FIELD IN PLACE DENSITY PROPORTIONS

Location	% of total tests
Free Edge of Mat ¹	20 to 33
Mat Interior	33 to 60
Joints ²	20 to 33

NOTES:

- 1 The free Edge of Mat test shall be taken in the area between one (1) foot and two (2) feet in from a free edge of a lift.
- 2 Joints shall include the longitudinal and transverse butt joints between adjacent lifts of asphalt having the same finish elevation. Tests may be taken on material placed against a cold joint edge of formed surface.

116.10.4.2.3.2 Samples of the compacted Types S-III, S-IV, B, C, and D asphalt concretes may be taken and tested to determine compaction conformance of the finished pavement with the specified requirements either as requested by the CONTRACTOR, or as directed by the ENGINEER. Cores shall be sampled and tested in accordance with 116.10.4 - Field Testing.

116.10.5.1 Test reports shall include but not be limited to the information specified in TABLE 116.H - TEST REPORT.

TABLE 116.H - TEST REPORT

A.	Field Data and Test Results:
1	Date of Sampling/Test
2	City of Albuquerque Project Number or Permit Number
3	Project Title
4	Asphalt Concrete Supplier
5	Delivery Ticket Number (asphalt concrete sample-only)
6	Job Mix Formula Number
7	Location of sample/test as defined by Contract Documents
8	Time of Sampling/testing
9	Material temperature at time of sampling, °F
10	Ambient temperature at time of sampling, °F
11	Field test results with reference specification limits (compaction test)
B.	Laboratory Test Results
1	Laboratory results as defined in TABLE 116.F
2	Field Test Data, 116.10.4
C.	Recommended Pay Adjustment Factor for a LOT
1	C_{LM} , material factor, see TABLE 116.J
2	C_{LC} , placement/compaction factor, see TABLE 116.K

116.10.5.2 Test results shall be reported to The ENGINEER, CONTRACTOR, Supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, in writing, within 7 working days of completion of the sampling of the asphalt and/or the field testing. Non-complying tests shall be reported to The ENGINEER, CONTRACTOR, supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, within 1 working day of completion of the test.

116.10.5.3 The New Mexico Registered Professional Engineer in direct charge of the laboratory shall certify on a quality assurance test report that the test procedures used to generate the report complied with the specifications.

116.11 MEASUREMENT AND PAYMENT

116.11.1 The measurement of the asphalt concrete material shall be by the ton delivered and unloaded at the project, and, by the square yard lift placement and compaction, for each mix type used on a project, each day.

116.11.2 Each LOT of asphalt concrete material shall be

paid at the adjusted CONTRACT unit price for asphalt concrete, calculated in accordance with the equation below, adjusted by a material factor, PF_M , specified in TABLE 116.J, as authorized by the ENGINEER. A LOT shall be defined as the total tonnage placed in a day, for each type of material placed. Acceptance samples shall be sampled and tested in accordance with the requirements of 116.10, and tested for compliance with the specifications. a material pay factor, PF_{M} , shall be determined in accordance with TABLE 116.J, as defined for test results for combined aggregate gradation and asphalt content, as compared to the authorized job mix formula's production specifications. All complying acceptance samples taken in a day for a material type shall represent a LOT in the computation specified in TABLE 116.J. Non complying acceptance samples shall be evaluated in accordance with this specifications as directed by the Engineer. The material factor, PF_M , for a LOT shall be determined based on the deviation of the average value, arithmetic mean, M , of the acceptance samples' test results from the job mix formula targets, T , adjusted for the range of the test results, maximum value minus the minimum value. If the absolute value of the deviation of the daily mean from the target is greater than the maximum allowable

deviation, the LOT will be removed and replaced with materials complying with the specifications at no cost to the OWNER, as directed by the ENGINEER. If it is determined by the ENGINEER to be more practical to accept the material under a specific project condition, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR at an assigned pay factor $PF_M = 0.70$, for a LOT having a compaction pay factor, PF_C , equal or greater than 0.85, as authorized by the ENGINEER.

$$UP' = PF_M \times UP$$

UP', adjusted contract unit price/ton
 UP, Contract unit price/ton
 PF_M , material adjustment factor

TABLE 116.J - MATERIAL FACTOR, PF_M , FOR GRADATION & BINDER CONTENT

NUMBER OF DAILY SAMPLES	For $ T-M $ equal or greater than D' , [1, 2]		
	D' , MAXIMUM ALLOWABLE DEVIATION [3]		
1	1.40D	1.20D	D
2	D + R	D + 0.37R	D - 0.10R
3	D + 0.30R	D + 0.07R	D - 0.14R
4	D + 0.16R	D - 0.01R	D - 0.17R
5	D + 0.11R	D - 0.03R	D - 0.20R
6	D + 0.09R	D - 0.05R	D - 0.22R
7	D + 0.07R	D - 0.07R	D - 0.24R
8	D + 0.06R	D - 0.08R	D - 0.25R
9	D + 0.05R	D - 0.09R	D - 0.26R
10 OR MORE	D + 0.04R	D - 0.10R	D - 0.27R
MATERIAL FACTOR, PF_M [3]	0.85	0.95	1.00

- [1] D, production tolerance +/- %, see TABLE 116.B and paragraph 116.4.2.2, and authorized job mix formula, R, range of test values, maximum - minimum values, M, average test value of a LOT's samples test results. T, target value specified in the authorized job mix formula.
- [2] If the deviation of the daily mean from the target exceeds the maximum allowable deviation for a LOT, $|T-M| > D'$, the LOT will be removed and replaced with material complying with this specification, at no cost to the OWNER, as directed by the ENGINEER. If determined by the ENGINEER to be more practical to accept the material, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR AT an assigned pay factor $PF_M = 0.70$, for compaction LOT(s) having a compaction factor, PF_C , equal or greater than 0.85, as directed by the ENGINEER.
- [3] The material factor, PF_M , shall be the lowest of the factors calculated for either the combined aggregate gradation of material passing the nominal maximum size aggregate screen, 3/8 inch, and smaller screens, or, the binder content.

116.11.3 The placement and compaction factor, PF_C , for a LOT shall be determined based on the average value of the compaction tests for the LOT, with any single test neither less than 90.0% nor greater than 98%, and TABLE 116.K. If a test for a LOT is either less than 90.0% or greater than 98%, the LOT will be evaluated as directed by the Engineer.

$$UP' = PF_C \times UP$$

UP', adjusted contract unit price
 PF_C , see TABLE 116.K
 UP, contract unit price

TABLE 116.K - PAY FACTOR (PF_c) FOR COMPACTION

Average of Acceptance Test Results	Pay Factor, PF _c
98.0% and greater	[1]
97.1 to 97.9	0.85
93.0 to 97.0	1.00
92.0 to 92.9	0.95
91.0 to 91.9	0.90 [2]
90.0 to 90.9	0.85 [2]
less than 90%	[1], [2]

- [1] The material defined for the Lot shall be removed and replaced with asphalt concrete material complying with this Specification at no cost to The OWNER, as directed by The ENGINEER. Upon written agreement, the CONTRACTOR and ENGINEER may determine that for practical purposes the Lot shall not be removed. If determined by the ENGINEER to be more practical to accept a LOT, a LOT may be accepted under written agreement between the OWNER and the CONTRACTOR at an assigned compaction pay factor $PF_c = 0.50$ [2], for a LOT having a material factor pay factor equal or greater than 0.85, as directed by the ENGINEER.
- [2] When the lift is the surface course, and is accepted at this pay factor, the CONTRACTOR shall be apply a sanded fog seal to the LOT complying with the requirements of SECTION 333, as directed by the ENGINEER, at no cost to The OWNER.

SECTION 117

ASPHALT REJUVENATING AGENTS

117.1 GENERAL

117.1.1 Type I asphalt rejuvenating agent, a cationic oil and resin emulsion, shall be composed of a petroleum resin oil base uniformly emulsified with water and conforming to the requirements contained herein.

117.1.2 Asphalt rejuvenating agents shall not be used except under the provisions in the approved supplemental technical specifications.

117.2 REFERENCES

117.2.1 ASTM
D 244
D 445

117.3 TESTING REQUIREMENTS

Table 117.3 indicates testing requirements for asphalt rejuvenating agents.

117.4 CERTIFICATION

The CONTRACTOR shall furnish the ENGINEER with the brand name and name of the manufacturer of the asphalt rejuvenating agent he proposes to use and the material shall be approved by the ENGINEER before it is used. The CONTRACTOR shall also furnish the ENGINEER with a manufacturer's certificate of compliance indicating quantity and specification control.

117.5 MEASUREMENT AND PAYMENT

117.5.1 If this material is to be paid for as a separate item, then the measurement and payment shall be by the treated square yard.

117.5.2 If this material is to be combined with other items as a complete unit, then the measurement and payment will be made in accordance with the applicable section and per the Bid Proposal.

TABLE 117.3
 ASPHALT REJUVENATING AGENT TEST
 REQUIREMENT

Specification Designation	Test Method	Requirements
Viscosity, S.F., at 77°F Sec.	ASTM D 244	15-40
Residue, % (1)	ASTM D 244 (Mod.)	58-62
Cement Mixing Test, %	ASTM D 244	Zero
Sieve Test, % Max. (2)	ASTM D 244 (Mod.)	0.10
Particle Charge Test	ASTM D 244	Positive
Test on Residue From ASTM D 244		
Viscosity, cs., 140°F	ASTM D 445	100-200

ASTM D 244 Modified Evaporation Test for percent residue is made by heating 50 gram sample to 300 degrees F until foaming ceases, then cool immediately and calculate results.

Test procedure identical with ASTM D 244 except that distilled water shall be used in place of 2 percent sodium oleate solution.

SECTION 118

HYDRATED LIME MINERAL FILLER

118.1 GENERAL

Hydrated lime mineral filler may be required as an additive to the entire aggregate portion of the asphaltic concrete surface course, asphaltic concrete overlays, and plant mix seal.

118.5 MEASUREMENT AND PAYMENT:

No separate measurement or payment will be made for the additive of hydrated lime mineral filler to specified asphaltic surfacing materials.

118.2 REFERENCES

118.2.1 ASTM
D 242

118.2.2 AASHTO
M 17

118.3 MATERIAL

Hydrated lime mineral filler shall conform to the requirements specified in ASTM D 242 and AASHTO M 17.

118.4 MIXING AND PROPORTIONS

118.4.1 The hydrated lime shall be added to the aggregate such that loss of hydrated lime is minimal or non-existent. Placement of the lime on an open conveyor belt will not be permitted. Placement of the lime on an enclosed belt that does not permit blowing or loss of lime is acceptable.

118.4.2 The CONTRACTOR shall provide appropriate weighing devices, approved by the ENGINEER, to assure that the proportionate amounts of hydrated lime are being added to the coarse aggregate, fine aggregate and filler (if required).

118.4.3 Hydrated lime will be added at a proportion of 1 percent to 2 percent by weight of total aggregate.

118.4.4 Hydrated lime shall be added to the combined aggregate materials in a pug-mill immediately after leaving the cold feed and just prior to introduction into the dryer drum or dryer.

118.4.5 Minimum moisture content of the combined aggregates shall be 3 percent by weight, at the time the aggregate and lime are mixed, to effect a complete coating of the aggregate with the hydrated lime.

118.4.6 The ENGINEER may authorize the increase of the moisture content of the coarse and fine aggregates or the combination of coarse and fine aggregates to obtain proper coating of the aggregates with hydrated lime and to eliminate dust pollution.

SECTION 119

PAVING FABRICS

119.1 GENERAL

This section specifies the materials for paving fabrics which may be part of a pavement rehabilitation project.

119.2 REFERENCES

- 119.2.1 ASTM
D 1117
D 1777
D 3776

119.3 MATERIALS

119.3.1 FABRIC PROPERTIES: The fabric shall consist of woven or nonwoven polypropylene and/or polyester material meeting the requirements of Table 119.3.1 when tested in conformance with the respective test method.

119.3.2 PACKAGING: The fabric shall be packaged in rolls with each roll wound onto a suitable cylindrical form or core to aid in handling and placing. Each roll and the form or core upon which it is rolled shall be packaged in a suitable wrapper which is defined to include a sheath or container to protect the fabric from damage due to ultraviolet light and moisture during storage and handling.

119.3.3 IDENTIFICATION: Each roll shall be labeled or tagged in such a manner that the information for sample identification and other quality control purposes can be read from the label without opening the wrapper. Each roll shall be numbered by the manufacturer and further identified as to lot number or control number, date of manufacture, tare weight of core plus wrapper, width and length of fabric, and gross weight of the entire roll which includes fabric, core, wrapper, tags, etc.

119.3.4 SAMPLING:

119.3.4.1 Test samples will be cut at the project from rolls selected at random and shall be no less than three feet in length by the full width of the roll. Nothing in this section shall negate the ENGINEER's right to take additional samples.

119.3.4.2 The samples will be taken according to the following frequency:

119.3.5 TESTING: Specimens will not be conditioned for testing. One-half of the above samples will be tested initially:

SQUARE YARDS

NO. OF SAMPLES

0-50,000	8
50,000-150,000	16
100,000-300,000	24
Over 300,000	32

if the average test results indicate the material meets specification requirements no additional testing will be done. If the test results indicate the material does not meet specification requirements, the CONTRACTOR will be notified and the remaining samples will be tested. These additional test results will be combined with the first set.

119.3.6 WEIGHT (ROLL ROLL): Weight determinations will be made using procedures described in ASTM D 3376 Option A. The CONTRACTOR shall provide scales and move the roll to said scales for this purpose. Net weight of the fabric is total weight minus the weights of the core, wrapper, tags, etc.

119.3.7 WEIGHT (SPECIMENS): Specimen weight determinations will be made using procedures described in ASTM D 3776 Option C. Each specimen taken for the strength/elongation test and the asphalt retention test will be weighted to the nearest 0.1 gram.

119.3.8 STRENGTH AND ELONGATION:

119.3.8.1 The "breaking load" will be determined in accordance with ASTM D 1117, using constant rate of traverse of 12 ± 0.5 inches per minute and 1-inch (wide) x 2-inch (long) smooth-faced jaws. Test specimens will be rectangular and measure four by eight inches. When placed in the jaws, the fabric will project one-half inch at each end and 1.5 inches on each side.

119.3.8.2 Twenty individual test specimens will be taken at random for tensile and elongation testing, ten with the long dimension in the machine direction and ten with the long dimension in the cross-machine direction. No test specimens will be taken from either edge of the roll which is defined as within the outer one-tenth of the width. Ten specimens (five in each direction) will be tested for breaking load and elongation.

119.3.8.3 The average test values for the machine-wise and the cross-machine specimens will be reported separately as the final test values.

119.3.9 THICKNESS: Using ASTM D 1777, thickness will be determined using a 0.5-inch-diameter foot exerting 45 grams per square centimeter pressure onto a 1.1-inch-diameter anvil. Five thickness measurements will be made on each specimen used in the strength/elongation tests and asphalt retention test: one measurement in the vicinity of each corner and one in the center.

119.3.10 ASPHALT RETENTION: Two machine-wise test specimens and two cross-machine specimens each three by fifteen inches will be selected from the full-width sample in the same manner as described in Subsection 119.3.8. Each test specimen will be weighed to the nearest 0.1 gram, saturated in asphalt cement maintained at $150 \pm 4^{\circ}\text{F}$, placed between sheets of newspaper and pressed with a hot iron to remove excess asphalt. (Presence of excess asphalt is evidenced by a glossy appearance.) The saturated specimen will be weighted to the nearest 0.1 g, then placed in naphtha heated to $110^{\circ} \pm 5^{\circ}\text{F}$ for 30 minutes. Fresh naphtha at the specified temperature will be alternated as necessary during the 30-minute period to effect removal of the asphalt cement from the specimen. The specimen will be blotted with paper towels and allowed to air dry to effect naphtha removal, then measured. Asphalt retention will be calculated as follows:

asphalt retention (oz./sq. yd.) =

$$\frac{(\text{wt w/ asphalt} - \text{weight init.})\text{gms} \times 0.0352739 \text{ oz./gm.}}{(\text{area of specimen after test, sq. in.}) / 1296 \text{ sq. in./sq. yd.}}$$

119.3.11 BASIS FOR REJECTION: If a roll fails to meet the weight requirements when it is weighed in accordance with Option A, that roll will be rejected. If the average of the test results shows that the material does not meet specification requirements for any property, the material shall be rejected.

119.3.12 TESTING TIME REQUIREMENT: Testing may require up to 20 working days. Paving fabric from a shipment shall not be placed until testing from the shipment is complete.

119.3.13 TACK COAT: The tack coat shall be composed of paving grade bituminous material of the type and grade specified

by the manufacturer of the fabric and shall meet the requirements of 85-100 or 120-150 penetration asphalt, CSS-1 or SS-1 emulsified asphalt, or AC-5 or AC-10 asphalt. The tack coat application rate shall consist of the total of the mean optimum asphalt content required by the fabric as determined by the Materials Lab Bureau plus an amount to satisfy the "surface hunger" of the existing pavement as determined by the City of Albuquerque Materials Testing Laboratory.

119.4 MEASUREMENT AND PAYMENT

Measurement and payment shall be as specified in Section 335.

TABLE 119.3.1

PROPERTY	ASTM DESIGNATION TEST*	VALUE	UNITS
Weight (Full Roll)***	D 3776, Option A	3.5 to 8.0***	oz./sq.yd.
Weight (Specimens)***	D 3776, Option C	3.5 to 8.0**	oz./sq.yd.
Grab Tensile Strength	D 1117	80.0 min.	pounds
Elongation at Break	D 1117	50.0 min.	percent
Fabric Thickness***	D 1777	.030 min.**	inches
Asphalt Retention	None	0.10 min.	gal./sq.yd.

*Information about unique procedures for each of the tests is included in Subsections 119. through 119.

**Maximum allowable coefficient of variation is 12.5% where coefficient of variation = (standard deviation/mean) x 100%.

***For spun-bonded fabric these minimum values are to be: Thickness, 0.015 inches and asphalt retention, 0.07 gal./sq.yd.

SECTION 121

PLASTIC PIPE

121.1 GENERAL: Plastic pipe for pressure and non-pressure uses shall be manufactured from polyvinyl chloride (PVC), high-density polyethylene (HDPE) or ultra-high molecular weight materials.

121.2 REFERENCES.

121.2.1 American Society for Testing and Materials (Latest Editions) (ASTM):

D1248 Specification for Polyethylene Plastics Molding and Extrusion Materials

D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

D1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings

D1601 Test Method for Dilute Solution Viscosity of Ethylene Polymers

D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics

D1784 Specifications for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

D2239 Specifications for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

D2657 Heat-Joining Polyolefin Pipe and Fittings

D2737 Specification for Polyethylene (PE) Plastic Tubing

D3034 Specification for type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

F477 Specification for Elastomeric Seals (Gaskets) for joining Plastic Pipe

F679 Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

F794 Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

F894 Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

121.2.2 American Water Works Association (Latest Edition) (AWWA):

C900 AWWA Standards for Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in. for Water Distribution

C905 AWWA Standard for Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameter 14 in. through 48 in.

121.2.3 THIS PUBLICATION:

SECTION 800 WATER TRANSMISSION, COLLECTOR DISTRIBUTION AND SERVICE LINES

SECTION 900 SANITARY AND STORM SEWER FACILITIES

SECTION 1502 SUBMITTALS

121.3 CERTIFICATION

121.3.1 The CONTRACTOR shall submit certification from the manufacturer of the pipe as specified in Section 1502 as to the pipe material and that the pipe meets or exceeds the required testing. Only pipe manufactured in the United States of America will be acceptable.

121.4 GENERAL PLASTIC PIPE REQUIREMENTS

121.4.1 POSITIVE IDENTIFICATION: All PVC pipe shall be coded in accordance with the applicable material standard to eliminate future confusion and prevention accidental damage and service interruption of the facilities. PVC pipe used for potable water mains shall be blue in color. PVC pipe used for non-potable water mains shall be purple in color. PVC pipe used for sanitary sewer collection lines shall be green in color.

121.4.2 LINE LOCATOR: Metallic tape shall be used as a locator for all plastic pipe which is installed less than 10 feet deep. The tape should be installed 2 ft. to 6 ft. below top of ground and centered over the pipe. When feasible, the tape shall be fastened to metallic appurtenances associated with the installation (i.e. valves, fittings, manhole rings, etc.) in an effort to enhance its detectability.

121.4.3 PIPE STORAGE: All types of plastic pipe shall be stored in a manner that the pipe will not be deformed as recommended by the manufacturer. PVC pipe is subject to potential degradation when exposed to prolonged periods of sunlight. Material degradation is generally indicated by

SECTION 121

PLASTIC PIPE

a discoloration of the pipe. PVC pipe shall be stored inside a building, under a cover or covered up totally. All discolored pipe shall not be installed and shall be immediately removed from the project.

121.4.4 JOINING SYSTEMS

121.4.4.1 All plastic pipe which is connected to a manhole, junction box, inlet or similar structure shall be installed with an approved manhole connection adapter or water-stop such that each connection is leak-free and that there is no detrimental affect resulting from the material property characteristic differences between the plastic pipe and the structure.

121.4.4.2 BELL AND SPIGOT JOINTS: Pipe with gasket joints shall be manufactured with a socket configuration, which will prevent improper installation of the gasket and will ensure that the gasket remains in place during joining operations. The gasket shall be manufactured from a synthetic elastomer material and shall conform to the requirements of ASTM F 477. The spigot end of each joint of pipe shall be marked circumferentially to indicate the proper home mark. Pipe, which is field-cut, shall be chamfered and the home mark identified in accordance with the applicable criteria.

121.4.4.3 HEAT-WELDED JOINTS: HDPE pipe, which is manufactured without the standard bell and spigot joint configuration shall be joined by a heated fusion process in accordance with ASTM D 2657.

121.5 MATERIALS AND UTILIZATION

121.5.1 Polyvinyl Chloride (PVC) Pressure Pipe:

121.5.1.1 The material in PVC pipe shall be in accordance with ASTM D 1784.

121.5.1.2 Pipe shall be suitable for use in the conveyance of water for human consumption. The pipe shall be marked with two seals of the testing agency that certified the pipe material is suitable for potable water use.

121.5.1.3 PVC pipe shall be approved by the Underwriters Laboratories (UL) and be furnished in cast iron pipe-equivalent outside diameters. Joints shall be push-on flexible elastomeric gasketed.

121.5.1.4 Pressure pipe shall have a minimum working pressure of 150 psi (DR 18) or as specified on the plans or in the Supplemental Technical Specifications.

121.5.1.5 Pipe lengths shall contain one bell-end or couple with an elastomeric gasket. Gasket shall meet the requirements of ASTM F 477. The bell shall be an integral

part of the pipe length and have the same strength and DR as the pipe. The spigot pipe end shall be beveled.

121.5.1.6 PVC pressure pipe in sizes 4-inch through 12-inch shall meet the requirements of AWWA C 900.

121.5.1.7 PVC pressure pipe in sizes 14-inch through 24-inch shall meet the requirements of AWWA C 905.

121.5.1.8 PVC pressure pipe shall not be used for public water mains larger than 24-inches.

121.5.2 Polyvinyl Chloride (PVC) Gravity Flow Pipe:

121.5.2.1 The material in PVC pipe shall be in accordance with ASTM D 1784.

121.5.2.2 PVC gravity flow pipe may be used for sanitary sewer applications for sizes 8-inch and greater, except for installation resulting in a depth of cover (to subgrade elevation) less than 3.1 feet or when the Contract documents specifically prohibit its use.

121.5.2.3 Lateral line connections shall be made at manholes or at factory manufactured saddles or tees only, unless specifically authorized by the ENGINEER.

121.5.2.4 PVC gravity flow pipe in sizes 8-inches through 15-inches shall meet the requirements of ASTM D 3034. Only solid wall pipe shall be used. Minimum wall classification shall be SDR 35.

121.5.2.5 PVC gravity flow pipe in sizes 18-inch and larger shall meet the requirements of ASTM F 679 or ASTM F 794. Minimum pipe stiffness shall be 46 psi.

121.5.2.6 Sanitary sewer service line connections to 15-inch and larger pipe diameter will not be permitted, unless authorized by the Water Authority.

121.5.3 Polyethylene (PE) Pipe:

121.5.3.1 The material in PE pipe shall be in accordance with ASTM D 1248.

121.5.3.1.1 Polyethylene (PE) or High Density Polyethylene (HDPE) shall not be used to construct public water lines.

121.5.3.2 High Density Polyethylene (HDPE) Profile Wall Gravity Flow Pipe:

121.5.3.2.1 High-density polyethylene (HDPE), large diameter, profile wall, gravity flow pipe shall meet all general requirements for plastic pipe and shall conform to requirements for plastic pipe and shall conform to

SECTION 121

PLASTIC PIPE

requirements in ASTM F 894 for diameters of 30-inch and larger.

121.5.3.2.2 Minimum wall thickness in pipe waterway shall be RSC 63. When using ASTM D 2412 for determining the strength value of pipe, the E' number (E= modulus of soil reaction) shall not exceed 1500 psi. The pipe manufacturer shall provide certification to the CONTRACTOR and ENGINEER that the class of pipe used is adequate for the specific pipe laying conditions, including, but not limited to, depth of bury, soil characteristics and groundwater conditions.

121.5.3.2.3 Sewer service line connections to PE pipe will not be permitted, unless specifically authorized in the plans and/or Supplemental Technical Specifications and/or by the ENGINEER.

121.5.3.2.4 Lateral line connections shall be made at manholes or at factory manufactured tees or saddles only, unless specifically authorized by the Water Authority and the ENGINEER.

121.5.3.3 All water service lines shall be copper per these specifications. Plastic water service lines will not be permitted.

121.6 MEASUREMENT AND PAYMENT:
Plastic pipe used for both pressure and gravity flow shall be measured and paid for at the contract unit price as specified in Section 800 and 900 and/or as defined in the Bid Proposal.

SECTION 122

PLASTIC LINER PLATE

122.1 GENERAL

These specifications include material requirements and installation of the plastic liner plate.

122.2 REFERENCES

122.2.1 ASTM
D 1243

122.3 MATERIALS

122.3.1 PROPERTIES OF MATERIALS:

122.3.1.1 The materials used in all sheets of plastic liner plate and in all joint, corner, and welding strips shall be a polyvinyl chloride resin and other necessary ingredients compounded to make permanently flexible sheets and strips which are impermeable to sewage. Copolymer resins will not be permitted. Polyvinyl chloride shall constitute not less than 99 percent by weight, of the resin used in sheets and joint strips. The resin shall have a specific viscosity of 0.40 when measured in accordance with Standard Method of Test ASTM D 1243 and a 10 gram sample of the resin when heated in a 30.cu. cm. crucible at 100 degrees C for one hour shall have a loss not exceeding 0.7 percent. The resin used in welding and corner strips and other accessory pieces shall be of the highest molecular weight that is compatible with field welding.

122.3.1.2 The material used in joint strips and in plain sheets of plastic liner plate shall be identical to that used in sheets having locking extensions.

122.3.1.3 The CONTRACTOR shall submit to the ENGINEER manufacturer's certifications of compliance of each type of plastic liner sheet and strip proposed for use, together with a list of all ingredients from which the sheets and strips are to be compounded. The list shall show the percentage of use of each ingredient.

122.3.1.4 The samples will be subjected to the tests set forth hereinafter; and when the samples and their ingredients have been approved, no changes will be permitted without prior approval by the ENGINEER.

122.3.1.5 The samples shall show no significant changes when exposed to soaps; detergents; animal, vegetable, or mineral oils, fats, greases, or waxes;

enzymes of sewer bacteria and fungi; or water solutions of any of the following chemicals at 85 degrees F:

<u>Chemical</u>	<u>Concentration (Percent)</u>
Sodium Hypochlorite	1
Ferric Chloride	1
Sulphuric Acid	20
Nitric Acid	1
Sodium Hydroxide	5
Ammonia	5

122.3.1.6 All plastic liner plate sheets; joint, corner, and welding strips; and accessories shall have the following physical properties when tested at 70 degrees F:

Tensile strength, minimum --- 2000 psi
Elongation at break, Minimum --- 200 percent

Shore Durometer (Type D) Readings
Instantaneous
50 minimum
60 maximum

10 Seconds
35 minimum
50 maximum

122.3.1.7 Liner plate locking extensions embedded in concrete shall withstand a test pull of at least 100 pounds per linear inch, applied perpendicular to the concrete surface for a period of one minute, without rupture of the locking extensions or withdrawal from embedment. This test shall be made at a temperature between 70 degrees F to 80 degrees F inclusive.

122.3.1.8 All plastic liner plate sheets, including locking extensions, and joint, corner, and welding strips shall be free of cracks, cleavages, or other defects adversely affecting corrosion resistance or required strength. The ENGINEER may authorize the repair of defects by approved methods.

122.3.1.9 Specimens taken at any time prior to final acceptance of the work from sheets and strips, when tested in accordance with tests specified hereinbefore, shall show no greater reduction in quality or change in dimensions than the reduction in quality and change in dimensions shown by the original approved samples when tested.

122.4 DETAILS AND DIMENSIONS

122.4.1 APPROVAL OF DETAILS: The CONTRACTOR shall submit for approval by the ENGINEER 30 days prior to any manufacturing of material, drawings showing details of liner plate, joint, corner, and other accessory plastic strips and devices. Such details shall conform to the requirements of these specifications and applicable provisions of the standard plans showing liner plate installation methods.

122.4.2 THICKNESS OF MATERIAL: Liner plate which is to be locked in concrete by means of integral extensions embedded in the concrete shall have a minimum thickness of 0.065 inch. Liner plate which is to be bonded to concrete or steel surfaces by means of adhesive shall have a minimum thickness of 0.075 inch. Welding strips shall have a minimum thickness of 0.125 inch plus or minus 0.031 inch.

122.4.3 SHEET AND STRIP SIZE: Sheets of liner plate used for pipe and cast-in-place sewers shall not exceed 16 feet 4 inches in length measured along the conduit. Sheets of liner plate for all other construction shall not exceed 16 feet by 16 feet. Said permitted maximum size shall be reduced where necessary to produce satisfactory results. Large sheets shall be formed by lapping basic size sheets a minimum of 1 inch in fusing the sheets together in such a manner as to produce a continuous welded joint. Specimens taken from welded joints shall show no cracks or separation and shall be tested in tension after flexing. Each specimen shall withstand a minimum load of 132 pounds per linear inch of weld or the product of 1800 and the minimum thickness in inches of the material adjoining the weld, whichever is greater. The thickness shall be taken within a 1 inch gauge length. The composition, corrosion resistance, and impermeability of specimens taken from the welded joints shall comply with the requirements of Subsection 122.3 above. Evidence of tears, cracks, or separation in the laps will be cause for rejection. Joint strips shall be four inches plus or minus 1/4 inch in width. Welding strips shall be one inch plus or minus 1/8 inch in width. Joint strips shall have each edge beveled prior to application. All welding and outside corner strips shall have edges beveled at time of manufacture. Sloping of the longitudinal terminal edges of liner plate at designated variations in circumferential coverage shall be as specified under Subsection 122.8 herein.

122.4.4 LOCKING EXTENSIONS: All liner plate applied to concrete shall have integral locking extensions embedded in the concrete, except that liner plate may be bonded to concrete surfaces with an adhesive if such is specifically shown on the plans, set forth in the Supplementary Specifications, or permitted by the ENGINEER. Locking extensions shall be of the same material as that of the liner plate, shall be integrally molded to or extruded with the sheets of liner plate, shall have an approved cross section with a minimum height of 3/8 inch and a minimum web thickness of 0.090 inch, shall be approximately 2 1/2 inches apart, and shall be such that when the extensions are embedded in concrete the liner plate will be held permanently in place. Locking extensions shall be parallel and shall be continuous except where omitted for joints and transverse weep channels. Weep channels which involve the omission of one inch of locking extensions as described in Subsection 122.8 herein may be made during the manufacture of liner plate. A locking extension shall be provided along all lower, terminal oblique, or longitudinal edges of liner plate.

122.4.5 PROVISIONS FOR STRAP CHANNELS: Unless alternate methods are approved by the ENGINEER, liner required to be secured to the inner form with straps shall have strap channels at not more than 20 inches on center perpendicular to the locking extensions. The channels, one-inch wide maximum, shall be formed by removing the locking extensions at strap locations so that a maximum of 3/16 inch of the base remains in the strap channel. Strap channels shall not be provided in the final two locking extensions adjacent to the terminal edge of the liner coverage.

122.5 TESTS

All liner plate shall be shop tested for holes, using an approved spark detector with a minimum of 20,000 volts. Sheets having holes shall be satisfactorily repaired in the shop and retested prior to shipping the sheets to the job site or the pipe manufacturing plant. Shop welds shall be subjected to testing for composition of the material after the weld has been made and for corrosion resistance, impermeability, and strength. Samples of liner plate shall be taken at the point of manufacture each week during production of sheet and strip material. These samples will be submitted to the ENGINEER for testing as provided in these specifications.

122.6 ADHESIVE

Adhesives used on liner plate shall be limited to those products made by the liner plate manufacturer specifically for use with the liner plate. Adhesives, solvents, and activators proposed for use shall be submitted to the ENGINEER for testing prior to use.

122.7 INSTALLATION OF PLASTIC LINER PLATE--GENERAL

112.7.1 INSPECTION: Wherever possible, liner plate shall be applied and secured to the forms and inspected and approved prior to the placement of reinforcing steel.

122.7.2 QUALIFICATIONS OF INSTALLERS:

122.7.2.1 APPLICATORS: The application of plastic liner plate to forms and other surfaces shall be considered as highly specialized work, and personnel performing this type of work shall be trained in methods of installation and demonstrate their ability to the ENGINEER.

122.7.2.2 WELDERS: Each welder shall successfully pass a welding test before making any field weld and may be retested at any time deemed necessary by the ENGINEER. All test welds shall be made in the presence of the ENGINEER and shall consist of the following: Two pieces of liner plate, at least 15 inches long and 9 inches wide, shall be lapped 1 1/2 inches and held in a vertical position. A welding strip shall be positioned over the edge of the lap and welded to both pieces of liner plate. Each end of the welding strip shall extend at least two inches beyond the liner plate to provide tabs. The weld specimen shall be submitted to the ENGINEER and tested as follows: Each welding strip tab, tested separately, shall be subjected to a 10 pound pull normal to the face of the liner plate with the liner plate being held firmly in place. There shall be no separation between the welding strip and the liner plate when the welding tabs are submitted to the test pulls. Three test specimens shall be cut from the welded sample tested in tension across the welds. If none of these specimens fail in the weld or within 1/2 inch adjacent to either edge of the weld when the specimens are individually subjected to a pull of 132 pounds per linear inch of weld or the product of 1800 and the minimum thickness in inches of the material adjoining the weld, whichever is greater, the weld will be considered as satisfactory in tension. The thickness used will be the minimum measured within a 1 inch

gauge length. If one of the specimens fails to pass the tension test, a retest will be permitted. The retest shall consist of testing three additional specimens cut from the original welded sample. If all three of the retest specimens pass the test, the weld will be considered satisfactory. A disqualified welder may submit a new welding sample when, in the opinion of the inspector, he has had sufficient off-the-job training or experience to warrant re-examination.

122.8 PLACING LINER PLATE

122.8.1 COVERAGE: Liner plate shall cover, as a minimum, the areas shown on the plans to be lined. The variation in circumferential coverage at each longitudinal terminal edge of adjoining sheets of liner plate shall not exceed one inch or one percent of the inside diameter of pipe, whichever is greater. In the case of cast-in-place conduits, the inside height of the conduit shall be used in lieu of pipe diameter in determining allowable variation in circumferential coverage. At a station where there is a difference in coverage, as shown on the plans, and the longitudinal terminal edges of liner plate downstream from said station are lower than those upstream, the terminal edges of the liner plate installed in the section of pipe or structure immediately upstream from the station shall be sloped uniformly for the entire length of the section of pipe or structure from the limits of the smaller coverage to those of the greater coverage. Wherever the longitudinal terminal edges of liner plate downstream from the station are higher than those upstream, the slope shall be accomplished uniformly throughout the length of the section of pipe or structure immediately downstream from the station. An approved locking extension shall be provided along all tapered lower terminal edges of liner plate.

122.8.2 POSITIONING LINER PLATE: All liner plate installed in pipe shall be positioned so that the locking extensions are parallel with the axis of the pipe. Liner plate shall be centered with respect to the "T" of the pipe when the inner form is positioned. Liner plate shall be set flush with the inner edge of the bell end of the pipe section and shall extend to the spigot end or to approximately four inches beyond the spigot end, depending upon the type of liner plate joint to be made with adjoining pipe. All liner plate installed in a cast-in-place sewer shall be positioned so that the locking extensions are

parallel to the axis of the sewer, and all liner plate installed in other sewer structures shall be positioned with locking extensions horizontal unless otherwise indicated on the plans or in the Supplementary Specifications. Liner plate sheets shall be closely fitted to inner forms. Sheets shall be cut to fit curved and warped surfaces using a minimum number of separate pieces. The CONTRACTOR shall furnish field sketches to the ENGINEER showing the proposed layout of liner plate sheets for cast-in-place sewerage structures. The sketches shall show the location and type of all field welds. The ENGINEER may require the use of patterns or the markings of sheet layout directly on the forms where complicated or warped surfaces are involved. At transverse joints between regular size sheets of liner plate, the space between ends of locking extensions, measured longitudinally, shall not exceed four inches. Where sheets are cut and joined for the purpose of fitting irregular surfaces, this space shall not exceed two inches.

122.8.3 SECURING LINER PLATE IN PLACE: Liner plate shall be held snugly in place against inner forms by means of light gauge steel wire, light steel banding straps, or other approved means. Banding straps or wire shall be located in strap channels to prevent crushing or tilting the extensions. Means approved by the ENGINEER shall be provided, if necessary, to prevent crushing or tilting locking extensions on extruded sheets. Where the form ties or form stabilizing rods pass through liner plate, provisions shall be made to maintain the liner plate in close contact with the forms during concrete placement.

122.8.4 WEEP CHANNELS: At 8-foot intervals longitudinally along liner plate installed in sewers, a gap not less than one inch nor more than four inches wide shall be left in all locking extensions to provide an unobstructed transverse weep channel. Any area behind liner plate which is not properly served by regular weep channels shall have additional weep channels one inch wide provided by cutting away locking extensions. Provisions shall be made to permit water behind the liner of concrete manhole shafts to drain into the weep channels of the lined sewer. A transverse weep channel shall be provided approximately twelve inches away from each liner plate return where surfaces lined with plastic liner plate join surfaces which are not so lined. As a part of the work of installing liner plate, all outlets of transverse weep

channels shall be cleared of obstructions which would interfere with their proper function.

122.8.5 LINER PLATE RETURNS: A liner plate return shall be installed wherever required as shown on the plans and wherever surfaces lined with plastic liner plate join surfaces which are not so lined, such as brick, clay pipe, cast-iron pipe, manhole frames, and metal, or clay tile gate guides. Unless otherwise indicated by the plans, the Supplementary Specifications, or the plans showing liner plate installation methods, returns shall be made as follows: Each liner plate return shall be a separate strip of liner plate at least four inches wide joined to the main liner plate by means of approved corner strips. Corner strips shall be continuously welded to the return and to the main liner plate and applied wherever possible from the back of the lining. Locking extensions shall be provided on returns to lock the returns to the concrete or plastic lined, cast-in-place structures. Locking extensions will not be required on liner plate returns installed on lined precast concrete pipe. Each liner plate return shall be sealed to adjacent construction with which it is in contact by means of a chemically resistant elastomeric material recommended by the manufacturer of the liner plate. If the joint space is too wide or the joint surfaces too rough to allow satisfactory sealing with this material, the joint space shall be filled with two inches of densely caulked cement mortar, lead wool, or other caulking material approved by the ENGINEER and finished with a minimum of one inch of an approved corrosion resistant material.

122.8.6 CORNERS: Liner plate corners shall be installed as detailed on the plans. If not so detailed and if the corner is a straight line, liner plate may be bent around the corner provided that the liner plate can be bent and secured in the forms in such a manner as to produce a satisfactory corner in the opinion of the ENGINEER. The radius of such a bend in liner plate shall not exceed one inch. Bending of liner plate to form a liner plate return will not be permitted. A separate liner plate return shall be installed at said locations in accordance with requirements specified in Subsection 122.8.5.

122.9 CONCRETE OPERATIONS

122.9.1 CONCRETE PLACEMENT: Concrete placed against liner plate shall be carefully vibrated so as to avoid damage to

the liner plate and to produce a dense, homogeneous concrete securely anchoring the locking extensions into the concrete. External vibrators shall be used if deemed necessary by the ENGINEER. If steel stiffener rods are used along locking extensions of liner plate installed in forms for pipe, they shall be completely withdrawn during the placement of concrete in the forms. The concrete shall be revibrated to consolidate the concrete in the void spaces caused by the withdrawal of the stiffener rods.

122.9.2 REMOVING FORMS: In removing forms, care shall be taken to protect liner plate from damage. Sharp instruments shall not be used to pry forms from lined surfaces. When forms are removed, any nails that remain in the liner plate shall be pulled without tearing the liner plate and the resulting holes clearly marked. Form tie holes shall be marked before ties are broken off and all areas of serious abrasion of the liner plate shall be marked.

122.10 JOINING LINER PLATE

122.10.1 GENERAL: No field joint shall be made in liner plate until the lined sewer or structure has been backfilled and flooding required therefor has been completed. Liner plate at joints shall be free of all mortar and other foreign material and shall be clean and dry before joints are made. Hot joint compounds shall not be brought in contact with liner plate. No coating of any kind shall be applied over any joint, corner, or welding strip, except where nonskid coating is applied to liner plate surfaces.

122.10.2 FIELD JOINT IN PIPE INSTALLATION: Field joints in liner plate at pipe joints shall be one of the following types: Type P-1--A Type P-1 joint shall consist of a four-inch joint strip, centered over the mortared pipe joint and secured along each edge to adjacent liner by means of a welding strip. Type P-2--A Type P-2 joint shall be made with an integral part of the liner plate extending four inches beyond the spigot end of the pipe, overlapping the liner plate downstream from the pipe joint and secured to the downstream liner by means of a welding strip. The four-inch strip of liner plate extending beyond the spigot end of the pipe shall be devoid of locking extensions and shall be protected from damage during pipe handling and jointing operations. Excessive tension and distortion in the strip caused by

bending it back sharply at the end of the pipe will not be permitted. Any four-inch integral joint strip which has been bent and held back during pipe laying and jointing operations shall be released well in advance of making the liner plate joint to allow the strip to return to its original shape and flatness. On beveled pipe, the liner plate extension at the spigot end of the pipe shall be trimmed to extend four inches beyond and parallel to the beveled end. Joints between lined pipe and lined cast-in-place structures shall be either Type C-1 or Type C-2 specified hereinafter.

122.10.3 FIELD JOINTS IN CAST-IN-PLACE STRUCTURES: Field joints in liner plate on cast-in-place structures shall be one of the following types: Type C-1--A Type C-1 joint shall be made in the same manner as a Type P-1 joint. The width of the space between adjacent sheets of liner plate in a Type C-1 joint shall not exceed 1/2 inch. This type of joint is the only type permitted as transverse contraction joints in concrete. Its only other use is for joints between pipe and cast-in-place structures. Type C-2--A Type C-2 joint shall be made by overlapping sheets not less than 1 1/2 inches and securing the overlap to the adjacent liner plate by means of a welding strip. The upstream sheet shall overlap the downstream sheet. The length of that part of the overlapping sheet not having locking extensions shall not exceed four inches. A welding strip shall be applied to the back of the joint if necessary to prevent leakage of concrete. This type of joint may be used at any transverse liner plate joint other than those at transverse contraction joints in concrete and shall be used for liner plate joints made at longitudinal joints in concrete. Type C-3--A Type C-3 joint shall be made by butting sheets of liner plate together and applying a welding strip over the back of the joint before concrete is poured and applying a welding strip over the front of the joint after concrete is poured. A Type C-3 joint will not be permitted at a transverse joint which extends to a lower terminal edge of liner plate or any joint where the gap between adjoining sheets of liner plate exceeds 1/8 inch.

122.10.4 INSTALLATION OF WELDING STRIPS: Welding strips shall be fusion welded to joint strips and liner plate by qualified welders using only approved methods and techniques. The welding

operation of any joint shall be continuous until that joint has been completed.

122.11 APPLICATION OF LINER PLATE TO CONCRETE SURFACES BY MEANS OF ADHESIVE

122.11.1 Application and bonding of liner plate to concrete surfaces by means of adhesive shall be accomplished by the following steps: The concrete surface shall be etched in lieu of being sand-blasted. After the sand blasting, the concrete surface shall be thoroughly cleaned of dust. Surfaces etched with acid shall be thoroughly washed with clear water after the etching and thoroughly dried before applying primer. Grouting Procedure--All concrete imperfections such as water and air pockets in poured concrete surfaces must be filled with cement grout. The concrete surface shall then receive two brush coats of an approved primer. Coverage shall not exceed 250 square feet per gallon for each coat. The first coat of primer shall be thinned with an equal amount of approved thinner. The first primer coat shall be permitted to dry for at least two hours before the application of the second primer coat. The second coat of primer shall be applied unthinned and permitted to dry for at least four hours. Brush apply one coat of manufacturer's recommended 19Y primer (at approximately 250 square feet/ gallon). The concrete surface and the back surface of the liner plate shall each be given one coat of an approved adhesive. Coverage shall not exceed 250 square feet per gallon for each coat.

122.11.2 One coat of an approved activator shall be applied to both the underside of liner plate and the adhesive coated concrete. Application of activator shall be limited to the extent that the application of coated liner plate can be completed within a 20-minute period. The activator shall be applied evenly by brushing. Coverage of activator shall not exceed 500 square feet per gallon. When the surface of the adhesive is barely tacky to the touch, the liner plate shall be positioned with one edge firmly pressed down. The liner plate shall then be rolled into place, care being taken to avoid the formation of air pockets. All joints shall be tight-fitting butt joints. The surface of the liner plate shall be rubbed vigorously to secure the liner plate firmly in place. Corner and welding strips shall be positioned over all joints and welded in place. No adhesive shall be applied to liner plate or to any of the liner plate strips which will

deleteriously affect the plate or strips in any way. Adhesive shall not be applied to the surfaces of concrete at liner plate joints or to the surfaces of liner plate or joint strips opposite said mortar and concrete surfaces.

122.12 NONSKID SURFACES

All surfaces of liner plate shown on the plans to be nonskid shall be treated as follows: After all corner and welding strips have been installed, the surface of the liner plate shall be cleaned, dried, and sprayed with an adhesive coating recommended by the manufacturer of the liner plate. The surface shall then be liberally sprinkled with clean, dry, well-graded sand, all of which will pass a No. 40 sieve but be retained on a No. 70 sieve. After the sanded surface has thoroughly dried, all excess sand shall be brushed away and a seal coat of the coating shall be sprayed over the sand in sufficient quantity to coat and bond the sand to the liner plate. The coat sand surface shall be allowed to dry thoroughly before any walking is permitted thereon.

122.13 APPLICATION OF LINER PLATE TO STEEL

Fabrication and welding of steel to be lined with plastic liner plate shall be completed before the liner is installed. Steel surfaces to which plastic liner is to be applied shall be sandblasted, leaving surfaces free of all mill scale, rust, grease, moisture, and other deleterious substances. All interior welds shall be ground smooth and all weld spatter removed. The application of primer unthinned, adhesive, and liner plate to steel surfaces shall conform to the requirements set forth herein for bonding of liner plate to concrete surfaces with adhesive. Field joints shall be tight-fitting butt joints. After the liner plate has been applied to steel surfaces, corner strips, or welding strips shall be applied over all joints and welded in place.

122.14 PROTECTION AND REPAIR OF LINER PLATE

All necessary measures and precautions shall be taken to prevent damage to liner plate from equipment and materials used in or taken through the work. Any damage to installed liner plate shall be repaired by the CONTRACTOR in accordance with the requirements set forth herein for the repair of liner plate. All nail and tie holes and all cut, torn, and seriously abraded areas in the liner

plate shall be patched. Patches made entirely with welding strip shall be fused to the liner plate over the entire patch. The use of this method is limited to patches which can be made with a single welding strip. The use of parallel, overlapping, or adjoining welding strips will not be permitted. Larger patches may consist of smooth liner plate over the damaged area with edges covered with welding strips fused to the patch and to the liner plate adjoining the damaged area. The size of a single patch of the latter type shall be limited only as to its width, which shall not exceed four inches. Wherever liner plate is not properly anchored to concrete or wherever patches larger than those permitted above are necessary, the repair of liner plate and the restoration of anchorage shall be as directed by the ENGINEER.

122.15 FIELD TEST

All liner plate, when installed, will be tested by the CONTRACTOR in the presence of the ENGINEER, using a spark type detector set at a minimum of 20,000 volts. All areas of liner plate failing to meet the field test shall be properly repaired and retested.

122.16 MEASUREMENT AND PAYMENT

Measurement for furnishing and installing plastic liner plate shall be included in the payment for the pipe or structure required to be lined, unless a different measurement is stipulated in the Bid Proposal.

SECTION 123

REINFORCED CONCRETE PIPE

123.1 GENERAL

123.1.1 These specifications cover reinforced concrete pipe intended to be used for the construction of storm drains, sewers, and related structures.

123.1.2 The size and class of the concrete pipe to be furnished shall be as shown on the plans or as specified under the item of work for the project of which the pipe is a part.

123.1.3 Unless otherwise specified, pipe shall be either cast, spun, or manufactured by an approved equal method.

123.1.4 The interior surface shall be smooth and well finished. Joints shall be of such type and design and so constructed as to be adequate for the purpose intended so that, when laid, the pipe will form a continuous conduit with smooth and uniform interior surface.

123.1.5 Bell and spigot shall be free from any deleterious substance or condition which might prevent a satisfactory seal at the joints.

123.1.6 Pipe stronger than that specified may be furnished at the manufacturer's option and at his own expense, provided such pipe conforms in all other respects to the applicable provisions of these specifications.

123.1.7 Reinforced concrete pipe utilized for sanitary sewers shall be fully lined with no longitudinal seams in accordance with Section 122.

123.2 REFERENCES

123.2.1 American Society for Testing and Materials (Latest Editions)(ASTM)

- C-33 Specification for Concrete Aggregates
- C-76 Specification for Reinforced Concrete Culverts, Storm Drain, and Sewer Pipe
- C-150 Specification for Portland Cement
- C-260 Specification for Air Entraining Admixtures for Concrete
- C-361 Specification for Reinforced Concrete Low-Head Pressure Pipe
- C-441 Test Method for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali Aggregates Reaction
- C-443 Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gasket
- C-494 Specification for Chemical Admixtures for Concrete
- C-618 Specification for Fly Ash and Raw of Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

123.2 American Concrete Pipe Association (ACPA)

Concrete Pipe Design Manual

123.2.3 This Publication
Section 102 Steel Reinforcement
Section 122 Plastic Liner Plate

123.3 PIPE LINE LAYOUTS

123.3.1 When specials and radius pipe and/or fittings are required, the required number of sets of the pipe line layout will be furnished to the ENGINEER prior to the manufacture of the concrete pipe. Storm inlet or inlet connector pipe need not be included in the pipe line layout; however, pipe stubs shall be included. In lieu of including storm inlet connector pipe line layout, a list of storm inlet connector pipes shall accompany the layout. The connector pipe list shall contain the following information:

123.3.1.1 Size, class, and wall type.

123.3.1.2 Station at which pipe joins main line.

123.3.1.3 Number of sections of pipe, length or section, type of sections (straight, horizontal bevel, vertical bevel, etc.).

123.4 MATERIALS

123.4.1 Reinforced Concrete Pipe shall consist of a mixture of Portland cement, aggregates, water and admixtures, proportioned and manufactured in accordance with the requirements of ASTM C76, latest edition, and this specification. The pipe shall be certified in accordance with the requirements of Section 13 of these specifications. Certification of compliance shall be submitted by the CONTRACTOR and approved by the ENGINEER prior to manufacture of the Reinforced Concrete Pipe. Reinforced Concrete Pipe shall not be used on a project without written approval of the ENGINEER.

123.4.2 Portland cement shall comply either with the requirements of ASTM C 150, Types I, II, III, and V, Low Alkali (LA) cements, or as specified herein, in the Supplementary Technical Specifications, plans, or as approved by the ENGINEER. The CONTRACTOR shall submit certification of compliance signed by the cement manufacturer, identifying the cement type and source (plant location), stating the portland cement used in the Reinforced Concrete Pipe delivered to the project complies with this specification. Portland cement concrete used in the manufacture of Reinforced Concrete Pipe shall have a minimum portland cement content of 470 lbs./cu.yd., except as either specified

herein, as specified in the Supplemental Technical Specifications, or as approved by the ENGINEER. Portland cement shall be of the same source and type for all Reinforced Concrete Pipe delivered to a project.

123.4.2.1 Portland cement concrete for Reinforced Concrete Pipe shall be proportioned to provide a minimum portland cement content of 470 lbs./c.y. (5 sks/c.y.) and a maximum water (W) to cementitious material ratio by weight, $W:(C+TA)=0.40$. Cementitious material shall consist of portland cement and class F fly ash complying with this specification. The fly ash shall be proportioned to provide a fly ash (FA) to portland cement (C) ratio by weight, FA:C+I:r.

123.4.3 Mineral admixtures shall be "Class F fly ash" and comply with the requirements of ASTM C 618 including Table 4 "Supplementary Optional Physical Requirements."

- A. Uniformity requirements, air entraining agent dosage for 18.0% vol of mortar, shall not vary by more than 20%
- B. Reactivity with cement alkalis: Reduction of mortar bar expansion at 14 days, minimum (ASTM C441) 65%

Reactivity with cement alkalis shall be determined in accordance with the requirements of ASTM C441, using DOW CORNING glass rod base for aggregates. The CONTRACTOR shall submit certification of compliance identifying the type fly ash and source (plant location), stating the fly ash used in the Reinforced Concrete Pipe delivered to the project complies with this specification. Fly ash shall be of the same source and type for all Reinforced Concrete Pipe delivered to the project.

123.4.4 Admixtures of any type, shall not be used without written approval of the ENGINEER. The CONTRACTOR shall submit certification of compliance signed by the admixture manufacturer, identifying the admixture and its source (plant location), stating the admixture(s) used complies with this specification. Admixtures shall be of the same source for all reinforced concrete Pipe delivered to a project.

123.4.4.1 Air entraining admixtures shall be used in all Reinforced Concrete Pipe provided under this specification. It shall conform to the requirements of ASTM C 260. Entrained air content shall comply with the following requirements:

Nominal Max Size Aggregate (inches)	Air Cont. Range (%)
3/8, 1/2 & 3/4	4 - 8
1	4 - 7
1-1/2	3 - 6

or as required by the Supplementary

Technical Specifications, on the plans and/or as approved by the ENGINEER.

123.4.4.2 Chemical admixtures shall conform to either the requirements of ASTM C 494, and/or as specified in the Supplementary Technical Specifications, on the plans, and/or as approved by the ENGINEER.

123.4.4.3 Neither calcium chloride nor non-calcium chloride accelerating admixtures shall be used in Reinforced Concrete Pipe provided to a project under this specification.

123.4.4 Aggregates shall be assumed to be alkali-reactive. Variance for a specific aggregate may be approved by the Engineer upon written request by the CONTRACTOR and submittal of test data, as required by the ENGINEER. Aggregates shall comply with the requirements of ASTM C 33 and ASTM C 76 and as specified herein. Aggregates shall be of the same source and type for all Reinforced Concrete Pipe manufactured and delivered to the project.

123.4.5 Reinforcement shall comply with the requirements of this specification and Section 102. The CONTRACTOR shall submit certification of compliance signed by the reinforcement manufacturer, identifying the material and its source (plant location), stating the reinforcement complies with this specification. Reinforcement shall be of the same source for all Reinforced Concrete Pipe delivered to the project.

123.5 CAUSES FOR REJECTION

Such inspection of pipe as may be deemed necessary by the ENGINEER will be made at the place of manufacture and pipe may be rejected for any of the reasons described in ASTM C 76, unless it can be repaired in accordance with the requirements noted therein and the approval of the ENGINEER.

123.6 ACCEPTANCE

Basis of acceptance shall be in compliance with ASTM C 76.

123.6.1 D-LOAD BEARING STRENGTH METHOD

123.6.1.1 The ENGINEER will select at random at the point of manufacture test specimens of the pipe to be furnished for the project.

123.6.1.2 The required number of test specimens and the test pipe shall conform in all respects to the applicable requirements of ASTM C 76. The pipe shall be tested by one of the two standard methods of testing; namely, (A) the three-edge bearing, (B) the sand bearing, as prescribed in ASTM C 76, and the required strength of the pipe specimens undergoing the bearing tests shall conform with the D-Load requirements designated therein.

123.6.2 STRUCTURAL DESIGN METHOD:

Where structural details of the pipe are shown on the plans, the manufacture of pipe shall be checked by making the appropriate tests on the concrete placed in the pipe forms, by inspection of the steel reinforcing cages that are to be used in the pipe, and by inspection of the fabrication of the pipe.

123.6.3 "DOWNGRADING" OF PIPE:

123.6.3.1 For the purpose of these specifications, "downgraded" pipe shall be defined as pipe which is to be used under loads less than that for which they have been designed.

123.6.3.2 Pipe manufactured in accordance with these specifications which have not met their designed test loads may be "downgraded" by the ENGINEER and used provided that:

123.6.3.2.1 Enough load tests are made to establish the load under which they may be used. The number of tests to be made shall be as determined by the ENGINEER; this may require the testing of each section for acceptance.

123.6.3.2.2 The comply with the test and inspection requirements of these specifications.

123.6.3.3 Individual specimens of pipe embodying major repairs or having numerous hairline cracks extending the full length of the section on the inside of the pipe at the minor axis or on the outside of the pipe at the major axis may be tested for acceptance at the discretion of the ENGINEER.

123.6.4 STOCKPILED PIPE:

123.6.4.1 Stockpiled pipe may be used only when approved by the ENGINEER provided the pipe meets all other specified requirements.

123.6.4.2 For the purpose of these specifications, "stockpiled" pipe shall be defined as pipe manufactured in quantity which will meet requirements of this section but which was not manufactured for use in specific projects; however, pipe which has been rejected by another agency will not be considered as "stockpiled" pipe, nor will such pipe be accepted.

123.7 JOINTS

123.7.1 For circular pipe, rubber gasket joints shall be required. Such joints shall conform to the requirements of ASTM C 443 and the requirements set forth in this document. The joint shall be designed for not less than 15%, or more than 50% deformation of the rubber gasket when the pipe is joined off-center with all manufacturing tolerances considered. Minimum manufacturing tolerances shall be

assumed to result in a centered annular space of 1.75 times the nominal design annular space. Joint mating surfaces shall be parallel and not be greater than 3.5° slopes. In addition to the hydrostatic joint test requirements per ASTM C 443, the pipe shall be loaded to cause maximum joint annular space to occur at the top. The pipe shall then be subjected to an internal hydrostatic pressure of 13 psi for 10 minutes. The test set up shall include a minimum of (2) pipe sections per lot. Bulkheaded end joints are acceptable, only mating pipe joints are allowed. Moisture or beads of water appearing on the surface of the joint will not be considered as leakage. If leakage of joints should initially occur, the manufacturer shall have the option to allow the pipe to soak under pressure for up to 24 hours and then retest. Any leakage during such retest will constitute failure of the test.

Pipe with beveled ends or pipe joints specifically designed to allow unsymmetrical joint closure may be provided for use around curves, the radii of which are shown on the drawings. Unless otherwise shown on the plans or specified in the Supplementary Specifications, either one or both ends may be beveled up to a maximum of 5 degrees, as required to provide well fitted joints. Beveled ends may conform to the Typical Method of Designing Curved Concrete Pipe sewers, as shown in the ACPA Concrete Pipe Handbook. Deflections per joint shall be limited to the manufacturer's standards for each particular diameter and type of pipe used.

123.7.2 For elliptical or arch reinforced concrete pipe, the joints shall be either bell and spigot or tongue and groove. Mastic material, such as RAMNEK, KENT SEAL, or approved equal, will be used to seal the joints.

123.7.3 Cement mortar joint fillers will not be accepted for round, elliptical, or

arch reinforced concrete pipe.

123.7.4 If required by the ENGINEER to meet specified laying tolerances, the pipe shall be "match marked" at the place of manufacture, and laying diagrams furnished to the CONTRACTOR by the manufacturer shall be subject to approval by the ENGINEER.

123.8 DIMENSIONS

123.8.1 LENGTH

123.8.1.1 The nominal length shall be as supplied by the manufacturer unless otherwise specified in the Supplementary Technical Specifications on the plans or required for bends or special joints.

123.8.1.2 Except for special shapes, the plane of the ends of the pipe shall be perpendicular to the longitudinal axis of the pipe, with the exception that variations in laying lengths of two

opposite sides of pipe shall be not more than 1/8 inch per foot of diameter with a maximum of 5/8 inch in any length of pipe.

123.8.2 WALL THICKNESS

The wall thickness of pipe shall conform to the requirements indicated for Wall B or Wall C, reinforced concrete pipe specified in ASTM C 76 unless otherwise specified.

123.9 REINFORCEMENT

Fabrication and placement of reinforcement for the various sizes and strengths of pipe shall conform to the applicable requirements of ASTM C 76.

123.10 CURING REQUIREMENTS

The pipe shall be cured in conformance with the applicable requirements of ASTM C 76.

123.11 MARKINGS:

123.11.1 Each section of pipe shall be marked in conformance with the requirements of ASTM C 76. The ENGINEER may at the place of manufacture, indicate his acceptance of the pipe for delivery to the job by marking the pipe with the Contracting Agency's mark. Such acceptance, however, shall not be considered a final acceptance.

123.11.2 If the pipe is subsequently rejected, the mark placed thereon by the ENGINEER shall be defaced. No pipe will be marked, "Reject." Only pipe accepted shall be marked, "Accepted."

123.12 LOW-HEAD PRESSURE PIPE

Reinforced concrete low-head pressure pipe shall conform to the requirements of ASTM C 361.

123.13 SELECTION FOR CLASS OF PIPE

123.13.1 The classes of reinforced concrete pipe and the D-Load to produce a 0.01-in. crack for each class of pipe are specified in ASTM C 76.

123.13.2 The appropriate formulas, tables and figures contained in the "Concrete Pipe Design Manual," prepared by the American Concrete Pipe Association, will be used, to determine the class of pipe to be installed between manholes or for a culvert. It is essential that maximum trench width, class of bedding and soil weight be considered in the pipe class selection.

123.13.3 The construction plans will indicate the following information for each length of pipe between manholes or for a culvert: the nominal diameter of the pipe, the class of pipe, the class of bedding and the maximum trench width at top of pipe.

123.14 MEASUREMENT AND PAYMENT

123.14.1 The measurement and payment for the materials specified in this section will be made as specified in the applicable section of these specifications or as specified in the supplemental technical specifications or as called for in the plans and as shown in the Bid Proposal.

SECTION 124

REINFORCED CONCRETE PRESSURE PIPE

124.1 GENERAL

These specifications cover three types of reinforced concrete pressure pipe, two of which are not prestressed and one prestressed, with internal diameters of 12 inches and larger and for pressures specified on the plans, to be used in the transmission and distribution systems that carry water under pressure.

124.2 REFERENCES:

124.2.1 ASTM
C 361

124.2.2 AWWA
C 300
C 301
C 302

124.3 MANUFACTURE AND TESTS

Reinforced concrete pressure pipe and fittings shall be manufactured and tested to conform to one of the following specification requirements:

124.3.1 AWWA C 300 for the steel bar reinforcement and cylinder type in pipe diameters of 24 inches and larger, for design pressures no greater than 40 psi, and for external loading conditions as may be designated on the plans or in the Supplementary Specifications.

124.3.2 AWWA C 301 for the prestressed steel wire reinforcement and cylinder type, in pipe diameters of 30 inches and larger, for design pressures to a maximum of 350 psi, and for external loading conditions as may be designated on the plans or in the Supplementary Specifications.

124.3.3 AWWA C 302 for the steel bar reinforcement (without cylinder) type, in pipe diameters 12 inches and larger, for design pressures of not more than 45 psi, and for external loading conditions as may be designated on the plans or in the Supplementary Specifications.

124.4 MEASUREMENT AND PAYMENT

124.4.1 When required as a separate material item, the measurement shall be by the linear foot and payment will be made at the unit price per linear foot per diameter of pipe, as specified in the Bid Proposal.

124.4.2 Reinforced concrete pressure pipe, when used in conjunction with a project, the measurement and payment will be as defined in Section 901 or 910.

SECTION 125

VITRIFIED CLAY PIPE

125.1 GENERAL

Vitrified clay pipe shall be extra strength, as specified in ASTM C 700 and shall be sound, durable, and well burned throughout its entire thickness.

125.2 REFERENCES

125.2.1 ASTM:

C 301 C 700
C 425

125.3 CERTIFICATION

A certification from the manufacturer shall be furnished to the ENGINEER with each shipment of pipe attesting that the pipe meets the requirements of this specification, including test reports for absorption, acid resistance, and loading tests as defined in ASTM C 301 and C 425.

125.4 MANUFACTURING REQUIREMENTS

125.4.1 SHAPE:

125.4.1.1 Pipe ends shall be square with the longitudinal axis; and sockets shall be true, circular, and concentric with the barrel of the pipe

125.4.1.2 The ends of the pipe shall be so formed that, when the pipes are laid together and the joints made, they shall constitute a continuous and uniform line of pipe and shall have a smooth and regular interior surface.

125.4.1.3 Deviation from a straight line shall not be greater than 1/16 inch per linear foot and shall be measured from a straight edge on the concave side. Variation from a true circle of the spigot or socket of the pipe shall not be greater than 3 percent of its nominal diameter.

125.4.2 STOPPERS, BRANCHES, TEES AND WYES, ENDS.

125.4.2.1 Stoppers shall be furnished with all pipes and branches that are to be left unconnected and shall be strong enough to meet the necessary load and hydrostatic requirements.

125.4.2.2 Branches, tees, and wyes of the size and quantity as required on the plans shall be furnished with connection securely and completely fastened to the barrel of the pipe in the process of manufacture.

125.5 CAUSE FOR PIPE OR FITTING REJECTION

125.5.1 Pipe and fittings must be free from injurious cracks, checks, blisters, broken extremities, or other imperfections.

125.5.2 The following imperfections in a pipe or fittings will be considered injurious and cause for rejection where not in conflict with ASTM C 700 which will govern:

125.5.2.1 A single crack in the barrel of the pipe or fitting extending through the entire thickness, regardless of the length of such crack. A single crack which extends through 1/5 of the shell thickness and is over 3 inches long. Any surface fire crack which is more than 1/16 inch wide at its widest point.

125.5.2.2 Lumps, blisters, pits, flakes, or tramped clay on the interior surface.

125.5.2.3 When the end of the pipe or fitting varies from a true circle more than 3 percent of its nominal diameter.

125.5.2.4 When a straight pipe or fitting exhibits a deviation from a straight line of more than 1/16 inch per linear foot.

125.5.2.5 Any piece broken from the end of the pipe or fitting.

125.6 TESTS

All tests shall conform to the requirements set forth in ASTM C 301, C 425, and C 700. Test results shall be furnished the ENGINEER. In addition to the stated tests, the ENGINEER may select at random pipe lengths or joints that should be tested by the CONTRACTOR, results of which will be furnished the ENGINEER.

125.7 JOINTS

Bell and spigot pipe or Plain End Pipe will be used as the method of connecting the pipes. Either rubber elastomer or polyurethane compression/sealing member of the joint will be shaped for the particular connection. These materials shall meet the requirements of ASTM C 425. For Plain End Pipe the collar used to couple the ends of the pipe shall be made from rigid unplasticized polyvinyl chloride and shall meet the requirements of ASTM C 425.

125.8 PERFORATED CLAY PIPE

This type of pipe is used in areas where ground waters are to be collected and transported to an outlet or for the purpose of a drain field for dispersion of waste water. The pipe is generally encased in gravel. Perforated clay pipe shall be extra strength pipe and shall conform to the requirements of ASTM C 700.

125.9 MEASUREMENT AND PAYMENT

Measurement and payment will be as defined in Section 901.

SECTION 127

STEEL WATER PIPE

127.1 GENERAL

This specification covers steel pipe and the interior and exterior protective coating for use only in connections to or repair of water supply and distribution systems carrying water under pressure, per authorization of Water Resources Department.

127.2 REFERENCES

127.2.1 ASTM

A 53

127.2.2 AWWA

C 200	C 207
C 201	C 208
C 203	M 11
C 204	

127.2.3 ANSI

B 16.5

127.2.4 Asphalt Institute

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127.3 PIPE

127.3.1 Pipe 6 inches and larger in diameter of either the fabricated or mill type shall be manufactured in accordance with AWWA C 200. Specific pipe type (fabricated or mill) shall be as specified in the Supplementary Specifications.

127.3.2 Wall thickness for steel pipe 6 inches and larger shall be based on the computation techniques contained in AWWA M-11, Steel Pipe Design Manual, computations shall take into consideration internal pressure, external pressure and any special physical loading.

127.3.3 Pipe in sizes less than 6 inches in diameter shall be in accordance with ASTM A 53, standard weight (Schedule 40).

127.3.4 Working pressure of 150 psi shall be used for pipe design.

127.4 FITTINGS

Fittings for pipe 4 inches and larger in diameter shall be fabricated of the same kind of steel and same wall thickness as the pipe to which they are to be connected. Dimensions shall be as shown in AWWA C 208.

127.5 FLANGES

Flanges shall be slip-on type conforming to AWWA C 207 drilled as specified in ANSI B 16.5.

127.6 JOINTS

127.6.1 Steel pipe shall be prepared for one of the following types of joints as noted on the plans or specified in the Supplementary Specifications:

127.6.1.1 Bell-and-spigot ends prepared for O-ring rubber gaskets.

127.6.1.2 Lap joints for field welding.

127.6.1.3 Beveled ends for field butt welding.

127.6.1.4 Plain ends fitted with butt straps for field welding.

127.6.1.5 Ends prepared for mechanical coupled field joints.

127.6.1.6 Plain ends fitted with flanges.

127.6.2 Unless otherwise shown on the plans or specified in the Supplementary Specifications, the pipe joints shall comply with AWWA Standards. Joints tolerances shall not exceed those specified in AWWA C 201.

127.7 COATINGS

Exterior of steel pipe and fittings shall be coated with coal-tar enamel. Coating shall be in accordance with AWWA C 203.

127.8 MEASUREMENT AND PAYMENT

Measurement shall be by the linear foot along center line of pipe through all fittings. Payment shall be made on the unit price per linear foot.

SECTION 128

CONCRETE CYLINDER PIPE

128.1 GENERAL

These specifications cover concrete cylinder pipe intended for use in water supply lines and distribution systems that carry water under pressure. Concrete cylinder pipe may be furnished in pipe diameters of 24 inches and larger for design pressure to a maximum of 400 psi. Unless otherwise shown on the drawings or specified in the Supplementary Specifications, concrete cylinder pipe shall be designed and manufactured for an internal working pressure of 150 psi with allowance for transient pressure in the amount of 50 percent of the indicated working pressure.

128.2 REFERENCES

128.2.1 American Water Works Association (Latest Edition) (AWWA)

C 207 Steel Pipe Flanges for Waterworks Service Sizes 4 in. through 144 in.

C 208 Dimensions for Fabricated Steel Water Pipe Fittings

C 303 Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, Pretensioned, for Water and Other Liquids

128.3 DESIGN

128.3.1 The calculation of the cross-sectional area of steel shall be based upon the design procedure stated in AWWA C 303, Appendix A. The design data used in the design of the pipe shall be as stated in the Supplemental Technical Specification or as shown on the plans. The design data shall include but not limited to normal operating pressure, surge pressure, external loading, bedding required, backfilling requirements, estimated weight of the soil to be used for backfilling, modulus of soil reaction, etc. Design calculations shall be submitted for approval prior to fabrication of pipe and fittings.

128.3.2 Use of welded wire fabric in the exterior coating shall conform to the manufacturer's standards; however, use of fabric shall not be included in the total steel area calculations.

128.4 MANUFACTURED PIPE AND FITTINGS

128.4.1 Pipe and fittings shall be manufactured in conformance with AWWA C 303 and shall be manufactured with minimum steel thickness as required in approved design calculations.

128.4.2 JOINTS:

128.4.2.1 Joints shall be flanged where shown on the drawings or as specified herein with steel flanges as specified herein. Unspecified joints shall be of the rubber

gasket type using a bell and spigot design, and shall be in conformance with AWWA C 303.

128.4.2.2 Bells and spigots shall conform to the requirements of AWWA C 303 with the following additions: The spigot ring shall be similar and equal to Carnegie Shape M 3516. Bell and spigot rings shall be designed using their respective internal diameters, with resulting thickness extending a minimum of one inch beyond the limits in the area of the connection between the bell or spigot and the regular cylinder.

128.4.3 Flange connections shall be used at junctures to valves or as may be required on the construction plans. Flanges shall conform to AWWA C 207, Class D.

128.4.4 Specials and Fittings. The ends of pipe or fittings for side street stub-outs or at juncture of valves will be flanged, with flanges conforming to the requirements of AWWA Specifications C 207 designed for a minimum operating pressure of connections to 150 psi.

128.5 DESIGN OF FITTINGS:

The design of tees, wyes, elbows, and bends using crotch plates shall be manufactured in accordance with design criteria established by Ameron Pipe Company and the paper on "Design of Wye Branches for Steel Pipe" by Swanson, Chaption, Wilkenson, King, and Welson and published in June, 1955 issue of "Journal of the American Water Works Association."

128.6 MEASUREMENT AND PAYMENT

The measurement and payment will be as specified in Section 801.

**SECTION 129
DUCTILE IRON PIPE**

129.1 GENERAL

Ductile iron pipe is acceptable for use in the installation of water lines for sizes 4-inches to 64-inches. Ductile iron pipe shall only be used for sanitary sewers where specifically required by the plans or authorized by the ENGINEER. The size and thickness class for ductile iron pipe shall be as specified herein or on the plans.

129.2 REFERENCES

129.2.1 American Society for Testing and Materials (Latest Editions) (ASTM)

A 674 Practice for Polyethylene Encasement for Ductile Iron Pipe for Water and Other Liquids

A 746 Specifications for Ductile Iron Gravity Sewer Pipe

129.2.2 American Water Works Association (Latest Editions) (AWWA)

C 104 American National Standard for Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water

C 105 American National Standard for Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids

C 111 American National Standard for Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings

C 115 American National Standard for Flanged Ductile Iron Pipe with treaded Flanges

C 150 American National Standard for the Thickness Design for Ductile Iron Pipe

C 151 American National Standard for Ductile Iron Pipe, Centrifugally Cast, for Water or Other Liquids

C 600 Installation of Ductile Iron Water Mains and Their Appurtenances

129.2.3 This Publication

Section 130 Gray Iron and Ductile Iron Fittings

Section 801 Installation of Water Transmission, Collector and Distribution Lines

Section 900 Sanitary and Storm Sewer Facilities

129.3.1 The ENGINEER shall determine the required class of ductile iron pipe based on the laying conditions, depth of cover and loading factors in accordance with AWWA C 150 but in no case shall the ductile iron pipe be less than pressure class 150. If a pressure class higher than 150 is required, it will be specified on the plans or in the Supplemental Technical Specifications.

129.3.2 Ductile iron pipe shall be manufactured in accordance with AWWA C 151 and shall be cement mortar lined with a bituminous seal coat in accordance with AWWA C 104.

129.3.3 Ductile iron pipe joints for underground installations shall be rubber-gasketed push-on, or mechanical type in accordance with AWWA C 111.

129.3.4 Where specified on the construction drawings, the ductile iron flanged joint pipe shall meet the requirements in AWWA C 115. Flanged joints shall only be utilized in above

**SECTION 129
DUCTILE IRON PIPE**

ground installations or within structures, such as: valve pits or vaults.

129.3.5 Ductile iron pipe connections to fittings shall be as specified in Section 130.

129.3.6 Ductile iron pipe shall be installed in accordance with AWWA C 600 and Section 801 and shall be polyethylene encased as per AWWA C 105.

129.3.7 BELL AND SPIGOT JOINTS: Pipe with gasket joints shall be manufactured with a socket configuration, which will prevent improper installation of the gasket and will ensure that the gasket remains in place during joining operations. The gasket shall be manufactured from a synthetic elastomeric material and shall conform to the requirements of ASTM F 477. The spigot end of each joint of pipe shall be marked circumferentially to indicate the proper home mark. Pipe, which is field-cut, shall be chamfered and the home mark identified in accordance with the applicable criteria.

129.4 DUCTILE IRON SANITARY SEWER PIPE

129.4.1 Ductile iron pipe, utilized for sanitary sewer installation, shall be asphaltic lined in accordance with ASTM A 746, unless otherwise specified on the plans or in the Supplemental Technical Specifications.

129.4.2 All pipes shall be a minimum of pressure class 150.

129.4.3 Polyethylene encasement shall be installed in accordance with ASTM A 674.

129.5 MEASUREMENT AND PAYMENT

129.5.1 Ductile iron pipe with polyethylene encasement for both pressure and gravity flow shall be measured and paid for at the contract unit price as specified in Section 801 and 900 and/or as defined in the Bid Proposal.

SECTION 130

GRAY IRON, DUCTILE IRON, AND STEEL FITTINGS

130.1 GENERAL

130.1.1 Fittings required in the installation of ductile iron, polyvinyl chloride and asbestos cement pipes shall be either gray iron or ductile iron, as specified herein.

130.2 REFERENCES

130.2.1 AWWA

C 104	American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
C110	American National Standard for Ductile-Iron and Gray-Iron Fittings for Water
C111	American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C153	American National Standard for Ductile-Iron Compact Fittings for Water Service
C208	American National Standard for Dimensions for Fabricated Steel Water Pipe Fittings
C226	American National Standard for Stainless-Steel Fittings for Waterworks Service Sizes 1/2 In. through 72 In.

130.3 COATINGS

130.3.1 All fittings shall be coated in accordance with AWWA C 110, C 111, and cement-mortar lined, per AWWA C 104.

130.4 MECHANICAL JOINT FITTINGS

130.4.1 Mechanical joint fittings shall be used in all buried installations. The type of fitting shall be as required to install the line in conformance with the grade and alignment shown on the construction drawings or as directed by the ENGINEER.

130.4.2 Mechanical joint fittings shall conform to the requirements of AWWA C 110, C 111, and C 153.

130.4.3 Fittings shall be installed in accordance with the manufacturer's published recommendations. Malleable iron or gray iron bolts, as per AWWA C 110 and C 111, shall be used to complete the connection. Bolts shall be of sufficient length to provide a minimum of three (3) threads

beyond the tightened nut. The bolts shall be tightened evenly such that the distance between the gland and the face of the flange is approximately equal around the circumference of the pipe. All bolts shall be tightened with a torque-measuring wrench and the torque values shall be as follows:

<u>FITTING SIZE</u>	<u>TORQUE RANGE</u>
4" – 24"	79 – 90
30" – 36"	100 – 120
Larger than 36"	120 – 150

130.5 FLANGED JOINT FITTINGS

130.5.1 Flanged end fittings shall only be used where specifically required on the construction drawings or as directed by the ENGINEER.

130.5.2 The bolting material for pipe connection and installation shall be the same as Subsection 130.4.3.

130.6 RESTRAINTS

130.6.1 Thrust restraint blocking shall only be used when adequate mechanical restraint length is not available. When approved by the Water Authority, recommended by the ENGINEER, or shown on the plans, a polyethylene liner, with a minimum thickness of 8 mils, shall be installed between the fitting and any concrete.

130.6.2 All restrained joints shall be by mechanical means unless directed or approved otherwise by the ENGINEER. Prior to the installation, the CONTRACTOR shall submit manufacturer's literature with sufficient data to the ENGINEER for review and approval in writing.

130.7 STEEL FITTINGS

130.7.1 Steel fittings shall only be used when authorized by the ENGINEER and when needed to connect to an existing steel water line. Measurement and payment for steel fittings, when authorized, shall be made at the contract unit price per pound based on weights of an all mechanical joint ends fitting of the type fitting and size used, as specified in AWWA C110. This payment shall include all fabrication and welding required on the fitting.

130.8 PRESSURE RATING

SECTION 130

GRAY IRON, DUCTILE IRON, AND STEEL FITTINGS

130.8.1 All fittings shall have a minimum pressure rating of 250 psi.

130.9 MEASUREMENT AND PAYMENT

130.9.1 All cast iron and ductile iron fittings shall be measured and paid for at the contract unit price per pound based on weights of an all mechanical joint ends fitting for the type and size of fitting used as specified in AWWA C110, regardless of the type of ends on the fitting installed. The contract unit price per pound of fittings shall include all gaskets, glands, bolts, and nuts required. No separate payment will be made for these items.

130.9.2 When the CONTRACTOR installs a Water Authority furnished fitting and replaces that fitting in the Water Authority's inventory, the CONTRACTOR shall be paid the full contract unit price of that fitting as outlined above. If the CONTRACTOR does not replace the fitting in the Water Authority's inventory, the payment to the CONTRACTOR will be at the contract unit price of the fitting less the cost of the fitting itself.

130.9.3 Fitting Insertion: The insertion of a fitting into an existing pipe line shall be measured and paid for at the contract unit price per pound based on weights of an all mechanical joint end fitting and if required an all mechanical joint connecting piece (coupling) of the type fitting and size used, as specified in AWWA C110, regardless of the type of ends on the fitting and coupling installed. This payment shall include all compensation for the excavation, cutting and removal of the existing pipe, installation of the fitting and coupling, if required, the re-cutting of the existing pipe or new pipe installed between the fitting and coupling, and backfill and compaction complete in place. In addition to the payment for the fitting insertion, the CONTRACTOR shall be paid for each non-pressurized connection and if pavement, curb and gutter, sidewalk, drive pad, etc., are removed, these items will be paid for as part of the appropriate item.

130.9.4 Restrained joint fittings shall be measured and paid for in the same manner as Subsection 130.9.1.

SECTION 135

CORRUGATED METAL PIPE AND ARCHES

135.1 GENERAL

135.1.1 Corrugated metal pipe, pipe arches, and connectors shall be manufactured and inspected in conformance with the requirements of AASHTO M 36 and as hereinafter specified. The size, type, and gauge of the pipe to be furnished shall be as shown on the plans or as specified in the Supplementary Specifications.

135.1.2 Nominal diameter of dimensions as referred to in M 36 shall be defined as meaning the minimum inside dimension of the pipe.

135.1.3 Corrugated metal pipe and arches shall only be used for transverse roadway culvert drainage applications.

135.2 REFERENCES

135.2.1 ASTM
A 36 A 123

135.2.2 AASHTO
M 36 M 196
M 190 M 219

135.3 MATERIALS

135.3.1 Materials for corrugated metal pipe, pipe arches, and connectors including base metal, rivets, and spelter coating shall be as specified in AASHTO M 36.

135.3.2 Headwalls or flared end sections may be used if called for on the plans or in the Supplementary Specifications.

135.4 FABRICATION

At the option of the CONTRACTOR, corrugated metal pipe may be fabricated by riveting, replacing rivets with resistance spot welds, or using a helically corrugated metal pipe with a continuous helical lock seam paralleling the corrugation or by a method of welding approved by the ENGINEER.

135.4.1 FABRICATION BY RIVETING: Pipe fabricated by riveting shall conform to AASHTO M 36.

135.4.2 FABRICATION BY WELDING: Pipe fabricated by replacing the rivets with resistance spot welds shall conform to AASHTO M 36.

135.5 FABRICATION BY CONTINUOUS LOCK SEAM

Pipes fabricated with a continuous helical lock seam parallel to the corrugations shall conform to the requirements of AASHTO M 36, M 196, and M 219.

135.6 BITUMINOUS COATING

When required by the Supplementary Specifications, pipes and connecting bands shall be protected, both inside and outside, with a bituminous coating or an asbestos fiber with a bituminous coating. The bituminous coating shall conform to the requirements of AASHTO M 190, Type A, Type B, or Type C.

135.7 REPAIR OF DAMAGED SPELTER COATING

Spelter coating which has been burned by welding or otherwise damaged in fabrication shall be repaired and recoated in accordance with AASHTO M 36.

135.8 MEASUREMENT AND PAYMENT

135.8.1 When only required as a separate material item, the following will apply:

135.8.1.1 The measurement and payment of corrugated metal pipe or corrugated metal arches will be by the linear foot measured along the centerline of the pipe or arch to the nearest foot.

135.8.1.2 Pipe culvert with beveled or skewed ends will be measured along the invert to the nearest foot.

135.8.1.3 End sections will be measured by the number of units each.

135.8.2 If this material is to be used in conjunction with a complete installation, then the measurement and payment will be defined in Section 910.

SECTION 136

STRUCTURAL STEEL PLATE FOR PIPE, ARCHES, AND PIPE ARCHES

136.1 GENERAL

136.1.1 Structural steel plate for pipe, arches, and pipe arches shall be of the sizes, gauges, and dimensions designated on the plans or in the Supplementary Specifications and as specified herein.

136.1.2 These types of pipe shall only be used for transverse roadway culverts drainage applications.

136.2 REFERENCES:

136.2.1 AASHTO
M 36 M 190
M 167

136.3 MATERIALS

136.3.1 Plates and nuts and bolts shall conform to the specifications of AASHTO M 167.

136.3.2 Galvanized surfaces which are damaged shall be repaired in accordance with the provisions in AASHTO M 36, Repair of Damaged Spelter Coating.

136.4 DISTORTION

136.4.1 In advance of placing backfill material around circular structural plate pipes, the pipe shall be distorted.

136.4.2 Distortion may be performed either at the fabricating shop or in the field.

136.4.3 If the plates are distorted in the fabricating shop, the plates shall be distorted to provide an increase in the vertical diameter of the pipe after assembly of approximately 5 percent for the full length.

136.4.4 Plates shall be marked in order to assure that they will be placed in proper position.

136.4.5 If the pipes are distorted in the field, the method of distortion shall conform to the details shown on the plans.

136.5 MEASUREMENT AND PAYMENT

136.5.1 When only required as a separate material item, the following will apply:

136.5.1.1 The measurement of structural plate for pipe, arches, and pipe arches will be by the linear foot measured along

the centerline of the pipe or arch to the nearest foot.

136.5.1.2 Structural plate for pipe with beveled or skewed ends measurement will be along the invert to the nearest foot.

136.5.1.3 Payment shall be made at the unit price per linear foot as defined in the Bid Proposal.

136.5.2 If this material is to be used in conjunction with a complete installation, then the measurement and payment will be defined in Section 910.

SECTION 137

CORRUGATED ALUMINUM PIPE AND ARCHES

137.1 GENERAL

137.1.1 Corrugated aluminum pipe, pipe arches, and connectors to be used or furnished shall be manufactured and inspected in conformance with the requirements of AASHTO M 196, AASHTO M 197, and as hereinafter specified. The size, type, and gauge of the pipe to be furnished shall be shown on the plans or as specified in the Supplementary Specifications.

137.1.2 Corrugated aluminum pipe may be fabricated by riveting or using a helically corrugated aluminum pipe with a continuous helical lock seam paralleling the corrugations.

137.1.3 Corrugated aluminum pipe arches shall consist of corrugated aluminum pipe which has been re-formed for a multi-centered pipe having an arch-shaped top with a slightly curved integral bottom.

137.1.4 The specifications contained herein for pipe shall also apply to pipe arches.

137.1.5 Nominal diameter or dimensions as referred to in AASHTO M 196 and M 197 shall be defined as meaning the minimum inside dimension of the pipe.

137.1.6 Corrugated metal pipe and arches shall only be used for transverse roadway culvert drainage applications.

137.2 REFERENCES:

137.2.1 AASHTO
M 190
M 196
M 197

137.3 MATERIALS

Corrugated aluminum products covered by this section may be fabricated of the kind of base metal listed in AASHTO M 196.

137.3.1 CONNECTING BANDS: The connecting bands shall conform to the requirements of AASHTO M 196, except that the minimum width of band for helical pipe shall be 12 inches.

137.3.2 END FINISH: If headwalls or flared end sections are not being provided and if called for on the plans or in the Supplementary Specifications, the inlet and outlet of all culverts fabricated of 16 or 14 gauge sheets shall be reinforced in a manner approved by the ENGINEER.

137.4 FABRICATION BY RIVETING

Pipe fabricated by riveting shall conform to AASHTO M 196.

137.5 FABRICATION BY CONTINUOUS LOCK SEAM

137.5.1 Pipes fabricated with a continuous helical lock seam parallel to the corrugations shall conform to the requirements of AASHTO M 197 for Type I without perforations and as specified herein.

137.5.2 Type I helical lock seam pipe may be fabricated in diameter 6 to 96 inches, inclusive.

137.6 BITUMINOUS COATING

137.6.1 When required by the Supplementary Specifications, pipes and connecting bands shall be protected both inside and outside with a bituminous coating. The bituminous coating shall conform to the requirements of AASHTO M 190 and as hereinafter specified.

137.6.2 The bituminous material shall conform to paragraph 4 of AASHTO M 190 except that it shall be at least 99 percent soluble in cold carbon disulfide.

137.6.3 When corrugated aluminum pipes are to be bituminous coated, the fabrication requirements specified in AASHTO M 196 shall be altered so that the rivet heads inside the pipe will be in the valley of the corrugations.

137.7 MEASUREMENT AND PAYMENT

137.7.1 When only required as a separate material item, the following will apply:

137.7.1.1 The measurement of corrugated aluminum pipe and arches will be by the linear foot measured along the centerline of the pipe or arch to the nearest foot.

137.7.1.2 Pipe culvert with beveled or skewed ends will be measured along the invert to the nearest foot. End sections will be measured by the number of units each. Payment shall be made at the unit prices bid as defined above.

137.7.2 If this material is to be used in conjunction with a complete installation, then the measurement and payment will be defined in Section 910.

SECTION 138

STRUCTURAL ALUMINUM PLATE FOR PIPE, ARCHES, PIPE ARCHES AND BOX CULVERTS

138.1 GENERAL

138.1.1 Structural aluminum plate for pipe, arches, pipe arches, and box culverts shall be of the size, gauges and dimensions on the construction plans.

138.1.2 Corrugated metal pipe and arches shall only be used for transverse roadway culvert drainage applications.

138.2 REFERENCES

138.2.1 ASTM

A 153	B 209
A 193	B 308
A 307	

138.2.2 AASHTO M 219

138.3 MATERIALS

138.3.1 Plates shall be fabricated from aluminum alloy 5052-H141, with chemical properties per ASTM B 209. Mechanical properties shall conform to AASHTO M 219.

138.3.2 Ribs shall be fabricated from aluminum alloy 6061-T6, with properties per ASTM B 209 and B 308.

138.3.3 Nuts and bolts and other special securing devices shall be galvanized steel and shall meet the standards of ASTM A 307 with the zinc coating in compliance with ASTM A 153.

138.3.4 Stainless steel nuts, bolts, and other securing items shall comply with ASTM A 193.

138.3.5 The shape of the nuts, bolts, and other special securing items shall be the same geometric configuration as recommended by the manufacturer of the plates.

138.3.6 All bolts or other special securing items, which require a bend, shall be bent to final position before galvanizing operation.

138.4 INSTALLATION

Structural aluminum plate structures shall be installed in accordance with the manufacturer's recommendations and shop drawings, and construction plans.

138.5 MEASUREMENT AND PAYMENT

138.5.1 The measurement of structural plate structures will be by the linear foot measured along the centerline of the culvert or pipe to the nearest foot.

138.5.2 Structural plate structures with beveled or skewed ends will be measured along the invert to the nearest foot.

138.5.3 Payment shall be made at the unit price per linear foot per type of structure, as specified in the Bid Proposal.

SECTION 139

STRUCTURAL AND RIVET STEEL, RIVETS, BOLTS, PINS, AND ANCHOR BOLTS

139.1 GENERAL

All steel, the class of which is not definitely designated herein, in the Supplementary Specifications, or on the plans, shall be structural steel and shall conform to the requirements of ASTM A 36.

139.2 REFERENCES

139.2.1 ASTM

A 6	A 490
A 36	A 502
A 242	A 572
A 307	A 668
A 325	E 10

139.3 REPORT OF TESTS

Before fabrication, the CONTRACTOR shall furnish to the ENGINEER a report in duplicate certified by the mill of the tests for each melt of steel or iron from which the material is to be fabricated. These tests shall include the chemical and physical tests required by the ASTM specifications for the materials.

139.4 ADDITIONAL TESTS

139.4.1 The ENGINEER reserves the right to require additional mill and laboratory tests to assure compliance with ASTM requirements.

139.4.2 By "identifiable stock" is meant material for which authentic records of the chemical and physical properties are available.

139.4.3 Test specimens shall be furnished, cut, and machined in accordance with ASTM specifications for the material to be tested, as referred to herein. Test specimens shall be furnished and machined at the CONTRACTOR's expense.

139.5 MILL TOLERANCES

Rolling and cutting tolerances, permissible variations in weight and dimensions, defects and imperfections shall not exceed the limits for structural steel contained in ASTM A 6.

139.6 STOCK MATERIAL

When the CONTRACTOR proposes to use material already in stock, he shall notify the ENGINEER of such intention at least ten days in advance of beginning

fabrication to permit sampling and testing.

139.7 STRUCTURAL STEEL:

139.7.1 STOCK MATERIALS: The CONTRACTOR shall select the material he wishes to use from stock and place it in a location apart from other stock material and accessible for inspecting and sampling. The CONTRACTOR shall select the material from as few heat numbers as possible and shall furnish certified mill test reports on each of the heat numbers. Two samples shall be taken by a representative of the ENGINEER from each heat number, one for the tension test and one for the cold bend test. If the heat numbers cannot be identified, the representative of the ENGINEER may, at his discretion, select random test specimens from the unidentifiable heats. The number of such test specimens shall be entirely within the discretion of the representative of the ENGINEER.

139.7.2 HIGH-STRENGTH LOW-ALLOY STRUCTURAL STEEL: The material shall conform to the requirements of ASTM M 242, A 572 (Grades 42, 50, 60, or 65).

139.7.3 COPPER BEARING STRUCTURAL STEEL: Copper bearing structural steel shall conform to the requirements of ASTM A 36 or as specified.

139.8 RIVETS

139.8.1 STOCK MATERIAL:

139.8.1.1 Rivets taken from identifiable stock shall be accepted by the ENGINEER in accordance with Subsection 139.4.2.

139.8.1.2 Rivets from unidentifiable stock (for which authentic records of the chemical and physical properties are not available) shall not be used except where shown on the shop drawing. See Subsection 139.6.

139.8.2 HIGH-STRENGTH STRUCTURAL RIVET STEEL:

The material shall conform to the requirements of ASTM A 502.

139.8.3 STRUCTURAL RIVET STEEL: The material shall conform to the requirements of ASTM A 502, except that the test

specimen shall be bent upon itself when performing the bend test.

139.9 BOLTS

139.9.1 UNFINISHED BOLTS

139.9.1.1 The bolts shall have square heads and square nuts unless otherwise specified. The bolts shall be long enough to extend entirely through the nut but not more than 1/4 inch beyond. Washers shall not be furnished unless specified.

139.9.1.2 Steel bolts shall conform to the requirements of ASTM A 307, except that steel manufactured by the acid-Bessemer process shall not be used.

139.9.2 HIGH-STRENGTH BOLTS: High Strength bolts shall conform to the provisions of the specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings of the American Institute of Steel Construction (ASTM A 325 or A 490).

139.10 ANCHOR BOLTS

Anchor bolts shall be manufactured from steel conforming to ASTM A 36 or A 307.

139.11 MILD-STEEL FORGINGS FOR STRUCTURAL PURPOSES

Steel forgings shall be made from steel of forging quality and shall conform to the requirements of ASTM A 668. They shall be Class C forgings with a maximum carbon content of 0.35 percent and shall be given a thorough annealing. The metal shall have a minimum Brinell hardness number of 130 and a maximum of 190 when tested in accordance with ASTM Test E-10.

139.12 MEASUREMENT AND PAYMENT

Structural and rivet steel, rivets, bolts, pins, and anchor bolts will be considered subsidiary items to major items of construction as listed in the specifications or required on the plans. No separate measurement or payment will be made.

SECTION 143

GALVANIZING

143.1 GENERAL

These specifications cover the hot-dip galvanizing of various metals where required by the detailed plans or specifications.

143.2 REFERENCES

143.2.1 ASTM

A 116	A 153
A 120	A 392
A 121	A 444
A 123	A 525

143.3 SPECIFICATIONS

Materials shall be hot-dip galvanized and the weight and uniformity of coating determined in accordance with the standard specifications given in the Table 143.3

143.4 WORKMANSHIP

The galvanizing shall be applied in such a manner that the spelter will not peel off. The finished product shall be free from blisters and excess spelter; and the coating shall be even, smooth, and uniform throughout. Machine work, dye work, cutting, punching, bending, welding, drilling, thread cutting, and other fabricating shall be done as far as is practicable before the galvanizing. No member shall be galvanized which is out of alignment. All members, nuts, bolts, washers, etc. shall be galvanized before a structural unit is assembled. All uncoated spots or damaged coatings due to poor workmanship, rough handling, or any other reason shall be cause for rejection.

143.5 TEST COUPONS

Test coupons for determining the quality of the galvanizing shall be wired to the materials to be galvanized before immersion in such a manner as to represent the amount of coating deposited on the materials.

143.6 REPAIR OF GALVANIZED SURFACES

Unless otherwise specified, where galvanized surfaces are field or shop cut, broken, burned, or abraded, thus breaking the galvanizing, the locations thus damaged shall be coated with "Galvalloy" or "Galvicon" or an approved equal.

143.7 MEASUREMENT AND PAYMENT

Galvanizing will be considered a subsidiary item to the product so treated. No separate measurement or payment will be made.

TABLE 143.3
GALVANIZING SPECIFICATIONS

Material or Test	Std. Spec. ASTM	Class
Corrugated Metal Pipe	A 444	
Flat Steel or Iron Sheets	A 525	
Iron or Steel Wire	A 116	2
Chain-Link Fabric (Galv. after Fabrication)	A 392	1
Barbed Wire	A 121	2
Steel Pipe Rails	A 120	
Structural Shapes, Tie Rods, Ornamental Iron Railings, Handrails, Manhole and Catch Basin Steps, and Curb Armor	A 123	
Bolts, Nuts, Washers, Anchor Bolts, Packing Spools, Gray Iron and Malleable Iron Castings, and Steel Castings	A 153	
Guard Rails	A 525	

SECTION 145

LUMBER

145.1 GENERAL

This section specifies the types and grading of lumber that will be acceptable for certain uses.

145.2 REFERENCES

145.2.1 United States Product Standard PS 1-66 for Softwood Plywood

145.2.2 Standard Specifications for Grades of California Redwood of the Redwood Inspection Service

145.2.3 Western Wood Products Association

145.3 LUMBER, PLYWOOD, AND REDWOOD

145.3.1 LUMBER AND PLYWOOD:

145.3.1.1 Unless otherwise specified or shown on the drawings, all lumber shall be Douglas fir or pine and shall be selected as to grade and shall conform in all particulars to the Standard Grading and Dressing Rules of the Western Wood Products Association or other grading agency approved by the ENGINEER.

145.3.1.2 Plywood shall conform to the performance standards for its type in United States Product Standard PS 1-66 for Softwood Plywood, Construction and Industrial.

145.3.1.3 Lumber or plywood for the uses listed in Table 145.3.1.3 shall not be lower than the grades shown.

145.3.2 REDWOOD:

145.3.2.1 Redwood lumber shall be selected as to grade and shall conform in all particulars to the Standard Specifications for Grades of California Redwood of the Redwood Inspection Service.

145.3.2.2 Redwood lumber for the uses listed in Table 145.3.2.2 shall not be lower than the grades shown.

145.4 GRADE MARKING

145.4.1 Each piece of lumber shall bear an official grade mark which, unless authorized otherwise, shall be the grade mark adopted by one of the following:

145.4.1.1 For Douglas fir and pine, marking shall be the Western Wood Products Association or other grading agency approved by the ENGINEER.

145.4.1.2 For redwood, marking shall be the Redwood Inspection Service.

145.4.1.3 For plywood, each sheet of plywood shall bear the official stamp of a quality control agency stating the grade of the sheet.

145.5 MEASUREMENT AND PAYMENT

145.5.1 Lumber, plywood, or redwood where required may be considered a subsidiary item. In which case no measurement or payment will be made.

145.5.2 If any one of these materials are considered as a pay item, then the unit of measurement and payment will be specified in the Bid Proposal.

TABLE 145.3.1.3
LUMBER AND PLYWOOD--USES AND GRADES

<u>USES</u>	<u>GRADES</u>
A. Permanent construction, such as bridges and culverts.	Select structural for beams and stringers; construction grade for balance of structure.
B. Minor permanent construction, such as fences, guard rails and posts, pavement headers, bulkheads, retaining structures, etc.	Construction grade.
C. Falsework and studs, and wales for formwork.	Construction grade framing, beams, or timbers.
D. Form sheeting for non-showing surfaces of ornamental concrete.	Standard grade boards; shiplap; or any grade of plywood.
E. Form sheeting for showing surface of ornamental concrete.	Vertical grain "C" industrial clear; concrete form grade of plywood; or overlay plywood.
F. Form sheeting for curved soffits of bridge and tunnel arches, plastered, or unplastered.	Select merchantable boards concrete grade of plywood; or overlay plywood.
G. Soffits of beams and girders and slabs between beams and girders; for beam and girder sides, except ornamental concrete; and for head-walls or end-walls of culverts or covered conduits.	Concrete form grade of plywood or overlay plywood.
H. Form sheeting for showing surfaces of channel walls or interior surfaces except floors, of covered conduit, and all other showing surfaces not specified above.	Tongue and groove flooring equal to Grade "C" and better flat grain; concrete form grade of plywood; or overlay plywood.
I. All other lumber.	Construction grade.

TABLE 145.3.2.2
REDWOOD USES AND GRADES

<u>USES</u>	<u>GRADES</u>
A. Bridges, culverts, and guardrail posts.	Select all heart structural timber.
B. All other redwood lumber.	Foundation.

SECTION 146

WOOD PRESERVATIVES

146.1 GENERAL

146.1.1 This work shall consist of treating lumber, timber, and piling. Lumber, timber, and piling to be treated shall conform to the requirements of the various sections of these specifications specifying these materials.

146.1.2 Where practical, lumber to be treated shall be cut to size and framed prior to treatment, unless indicated otherwise on the drawings. Proper allowance for shrinkage in the sizes of lumber shall be made by the CONTRACTOR where it is necessary to meet definite dimensions shown on the drawings.

146.2 REFERENCES

146.2.1 ASTM

D 390	D 1625
D 391	D 1760
D 1032	D 1858
D 1272	D 1859
D 1325	D 2604
D 1624	D 2605

146.2.2 AASHTO M 133

146.3 OIL-TYPE PRESERVATIVE TREATMENT:

Preservatives under this specification shall be creosote, creosote-coal tar solutions, creosote petroleum solutions, or pentachlorophenol in petroleum oils, conforming to ASTM D 390, D 391, D 1858, D 1272, and/or AASHTO M 133, respectively, with petroleum oils per ASTM D 1859, D 2604, and D 2605 or any combination of above preservatives as approved by the ENGINEER.

146.4 WATER-BORNE SALT PRESERVATIVES TREATMENT

146.4.1 Preservatives under this section shall conform to the requirements of ASTM D 1032, D 1325, D 1624, and D 1625.

146.4.2 Unless indicated otherwise on the plans, the amount of preservative to be retained shall conform to the requirements of ASTM D 1760.

146.5 TREATMENT

146.5.1 The treating operations shall conform to the applicable requirements of ASTM D 1760 and/or AASHTO M 133.

146.5.2 Unless indicated otherwise on

the plans or in the Supplementary Specifications, the amount of preservative to be retained and the treating process to be used for the various types of service shall conform to the requirements established in the standards referenced in this section.

146.6 PENETRATION

Penetration shall conform to the applicable specification or ASTM D 1760, unless otherwise indicated on the plans or Supplementary Specifications.

146.7 INCISING

Timber of those species required to be incised by ASTM Specifications shall be incised before treatment only when it is 3 inches or more in nominal thickness and 4 inches or more in nominal width, as a means of securing penetration of the preservative. If such thickness is less than 4 inches, the material may be incised on the wide faces only, otherwise all four faces shall be incised.

146.8 PENETRATION

Penetration shall conform to the applicable ASTM Specification listed in Subsection 146.6.

146.9 FIELD TREATMENT OF CUT SURFACES

146.9.1 When sawing or drilling is necessary after plant treatment of creosoted materials, the cut surfaces shall be thoroughly brushed with 2 coats of hot coal tar creosote of the same kind used at the plant. If such hot application is not practicable, then a cold application shall be made.

146.9.2 In treating surfaces exposed when pile heads are cut off, the brush treatment shall be given with great care and thoroughness. A coat of pitch, asphalt, or similar material should then be applied over the creosote, followed by some protective sheet material such as metal, roofing felt, or saturated fabric fitted over the pile head and brought down the sides far enough to protect against damage to the top treatment.

146.9.3 Lumber sawed or cut after salt treatment shall have the cut surfaces well-brushed with the same preservative that was used at the plant.

146.10 INSPECTION

146.10.1 All material treated under this specification will be subject to inspection for compliance with the prescribed requirements.

146.10.2 Acceptance of material at any step from vendor through treatment, storage, and incorporation into the work, will not bar subsequent rejection for damage of any nature. All material so rejected shall be replaced at the expense of the CONTRACTOR.

146.10.3 All facilities and supplies that may be required for testing and for ascertaining compliance with the provisions of this specification relative to the treatment of the material shall be furnished by the treatment plant for use by the ENGINEER. Duly authorized representatives of the ENGINEER shall be given free access to all parts of the plant in which any work is being done and to all records pertaining to the performance of such work.

146.11 HANDLING AND PROTECTION OF TREATED MATERIAL

Material that is stored on the site of work prior to its use shall be neatly piled on skids to raise it from the ground and shall be protected from the sun and weather. When so required, the material shall be accessible for inspection.

146.12 MEASUREMENT AND PAYMENT

Wood preservatives where called for shall be considered a subsidiary item. No measurement and payment will be made.

SECTION 150

TIMBER PILES

150.1 GENERAL

This work shall consist of furnishing timber piles of type and size shown on the plans or specified.

150.2 REFERENCES

150.2.1 ASTM

D 25

150.2.2 AASHTO

M 133

150.2.3 This publication SECTION 502

150.3 MATERIALS

150.3.1 Timber piling shall be dense southern yellow pine, Coast Region Douglas fir, or western larch cut from sound trees. Piling shall meet the requirements of ASTM D 25 and shall comply with the minimum circumference values given in the Table 150.3.1.

150.3.2 Unless otherwise provided, piles shall be furnished in lengths shown on the plans. Variations of one foot from the designated length will be permitted, except that the average length of all piles of a specified length shall be equal to or greater than the required length. The supplier shall legibly mark the size and length on the butt end of each pile. Tips and butts shall be cut at right angles to the axis of the pile. Tips shall be pointed to a 4 inch square point when approved by the ENGINEER.

150.3.3 Piles shall be cut from the main body of the tree and shall be cut above the ground swell with a gradual taper from the point of butt measurement to the tip.

150.3.4 All piling shall be subject to inspection by the ENGINEER before and after treatment. In the rejection of materials not found suitable, the judgment of the ENGINEER shall be accepted. The butt and tip of each pile accepted will be branded with a marking hammer showing the identity of the ENGINEER who performed the work.

150.3.5 Treated timber piling not inspected prior to treatment will not be accepted unless approved in writing by the ENGINEER.

150.3.6 The method of handling and storing piles shall be such as to prevent injury during handling or damage during storage. Piles shall be handled with slings or other approved methods. Cant hooks, pike poles, or similar tools shall not be used where such tools will penetrate the wood.

150.3.7 Timber piling shall be treated with creosote oil conforming with the requirements of AASHTO M 133. The amount of preservative retained shall be 12 pounds per cubic foot of wood. The empty-cell process shall be used.

150.4 MEASUREMENT AND PAYMENT

Measurement and payment shall be as specified in Section 502.

TABLE 150.3.1
MINIMUM CIRCUMFERENCE VALUES

Pile Length (Feet)	Minimum Circumference 3 Feet from Butt (Inches)
40 and under	38
41 to 50 inclusive	41
51 to 60 inclusive	44
61 to 70 inclusive	50
Over 70	Shown on Plans

SECTION 151

STEEL PILES

151.1 GENERAL

Steel piles furnished under this specification shall consist of structural steel shapes and other steel shapes that fulfill the requirements prescribed below for such material and shall conform to the details and dimensions indicated by the drawings and specifications relating directly thereto. The kind and type of steel piling to be used in the Work shall be as indicated on the plans or Supplementary Specifications.

151.2 REFERENCES

151.2.1 ASTM

A 36
A 252
A 328

151.2.2 AASHTO

M 150
M 183

151.2.3 American Welding Standard Specifications for Welding Highway and Railroad Bridges

151.2.4 This publication

SECTION 157
SECTION 502

151.3 MATERIALS

151.3.1 The CONTRACTOR shall furnish the ENGINEER with manufacturer's certificate indicating that structural steel piles and pile columns and steel pipe piles and pipe pile columns conform with all the requirements herein provided.

151.3.2 Unless otherwise provided, after installation, the exposed areas of steel piles or steel pile columns, together with all steel bracing, shall be given 3 coats of paint in conformity with Section 157. The areas to be painted shall extend from the bottom of the concrete cap to 2 feet below ground surface or to the surface of the water, when the water surface is normal or below normal.

151.3.3 When approved by the ENGINEER, the CONTRACTOR, for his convenience, may furnish steel piles over 30 feet in length or in lengths less than the full length of piles shown on the plans. Such piles shall be spliced not more than two splices per pile to obtain not less than required length, with minimum piece length of 5 feet prior to driving. All splicing shall conform to details shown on the plans and will be considered

incidental to the completion of the Work and no payment will be made therefor.

151.3.4 All welding shall conform with American Welding Society Standard Specifications for Welding Highway and Railroad Bridges.

151.3.5 Structural Steel Piles-- Structural steel for bearing piles shall conform to the requirements of AASHTO M 183 or ASTM A 36. Camber and sweep in excess of the mill tolerance will not be accepted. Unless otherwise noted, HPS 10 x 57 piling may be substituted where HP 10 x 57 piling is called for on the plans.

151.3.6 Closed End Steel Pipe Piles-- Steel pipe piles shall conform with ASTM A 252, Grade 2. Concrete for filling steel pipe piles shall have a minimum 28 day compressive strength of 3000 psi.

151.3.7 Steel Pipe Pile Columns--Steel pipe pile columns shall conform with ASTM A 252, Grade 2. Concrete for filling steel pipe columns shall have a minimum 28 day compressive strength of 3000 psi.

151.3.8 Structural Steel Pile Columns-- Structural steel for pile columns shall conform with AASHTO M 183 or ASTM A 36. Camber and sweep in excess of the mill tolerance will not be accepted. Unless noted otherwise, HPS 10 x 57 piling may be substituted where HP 10 x 57 piling is called for on the plans.

151.3.9 Steel sheet piles shall conform to ASTM A 328.

151.3.10 Steel sheet piling shall consist of standard interlocking sheet pile sections or as shown on the plans and specified herein.

151.4 MEASUREMENT AND PAYMENT

Structural or round bearing piles shall be measured by the linear foot, complete in place, to the specified cut off point including all splices. Sheet pile shall be paid for as specified in Bid Proposal. Payment for driving piling shall be as specified in Section 502.

SECTION 152

CONCRETE PILES

152.1 GENERAL

Four types of concrete piles are covered by these specifications; namely, precast piles, cast-in-place piles, prestressed piles, and centrifugal cast piles. The type to be used or furnished shall be as indicated on the drawings or specified in the Supplementary Specifications. The manufacture of prestressed piles shall be performed in accordance with Section 502. Driving of pile shall conform to Section 502.

152.2 REFERENCES

152.2.1 ASTM

A 252
C 31

152.2.2 This publication

SECTION 101
SECTION 102
SECTION 502
SECTION 512

152.3 PRECAST PILES

152.3.1 Precast concrete piles shall be constructed of concrete of such quality that the finished piles can be handled and driven to required bearing without cracking or other damage which would impair their strength or durability. Concrete shall have a strength at 28 days of not less than 4,000 pounds per square inch in compression and shall be mixed and proportioned in accordance with the requirements of Section 101 with a minimum cement content of 6.5 sacks per cubic yard. Reinforcing steel placed therein shall conform to the requirements of Section 102.

152.3.2 Concrete for precast concrete piles shall be poured in smooth, mortar-tight forms so supported as to prevent appreciable deformation or settlement during pouring or curing. The piles after being poured shall be cured by water curing, steam curing, application of curing compound, or such other method of curing as may be approved by the ENGINEER. Curing shall be continued until specimens of the concrete from which the piles were poured, cured in the same manner as the piles, attain a compressive strength of at least 4,000 pounds per square inch. Piles shall not be driven until completion of the curing.

152.3.3 Upon completion, the piles shall present true, smooth, even surfaces, free

from honeycombs or voids and shall be sufficiently straight that a line stretched from butt to tip along any face will not deviate therefrom nor be deflected more than 1 inch in 50 feet at any point. Repaired defects in any pile may be accepted by the ENGINEER if repaired to his satisfaction.

152.3.4 If dowel extensions are required, the piles may be cast the full length of the reinforcing rods provided that the tops are cut off after driving to expose the ends of the rods as specified or indicated by the drawings.

152.3.5 Precast piles must at all times be so handled as to avoid and prevent cracking, breaking, or chipping the edges thereof. Slings shall be provided at or near the quarter points for raising and transporting long piles.

152.4 CAST-IN-PLACE CONCRETE PILES

152.4.1 METAL CASED CAST-IN-PLACE CONCRETE PILES:

152.4.1.1 Concrete shall have a minimum strength at 28 days of 3,000 pounds per square inch in compression and shall be mixed and proportioned in accordance with the requirements of Section 101. Reinforcing steel placed therein shall conform to the requirements of Section 102.

152.4.1.2 Piles shall be cast in steel shells that have been previously driven to the penetration and bearing value specified or indicated on the drawings.

152.4.1.3 The sheet shall be cylindrical, fluted, step-tapered, or uniformly tapered from butt to tip.

152.4.1.4 The shells shall be of such material and construction as to properly and satisfactorily serve the intended purpose. Those that are driven without a mandrel shall be constructed of material conforming to the requirements prescribed in ASTM A 252, Grade 2, being of sufficient thickness, strength, and rigidity to withstand distortion as a consequence of driving, soil pressure, or the driving of adjacent piles.

152.4.1.5 After being driven but prior to placing of the reinforcing steel and concrete, the shells shall be examined for collapse or reduced diameter at any point, the CONTRACTOR being required to

provide and have available at all times a suitable light for the inspection of the shell throughout the entire length thereof. Shells that are improperly driven or are broken or show partial collapse will not be accepted and shall be replaced by and at the expense of the CONTRACTOR. Driven shells shall be clean and free of water before reinforcing steel and concrete is placed therein. The replacement of the shell shall be made by withdrawing the entire shell and driving another in its place. Driving one shell within a shell already driven will not be permitted. If the withdrawal of the defective shell is impossible or impracticable as decided by the ENGINEER, the CONTRACTOR shall fill the defective shell with concrete and shall replace the defective pile with another pile driven alongside. Any enlargement of the footing required to accommodate such piling shall be at the expense of the CONTRACTOR. Partial collapse of pile shells shall be interpreted to mean any collapse which reduces any diameter of the shell at any point in its length to less than 80 percent of the original diameter at such point, and such partial collapse shall be cause for rejection.

152.4.2 CAST IN DRILLED HOLE PILES:

152.4.2.1 All holes for concrete piles cast in drilled holes shall be drilled dry to the tip elevations shown on the plans or to the elevations determined by the ENGINEER. All holes shall be examined for straightness and any hole which on visual inspection from the top shows less than 1/2 of the diameter of the hole at the bottom of the hole shall be rejected. Suitable casings shall be furnished and placed when required to prevent caving of the hole before concrete is placed therein.

152.4.2.2 All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed before placing concrete in the hole.

152.4.2.3 The use of water for drilling operations or for any other purpose where it may enter the hole will not be permitted. Surface water shall not be permitted to enter the hole and all water which may have infiltrated into the hole shall be removed before placing concrete therein.

152.4.2.4 Casing, if used in drilling operations, shall be removed from the hole as concrete is placed therein. The bottom of the casing shall be maintained not more than 5 feet nor less than 1 foot

below the top of the concrete during withdrawal and placing operations, unless otherwise permitted by the ENGINEER. Separation of the concrete during withdrawal operations shall be avoided by hammering or otherwise vibrating the casing.

152.4.2.5 Care shall be exercised to insure that the concrete in the hole is dense and homogeneous. Vibration of the concrete during placing will not be required, however, rodding may be required. After the hole has been filled with concrete, the concrete at the top 10 feet of the hole or for the length of the reinforcing, whichever is the greater, shall be vibrated.

152.4.2.6 The reinforcing cage shall be placed and secured symmetrically about the axis of the pile and shall be securely blocked to clear the sides of the hole.

152.5 PRESTRESSED CONCRETE PILES

152.5.1 MATERIAL:

152.5.1.1 Piles shall be homogeneous, high strength concrete from head to tip, stressed with high tensile cold drawn strands. Piles of cross section differing from the section shown on the drawings for bearing piles may be accepted by the ENGINEER provided the surface area, sectional area, bending resistance, and prestress are equivalent to that indicated.

152.5.1.2 Bearing piles showing defects when forms are stripped in the upper 10 feet of the pile which reduce the cover over the steel to less than required will be rejected. Defects in the remainder of the pile may be repaired and the pile accepted if repaired in a manner satisfactory to the ENGINEER.

152.5.1.3 Upon completion, the piles shall present true, smooth, even surfaces, free from honeycombs or voids and shall be sufficiently straight that a line stretched from butt to tip along any face will not deviate therefrom nor be deflected more than 1 inch in 50 feet at any point. Defects in any pile may be repaired and the pile accepted by the ENGINEER if repaired to his satisfaction.

152.5.2 HANDLING

152.5.2.1 Piles may be removed from the prestressing bed for transportation of storage after the concrete has reached a compressive strength of 3,500 pounds per

square inch, but they shall not be driven until they have attained a minimum compressive strength of 5,000 pounds per square inch as determined by tests on concrete cylinders cast and cured under the same conditions as the piles. The compressive strength test specimens shall be made in accordance with ASTM C 31 at no additional cost to the OWNER.

152.5.2.2 Lifting shall be only at pre-determined points of pickup and in such a manner as to avoid cracking, spalling, excessive bending, or other injurious results.

152.6 CENTRIFUGAL CAST CONCRETE PILES

152.6.1 Materials shall conform to the requirements of Section 101 unless otherwise specified in the Supplementary Specifications. Concrete casings shall be manufactured by the centrifugal process. They shall be formed and compacted by centrifugal force in a machine of suitable type so designed that the casing molds may be revolved without harmful vibration at sufficient speeds to insure even distribution and dense packing of the concrete true design.

152.6.2 Filling of the mold and spinning shall be a continuous operation, and the spinning shall take place before any of the concrete in the mold has taken an initial set.

152.6.3 When filled, the mold shall be placed on the spinning machine in a horizontal position and rotated at a gradually increasing speed until maximum rotation is attained. Excess water and laitance forced to the center of the mass shall be drained or expelled in a suitable manner.

152.6.4 The concrete casing shall not be removed from the mold until the concrete has attained sufficient strength to prevent deformation. The casing shall be cast full length in one piece and the finished casing shall have a wall thickness not less than the thickness shown on the plans.

152.6.5 The casing shall be reinforced in accordance with the details shown on the plans. Prior to spinning the casing, each longitudinal bar shall be prestressed to a value of 10,000 pounds per bar and such prestresses shall be maintained in each bar until after the concrete has set.

152.6.6 The proportion of Portland cement in the concrete mixture for the

casings shall not be less than 6 sacks per cubic yard of concrete. The concrete aggregate shall be so graded and proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the resulting casing shall be of sufficient strength to resist the stresses resulting from handling and driving without cracking or other damage which would impair its strength or durability.

152.6.7 Following removal from the molds, the finished casings shall be cured for such period of time as may be necessary to produce a strength satisfactory for handling and driving. Curing may be any of the following methods:

152.6.7.1 Continuous spraying with water for at least 72 hours.

152.6.7.2 Covering with heavy burlap or other suitable material which is kept saturated with water for at least 72 hours.

152.6.7.3 Steam Curing--The manufacturer shall provide adequate facilities for curing the piles including a suitable enclosure. Humidity in the enclosure shall be provided to keep the surfaces of the piles moist at all times and the temperature shall be maintained continuously between 120 degrees F and 170 degrees F. Piles shall be cured for not less than 30 hours and for a longer time when so directed by the ENGINEER.

152.7 MEASUREMENT AND PAYMENT

Measurement shall be by the linear foot in place to the specified cut-off point. Payment shall be made at the unit price per linear foot.

SECTION 157

PAINT

157.1 GENERAL

This work shall consist of furnishing paint and other materials, cleaning the surfaces to be painted, and applying the paint in substantial compliance with the specifications and as shown on the plans or directed by the ENGINEER.

157.2 REFERENCES

157.2.1 AASHTO

M 67	M 70
M 68	M 72
M 69	

157.2.2 Federal Specifications TT-E-496

157.3 MATERIALS

157.3.1 The various types of paint and other materials shall be furnished in accordance with the following specifications:

157.3.1.1 Unless otherwise provided, red lead shall conform to the provisions of AASHTO M 72, Type I.

157.3.1.2 Aluminum paint shall conform to the provisions of AASHTO M 69, Type I.

157.3.1.3 Foliage green bridge paint shall conform to the provisions of AASHTO M 67, Type II.

157.3.1.4 White paint shall conform to the provisions of AASHTO M 70, Type II.

157.3.1.5 Black bridge paint shall conform to the provisions of AASHTO M 68.

157.3.1.6 Black paint shall conform to the provisions of FSS TT-E-496, Type II.

157.3.1.7 Graphite shall be natural or synthetic. Graphite shall be free from grit, dirt, or other deleterious substances. Natural graphite shall contain not less than 65 percent carbon. The other ingredients shall be silica, iron, and aluminum. Not less than 97 percent of the graphite material shall pass the No. 325 sieve. Flake graphite will not be accepted.

157.3.2 The manufacturer shall submit to the ENGINEER the required number of certified copies of the paint analysis, prior to delivery of such paint. When required, the manufacturer shall submit

samples of paint in the amounts required by the ENGINEER prior to delivery of such paint.

157.4 CONSTRUCTION REQUIREMENTS

157.4.1 All surfaces to be painted shall be clean and dry before paint is applied. Paint shall be applied only when the atmospheric temperature is above 50 degrees F. When paint is applied in cold or damp weather, adequate heated enclosures shall be provided and maintained until the paint is dry.

157.4.2 All paint shall be thoroughly mixed before and during application with approved mechanical mixers. Thinner shall not be added unless approved by the ENGINEER. The amount of thinner to be added shall not exceed 5 percent by volume. For minor structural steel items, red lead paint for field applications by spraying may be thinned with not more than one part of mineral spirits to 8 parts of paint, as packaged, by volume.

157.4.3 Shop and field paint may be applied by brush, roller, or spray. Paint spraying equipment for field painting shall be approved by the ENGINEER prior to use. Each coat of paint shall be applied in a continuous film of uniform thickness, free from pinholes, and shall be thoroughly dry before the next coat of paint is applied. The shop coat shall have a minimum dry film thickness of 1.5 mils, and each field coat shall have a minimum dry film thickness of 1.0 mils. Defective areas shall be repainted and permitted to dry before the next coat of paint is applied.

157.4.4 When requested by the CONTRACTOR and after shop inspection, steel work shall be given a shop coat of paint. Prior to applying the paint, the surfaces shall be cleaned of loose rust, loose mill scale, dirt, grease, and other deleterious material by sand blasting or other approved methods, without damage to the surface of the steel. After the shop coat has been applied and prior to shipment, areas that have been damaged or that are defective shall be cleaned and repainted.

157.4.5 Contact surfaces which are to be riveted, welded, or bolted with high strength bolts, in the shop or in the field, and surfaces that are to be embedded in concrete shall not be painted.

Surfaces that will be inaccessible after fabrication or field erection shall be painted prior to erection.

157.4.6 After erection, rust, dirt, grease, and other deleterious material shall be removed from the steel members as directed by the ENGINEER. The heads of rivets and bolts, nuts, field welds, edges of contact surfaces, and all surfaces from which the shop coat was omitted shall be thoroughly cleaned and painted with one coat of the same type of paint as the shop coat. Field painting shall consist of the type of paint and the number of coats as specified. Where successive paint coats are of the same color, the initial coat shall be tinted slightly to permit distinction between the coverage of each coat. The final coat shall not be tinted.

157.4.7 Wood surfaces shall be painted as specified.

157.4.8 All structural steel shall receive a prime coat of red lead paint and two field coats of aluminum paint, conforming with the requirements of Section 157.3. Red lead paint may be applied either in the shop or in the field. Red lead paint conforming with the requirements of AASHTO M72, Type III or Type IV, may be used for the prime coat, provided the steel is thoroughly cleaned by sandblasting immediately prior to application of the paint. Structural steel contact surfaces, including surfaces to be embedded in concrete, shall not be painted. Surfaces of steel railing posts to be in contact with concrete and post shims shall receive the three required coats of paint before erection. No increase in the computed pay weight of steel will be allowed for paint.

157.5 TRAFFIC PAINT

Traffic paint shall conform to the requirements of the New Mexico State Highway Department.

157.6 MEASUREMENT AND PAYMENT

Paint and the application thereof shall be considered a subsidiary item and no separate measurement or payment will be made.

SECTION 160

STEEL CASTINGS

160.1 GENERAL:

160.1.1 Steel castings shall be as shown on the plans and specified herein, including rockers and rocker plates. The castings shall be true to pattern in form and dimension and free from pouring faults, sponginess, cracks, blowholes, or defects that would affect the service value of the casting.

160.1.2 Blowholes shall not have a depth sufficient to affect injuriously the strength of the castings. Minor defects which do not impair the strength of a casting may, with the approval of the ENGINEER, be welded by an approved process. Defects shall be cleaned out to solid metal by chipping or other satisfactory means and after welding, the castings shall be annealed, if so required by the ENGINEER. Castings which have been welded without the permission of the ENGINEER shall be rejected.

160.2 REFERENCES:

160.2.1 ASTM
A 27 E 10
A 148 E 30

160.3 FINISH:

160.3.1 The dimensions of the finished castings shall be not less than the specified dimensions. Castings shall be not more than 7 1/2 percent overweight.

160.3.2 The bearing surfaces of rockers and rocker plates shall be machined accurately to the dimensions shown on the plans. The final surface shall be produced by a finishing cut. They shall be straight, smooth, and free from flows.

160.3.3 Chemical analysis shall be performed in accordance with ASTM E 30.

160.4 TEST SPECIMENS:

160.4.1 Test coupons from which tension test pieces are prepared shall be attached to the castings where practicable. If, in the opinion of the manufacturer, the design of the casting is such that test coupons should not be attached thereon, the test coupons shall be cast attached to separate cast blocks. Sufficient coupons shall be cast to represent each lot with additional specimens for use in case retests should be required. A lot shall be considered as

all castings in a melt which have constituted part or all of a heat-treatment charge.

160.4.2 Coupons shall remain attached until after the annealing process has been completed. Coupons may be identified by a representative of the ENGINEER. Where test coupons are cast separately from the castings, a representative of the ENGINEER may be present at the time of pouring to identify both coupons and castings. Coupons cast separately from the castings shall not be detached from the block to which they are fastened until identified.

160.4.3 The test coupons shall be of such size that test specimens can be machined to dimensions as specified in the ASTM procedure referred to herein. Where a specimen or machining appears faulty and is intended as a true sample of the lot of casting to which it belongs, the representative of the ENGINEER may substitute another coupon of the lot in question. Test specimens shall be furnished and machined at the CONTRACTOR's expense.

160.5 RETESTS: If the results of the physical test for any lot do not conform to the requirements specified, the manufacturer may reheat-treat such lot. Representative coupons shall be reheat-treated with the lot to serve as retest specimens.

160.6 HIGH-STRENGTH STEEL CASTINGS FOR STRUCTURAL PURPOSES: Castings shall conform to ASTM A 148, Grade 80-50 except that the steel shall contain not less than 0.60 percent of manganese and not less than 0.20 percent of silicon.

160.7 MILD-TO-MEDIUM STRENGTH CARBON-STEEL CASTINGS FOR GENERAL APPLICATION: Casting shall conform to ASTM A 27, Grade 65-35. The metal shall have a minimum Brinell hardness number of 130, when tested in accordance with ASTM Test E-10.

160.8 MEASUREMENT AND PAYMENT

Payment shall be per unit price as specified in the Bid Proposal or may be included in the major construction item unit cost.

SECTION 161

GRAY IRON CASTINGS

161.1 GENERAL

161.1.1 Gray iron castings shall be as shown on the construction plans or the Standard Detail Drawings, and shall be as specified herein. The castings may include: rockers, rocker plate bearings, bearing plates, manhole frames and covers, water valve frames and covers, railings, railing posts, wheel guards, gratings, etc.

161.1.2 The castings shall be true to patterns in form and dimension and free from pouring faults, sponginess, cracks, blowholes, or other defects in locations affecting their strength and value for the service intended. Castings shall be filleted at angles, and risers shall be sharp and true.

161.2 REFERENCES

161.2.1 American Society for Testing and Materials (Latest Editions) (ASTM)

A-48 Standard Specification for Gray Iron Castings

A-438 Standard Test Method for Transverse Testing of Gray Cast Iron

161.3 TEST SPECIMENS

161.3.1 The number of tension test specimens and their machined dimensions shall be as specified in ASTM A-48.

161.3.2 Depending on the configuration and use of the castings, the ENGINEER may specify that transverse tests of the castings material shall be made in accordance with ASTM A-438. These tests shall be made in addition to the tensile tests.

161.3.3 The manufacturer shall furnish a notarized certificate of compliance which states that the casting material meets or exceeds the requirements for the specified class of material. Test results shall be included with the certificate. The CONTRACTOR shall forward the manufacturer's certificate of compliance and test results to the

ENGINEER for each project on which the casting are installed. The CONTRACTOR shall also furnish the ENGINEER with a copy of the manufacturer's shop drawing at the time the certificate of compliance is submitted.

161.4 STORM DRAIN MANHOLE FRAMES AND COVERS

161.4.1 Castings shall conform to ASTM A-48, Class 30B.

161.4.2 The frame and cover dimensions shall conform to the dimensions shown on the Standard Detail Drawing.

161.4.3 The bearing surfaces of the frames and covers shall be machined or ground to provide a uniform, flat, non-rocking seat for the cover on the frame.

161.4.4 The contact sides of the frame and cover shall be tapered as shown on the Standard Detail Drawing.

161.4.5 Manhole frame shall weigh 145 pounds with a plus or minus tolerance of five percent, and the cover shall weigh 180 pounds with a plus or minus tolerance of five percent.

161.4.6 The words "STORM" and "CITY OF ALBUQUERQUE" shall be cast on the manhole cover to indicate the respective system and the name of the city. The letter size shall be 1 inch in height. The words shall be placed as shown in the Standard Detail Drawing. In addition, the name of the foundry shall be cast on the top of the cover, either in the center or within one of the inner concentric circles.

161.5 SANITARY SEWER AND WATER MANHOLE FRAMES AND COVERS (excluding 24-inch covers)

161.5.1 Castings shall conform to ASTM A-48, Class 30B.

161.5.2 The frame and cover dimensions shall conform to the dimensions shown on the Standard Detail Drawing.

SECTION 161

GRAY IRON CASTINGS

161.5.3 The bearing surfaces of the frames and covers shall be machined or ground to provide a uniform, flat, non-rocking seat for the cover on the frame.

161.5.4 The contact sides of the frame and cover shall be tapered as shown on the Standard Detail Drawing.

161.5.5 The weight of the manhole frame and cover shall conform to the weights as shown on the Standard Detail Drawing.

161.5.6 The words "SANITARY" or "WATER" shall be cast on the manhole cover to indicate the respective system. The words shall be placed as shown in the Standard Detail Drawings.

161.6 WATER VALVE, FIRE LINE, AND VACUUM SEWER VALVE FRAME AND COVER

161.6.1 Castings shall conform to ASTM A-48, Class 30B.

161.6.2 The frame and cover dimensions shall conform to the dimensions shown on the Standard Detail Drawing.

161.6.3 The bearing surfaces of the frames and covers shall be machined or ground to provide a uniform, flat, non-rocking seat for the cover on the frame.

161.6.4 The words "WATER", "FIRE", or "SEWER" shall be cast on the ring and cover to indicate the respective system. The letters "USA" and the manufacturer's logo shall be cast on the ring and cover as shown on the Standard Detail Drawing.

161.7 RAILINGS, RAILING POSTS, AND WHEEL GUARDS

161.7.1 Castings shall conform to ASTM A-48, Class 40B.

161.8 ROCKERS, ROCKER PLATE BEARINGS, AND BEARING PLATES FOR BRIDGES

161.8.1 Castings shall conform to ASTM A-48, Class 50B.

161.8.2 Castings shall be machined and finished as specified on the plans. Tool marks on sliding contact surfaces shall run in the direction of plate movement, and in case of rocker plate bearings marks shall be perpendicular to the rocker movement.

161.9 UNCLASSIFIED CASTINGS

161.9.1 All castings not specifically classified, shall conform to the minimum requirements for ASTM A-48, Class 30.

161.10 COATINGS

161.10.1 Manhole frames and covers, and other castings will show bare metal. If specifically required, the castings shall be painted with or dipped in commercial quality asphaltum paint.

161.11 ORIGIN OF MANUFACTURE

161.11.1 To ensure that the specified quality of castings will be guaranteed, only castings manufactured in the United States of America will be acceptable.

161.12 MEASUREMENT AND PAYMENT

161.12.1 Measurement and payment shall be per unit price per defined unit in the bid proposal, or the cost of the castings may be included in major construction item unit costs, such as manhole frame and cover may be included in the cost of the manhole.

SECTION 162

ALUMINUM CASTINGS

162.1 GENERAL

Aluminum castings will be used for water valve extension collar and insert, and may be used for other items as per construction requirements.

162.2 REFERENCES

162.2.1 ASTM B 108

162.3 MATERIAL

162.3.1 The casting shall be true to pattern in form and dimension and shall be free from pouring faults, cracks, blowholes, or other defects in locations affecting the units strength and value of service.

162.3.2 Unless otherwise approved by the ENGINEER, the units shall be cast in permanent molds, using aluminum alloy No. 356, meeting the chemical and tensile strength requirements, as specified in ASTM B 108.

162.3.3 The surfaces, requiring grinding or machining, shall be noted on the drawings.

162.4 WATER VALVE EXTENSION COLLAR AND INSERT

The aluminum water valve extension collar and insert shall be cast and finished in accordance with Standard Detail Drawing.

162.5 OTHER ALUMINUM CASTINGS

For other aluminum casting configurations or uses, detailed or shop drawings shall identify the required dimensions, finishes, and aluminum alloy number.

162.6 MEASUREMENT AND PAYMENT

Measurement and payment shall be the unit price per unit, as specified in the Bid Proposal or may be included in the major construction item's unit cost.

SECTION 163

DUCTILE IRON CASTINGS

163.1 GENERAL:

Ductile iron castings will be used for water meter covers and lids and 24-inch water and 24-inch sanitary sewer manhole covers.

163.2 REFERENCES

163.2.1 American Society for Testing and Materials (Latest Editions) (ASTM)

A-536 Specifications for Ductile Iron Castings

163.2.2 American Association of State Highway and Transportation Officials

M 306 Specification for Drainage, Sewer, Utility, and Related Castings

163.3 MATERIALS

163.3.1 The casting shall be true to pattern in form and dimension and shall be free from pouring faults, cracks, blowholes, or other defects in locations affecting the unit's strength and value of service.

163.3.2 Unless otherwise approved by the ENGINEER, the units shall be cast in sand molds, using ductile iron, meeting the chemical and tensile strength requirements, as specified in ASTM A536, Grade 70-50-05.

163.3.3 The surfaces requiring grinding or machining, shall be noted on the drawings.

163.4 TESTING

163.4.1 Separately cast test bars shall be tested and conform to specified tensile requirements including tensile strength, yield strength, and elongation as per ASTM A536.

163.4.2 Castings shall pass proof load testing as specified in AASHTO Std. M 306 for heavy duty, H-20, traffic loads.

163.4.3 The manufacturer shall furnish a certificate of compliance which states that the casting material meets or exceeds the requirements for the specified material. Test results shall be included with the certificate. The CONTRACTOR shall forward the manufacturer's certificate of compliance and test results to the ENGINEER for each project on which the castings are installed. The CONTRACTOR shall also furnish the ENGINEER with a copy of the manufacturer's shop drawing at the time the certificate of compliance is submitted.

163.5 METER COVER AND LID

163.5.1 The meter cover and lid dimensions shall conform to the dimensions shown on the Standard Detail Drawing.

163.5.2 The bearing surface of the lid and cover shall be machined or ground to provide a uniform, flat, non-rocking seat for the lid on the cover.

163.5.3 The words "WATER AUTHORITY" shall be cast on the lid.

163.6 24-INCH MANHOLE COVERS

163.6.1 The cover dimensions shall conform to the dimensions shown on the Standard Detail Drawing.

163.6.2 The bearing surfaces of the frames and covers shall be machined or ground to provide a uniform, flat, non-rocking seat for the cover on the frame.

163.6.3 The contact sides of the frame and cover shall be tapered as shown on the Standard Detail Drawing.

163.6.4 The weight of the manhole frame and cover shall conform to the weights as shown on the Standard Detail Drawing.

163.6.5 The words "SANITARY" or "WATER" shall be cast on the manhole cover to indicate the respective system. The name of the foundry shall be cast on the cover. The words "ALBUQUERQUE BERNALILLO COUNTY WATER UTILITY AUTHORITY" shall be cast on the 24" covers. The words shall be placed as shown in the Standard Detail Drawings.

163.7 COATINGS

163.7.1 Manhole covers and water meter covers and lids will show bare metal. If specifically required, the castings shall be painted with or dipped in commercial quality asphaltum paint or other approved bituminous seal coat.

163.8 ORIGIN OF MANUFACTURE

163.8.1 To ensure that the specified quality of castings will be guaranteed, only castings manufactured in the United States of America will be acceptable.

163.9 MEASUREMENT AND PAYMENT

163.9.1 Measurement and payment shall be per unit price per defined unit in the bid proposal, or the cost of the castings may be included in major construction item unit cost such as meter box rehabilitation, installation, or relocation.

SECTION 170
ELECTRONIC MARKER DEVICES

170.1 GENERAL: Electronic location markers shall consist of devices having a passive inductive device capable of reflecting a specifically designated impulse frequency, unique to the utility being installed. Devices shall be color-coded in accordance with the American Public Works Association's Utility Location and Coordinating Council Standards. Electronic Marker Devices (EMDs) shall be from a listed manufacturer on the current Water Authority Approved Product List

170.2 REFERENCES

170.3 INSTALLATION: Marker devices shall be installed approximately 6-inches over the point to be located, and a minimum of 6-inches from any metal object. However, depth of burial shall not be less than 2-1/2-feet nor more than 6-feet. Devices shall be hand backfilled to 1-foot above the device to prevent movement or damage.

170.4 PLACEMENT: Electronic Marker Devices shall be installed at the following locations:

170.4.1 SANITARY SEWER

170.4.1.1 At all manholes, one foot upstream of the manhole over the centerline of the main line.

170.4.1.2 At temporary dead ends of lines.

170.4.1.3 At the property line for all service laterals, including service stubs from vacuum pits.

170.4.1.4 At the centerline of the gravity main line over all taps, risers, or wyes.

170.4.1.5 At all plugged tees.

170.4.1.6 At upper bend on vacuum sewer lifts.

170.4.1.7 At wye for branch line connection to vacuum sewer main.

170.4.1.8 At valves on vacuum sewer mains, one foot north or west of the valve over the line.

170.4.1.9 On Sanitary Sewer Force Mains:

170.4.1.9.1 At valves, one foot north or west of the valve over the main line.

170.4.1.9.2 At bends, 22 1/2-degrees and larger.

170.4.1.9.3 At capped or plugged ends.

170.4.1.9.4 At tees over the main line.

170.4.1.9.5 For single services, over the main line at the service tap.

170.4.2 WATER LINES:

170.4.2.1 At valves, one foot north or west of the valve over the main line.

170.4.2.2 At flanged outlets on concrete cylinder pipes.

170.4.2.3 At bends, 22 1/2-degrees and larger.

170.4.2.4 At capped or plugged ends.

170.4.2.5 At tees over the main line.

170.4.2.6 For single services, over the main line at the service tap.

170.4.2.7 For double services, over the main line halfway between the service taps.

170.5 CERTIFICATION

170.5.1 The CONTRACTOR shall certify in writing that the Electronic Marker Device is in place, prior to paving over any of the above locations. Electronic Marker Devices that are found to be missing shall be installed at the CONTRACTOR's expense.

170.6 MEASUREMENT AND PAYMENT: No separate measurement or payment will be made for Electronic Marker Devices.

SECTION 200

EARTHWORK

200.1 GENERAL

This section contains the requirements for earthwork activities associated within rights-of-way easements, or open areas. These activities include: clearing and grubbing, roadway excavation, fill construction, borrow excavation, and open area land leveling. Earthwork requirements for channels, dikes and dams are contained in Section 600, Channel Construction.

200.2 CONTENTS

<u>Section No.</u>	<u>Title</u>
201	Clearing and Grubbing
202	Roadway Excavation
204	Fill Construction
205	Borrow Excavation
207	Lean Fill Construction
210	Open Area Land Leveling

SECTION 201

CLEARING AND GRUBBING

201.1 GENERAL

This work shall consist of removing natural and man-made objectionable material from the right-of-way, construction areas, road approaches, material and borrow sites, areas through which ditches and channels are to be excavated, and such other areas as may be shown on the plans. Clearing and grubbing shall be performed in advance of grading operations except that in cuts over 3 feet in depth, grubbing may be done simultaneously with excavation, provided stumps, roots, embedded wood, foundations and slabs are removed as specified. Clearing and grubbing shall be in accordance with the requirements herein specified, such as erosion control requirements. Demolition of structures, other than foundations or slabs, shall be as shown on the plans.

201.2 REFERENCES

201.3 PRESERVATION OF PROPERTY

Existing improvements, adjacent property, utility and other facilities, and trees and plants not to be removed shall be protected from injury or damage resulting from the CONTRACTOR's operations. Only trees and plants designated or marked for removal by the ENGINEER shall be removed.

201.4 CONSTRUCTION METHODS

201.4.1 The natural ground surface shall be cleared of vegetable growth, such as trees, tree stumps, logs, roots or downed trees, brush, grass, weeds, and surface boulders, as well as fences, walls, rubbish, foundations and slabs.

201.4.2 Unless otherwise shown on the plans, the entire area of the project within the limit lines specified below shall be cleared and grubbed. No payment will be made to the CONTRACTOR for clearing and grubbing outside these limits, unless such work is authorized by the ENGINEER.

201.5 LIMIT LINES: Except when limit lines for clearing and grubbing are shown on the plans or are staked by the ENGINEER, clearing and grubbing shall extend only within reasonable limits of the work area.

201.6 REMOVAL OF TREES AND TREE BRANCHES

201.6.1 Trees shall be removed in such a manner as not to injure standing trees,

plants, and improvements which are to remain. Tree branches extending over a roadway and which clear finish grade by 12 feet or less shall be cut off close to the boles in a workmanlike manner.

201.6.2 Trees requiring trimming to facilitate normal construction operations shall be trimmed by a tree surgeon.

201.7 REMOVAL AND DISPOSAL OF DEBRIS

Debris to be removed shall be disposed of outside the right-of-way at a location satisfactory to the ENGINEER, except when burning of combustible debris is permitted. The area to be graded and adjacent areas shall be left with a neat and finished appearance. No accumulation of flammable material shall remain on or adjacent to the property line. In case burning precedes construction operations, the piles may be placed in the center of the area; otherwise, the piles shall be placed in the most convenient location at the side of the area and beyond slope lines where they may be burned without damage to surrounding forest cover or adjacent property. Burning shall be done in conformance with local regulations and at such times and in such manner as to prevent the fire from spreading to areas adjoining the construction site. In areas where burning is prohibited by local regulations, all removed material shall be disposed of outside the construction area.

201.8 REMOVAL AND DISPOSAL OF SALVAGEABLE ITEMS

Items and materials of salvage value as shown on the plans or as determined by the ENGINEER, unless incorporated in the new work, shall remain the property of the OWNER and shall be delivered to approved storage areas as directed by the ENGINEER. Such items and materials shall be carefully removed and delivered in such a manner as to permit re-use.

201.9 MEASUREMENT AND PAYMENT

201.9.1 CLEARING AND GRUBBING:

201.9.1.1 When the proposal includes an item for clearing and grubbing, the quantity for measurement shall be as indicated in the Bid Proposal.

201.9.1.2 The unit price per acre paid for clearing and grubbing shall include full compensation for furnishing all labor, materials, tools, equipment, and

incidentals and for doing all the work involved in clearing and grubbing as shown on the plans, as provided in these specifications and as directed by the ENGINEER, including the removal and disposal of resulting material.

201.9.1.3 When the Bid Proposal does not include a pay item for clearing and grubbing as above specified and unless otherwise specified in the Supplementary Specifications, full compensation for any necessary clearing and grubbing required to perform construction operations specified shall be considered as included in the price paid for other items of work and no additional compensation will be allowed therefor.

201.9.2 REMOVAL AND DISPOSAL OF TREES:
If the Bid Proposal includes separate estimates of quantities for the removal of trees, the trees shall be classified by size as follows:

201.9.2.1 Trees less than 12 inches in circumference at 3 feet above the original ground surface shall be considered as included in the price for clearing and grubbing or excavation, and no additional compensation will be allowed therefor.

201.9.2.2 Trees between 12 and 30 inches in circumference shall be measured as a unit price for each tree in the item provided in the Bid Proposal for trees of this dimension.

201.9.2.3 Trees more than 30 inches in circumference shall be measured as a unit price for each tree in the item provided in the Bid Proposal for trees of this dimension.

SECTION 202
ROADWAY EXCAVATION

202.1 GENERAL

Roadway excavation shall consist of excavation involved in the grading and construction of roadways, except structure excavation, trench excavation, and any other excavation separately designated.

202.2 REFERENCES

202.2.1 This publication Section 204

202.3 UNSUITABLE MATERIAL

202.3.1 Unsuitable materials include all material that contains debris, roots, organic matter, stones or boulders too large to be used in the intended construction, or other materials that are determined by the ENGINEER to be unsuitable. Otherwise suitable materials which are unsuitable due to excess moisture content will not be classified as unsuitable material unless it cannot be dried by manipulation, aeration or blending with other materials satisfactorily as determined by the ENGINEER.

202.3.2 Material that is unsuitable for the intended use shall be excavated and removed from the site or otherwise disposed of as approved by the ENGINEER.

202.3.3 The removal and disposal of such unsuitable material will be paid for as roadway excavation for the quantities involved.

202.4 ROCK EXCAVATION

202.4.1 Rock excavation shall consist of igneous, metamorphic and sedimentary rock, naturally in place, which cannot be excavated without blasting or the use of rippers, and all boulders or other detached stones having a volume of one (1) cubic yard or more, as determined by physical measurements or visually by the ENGINEER. Where any portion of the excavation contains strata classified as Rock Excavation and the various strata are parted with strips or strata not classified as Rock Excavation which constitute twenty-five (25) percent or less of the total thickness of the rock plus non-rock layers, the entire volume of the combined layers shall be paid as Rock Excavation. Removal of Surface boulders in excess of 1 cubic yard in volume shall be paid for under Clearing and Grubbing, unless specifically identified as Rock Excavation.

202.4.2 OVERSHOOTING: Excessive blasting will not be permitted. Material outside the authorized cross section which may be shattered or loosened because of blasting shall be removed at the CONTRACTOR'S expense. The CONTRACTOR shall discontinue any method of blasting which leads to overshooting and is dangerous to the public or destructive to property or to natural features.

202.5 SLIDES AND SLIPOUTS

202.5.1 Material outside of planned roadway or ditch slopes which in the opinion of the ENGINEER is unstable and constitutes potential slides, material which has intruded into the roadway channel or ditch, and material which has escaped from new or old embankments shall be excavated and removed. The material shall be excavated to designated lines or slopes either by benching or in such a manner as approved by the ENGINEER. Such material shall be used in the construction of the embankments or disposed of as approved by the ENGINEER.

202.5.2 The removal and disposal of slide and slipout material as above specified not resulting from overshooting as defined in Subsection 202.4 will be paid for at the contract price for excavation for the quantities involved. However, if due to the character of the work the removal and disposal of such material is not properly compensable at the contract price for roadway excavation, the work may be paid for as extra work provided the CONTRACTOR requests in writing such payment prior to performing the work. Authorization for the work will be by change order.

202.5.3 Only those quantities of slide or slipout material which are actually removed as ordered by the ENGINEER will be approved for payment.

202.5.4 The above provisions shall not be so construed as to relieve the CONTRACTOR from his obligation to maintain all slopes true and smooth.

202.6 SLOPES

202.6.1 Excavation slopes shall be finished in conformance with the lines and grades shown on the plans. Debris and loose material shall be removed. When completed, the average plane of the

slopes shall conform to the slopes indicated on the plans and no point on the completed slopes shall vary from the designated plane by more than 6 inches measured at right angles to the slope. Except where excavation is in rock no point shall vary more than 2 feet from the designated plane of the slope. In no case shall any portion of the slope encroach on the construction area.

202.6.2 Tops of excavation slopes and ends of excavations shall be rounded as shown on the plans or as directed by the ENGINEER, and these quantities will not be included in the payment for excavation. This work will be considered as a part of finishing slopes, and no additional compensation will be allowed therefor.

202.6.3 Embankment slopes shall be finished in conformance with lines and grades shown on the plans. When completed, the average plane of embankment slopes shall conform to slopes indicated on the plans, and no point on completed slopes shall vary from the designated plane by more than 6 inches measured at right angles to the slope.

202.7 SURPLUS MATERIAL

202.7.1 Unless otherwise shown on the plans, specified in the Supplementary Specifications, or approved by the ENGINEER, no surplus excavated material shall be disposed of within the construction area. The CONTRACTOR shall make all arrangements for disposal of the material at offsite locations as may be approved by the ENGINEER and shall, upon request, file with the ENGINEER the written consent of the owner of the property upon which he intends to dispose of such material.

202.7.2 If the quantity of surplus material is shown in the plans or specified in the Supplementary Specifications, the quantity shown or specified is approximate only. The CONTRACTOR shall satisfy himself that there is sufficient material available for the completion of the embankments before disposing of any indicated surplus material inside or outside the area. Any shortage of material caused by premature disposal of surplus material by the CONTRACTOR shall be replaced by him, and no compensation will be allowed the CONTRACTOR for such replacement.

202.8 SELECT MATERIAL

202.8.1 Select material shall be considered as material which can be

compacted to the densities specified in Section 204.

202.8.2 Select material encountered in excavation within the right-of-way shall be used for finishing the top portion of the roadbed or for constructing shoulders or used for structure backfill or used as shown on the plans or as directed by the ENGINEER.

202.8.3 Where practicable, select material shall be hauled directly from excavation to its final position in the construction prism and compacted in place, and such work will be paid for at the contract price for excavation.

202.8.4 Select material shall remain in place until it can be placed in final position as provided above, except, if ordered in writing by the ENGINEER, select material may be excavated and stockpiled at locations designated by him and later placed in final position in the construction prism.

202.8.5 Excavating select material and stockpiling, if required, will be paid for at the contract price for roadway excavation. Removing the select material from stockpiles and placing it in final position in the roadway prism will again be paid for at the contract price for roadway excavation, except that the quantities to be paid for will be determined from measurements of the material in the stockpiles prior to removal. No payment for stockpiling of select material will be made unless such stockpiling is ordered by the ENGINEER.

202.8.6 Topsoil placed along the tops of slopes in connection with erosion control work will not be considered as stockpiled material when determining pay quantities of earthwork.

202.9 MEASUREMENT AND PAYMENT

202.9.1 All earthwork shall be measured by the cubic yard in place at the time of excavation. The following earthwork operations will be measured as excavation for the quantities of material involved.

202.9.1.1 Excavating the construction area including public and private road approaches, connections, and driveways; excavating unsuitable material when shown on the plans or specified in the Supplementary Specifications; excavating slides and slipouts not resulting from over-shooting; excavating surplus material; excavating selected material and topsoil from within the limits of project and

removing such materials from stockpiles when stockpiling is ordered; and excavating local borrow.

202.9.2 Excavation beyond the authorized cross section will not be included in measurement or payment.

202.9.3 Rock excavation will be paid by the cubic yard in place, prior to start of construction and measured to limits of excavation specified on plans. No compensation will be made to the CONTRACTOR for excess rock excavation due to overshooting, nor for the cost of backfilling voids or depressions resulting from overshooting.

SECTION 204

FILL CONSTRUCTION

204.1 GENERAL

Fill construction shall consist of constructing roadway embankments (including the preparation of areas upon which they are to be placed), the placing and compacting of approved material within areas where unsuitable material has been removed; and the placing and compacting of suitable materials in holes, pits and other depressions.

204.2 REFERENCES

- 204.2.1 ASTM
D 1557
D 4254

204.3 PLACING

204.3.1 Unless otherwise specified, the upper 6 inches of the original ground area upon which fills are to be constructed shall be compacted to a density of not less than 90 percent of maximum density as determined by ASTM D 1557, or in soils containing less than 5 percent passing the #200 sieve, a minimum relative density of 70 percent as determined by ASTM D 4254.

204.3.2 Rocks, broken concrete, or other solid materials which are larger than 4 inches in greatest dimension shall not be placed in fill areas where piles are to be placed or driven.

204.3.3 When fill is to be made and compacted on hillsides or where new fill is to be compacted against existing fill or where embankment is built 1/2 width at a time, the slopes of original hillsides and old or new fills shall be started wherever the vertical cut of the next lower bench intersects the existing ground.

204.3.4 Material thus cut out shall be recompacted along with the new embankment material at the CONTRACTOR's expense, unless the width of the bench required exceeds 4 feet, in which case the excavated material in excess of 4 feet will be measured and paid for as excavation.

204.3.5 Clods or hard lumps of earth of 6 inches in greatest dimension shall be broken up before compacting the material in embankment, except as provided in the following paragraph.

204.3.6 When the fill material includes large rocky material or hard lumps, such

as hardpan or cemented gravel which cannot be broken readily, such material shall be well distributed throughout the fill. Sufficient earth or other fine material shall be placed around the larger material as it is deposited so as to fill the interstices and produce a dense, compact fill. However, such material shall not be placed within 2 feet of the finished grade of the fill.

204.3.7 Embankment construction shall not be performed when material is frozen.

204.4 COMPACTING

204.4.1 Fill shall be constructed in compacted layers of uniform thickness and each layer shall be compacted in accordance with the requirements herein specified with the following exception.

204.4.2 Where fills are to be constructed across low, swampy ground which will not support the weight of hauling equipment, the lower part of the embankment may be constructed by dumping successive loads of suitable material in a uniformly distributed layer of a thickness not greater than that necessary to support the equipment while placing subsequent layers, after which the remainder of the embankment shall be constructed in layers and compacted as specified.

204.4.3 The placing and compacting of approved material within the project (where unsuitable material has been removed, and the filling of holes, pits and other depressions has been accomplished) shall conform to all of the requirements herein specified for compacting fills.

204.4.4 The loose thickness of each layer of fill material before compacting shall not exceed 8 inches, except as provided in the following paragraph for rocky material. The ENGINEER may authorize roadway fill materials to be placed in layers in excess of 8 inches thickness if the CONTRACTOR can demonstrate that the required compaction can be achieved for the full depth of the lift. However, in no case shall the loose layer exceed 24 inches. Each layer shall be compacted in accordance with the following requirements to a density of not less than 90 percent of maximum density, as determined by ASTM D 1557, or in soils containing less than 5 percent passing the #200 sieve, a minimum relative density of 70 percent as determined by ASTM D-4254. In areas of new or widened roadways and

required appurtenances, the density of the upper 12 inches shall not be less than 95 percent as determined by ASTM D 1557.

204.4.5 When fill material contains by volume over 25 percent of rock larger than 6 inches in greatest dimension, the fill below a plane 3 feet below finished grade may be constructed in layers of a loose thickness before compaction not exceeding the maximum size of rock in the material but not exceeding 3 feet in thickness. When more than 65 percent is retained on the No. 4 sieve, moisture and density control is not required.

204.4.6 The interstices around the rock in each layer shall be filled with earth or other fine material and compacted. Broken portland cement concrete obtained from the project excavation will be permitted in the fill with the following limitations.

204.4.6.1 The maximum dimensions of any piece used shall be 6 inches.

204.4.6.2 Pieces larger than 4 inches shall not be placed within 12 inches of any structure.

204.4.6.3 Pieces larger than 2 1/2 inches shall not be placed within 12 inches of the subgrade for paving.

204.4.6.4 "Nesting" of pieces will not be permitted.

204.4.7 At locations where it would be impractical to use mobile power compacting equipment, fill layers shall be compacted to the specified requirements, by any approved method that will obtain the specified relative compaction.

204.4.8 At the time of compaction the moisture content of fill material shall be optimum plus or minus 2 percent. Fill material which contains excessive moisture shall not be compacted until the material is dry enough to obtain the required relative compaction. Full compensation for any additional work involved in drying fill material to the required moisture content shall be considered as included in the unit price per Bid Proposal and no additional compensation will be allowed. Fills shall be maintained to the grade and cross sections shown on the plans until the acceptance of the contract.

204.5 MEASUREMENT AND PAYMENT

Fill construction shall include excavation, placement, compaction and all

related work, and shall be measured in place after compaction. Payment will be made on the unit price per cubic yard for compacted fill unless otherwise noted on the Bid Proposal.

SECTION 205

BORROW MATERIAL

205.1 GENERAL

Borrow material shall consist of naturally occurring granular material, such as: pit-run gravel, sand, decomposed granite, or slide rock; and shall be free from wood, vegetation, or other deleterious matter, but shall contain sufficient sand or filler to permit proper compaction of the subgrade. The maximum size of this material shall not be greater than $\frac{2}{3}$ the compacted thickness of the course placed in the subgrade. The CONTRACTOR shall notify the ENGINEER sufficiently in advance of opening any material sites so that cross section elevations and measurements of the ground surface after stripping may be taken and sufficient time for testing the material will be allowed.

205.2 REFERENCES

205.2.1 This publication:

Section 202
Section 204

205.3 PLACING AND COMPACTING

Borrow shall be placed and compacted as specified in Section 204. The CONTRACTOR shall satisfy himself that there is sufficient space available in fill locations for placing any excavated material before placing borrow. Any excess excavation which develops as a result of placing imported borrow in advance of completing excavations shall be disposed of at the CONTRACTOR's expense in accordance with the provisions in Subsection 202.7 and a corresponding reduction in the quantity of borrow to be paid for will be made, for which the CONTRACTOR will have no claim for compensation. Borrow pits shall be excavated to regular lines to permit accurate measurement; depth of excavation throughout the areas of borrow pits shall be as uniform as practicable and the side slope shall be dressed to such slope as may be directed by the ENGINEER, leaving the borrow pit area in a clean and safe condition.

205.4 MEASUREMENT AND PAYMENT

205.4.1 Quantities of borrow outside of physical limits of the work will be measured as per cubic yard. Material excavated at the borrow site and not used on the work will be deducted from the computed quantities and no payment will be made therefor.

205.4.2 If borrow is acquired from a commercial pit, alternate methods of determining cubic yardage of borrow material delivered to the site may be used. Such alternate method shall be agreed to and documented by the ENGINEER and CONTRACTOR prior to the start of any borrow operation.

SECTION 207
LEAN FILL CONSTRUCTION

207.1 GENERAL

LEAN FILL CONSTRUCTION shall consist of filling shallow excavations, pipe zones in deep excavations and as authorized by the ENGINEER, with LEAN FILL, a flowable mixture of Portland cement, aggregates, admixtures and water. It shall be identified by a unique design mix number as defined by the supplier. A design mix, upon request by a supplier, may be authorized by the Public Works Department Construction division for use on City and City related projects for a period of 14 months, from the date of sampling of reference aggregates used in the job mix formula. A design mix shall not be used on a project without written authorization of the ENGINEER.

207.2 REFERENCES

- 207.2.1 American Society for Testing and Materials (Latest Edition) (ASTM).
- ASTM C31 Practice for Making and Curing Concrete Test Specimens in the Field
- ASTM C33 Specifications for Concrete Aggregates
- ASTM C94 Specifications for Ready-Mixed Concrete
- ASTM C138 Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
- ASTM C143 Test Method for Slump of Portland Cement Concrete
- ASTM C150 Specification for Portland Cement Concrete
- ASTM C172 Method of Sampling of Freshly Mixed Concrete
- ASTM C173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
- ASTM C192 Practice for Making and Curing of Concrete Test Specimens in the Laboratory
- ASTM C231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- ASTM C260 Specification for Air-Entraining Admixtures
- ASTM C558 Test Methods for Moisture Density Relations of Soil-Cement Mixtures
- ASTM C618 Specification for Fly Ash and Raw or Calcined Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
- ASTM C685 Specifications for Concrete Made by Volumetric Batching and Continuous Mixing
- ASTM D1633 Test Method for compressive Strength of Molded Soil-Cement Cylinders
- ASTM D2922 Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM C3017 Standard Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

207.2.2 American Concrete Institute (ACI) (Latest Edition).

ACI 211 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

ACI 340.2R Placing Concrete by Pumping Methods

207.3 PORTLAND CEMENT

207.3.1 Portland cement to be either used or furnished under this specification shall conform to the requirements of ASTM C150. The type of cement shall be either Type I or Type II, "low alkali" (LA) cement.

207.3.2 The CONTRACTOR shall submit certification of compliance signed by the cement manufacturer, identifying the cement Type and source (plant location), stating the Portland cement furnished to the project, and or used in the concrete delivered to the project complies with this specification. If required, certification of the Portland cement used for each day's concrete placement, shall be submitted to the ENGINEER for each type of cement and each design mix used on the project.

207.3.3 Portland cement used in the manufacture of LEAN FILL for a project shall be of the same brand and type for all LEAN FILL batched and delivered to a project under the authorized design mix identification, unless authorized by the ENGINEER.

207.4 AGGREGATES

207.4.1 Aggregates shall be sampled and tested as prescribed in said ASTM specification. The CONTRACTOR shall obtain a certification of compliance in accordance with the requirements of SECTION 13, identifying the aggregates, reporting test results, and stating the aggregates comply with this specification.

207.5 AGGREGATE GRADING

207.5.1 The maximum nominal aggregate size shall be one (1) inch.

207.6 WATER

207.6.1 Water shall conform to the requirements of ASTM C94.

207.7 AIR ENTRAINING ADMIXTURES

207.7.1 Air entraining admixtures shall conform to the requirements of ASTM C260, as authorized by the ENGINEER.

207.8 MINERAL ADMIXTURES

207.8.1 Mineral admixtures shall be fly ash complying with the requirements of Class "F" fly ash as specified in ASTM C618 and Section 101 of this specification.

207.8.2 Mineral admixtures shall be proportioned by weight as required to improve pumpability.

207.9 PROPORTIONING

207.9.1 The CONTRACTOR shall be solely responsible for the LEAN FILL design mix proportions either batched at and/or delivered to the site. A design mix shall be prepared in a laboratory under the direct supervision of a Registered New Mexico Professional Engineer. The testing equipment used in the design/development testing shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certificates of calibration shall be maintained at the laboratory for review by the ENGINEER. A copy of the certificates shall be submitted to the ENGINEER upon request. The mix shall be certified that it complies with the requirements of this specification.

207.9.1.1 The materials shall be proportioned such that if placed at maximum slump, the laboratory dry density, as determined from molded specimens, at 24 (+/- 4) hours, is equal to or greater than 95 per cent of the maximum dry density of the blended cement and aggregate, determined in accordance with ASTM D558. The dry density of the laboratory molded LEAN FILL specimens shall be computed based on the average unit weight of the compressive strength specimens, corrected for the moisture content at the time of testing.

207.9.2 The Portland cement content shall be one-half (1/2) sack, 47 lbs., per cubic yard in all LEAN FILL produced under this specification, except as noted herein, or as specified in the Supplemental Specifications, or plans or as authorized by the ENGINEER.

207.9.3 The combined aggregate gradation shall comply with the following limits.

SCREEN SIZE	% PASSING
1 in.	100
3/4 in.	95-100
3/8 in.	82-100
no. 4	70-100
no. 8	55-85
no. 16	38-60
no. 50	6-30
no. 100	2-10

The mix gradation, when plotted on a US Bureau of Public Road 0.45 Power Gradation Chart, shall be similar to the plots of the specified gradation limits in the shape of the characteristic gradation curve.

207.9.4 Air-entraining admixtures shall conform to the requirements of ASTM C260. Air entraining admixtures shall be proportioned to provide air entrainment of not less than 2 per cent, as authorized by the ENGINEER.

207.9.5 Water shall be proportioned as required.

207.9.6 The design mix shall be proportioned to provide a slump of not less than 5 inches and not greater than 8 inches.

207.9.7 The compressive strength of the design mix shall not exceed 60 psi at 28 days when sampled and tested in accordance with ASTM C172 and D1633, and as specified in this section.

207.9.8 Laboratory compressive strength test specimens shall consist of cylinders molded by pouring a sample of the design mix in two equal lifts, into drained rigid molds, conforming to the dimensional requirements of ASTM D558, having a capacity of 1/30, +/-0.0004, c.f., with an internal diameter of 4.0, +/-0.016, inches (4" dia. x 4.5" ht., nominal dimensions). Molds cut from PVC (SCHD40) pipe having the specified internal dimensions and volume of that specified in ASTM D558 may be used. Molds shall be free draining at the base. If molds complying with the requirements of ASTM D558 are used, they shall not be clamped to the base. A free draining base may be accomplished by setting the molds on plywood for molding and initial curing. The cylinders shall be cured in the molds for the first 24 +/-4 hours. After 24 +/-4 hours curing in the molds, the cylinders shall be extruded and cured until testing.

207.9.9 Laboratory strength test specimens shall be cured in accordance with ASTM C192. Test specimens shall not be cured in a curing tank.

207.9.10 Four (4) specimens shall be weighed, measured and tested for compressive strength in accordance with the requirements of ASTM D558 at one (1) day, seven (7) days, and two (2) at 28 days, respectively.

207.9.11 An optimum moisture maximum density relationship for the combined aggregates and cement, proportioned by weight as defined by the proposed blends of the aggregates and cement, shall be determined in accordance with the requirements of ASTM D558.

207.9.12 The LEAN FILL design mix submittal shall include but not be limited to the following information, as directed by the ENGINEER:

a. Certification of compliance of the design mix under the requirements of this specification in accordance with Section 13 of these specifications,

b. Certification of the component materials used in the design mix in accordance with Section 13 of these specifications,

c. Plastic characteristics of the design mix to include temperature, slump, air entrainment, wet unit weight, yield and cement factor,

d. Performance characteristics of the hardened LEAN FILL to include the compressive strength of all test specimens and the corresponding average compressive strength, compressive strength test shall be reported for 1 day, 7 days and 28 days laboratory cure,

e. Dry unit weight and moisture content of the compressive strength specimens at the time of testing, average dry unit weight for each test series reported as a percent of the maximum dry density as determined by ASTM D 558,

f. The optimum moisture maximum dry density relationship for the combined aggregates and cement and a graphical plot of the moisture density relationship as determined in accordance with ASTM D 558 in the laboratory.

207.10 BATCHING, MIXING AND DELIVERY

207.10.1 Batching, mixing and delivery shall conform to the requirements of either ASTM C94 or ASTM C685. The CONTRACTOR shall provide to the ENGINEER with each load of LEAN FILL batched and delivered to the job site, before unloading at the site, a delivery ticket on which the information specified in the following table is printed, stamped or written, certifying said LEAN FILL.

TABLE 207

Name of LEAN FILL Supplier
Delivery Ticket Number
Date of Delivery
Contractor
Project (optional)
Design Mix Number
Volume of LEAN FILL in Load
Time Loaded
Batched Weight of Cement
Batched Weight of Fine Aggregate
Batched Weight of Coarse Aggregate
Batched Weight or Volume of Admixtures
Weight or volume (gal.) of water batched/ added at the plant
Reading of Mixer Drum Revolution Counter at the Start of Mixing
Certification that the materials delivered are the same brand, type and source as the materials defined in the reference Design Mix, as authorized by the ENGINEER.
Design Mix Target Proportions
Weight or Volume (gal.) of water added at the site
Weight or Volume of Admixtures Added at the Job Site
Signature & name of person who authorized

the addition of water at the site and
affiliation to project

207.11 TESTS

207.11.1 Lean Fill material tests shall be performed in accordance with the requirements of this specification, the supplemental technical specifications, or as required by the ENGINEER. Testing equipment used in the performance of specified testing shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certification records shall be maintained at the laboratory for review by the ENGINEER. A copy of the certifications shall be submitted upon request to the ENGINEER. A test sample shall be taken in the field for each 150 c.y. or each day's placement, whichever is greater. Field testing shall include standard tests for slump, air entrainment, unit weight, temperature, yield and cement factor. A minimum of four (4) compressive strength specimens shall be molded from a single sample. The samples shall be molded in accordance with the requirements of paragraph 207.8. Compressive strength specimens shall not be molded with material used either for slump or air entrainment tests. The cylinders shall be allowed to set for 24 (+/-4) hours in a closed plastic bag and then transported in the molds to the laboratory. The cylinders should be extruded from the molds and moist cured until compressive strength testing. The samples shall be tested for compressive strength in accordance with requirement of ASTM D1633. One specimen shall be tested for compressive strength at seven (7) days, two (2) samples shall be tested for compressive strength at 28 days. Test results shall be reported to the ENGINEER, CONTRACTOR, SUPPLIER, and CoA Pavement & Materials Engineer in writing, within four (4) days of completion of a test. Non-complying test results shall be reported within one working day after completion of a test.

207.11.2 Curing of field strength specimens for acceptance tests shall be conducted in accordance with ASTM C31. Cylinders shall not be cured in a water bath.

207.11.3 Field density/compaction tests in accordance with the requirements of ASTM D2922 and ASTM D3017 shall be taken at the rate of two tests per 150 c.y. of material or fraction thereof placed, as directed by the ENGINEER. The material shall either have an in-place density equal to or greater than 95% of maximum dry density of the combined dry materials as determined under paragraph 207.8, or 24 hours cure, prior to placement of fill, subbase, base course, treated base, pavement or structure.

207.12 TEMPERATURE/ENVIRONMENTAL CONTROLS

207.12.1 When the ambient temperature at the time of placement is less than 40

degrees F, the temperature of the LEAN FILL placed shall not be less than 50 degrees F. The materials shall be cured at a minimum temperature of 40 degrees F for 24 hours after placement.

207.13 PLACEMENT

207.13.1 LEAN FILL shall be placed in lifts not exceeding four (4) feet in height, at time intervals of not less than 1 hour per lift, as authorized by the ENGINEER. Fill shall not be placed to a height above top of pipe exceeding two (2) feet when used to fill a pipe zone, nor placed full depth in a trench to finish subgrade elevation, unless authorized by the ENGINEER. Caution should be taken in placing material in the pipe zone to above the pipe. If the buoyancy of the pipe will result in flotation, the pipe should be anchored or filled with water to counteract the buoyant condition until the LEAN FILL densifies.

207.13.2 LEAN FILL shall not be placed in standing water and shall be protected from flooding for at least 12 hours after placement.

207.13.3 LEAN FILL shall not be placed on either frozen and/or saturated ground.

207.13.4 LEAN FILL shall only be vibrated after placement if required by the ENGINEER.

207.14 MEASUREMENT AND PAYMENT

207.14.1 Unless Lean Fill is specified in the specification or shown on the plans or required by the OWNER, the CONTRACTOR has the option of using Lean Fill in place of conventional backfill and compaction. The Lean Fill material, placement, and the disposal of the excess material generated by the use of the Lean Fill shall be considered incidental to the item of work in which it is used and no separate or direct payment will be made for Lean Fill.

207.14.2 When Lean Fill is specified in the specification or shown on the plans, it shall be measured by the cubic yard, complete in place. Payment for Lean Fill shall be at the contract unit price per cubic yard, complete in place, which shall include all labor, material and equipment required in placing the Lean Fill and removal and disposal of the excess material generated by the use of the Lean Fill.

SECTION 210

OPEN AREA LAND LEVELING

210.1 GENERAL

Open area land leveling shall pertain to leveling of land for public works, park areas, ponding areas behind a dam, athletic fields, or future sites for public facilities. This section defines the requirements for land leveling.

210.2 REFERENCES

210.2.1 This publication:
SECTION 201 SECTION 205
SECTION 204 SECTION 1011

210.3 CONSTRUCTION DRAWINGS

The construction drawings for the project shall define the limit lines of the open area land leveling. Drawings shall also indicate the areas of cut and fill, and percent(s) of compaction required for parts or all of the area.

210.4 CLEARING AND GRUBBING

Clearing, grubbing, and tree removal for the designated open areas shall be completed in accordance with Section 201.

210.5 FILL CONSTRUCTION

Unsuitable on-site materials shall be removed and disposed of per direction of the ENGINEER. Holes, pits, or other depressions may be filled with on-site materials or with suitable borrow material. The fill and borrow construction work shall be accomplished in accordance with Sections 204 and 205.

210.6 GRADING CLASSIFICATIONS

210.6.1 Final grading operations in areas designated for Land Leveling shall comply with the following classifications, as specified on the plans:

210.6.1.1 ROUGH GRADING, when specified, shall produce reasonably uniform surface, free of major rutts, wind-rows and undulations. Finish grades shall match plan grades or contours within $\pm 0.5'$.

210.6.1.2 FINE GRADING, when specified, shall produce a uniform ground surface, free of rutts, wind-rows and undulations. Finish grades shall closely match plan grades or contours within a tolerance of $\pm 0.1'$.

210.6.2 Section 1011 provides specifications for grading and soil preparation in areas specified to receive seeding or sod.

210.7 MEASUREMENT AND PAYMENT

210.7.1 Clearing and grubbing may be measured by the acre for only this operation or may be included in the overall land leveling work. Payment shall be made at the unit price per acre or as otherwise specified in the Bid Proposal.

210.7.2 Open area land leveling may include: clearing and grubbing, fill construction, removal, and disposal of unsuitable materials and providing suitable borrow material. All of this work may be combined into one unit and measured by the acre or in the case of a small site it may be measured as lump sum unit. Payment shall be made at the unit price per acre or lump sum, as specified in the Bid Proposal.

210.7.3 If each of the land leveling operations are to be considered separately, then the measurements and payments would be as follows:

210.7.3.1 Removal and disposal of unsuitable materials will be measured by the cubic yard, as determined by the cross-sectional site drawings. Payment shall be made at the unit price per cubic yard, as defined in the Bid Proposal.

210.7.3.2 Cut and fill operations may be measured by the acre or by the cubic yard, as determined by the cross-sectional site drawings. Payment shall be made at either the unit price per acre or unit price per cubic yard, as indicated in the Bid Proposal.

210.7.3.3 Borrow material shall be measured by the compacted cubic yards, as determined by the cross-sectional site drawings. Payment shall be made at the unit price per compacted cubic yard, as per Bid Proposal.

210.7.4 When select borrow material is required for seeding or sodding of the area, the measurement and payment will be defined in the landscaping section of the project specifications.

SECTION 300

STREETS AND RELATED WORK

300.01 GENERAL

The contents of this section pertains to the construction activities, as related to streets, alleys, curbs and gutters, drivepads, median paving, and sidewalks.

300.2 CONTENTS

<u>Section No.</u>	<u>Title</u>
301	Subgrade Preparation
302	Aggregate Base Coarse Construction
304	Lime Treated Subgrade and/or Subbase
305	Cement Treated Base
306	Bituminous Stabilized Base and Surfacing
307	Plant Mixed Bituminous Treated Base Construction
308	Natural Gravel Surfacing for Unpaved Roadways
320	Utility and Monument Access Cover Adjustments
328	Quite Asphalt Concrete Pavement
329	Plant Mix Seal Coat
330	Asphalt Emulsion Slurry Seal
331	Asphalt Concrete Overlay
332	Heater-Remix Resurfacing
333	Fog Seal Coat
334	Seal Coat and Chips and Precoated Chip Seal Coat
335	Paving Fabric Installation
336	Asphalt Concrete Pavement
337	Portland Cement Concrete Pavement
340	Portland Cement Concrete Curbs, Gutters, Walks, Driveways, Alley Intersections, Slope Paving, and Median Paving
341	Extruded Asphalt Curb
342	Soil Sterilization
343	Removal and Disposal of Existing Pavements, Curbs, Gutters, Sidewalks, and Drivepads
344	Cold Milling of Pavement Surfaces
346	Textured Concrete
347	Brick Sidewalk
348	Brick Pavement Surface
349	Concrete Curing

**SECTION 301
SUBGRADE PREPARATION**

301 GENERAL

301.1 The work performed under this specification shall include, but not be limited to providing the equipment, labor and materials for the preparation of soil subgrade and maintenance of the prepared subgrade for the construction of graded aggregate base, asphalt treated base, cement treated base, asphalt concrete, Portland cement concrete, sidewalks, curb and gutter, drive pads, valley gutter, median pavements and/or any other roadway improvements.

301.2 REFERENCES

301.2.1 American Society for Testing and Materials (Latest Editions)(ASTM)

C136 Test for Sieve or Screen Analysis of Fine and Coarse Aggregate

D423 Test for Liquid Limit of Soils

D424 Test for Plastic Limit and Plasticity Index of Soils

D-698 Test Methods for Moisture - Density Relations of Soils and Soil-Aggregates, Using 5.5-16.(2.49 kg) Rammer and 12-in (304.8-mm) Drop

D-1140 Amount of Materials In Soils Finer Than No.200(75um)Sieve

D-1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregates Mixtures Using 10-16 (4.54-kg) Rammer and 18-in (457 mm) Drop

D-2844 Test Methods for Resistance R-Value and Expansion Pressure of Compacted Soils

D2922 Density of Soil and Soil Aggregate In-Place by Nuclear Methods

D3017 Moisture Content of Soil and Soil Aggregate In-Place by Nuclear Methods

301.2.2 This publication
Section 204 Fill Construction

301.3 MATERIAL

301.3.1 Subgrade material may be on site soil, combinations of pulverized asphalt concrete and soil, and/or pulverized Portland cement concrete and soil, imported soils, complying with the requirements of this specification. Flowing, sugar sands shall not be used for subgrade material.

301.3.2 All soft and unstable material and other portions of the subgrade which will

not compact readily or serve the intended purposes shall be removed and replaced with suitable material from excavation or borrow or suitable materials shall be added and, by manipulations, be incorporated into the subgrade to produce a material meeting subgrade requirements.

301.3.3 All subgrade material shall have a minimum Resistance Value (R-Value), as determined by ASTM D-2844, equal to or greater than the design R-Value for the pavement section. If the subgrade soils encountered during construction have a R-Value less than the design R-Value, those subgrade materials shall be removed to a depth of not less than two (2') feet below the finished subgrade elevation or as authorized by the ENGINEER and to the horizontal limits authorized by the ENGINEER, and replaced with subgrade material having an R-Value greater than the design R-Value. On small projects, in areas that just involve replacement of existing roadway items or when no design R-Value has been established this R-Value requirement may be waived if authorized by the ENGINEER.

301.4 SUBGRADE COMPACTION

301.4.1 Subgrade preparation shall extend to one foot (1') beyond the limits of the improvement to be placed on the subgrade except when that improvement abuts an existing structure and/or the limits of the right of way. Where an improvement abuts an existing structure and/or the limits of right of way, the subgrade preparation shall extend to the edge of the existing structure and/or the limits of right of way, as specified in the plans, specifications, supplemental technical specifications or as directed by the ENGINEER. Where existing structures are in the right of way or construction easements, subgrade preparation shall extend to the face of the structure, as specified above. Subgrade preparation shall not extend below the bottom of the foundation of an existing structure without specific authorization by the ENGINEER.

301.4.1.1 Subgrade preparation for roadway improvements shall be performed after completion of earthwork construction, subsurface utility installation and trenching back fill within the limits specified, as directed by the ENGINEER. The subgrade preparation shall extend the full width of the roadway to either one (1) foot back of new curb and gutter, and/or to the face of existing structures, and or the limits of right of way, as specified in the plans and specifications, as directed by the ENGINEER.

301.4.1.2 Subgrade preparation for

sidewalks and drive pads shall extend a minimum of one (1') beyond the free edge of the improvement, and/or to the limits of right of way, and/or to the face of existing structures.

301.4.1.3 The subgrade preparation for roadway construction without curb and gutter, shall extend one (1') beyond the edge of the pavement, and/or to the face of existing structures, and/or to the limits of right of way, as specified in the plans and specifications, as authorized by the ENGINEER.

301.4.1.4 Subgrade preparation shall extend the full width of roadway medians four (4) feet wide or less. In areas that the medians are wider than four feet (4') the subgrade compaction shall extend one foot (1') beyond the median edge of the pavement or back of the median curb.

301.4.2. The subgrade for arterial/collector roadway shall be ripped to a minimum depth of one (1) foot, brought to uniform moisture content, and compacted to the requirements of plans and specification, as authorized by the ENGINEER. Subgrade material with either 20 per cent or more material passing a no. 200 sieve shall be uniformly mixed and moisture conditioned using a tractor mounted mixer or disced after ripping, as specified in the plans and specifications, as authorized by the ENGINEER. The subgrade for reconstructed curb and gutter, sidewalks, drive pads, residential roadways, bicycle paths and other roadways shall be scarified to a minimum depth of six (6) inches, brought to uniform compaction moisture content, and compacted to the requirements of plans and specification, as authorized by the ENGINEER.

301.4.3 Subgrade area shall be compacted to a dry density greater than 95 per cent of maximum dry density in a moisture range of optimum moisture $\pm 2\%$ as determined in accordance with ASTM D1557, unless the material contains 35% or more material finer than the No.200 sieve. If the subgrade material has 35% or more material finer than the No.200 sieve, the subgrade shall be compacted to a dry density greater than 95 percent of maximum dry density in a moisture content range of at least optimum moisture to optimum moisture $+4\%$, as determined in accordance with ASTM D698.

301.4.4 Areas on which roadway pavement items are to be placed shall be compacted uniformly to the required subgrade density at the same time. Obtaining the required subgrade density in trench areas at a different time than obtaining the required subgrade density in the adjacent pavement areas will not be permitted.

301.4.5 Upon completion of the subgrade preparation, the CONTRACTOR shall maintain the compacted subgrade density and moisture

content at the specified levels until the next lift of material is completed. The CONTRACTOR shall provide continuous moisture protection of the subgrade by either sprinkling or the application of a prime coat, as directed by the ENGINEER.

301.5 SUBGRADE TOLERANCES

Subgrade upon which pavement, sidewalk, curb and gutter, drive pads, or other structures are to be placed shall not vary more than $\pm 1/4$ inch or $\pm 1/2$ inch per 10 foot in any direction from the specified grade and cross section. Subgrade upon which base material is to be placed shall not vary more than $\pm 1/2$ inch or ± 1 inch per 20 foot in any direction from the specified grade and cross section. Variations within the above specified tolerances shall be compensating so that the average grade and cross section specified are met.

301.6 TESTING:

301.6.1 A sample of each type of soil encountered shall be classified in accordance with the requirements of ASTM D2487, the moisture density relationship determined in accordance either ASTM D698 or D1557, whichever is applicable and an estimated resistance R-value assigned based on plasticity index, PI, and percent material passing the No.200 sieve.

301.6.2 Compaction tests shall be taken for each 500 sy or less, as directed by the ENGINEER. Compaction tests shall be taken in accordance with ASTM D2922 and D3017. Areas represented by non complying tests shall be reworked as specified, and retested for compliance.

301.6.3 Test reports shall include but not be limited to the requirements of TABLE 301.A.

**TABLE 301.A
TEST REPORT INFORMATION**

- A. Field Data
 - Date of Sampling/Field Test
 - Project Number or
 - Permit Number
 - Project Title
 - Location of sample/field test as defined by the project plans and specifications
 - Time of Sampling/field testing
 - Field test results with reference specification limits
- B. Laboratory Data
 - Soil classification
 - Soil gradation
 - Plasticity index
 - Liquid limit
 - Optimum moisture/maximum dry density relationship and graph
 - Estimated soil resistance R-Value

301.6.4 Test results shall be reported to the ENGINEER, CONTRACTOR, and Materials and Testing Laboratory, Construction Division,

Public Works Department, in writing, within 4 working days of completion of the sampling and or field test. Non-complying test shall be reported within 1 working day of completion of the test.

301.7 MEASUREMENT AND PAYMENT:

301.7.1 Measurement for payment of roadway subgrade preparation will be by the square yard to the limits of the surfacing, as authorized by the ENGINEER. Payment for subgrade preparation shall include all labor and equipment required to shape, mix, add moisture, compact, bring to grade and maintaining the prepared subgrade moisture and density until the next course of material is placed.

301.7.2 The measurement of payment for subgrade preparation for non-pavement roadway items such as curb and gutter, valley gutter, drive pads and sidewalks etc., shall be included in that item. No separate payment will be made.

**SECTION 302
AGGREGATE BASE COURSE CONSTRUCTION**

302.1 GENERAL

The work provided under this specification shall include the furnishing, placement and compaction of aggregate base course (ABC) to the lines, grades, dimensions, moisture, density and typical sections as specified in the plans and specifications, and or as directed by the ENGINEER. The CONTRACTOR shall be solely responsible for the aggregate base course either batched at and/or delivered to the site. A job mix formula for aggregate base course, shall be certified in accordance with the requirements of Section 13 of these specifications. Each job mix formula submitted and authorized for use under this specification shall be identified by a number, unique to that job mix formula and aggregate production plant/pit. If a change in material(s) from that specified in the job mix formula occur during a project, the CONTRACTOR shall submit a new job mix formula to include the changed materials for approval by the ENGINEER. A job mix formula shall not be used on a project without written approval of the ENGINEER. A job mix formula, upon request by an aggregate supplier, may be authorized by the Public Works Department Construction Division for use on City and City related projects for a period of 14 months, from the date of sampling of aggregates used in the job mix formula.

302.2 REFERENCES

302.2.1 American Society for Testing and Materials (ASTM), (Latest Edition)

- C136 Test for Sieve or Screen Analysis of Fine and Coarse Aggregate
- D75 Sampling Aggregates
- D422 Particle Size Analysis of Soils
- D423 Test for Liquid Limit of Soils
- D424 Test for Plastic Limit and Plasticity Index of Soils
- D1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb(4.54-kg) Rammer and 18-in.(457mm) Drop
- D2419 Test for Sand Equivalent Value of Soils & Fine Aggregate
- D2844 Test Method for R-Value and Expansion Pressure of Compacted Soils
- D2922 Test Methods for Density of Soil and Soil-Aggregates in Place by Nuclear Methods
- D2940 Standard Specification for Graded Aggregate Materials for Bases or Subbases for Highways or Airports
- D3017 Test Method for Moisture Content of Soil and Soil Aggregates in place by Nuclear Methods (Shallow Depth)

302.2.2 This Publication:

- Section 113 Emulsified Asphalts
- Section 301 Subgrade Preparation

302.3 MATERIALS

302.3.1.1 Aggregate base course shall be coarse aggregate of either crushed stone, or crushed gravel, or crushed asphalt concrete, or crushed Portland cement concrete, or any combination, and natural sand, the combination of materials conforming to the requirements of ASTM D2940 and the plans and specifications, as authorized by the ENGINEER.

302.3.1.2 Coarse aggregates retained on the No.4 sieve shall consists of durable particles of either crushed gravel, or crushed asphalt concrete pavement, or crushed portland cement concrete, or any combination, capable of withstanding the effects of handling, spreading and compacting without degradation production of deleterious fines. At least 50% of the particles retained on the 3/8-inch sieve, shall have two or more fractured faces. Coarse aggregate shall comply with the requirements of TABLE 302.A.

302.3.1.3 Fine aggregate passing the No.4 sieve shall consists of fines from the operation of crushing coarse aggregate; where available and suitable, natural sand or finer mineral matter or both, may be added. Fine aggregate shall comply with the requirements of TABLE 302.A.

302.3.1.4 The job mix formula gradation shall comply with the requirements of TABLE 302.B, and have the same or similar characteristic gradation curve as either range limit, when graphically plotted on a standard "0.45 POWER" Gradation Chart.

302.3.1.5 Aggregate base course furnished and placed under this specification shall have a resistance value, (R-Value), not less than 76 as determined by ASTM D2844.

302.3.1.6 A job mix formula, certified by a Registered New Mexico Professional Engineer to comply with the requirements of this specification, shall be submitted to and authorized for use by the ENGINEER before the material may be incorporated in the construction. A submittal shall include, but not be limited to, the items in TABLE 302.C. Prior to delivery of the material, the CONTRACTOR may be required to furnish samples of the aggregates base course to the ENGINEER for testing. Gradations for the aggregate base course used in a particular day's placement shall be submitted to the ENGINEER upon request.

302.3.2 Prime coat for surface sealing of compacted aggregate base course shall comply with the requirements of CSS-1H Cationic Emulsified Asphalt as specified in Section 113.

302.4 TRANSPORTATION AND PLACEMENT

302.4.1 Aggregate base course shall be transported in suitable vehicles with a cover. A load shall be covered immediately after loading and remain covered until unloading.

302.4.2 The CONTRACTOR shall provide to the ENGINEER with each load of batched and/or delivered to the job site, before unloading at the site, a copy of the delivery ticket on which is printed, stamped or written, the information defined in TABLE 302.D.

302.4.3 Aggregate base course shall be placed on prepared subgrade, prepared in accordance with the requirements of SECTION 301, the plans and specifications, and or as directed by the ENGINEER.

302.4.4 Aggregate base course shall be placed in lifts which will provide not less than four (4) inches and not more than 6 inches compacted thickness. The material shall be moisture conditioned within a range of optimum moisture plus or minus two percent (+/-2%), and compacted to a dry density greater than ninety-five (95) percent of maximum dry density as determined in accordance under the procedures specified in ASTM D1557.

302.4.5 The finish surface of the compacted aggregate base course shall not deviate from finish grade in excess of 1/2 inch in 10 feet when tested with a 10-foot straight edge in any direction. All deviations in excess of the specified shall be corrected by the CONTRACTOR prior to authorization for placement of the next life of material.

302.4.6 Immediately upon completion of compaction, the CONTRACTOR shall seal the surface of the compacted aggregate base course with a prime coat. The prime coat shall be applied as required to provide a uniform coverage of the surface. Application shall be between 0.05 and 0.15 gallons per square yard of surface. If final surfacing is to be placed within twenty four (24) hours after completion of compaction, the prime coat may be waived as authorized by the ENGINEER. The surface shall be kept at compaction moisture until the final surfacing is placed in the event the prime coat is waived.

302.4.7 Traffic on compacted aggregate base course shall be limited to moisture control application and final surfacing traffic only, as authorized by the ENGINEER.

302.5 TESTING

302.5.1 A sample of material delivered to the project shall be taken for each 300 tons placed or each days placement, whichever is greater, and tested for gradation and moisture density relationship. The average value of individual gradation tests, for all sieve size determinations, shall comply with the

job mix formula within the tolerances specified in TABLE 302.B. Individual sample gradation test results, for all sieve size determinations, shall comply with the tolerance range plus two (2) percent. Non complying material shall be re-sampled and tested for compliance. Material not in compliance after the initial and follow up testing shall be removed and replaced by the CONTRACTOR at no cost to the OWNER, as directed by the ENGINEER.

302.5.2 Compaction tests shall be taken at the rate of one test for each 500 sy/lift placed, or as directed by the ENGINEER, in accordance with the requirements of ASTM D 2922 and D 3017. Areas represented by non complying tests shall be reworked and retested for compliance.

302.5.4 Test reports shall include but not be limited to the requirements of TABLE 302.E.

302.5.5 Test Results shall be reported to the ENGINEER, CONTRACTOR, and Materials and Testing Laboratory, Construction Division, Public Works Department, in writing, within 4 working days of completion of the sampling and or field test. Non-complying test shall be reported within 1 working day of completion of the test.

302.6 MEASUREMENT AND PAYMENT

302.6.1 Measurement of aggregate base course shall be by the square yard per each thickness required, complete in place.

302.6.2 Payment shall be at the contract unit price per square yard per each thickness required, complete in place which shall include all material, labor and equipment required in placing, grading and compacting the aggregate base course.

TABLE 302.A
ENGINEERING REQUIREMENTS

CHARACTERISTIC Aggregate Type	SPECIFICATION LIMIT(S)	
	Fine	Coarse
Los Angeles Abrasion Wear (ASTM C 131)		40% max.
Soundness (5 cycles ASTM C 88)	15% max.	15% max.
Crushed Aggregate (% Material Retained on 3/8 inch sieve by wt., having at least two (2) fractured faces)		50% max.
Maximum % passing No.200	60% of -No.30	
Plasticity Index (Material finer than No.40 sieve)	4.0 max.	
Sand Equivalent Value	35 min.	

TABLE 302.B
GRADATION RANGES AND TOLERANCES

SIEVE SIZE\TYPE	PRODUCTION RANGE (% passing)		PRODUCTION TOLERANCES(+/-%)
	I	II	
1-1/2 inch	100	100	
1 inch	95-100	100	
3/4 inch		90-100	8
1/2 inch	65-75		8
3/8 inch		65-80	8
No.4	35-46	48-55	8
No.30	12-18	18-25	5
No.200	5-12	6-15	3

TABLE 302.C
SUBMITTAL REQUIREMENTS

- A. Supplier
- B. Date
- C. Design Mix Identification Number
- D. Contractor
- E. Construction project number
- F. Construction Project Title (contract)
- G. Certification of compliance
- H. Target Gradation of Material
- J. Optimum moisture and maximum dry density relationship of material and graph

The submittal shall be rejected without review if the specified data is not included.

TABLE 302.D
DELIVERY TICKET INFORMATION

- A. Name of Supplier
- B. Date of Delivery
- C. Delivery Ticket Number
- D. Name of Contractor
- E. Project Name (optional)
- F. Job mix formula identification number
- G. Weight of load
- H. Time loaded

TABLE 302.E
TEST REPORT INFORMATION

- A. Field Data
 - Date of Sampling/Field Test
 - Project Number or
 - Permit Number
 - Project Title
 - Location of sample/field test as defined by the project plans and specifications
 - Time of Sampling/field testing
 - Field test results with reference specification limits

- B. Laboratory Data
 - Base course classification
 - Gradation
 - Plasticity index
 - Liquid limit
 - Optimum moisture/maximum dry density relationship and graph
 - Estimated soil resistance R-Value

SECTION 304

LIME TREATED SUBGRADE AND/OR SUBBASE

304.1 GENERAL

This work shall consist of the treatment of one or more courses of subgrade or subbase material with hydrated lime as indicated on the plans or as specified in the Supplementary Specifications.

304.2 REFERENCES

ASTM
C 207
D 1557

This publication:
SECTION 301

304.3 MATERIALS

Hydrated Lime--Commercial grade hydrated lime shall conform to the requirements of ASTM C 207 or Type N granular quick-lime which is free flowing with a minimum of 94% CaO and 100% passing the No. 4 screen.

304.4 CONSTRUCTION REQUIREMENTS

General--Where designated, the depth of subgrade or subbase shown on the plans shall be treated with amounts of commercial grade hydrated lime as established by the ENGINEER.

304.4.1 The lime may be placed on the subgrade or subbase in either dry form or may be applied as a slurry. The lime or lime slurry shall be thoroughly mixed with the material to be treated as soon as practical. The CONTRACTOR shall handle the processing of lime in such a manner that lime dust will not be hazardous to workmen nor to the public. Initial mixing shall be performed the same day the lime is placed.

304.4.2 After preliminary mixing, the section so treated shall be shaped, lightly compacted, and cured for a period of 1 to 4 days as directed by the ENGINEER. During the curing period, the moisture content of the mixture shall be maintained from 2 to 5 percent above the optimum required for compaction.

304.4.3 Following the curing period, the CONTRACTOR shall again mix the treated material until 100% of the slaking fraction passes the 1 1/2 inch sieve and a minimum of 60% passes the No. 4 sieve using approved road mixers or other approved equipment which is capable of thoroughly mixing and processing the

combined materials. Compaction shall begin immediately after final mixing. Each course of lime treated subgrade and subbase shall be compacted to 90 percent of maximum density, as determined by ASTM D 1557, except that when pavement, curb, gutter, driveways, sidewalks, or other structures are to be placed directly upon the lime treated material, the top 6 inches thereof shall be compacted to 95 percent of maximum density and in accordance with the applicable provisions of Section 301, Subgrade Preparation.

304.4.4 When compacting and shaping are complete, the subgrade shall be kept moist until the first layer of base or other surfacing material has been placed, in order to prevent shrinkage cracks.

304.5 MEASUREMENT AND PAYMENT

Measurement for lime treated subgrade and subbase, except for quantity of hydrated lime, will be made on the square yard basis. Measurement to determine area shall be made horizontally. Measurement for hydrated lime will be made on the number of tons (2,000 pounds dry weight) delivered and placed as approved by the ENGINEER. Payment will be as specified in the Bid Proposal.

SECTION 305

CEMENT TREATED BASE CONSTRUCTION

305.1 GENERAL: The work provided shall include the furnishing, placement and compaction of one or more courses of plant mixed Portland cement treated base course (CTB) to the lines, grades, dimensions, moisture, density and typical sections as specified in the plans and specifications, and as directed by the Engineer. The Contractor shall be solely responsible for the cement treated base either batched at and/or delivered to the site. A design mix for CTB shall be certified in accordance with the requirements of Section 13 of these specifications. Each design mix submitted and authorized for use under this specification shall be identified by a number, unique to that design mix and aggregate production plant/pit. If a change in material(s) from that specified in the design mix occur during a project, the Contractor shall submit a new design mix to include the changed materials for authorization by the Engineer. A design mix shall not be used on a project without authorization by the Engineer. A design mix, upon request by a supplier, may be authorized by the Public Works Department Construction Division for use on City and City related projects for a period of 14 months, from the date of sampling of aggregates used in the job mix formula.

305.2 REFERENCES.

305.2.1 American Society for Testing and Materials (ASTM), (Latest Edition):

- C136 Standard Test Method for Sieve Analysis of Fine and Course Aggregates
- C150 Standard Specifications for Portland Cement
- D75 Standard Practice for Sampling Aggregates
- D422 Standard Test Method for Particle-Size Analysis of Soils
- D558 Standard Test Methods for Moisture-Density Relations of Soil-Cement Mixtures
- D559 Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures
- D560 Standard Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures
- D1632 Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
- D1633 Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders
- D2419 Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
- D2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods

- D2940 Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports
- D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods
- D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

305.2.2 This Publication:

SECTION 113 WARRANTY AND GUARANTEE;
TESTS AND INSPECTIONS;
CORRECTIONS, REMOVAL, OR
ACCEPTANCE OF DEFECTIVE WORK

SECTION 301 SUBGRADE PREPARATION

SECTION 302 AGGREGATE BASE COURSE
CONSTRUCTION

305.3 MATERIALS.

305.3.1 Portland cement to be used or furnished under this specification shall comply either with the requirements of ASTM C150, Type II, Low Alkali (LA) cement, or as specified herein, or as specified in the Supplementary Technical Specifications, Drawings, or as approved by the Engineer. The Contractor shall submit certification of compliance signed by the cement manufacturer, identifying the cement Type and source (plant location), stating the Portland cement used in the cement treated base delivered to the project complies with this specification. If required, certification of the portland cement used for each day's concrete placement, shall be submitted to the Engineer. Portland cement specified in an authorized design mix shall be of the same source and type for all cement treated base under that design mix identification number, as specified in the design mix.

305.3.2 Aggregates for cement treated base course shall consist of a combination of crushed stone, crushed gravel, crushed portland cement concrete, and natural or manufactured sand conforming to the requirements of SECTION 302, GRADED AGGREGATE BASE COURSE CONSTRUCTION.

305.3.3 Water used in cement treated base shall be clean and free from injurious amounts of oil, acids, alkalis, salts, organic materials, or other deleterious substances. Nonpotable water shall not be used unless the requirements of ACI 318.3.4.3.2 are met.

305.3.4 Prime coat for surface sealing of compacted cement treated base shall comply with the requirements of CSS-IH Cationic Emulsified Asphalt as specified in Section 112.

305.4 PROPORTIONING.

305.4.1 The Contractor shall be solely responsible for the cement treated base design mix proportions and material batched and delivered to the site.

305.4.2.1 A cement treated base design mix shall be a blend of portland cement, aggregate base course and water. The design mix shall be prepared in a laboratory under the direct supervision of a New Mexico Registered Professional Engineer. The testing equipment used in the design development of the design mix shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certificates of calibration shall be maintained at the laboratory for review by the Engineer. A copy of the certifications shall be provided to the Engineer upon his request.

305.4.2.2 Portland cement shall be proportioned by percent of dry weight of aggregates. The amount of portland cement shall be the minimum cement content that will provide a aggregate cement water mixture, when compacted at optimum moisture, as determined by ASTM D558, and that will comply with the requirements of TABLE 305.A.

TABLE 305.A
CEMENT TREATED BASE PROPERTIES

CHARACTERISTIC	SPECIFICATION	
A. Weight Loss After 12 Cycles:		
Wetting and Drying Tests	15% maximum	ASTMD559
Freezing and Thawing Tests	15% maximum	ASTMD560
B. Compressive Strength (average of 2 samples)	550 750 psi @7 days	
Samples Molded	ASTM D558	Method A
Samples Cured	ASTM D1632	
Samples Tested	ASTM D1633	

305.4.2.3 A submittal for cement treated base shall include but not be limited to the TABLE 305.B.

TABLE 305.B
SUBMITTAL REQUIREMENTS

- A. Design Mix Identification Number
- B. Supplier
- C. Aggregate production plant/pit
- D. Name of Contractor
- E. Construction Project Title and Number
- F. Certifications of compliance of materials
- G. Certification of compliance of design mix
- H. Proposed proportions of materials
- J. Wet Dry Test results
- K. Freeze Thaw Test results
- L. Target gradation of aggregate
- M. Optimum moisture maximum dry density relationship and graph.
- N. Compressive strength test results, average of two briquettes (each), at 2 days, 7 days, and 28 days

The submittal shall be rejected without review if the specified data is not included.

305.5 BATCHING.

305.5.1 Cement treated base shall be proportioned and mixed in a central mixing plant, either weigh batching or volume batching. The plant shall be equipped with feeding and metering devices which will introduce the aggregates, cement and water into the mixer in the proportions specified in the authorized design mix. The plant shall be calibrated at the particular configuration, to include but not be limited to scales, belt speeds, gate settings, dispenser rates and mixing time, to proportion a specified mix. The production configuration required for a design mix shall be maintained on file at the plant for review by the Engineer. Certification by the supplier that the required configuration was used in the production of cement treated base for each days production shall be maintained at the batch plant for review by the Engineer. Batch weights of materials and/or daily production weights will be recorded at the batch plant and maintained on file for review by the Engineer.

305.6 TRANSPORTATION AND PLACEMENT.

305.6.1.1 Material shall be transported in suitable vehicles with a cover. Loads of material shall be covered immediately after loading and remain covered until unloading.

305.6.1.2 The Contractor shall provide to the Engineer with each load of material batched and/or delivered to the

job site, before unloading at the site, a copy of a delivery ticket on which is printed, stamped or written, the information defined in TABLE 302.C.

TABLE 305.C
DELIVERY TICKET INFORMATION

- A. Name of Supplier
- B. Date of Delivery
- C. Delivery Ticket Number
- D. Name of Contractor
- E. Project Name (optional)
- F. Job mix formula identification number
- G. Weight of load
- H. Time loaded

305.6.2 Material shall be placed on prepared subgrade, prepared in accordance with the requirements of SECTION 301, SUBGRADE PREPARATION, in lifts to provide a compacted thickness of not less than four (4) inches and not more than six (6) inches, to the required limits and sections specified in the plans and specifications or as authorized by the Engineer.

305.6.3 Compaction of the material shall be initiated within sixty (60) minutes from the time of mixing. The material shall be compacted to an equivalent dry density greater than ninety five (95) percent of maximum dry density, at a moisture content range of optimum moisture to optimum moisture plus four (4) percent, as determined in accordance with ASTM D558. Compaction shall be completed within three (3) hours from the time of mixing as directed by the Engineer.

305.6.4 Upon completion of compaction, the surface of the compacted cement treated base shall be sealed with a prime coat. The prime coat shall be applied as required to provide a uniform coverage of the surface. Application shall be between 0.05 and 0.15 gallons per square yard of surface. If final surfacing is placed within 24 hours after completion of compaction, the prime coat may be waived as authorized by the Engineer. The surface shall be kept at compaction moisture until the next lift of material is placed in the event the prime coat is waived.

305.6.5 Cement treated base shall not be placed on frozen subgrade or subgrade with a surface temperature less than 40°F. The material shall not be placed when the ambient temperature is less than 40°F.

305.6.6 Cement treated base shall be protected from freezing for a minimum of 7 days after placement. The material shall be cured before opening to traffic in accordance with the requirements of TABLE 305.D.

TABLE 305.D
CURING TO TRAFFIC SCHEDULE

CURING TEMPERATURE RANGE °F	CURING TIME (days)
40-55	7
56-75	5
T>76	3

305.6.7 The finish surface of the graded aggregate base shall not deviate in excess of 1/4 inch in 10 foot when tested with a 10 foot straight edge in any direction. All deviations from this tolerance shall be corrected at no expense to the Owner. Corrections, if required shall be completed within 3 hours of mixing and prior to placement of prime coat.

305.7 TESTING.

305.7.1 Tests shall be performed in accordance with the requirements of this specification, the supplemental technical specifications, or as required by the Engineer. Testing equipment used in the performance of specified testing shall be calibrated annually with calibration standards traceable to the National Bureau of Standards, Certification records shall be maintained at the laboratory for review by the Engineer. A copy of the certifications shall be submitted upon request to the Engineer.

305.7.2 A construction sample of material supplied to a project shall be taken at a rate of one sample per each 300 tons delivered, or one sample per day, whichever is greater, or as directed by the Engineer. The sample shall be of such size to provide material for all tests specified. A sample shall be tested for but not limited to the properties specified in TABLE 305.E.

TABLE 305.E
CEMENT TREATED BASE FIELD TESTS

- A. Gradation
- B. Moisture content
- C. Maximum density
- D. Compressive strength
 - 2 briquettes tested at 2 days
 - 2 briquettes tested at 7 days

The average values of individual tests of all sieve size determinations shall comply with the job mix formula within the permissible tolerances shown in TABLE 302.B, SECTION 302., except material passing the No.200 sieve. Results of tests of an individual sample may fall outside the permissible limits by no more than 2 percentage points on any sieve except the No.200 sieve. Non compliance shall necessitate that the entire lot be resampled and tested for

compliance. Non complying material shall be removed and replaced as directed by the Engineer. The City will only pay for complying material or as directed by the Engineer. Cost of removal and replacement of non complying material shall be the responsibility of the Contractor.

square yard per each thickness required, complete in place which shall include all material, labor and equipment required in placing, grading, compacting the cement treated base course and prime coat/moisture control, as authorized by the Engineer.

305.7.3 Field compaction tests shall be conducted in accordance with the requirements of ASTM D2922 and D3017, at the rate of one test per lift per 500 sy of material placed, or one (1) test per day, or as directed by the Engineer.

305.7.4.1 Test reports shall include but not be limited to the requirements of TABLE 305.F.

TABLE 305.F
TEST REPORT INFORMATION

A. Field Data

Date of Sampling/Field Test
Project Number or
Permit Number
Project Title
Material Supplier
Delivery Ticket Number (material sample only)
Design Mix identification Number
Location of sample/field test as defined by the project plans and specifications
Time of Sampling/field testing
Ambient temperature at time of sampling/, °F
Test results with reference specification limits

B. The laboratory test results and corresponding production limits and/or specifications.

305.7.4.2 Test results shall be reported to the Engineer, Contractor, Supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, in writing, within 7 working days of completion of the sampling and or field test. Non complying test shall be reported within 1 working day of completion of the test.

305.7.4.3 The testing shall be certified to have been performed in compliance with the specifications by the NM Registered Professional Engineer in direct charge of the testing program.

305.8 MEASUREMENT AND PAYMENT.

305.8.1 Measurement of cement treated base course shall be by the square yard per each depth specified, complete in place.

305.8.2 Payment shall be at the contract unit price per

SECTION 306

BITUMINOUS STABILIZED BASE AND SURFACING

306.1 GENERAL

Bituminous stabilized base and surfacing shall consist of a mixture of aggregate and emulsified or liquid asphalt.

306.2 REFERENCES

306.2.1 AASHTO:
T 176

306.2.2 This publication:
SECTION 115

306.3 AGGREGATES

306.3.1 The aggregates shall consist of soil or mineral aggregates or blends thereof, which, when stabilized with asphalt and allowed to cure, will meet the specified requirements for stability. A representative sample of minus No. 4 material taken from the proposed mixture of aggregates and soil material shall yield a sand equivalent of 40 or more when tested in accordance with AASHTO T 176. The CONTRACTOR shall notify the ENGINEER if he intends to import material in sufficient time to allow for the testing thereof to determine the suitability of the material and quantity of stabilizer required.

306.3.2 Gradation will be the same as specified for Classes I or II, Section 302.3.2.

306.4 ADVANCE TESTS

When mixing is to be done on the site, a representative sample of the aggregates shall be taken from each 10,000 square feet to be stabilized. When mixing is done in a central mixing plant, samples which are representative of the aggregates to be used shall be taken for tests. The stabilizer and aggregates for the work shall meet the requirements of the Supplementary Specifications. The quantity of stabilizer shall be as specified. In the case of emulsified asphalt, the ENGINEER will determine the quantity of water to be added.

306.5 MIXING

The aggregate and asphalt shall be thoroughly mixed in a central pugmill-type mixing plant (blade mixing shall not be used). The mixture shall be uniform and contain the percent, by weight or volume, of dry aggregate and asphalt as specified. If necessary, water shall

be added to the aggregate in a quantity sufficient to completely disperse the emulsified asphalt and produce a plastic mixture free from balled fines or balled asphalt.

306.5.1 CENTRAL PLANT MIXING: Bituminous stabilized base shall be placed on prepared subgrade, subbase, or base course as provided. Base course aggregate and bituminous materials shall be processed in a stationary mixing plant conforming to the requirements of Section 115, Asphalt Concrete, except that base course aggregate may not be placed in one stockpile. The base course aggregate shall be separated into not less than two bins.

306.5.2 TRAVEL MIXING:

306.5.2.1 The travel mixing machine shall be of the pug type or auger type. The traveling mixer shall have provision for introducing the asphalt and water at the time of mixing through a metering device or other approved method. Both the asphalt and the water shall be applied by means of separate controls which will supply a uniform ratio of asphalt and/or water to the amount of aggregate passing through the mixer and produce a complete mixture with a uniform moisture content. Leakage of asphalt and/or water from equipment will not be permitted and care shall be exercised to avoid the addition of asphalt or water by spilling or any other means. Prior to mixing in the traveling mixer, the aggregate shall be placed in such a manner that all the material will be passed through the mixing machine in one mixing operation. If aggregate is brought to the site in separate sizes, each of the sizes in proper amount shall be deposited by means of approved spreading device equipped with a readily adjustable strike-off device.

306.5.2.2 The rate of movement of the mixing machine, the amount of material mixed, and the amount of mixing shall be so regulated that a mix satisfactory to the ENGINEER shall result. The material shall be mixed so that a uniform mixture of unchanging appearance is obtained and all particles of aggregate are coated with asphalt.

306.6 PLACING AND MIXTURE

The mixed base material shall be laid to the thickness shown on the plans in layers not to exceed 6 inches in

compacted thickness. Laydown of the bituminous stabilized base shall be accomplished with the use of an approved laydown machine.

306.7 COMPACTING THE MIXTURE

Rolling of the mixture shall commence immediately after it has been placed on the subgrade. Compaction shall be accomplished with the use of pneumatic rollers, steel wheel rollers, or vibratory rollers, as approved by the ENGINEER. After the specified compaction has been secured in the top layer with the pneumatic-tired rollers, the roadway shall be thoroughly rolled with self-propelled tandem rollers with smooth steel wheels. Rolling shall commence at the outer edge of the base course and progress toward the center. Each base course layer shall be rolled until it is compacted and true to grade and cross section. Areas inaccessible to the roller shall be compacted by power tamping until as well compacted as the rolled portion. The surface of each layer shall be clean prior to placing the succeeding layer of material.

306.8 DENSITY AND TOLERANCES

Rolling shall be continued until at least 96 percent relative compaction is obtained as per AASHTO T 116. The thickness of stabilized base compacted in place may deviate not more than plus or minus 1/2 inch from that specified, provided such variations are compensating. The surface shall not show any deviations in excess of 3/8 inch when tested with a 10 foot straightedge applied parallel with the centerline of the roadway.

306.9 MEASUREMENT AND PAYMENT

306.9.1 Bituminous stabilized base will be measured horizontally by the square yard. Payment will be as specified in the Bid Proposal.

306.9.2 Asphalt binder material will be measured by the gallon or ton. Unit of payment will be as specified in the Bid Proposal.

SECTION 307

PLANT MIXED BITUMINOUS TREATED BASE CONSTRUCTION

307.1 GENERAL: The work provided under this specification shall include the furnishing, placement and compaction of one or more courses of hot plant mixed bituminous treated base course (BTB) to the lines, grades, dimensions and typical sections as specified in the plans and specifications, as directed by the Engineer. The Contractor shall be solely responsible for the BTB either batched at and/or delivered to the site. A job mix formula used for BTB shall be certified in accordance with the requirements of Section 13 of these specifications. Each job mix formula submitted and authorized for use under this specification shall be identified by a number, unique to that job mix formula and production plant. If a change in material(s) from that specified in the job mix formula occur during a project, the Contractor shall submit a new job mix formula to include the changed materials for approval by the Engineer. A job mix formula shall not be used on a project without written approval of the Engineer. A job mix formula, upon request by a supplier, may be authorized by the Public Works Department Construction Division for use on City and City related projects for a period of 14 months, from the date of sampling of aggregates used in the job mix formula.

307.2 REFERENCES.

307.2.1 American Society for Testing and Materials (ASTM), Latest Edition:

- C117 Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
- C136 Standard Test Method for Sieve Analysis of Fine and Course Aggregates
- C150 Standard Specification for Portland Cement
- C207 Standard Specification for Hydrated Lime for Masonry Purposes
- D979 Standard Practice for Sampling Bituminous Paving Mixtures
- D995 Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
- D1075 Standard Test Method for Effect of Water on Compressive Strength of Compacted Bituminous Mixtures
- D1559 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
- D2172 Standard Test Method for Quantitative Extraction of Bitumen From Bituminous Paving Mixtures
- D2493 Standard Viscosity-Temperature Chart for

Asphalts

- D2726 Standard Test Method for Bulk Specific Gravity and Density of Non Absorptive Compacted Bituminous Mixtures
- D2950 Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
- D3515 Standard Specifications for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

307.2.2 American Association of State Highway and Transportation Officials AASHTO:

- T245 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

307.2.3 This Specification:

SECTION 112 ASPHALT BINDER

SECTION 302 AGGREGATE BASE COARSE CONSTRUCTION

SECTION 336 ASPHALT CONCRETE PAVEMENT

307.3 MATERIALS.

307.3.1 Aggregate for plant mixed bituminous base course (BTB) shall consist of a combination of crushed "stone, crushed gravel, crushed asphalt concrete, crushed portland cement concrete, and natural or manufactured sand conforming to the requirements of sub section 302.3, SECTION 302, AGGREGATE BASE COURSE CONSTRUCTION.

307.3.2 The asphalt binder shall conform to the requirements of either SECTION 112 ASPHALT BINDER, and TABLE 307.A, the Supplemental Technical Specifications, and/or as authorized by the Engineer. The Contractor shall submit laboratory analysis of the asphalt binder used in the design development of the job mix formula, certification of compliance, identifying the grade and source (plant location), temperature viscosity relationship reported in accordance with ASTM O 2493, and the minimum mixing and compaction temperature ranges. The certification shall state the asphalt binder to be furnished to the project, and/or used in the bituminous treated base course delivered to the project complies with this specification. Certification of the asphalt binder used for each day's placement, shall be submitted to the Engineer, upon request, for each grade and each job mix formula used on the project.

TABLE 307.A ASPHALT BINDER GRADE

Application	Grade		
	Penetration	Viscosity	Performance Grade (PG)
All	60-70	AC 20	70-22

307.3.3 Admixtures shall be proportioned as a percent (%) by weight or liquid ounces per unit weight, of dry aggregate shall be used in BTB provided under this specification. Antistrip admixtures shall be either hydrated lime, or portland cement, or a liquid admixture, or modified asphalt proportioned as a percent (%) by weight or liquid ounces per unit weight, of dry aggregate, as approved by the Engineer.

307.4 PROPORTIONING.

307.4.1 The Contractor shall be solely responsible for the bituminous treated base job mix formula proportions and material batched and delivered to the site under this specification.

307.4.2 A bituminous treated base (BTB) job mix formula shall be a blend of asphalt binder, graded aggregate base and anti strip admixture proportioned in accordance with the requirements of this specification. The job mix formula shall be prepared in a laboratory under the direct supervision of a New Mexico Registered Professional Engineer. The testing equipment used in the design development shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certificates of calibration shall be maintained at the laboratory for review by the Engineer. A copy of the certifications shall be provided to the Engineer upon his request.

307.4.3 A job mix formula shall be determined based on a minimum of five (5) asphalt binder contents reference points, with a minimum of two reference points bracketing the recommended asphalt content, containing only that portion of a mix that passes a one inch sieve. Job mix formula submittals shall include all information required to verify the proposed job mix formula complies with the production ranges and/or variations specified.

307.4.4 Asphalt binder shall be proportioned by percent of dry weight of aggregates. The amount of binder shall be the minimum cement content that will provide an asphalt aggregate anti strip mixture, when compacted in accordance with ASTM D1559, that will comply with the requirements of TABLE 307.B.

TABLE 307.B BITUMINOUS TREATED BASE PROPERTIES

PROPERTY	SPECIFICATION
Unconfined Compressive Strength	250 psi

307.4.5 The asphalt content shall be selected, based on laboratory testing such that the job mix formula physical properties do not exceed the tabulated limits for a variation in asphalt content of $\pm 0.5\%$.

307.4.6 Anti strip admixture shall be proportioned to provide a minimum compressive strength of 85% or greater retained strength as determined by ASTM D1075. BTB prepared with an anti strip admixture shall have an unconfined compressive strength at least equal to the BTB without the anti strip admixture.

307.5 SUBMITTALS.

307.5.1 A job mix formula submittal shall include but not be limited to that defined in TABLE 307.C, as directed by the Engineer. A submittal shall be rejected if it does not include the information specified.

TABLE 307.C
SUBMITTAL REQUIREMENTS

- A. Name of Supplier
- B. Date of submittal
- C. Job mix formula identification number
- D. Date of sampling of aggregates
- E. Certification of compliance of materials
- F. Temperature viscosity curve with recommended mixing and compaction temperatures for proposed asphalt binder
- G. Proposed job mix formula target proportions of materials
- H. Certification of compliance of proposed job mix formula by the NM Registered Professional Engineer
- J. Job mix formula performance target characteristics and specification limits
- K. Tabulation of laboratory design development test results
- L. Graphical representation of the following test results:
 - i. Unconfined compressive strength vs. Asphalt Content
 - ii. Marshall Density (pcf) vs. Asphalt Content (%)
 - iii. Voids In Mineral Aggregate (%VMA) vs. Asphalt Content (%)
- M. Specific gravity of asphalt cement
- N. Bulk Specific Gravity of aggregate

307.6 BATCHING.

307.6.1 BTB shall be batched in accordance with the requirements of ASTM D3515, the requirements of this specification, and/or as approved by the Engineer. Batching facilities shall comply with the requirements of ASTM D 995, and this specification. A batch plant shall be certified annually by an independent New Mexico Registered Professional Engineer, to comply with the requirements of this specification and Section 13. Certification shall be completed within 12 months prior to submittal of a job mix formula to be produced at the plant. The batch plant shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certificates of calibration and production certifications shall be maintained at the plant for review by the Engineer. A copy of the certifications shall be submitted to the Engineer upon request.

307.7 TRANSPORTATION AND PLACEMENT.

307.7.1 Material shall be transported in suitable vehicles with a cover. Material shall be covered immediately after loading and remain covered until unloading. Diesel fuel or other petroleum based solvents shall not be used in the bed of transport vehicles as a release agent to prevent build up of material.

307.7.1.1 The Contractor shall provide to the Engineer with each load of asphalt concrete batched at and/or delivered to the job site, before unloading at the site, a copy of the delivery ticket on which is either printed, stamped or written, the information defined in TABLE 307.D.

TABLE 307.D
DELIVERY TICKET REQUIREMENTS

A. Name of Supplier
B. Date of Delivery
C. Delivery Ticket Number
D. Name of Contractor
E. Project Name (optional)
F. Job mix formula identification number
G. Weight of load
H. Time loaded

307.7.2 Bituminous treated base shall be placed in uniform layers/lifts in accordance with the requirements of Section 336. The thickness of a layer/lift shall not less than 4 inches, be at least equal to three (3) times the nominal maximum size aggregate of the job mix formula used but not greater than 8 inches.

307.7.3 The material shall be compacted when the material temperature is in the range specified by the asphalt

cement supplier's temperature viscosity curve in the approved job mix formula. Compaction shall be completed before the temperature of the material cools to 200 °F. Compaction shall not be allowed when the material temperature is equal to or less than 200 °F. The materials shall be compacted to a density greater than 96% of laboratory Marshall density. At the direction of the Engineer, core samples may be taken to verify constructed asphalt concrete properties. The Contractor shall be responsible for patching core holes with the same or similar material as the adjacent asphalt concrete. Diesel fuel or other petroleum based solvents shall not be used as a release agent to clean equipment used to place and compact asphalt concrete.

307.8 TESTS.

307.8.1 Construction quality control tests shall performed in accordance with the requirements of this specification, the supplemental technical specifications, or as required by the Engineer. Testing equipment used in the performance of specified testing shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certification records shall be maintained at the laboratory for review by the Engineer. A copy of the certifications shall be submitted upon request to the Engineer.

307.8.2 A field sample shall be taken in accordance with the requirements of ASTM D979, either for each 300 tons delivered per day to a project, or 2 samples per day, or as directed by the Engineer. The sample shall be of such size to provide material for all tests specified.

307.8.3 A sample shall be tested for but not limited to the properties specified in TABLE 307.E.

TABLE 307.E BTB SAMPLE TESTS [1]

A. Marshall Density (75 blows/face) [2,3]
B. Marshall Bulk Specific Gravity/Density
C. Unconfined compressive strength of Marshall Briquettes (average of 3)
D. Asphalt binder content
E. Extracted aggregate gradation

[1] Material used for an individual test shall be split from the same sample

[2] Compaction temperature for material can be five (5)°F less but not more than five (5)°F greater than the median compaction temperature recommended in the temperature viscosity curve in the authorized submittal

[3] A minimum of three (3) standard briquettes shall be molded

307.8.4 Field compaction tests shall be conducted in accordance with the requirements of ASTM D2950, at the rate of one test per lift per 500(+/- 50) sy of asphalt material placed, or fraction thereof placed, per day, or as directed by the Engineer. Samples of the compacted asphalt pavement may be taken and tested to determine conformance of the finished BTB with the specified requirements either as requested by the Contractor, or as directed by the Engineer. The Contractor shall be responsible for all sampling and material replacement at no cost to the Owner where samples are removed. Three (3) six (6") inch diameter cores shall be taken to represent a Lot, as directed by the Engineer and tested for compaction in accordance with the requirements of ASTM D2726. Test results shall be reported as specified.

307.8.5 Test reports shall include but not be limited to the information defined in TABLE 307.F.

TABLE 307.F
TEST REPORT REQUIREMENTS

A.	Date of Sampling/Field Test
B.	Project Number or Permit Number
C.	Project Title
D.	Supplier
E.	Delivery Ticket Number (sample only)
G.	Job Mix Formula Identification Number H.
	Location of sample/test as defined by the project plans and specifications
J.	Time of Sampling/Field Test
K.	Material temperature at time of sampling, °F
L.	Material
M.	Ambient temperature at time of sampling, °F
N.	Test results with reference specification limits

307.8.6 Test results shall be reported to the Engineer, Contractor, supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, in writing, within 7 working days of completion of the sampling and/or field test. Noncomplying test shall be reported to the Engineer, Contractor, supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, within 1 working day of completion of the test.

307.8.7 The testing shall be certified to have been performed in compliance with the specifications by the NM Registered Professional Engineer in direct charge of the testing program.

307.9 MEASUREMENT AND PAYMENT.

307.9.1 Measurement of Plant Mixed Bituminous Treated Base Course shall be by the square yard per each thickness required, complete in place.

307.9.2 Payment shall be at the contract unit price per square yard per each thickness required, complete in place which shall include all material, labor and equipment required in placing, grading and compacting the Plant Mix Bituminous Treated Base Course. Payment will be made for material and placement/compaction that complies with the requirements of the specifications, as authorized by the Engineer.

SECTION 308

NATURAL GRAVEL SURFACING FOR UNPAVED ROADWAYS

308.1 GENERAL

This section defines the material and construction requirements for natural gravel surfacing for unpaved roadways.

Screen Or sieve	Percent Passing
1 1/2 inch	100
1 inch	90 - 100
No. 4	40 - 75
No. 200	6 - 20

308.2 REFERENCES

308.2.1 ASTM:

C 117
C 131
C 136

308.2.2 AASHTO:

T 90
T 180

308.3 MATERIALS

308.3.1 CLASSIFICATION: Materials for use as natural gravel surfacing shall be classified, in order of preference, as follows

308.3.1.1 Processed natural material

308.3.1.2 Decomposed granite

308.3.1.3 The CONTRACTOR may supply either of these materials when natural surfacing is specified without further qualification.

308.3.2 PROCESSED NATURAL MATERIAL: Processed natural material shall consist of hard, durable fragments of stone or gravel and a filler sand or other finely divided mineral matter. It shall be free from an excess of soft or disintegrated pieces, alkali, adobe, vegetable matter, loam or other deleterious substances.

308.3.2.1 Physical Requirements: When sampled and tested in accordance with standard testing methods, the aggregate shall meet the following requirements:

308.3.2.2 Percentage of Wear: When tested in accordance with ASTM C 131, the percentage of wear shall not exceed 40 percent after 500 revolutions.

308.3.2.3 Plasticity Index: When tested in accordance with AASHTO T 90, the plasticity index shall not be more than 8 nor less than 3.

308.3.2.4 Grading: The aggregate shall be well graded when tested in accordance with ASTM C 136 and C 117. The percentage composition by dry weight shall be within the following limits:

308.3.3 DECOMPOSED GRANITE: Decomposed granite shall be any granitoid rock which has been weathered in place and which has principle constraints granular fragments of quartz and feldspar. It may also contain fragments of granitic rock not yet broken down into the component minerals. This material shall remain stable when saturated with water. Particles larger than 2 inches which will not be broken in the process of rolling and tamping during construction, shall not be used. Decomposed granite shall meet the following specifications:

308.3.3.1 Physical Requirements: When sampled and tested in accordance with the standard testing methods the aggregate shall meet the following requirements:

308.3.3.2 Percentage of Wear: Testing shall be in accordance with ASTM C 131, except that a 15 pound total representative sample shall be utilized and that nothing shall be placed in the drum other than the sample. When tested as herein described not more than 20 percent of the total sample shall pass the No. 200 sieve after 500 revolutions. Testing of this product shall be in accordance with ASTM C 117.

308.3.3.3 Plasticity Index: When tested in accordance with AASHTO T 90, the plasticity index shall not be more than 10 nor less than 3.

308.3.3.4 Grading: When tested in accordance with ASTM C 136 and C 117, the percentage composition by dry weight shall be within the following limits:

Screen or Sieve	Percent Passing
2 inch	100
No. 4	40 - 75
No. 200	6 - 20

308.4 SAMPLE

A representative sample of proposed material to be utilized as natural gravel surfacing shall be submitted to the City Materials Testing Laboratory two weeks prior to intended use. This material

shall be tested for specification compliance and recommendations.

308.5 CONSTRUCTION OF ROADWAY

308.5.1 Natural gravel surfacing shall have a minimum compacted thickness of 6 inches. The construction plans may require a greater thickness, due to local conditions.

308.5.2 The surfacing material shall be compacted to 95 percent of maximum density as determined by AASHTO T 180 for full thickness of surface.

308.5.3 The slope of roadway surface from crown to edge of surfacing shall be 2 percent.

308.6 MEASUREMENT AND PAYMENT

The measurement for natural gravel surfacing shall be the square yard for a specified thickness. Payment will be made at the unit price per square yard as indicated in the Bid Proposal.

SECTION 320

UTILITY AND MONUMENT ACCESS COVER ADJUSTMENTS

320.1 GENERAL

It is essential that the location of all access covers shall be known and that accessibility to operational utilities shall be maintained during paving operations.

320.2 REFERENCES

320.3 PRE-CONSTRUCTION

320.3.1 Prior to the placement of street paving materials the ENGINEER and the CONTRACTOR shall separately record in written form the locations of all existing utility and monument access covers within the construction area. Recordings shall be coordinated between the ENGINEER and CONTRACTOR.

320.3.2 The ENGINEER shall notify the City Surveyor that there are survey reference markers in the construction area that may be damaged or destroyed during paving operations.

320.3.3 During the pre-construction conference the ENGINEER shall advise all the utility representatives that access cover adjustments may be required. The ENGINEER shall be advised by the representatives as to the actions planned for the cover adjustments.

320.4 ACCESS COVER ADJUSTMENTS

320.4.1 WATER VALVE BOXES: Grade and adjustments of valve boxes will be made in accordance with Standard Detail Drawings.

320.4.2 MANHOLES: Grade adjustments to manholes may be made by utilizing adjustment rings, by adding or subtracting layer(s) of bricks, or by adding or subtracting to the barrel of the manhole. See Standard Detail Drawings.

320.4.3 MONUMENTS: Several types of monument containers and covers would basically require removal of the container and resetting to new elevations or the possibility of using an adjustment ring. Currently the City is using surface type markers at new construction sites. These markers can be raised or lowered by an adjusting bolt. City Surveyor's responsibility.

320.4.4 TRAFFIC OR FIRE ALARM SYSTEM BOXES: The traffic or fire alarm system

boxes are of the pull box configuration and are normally located outside of the paved area. Any required grade adjustment would be made by removal and relaying the box.

320.4.5 OTHER UTILITIES: For grade adjustments to access covers of other utility company facilities, the ENGINEER shall contact the concerned utility as to their requirements. Any details will be shown on the construction plans.

320.5 TIME OF ADJUSTMENT

320.5.1 NEW PAVING: Prior to placement of surface course all access covers shall be adjusted to final grade.

320.5.2 OVERLAY HEATER REPAVING OR OTHER TYPES OF RESURFACING

320.5.2.1 Generally overlay, heater repaving or other types of resurfacing occur in a developed area. Therefore, it is essential that all utility access cover locations be recorded as specified in Subsection 320.3.1.

320.5.2.2 If the CONTRACTOR elects to remove valve boxes, valve covers, manhole rings, or other access covers which may interfere with the milling operation, the CONTRACTOR shall replace these items immediately after the passage of the milling equipment. Under no circumstances will these openings remain covered with a flat wood or metal barrier and a paving section material for more than 8 hours after milling.

320.5.3 SURFACE SEALS: Surface sealing occurs in developed areas; therefore, access covers shall be exposed as soon as sealed surface permits vehicle access to the area. Removal of any sealing materials from covers shall be completed within two working days after application.

320.6 MEASUREMENT AND PAYMENT

Depending upon the type of street improvement being constructed the following measurements and payment shall be used:

320.6.1 For new street paving there will be no payment made for adjustments of the access covers in order to position them at the proper elevations.

320.6.2 When the work consists of overlay, slurry seal or heater remix

resurfacing, the access cover adjustments may involve specific methods for various types of covers. Payment shall be made as specified in the Bid Proposal.

320.6.3 If a form of surface seal (1/4" or less in applied thickness) is used, grade adjustments should not be necessary. All access cover surfaces shall be exposed immediately after application of treatment. No separate payment will be made.

SECTION 328

QUIET ASPHALT CONCRETE PAVEMENT

328.1 GENERAL: Quiet asphalt concrete (QAC) pavement shall consist of proportioning, mixing in a central plant, aggregate, bituminous materials, admixtures as required, transporting, placing, and compaction, in substantial compliance with this specification, at the areas/volumes and dimensions specified in the CONTRACT plans and specifications. The CONTRACTOR shall be solely responsible for the QAC materials and construction. A job mix formula used for QAC shall be certified in accordance with the requirements of Section 13 of these specifications. Each job mix formula submitted and authorized for use under this specification shall be identified by a number, unique to that job mix formula and production plant. If either a change in material(s) or material supplier(s) from that specified in the job mix formula occurs during a project, authorized use of the job mix formula on the project may be canceled as directed by the ENGINEER. A job mix formula shall not be used on a project without written approval of the ENGINEER. A job mix formula, upon request by a supplier, may be authorized by the Public Works Department Construction Division for use on City and City related projects for a period of 14 months, from the date of sampling of aggregates used in the job mix formula.

328.2 REFERENCES:

328.2.1 American Society For Testing and Materials (ASTM), (Latest Edition):

C88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C117	Method for Material Finer Than 0.75 um (No.200) Sieve In Mineral Aggregates by Washing
C131	Test Method for Resistance to Degradation of Small-size Coarse Aggregate by Abrasion and Impact in a Los Angeles Machine
C136	Method for Sieve Analysis of Fine and Coarse Aggregate
D242	Specifications for Mineral Filler for Bituminous Paving Mixtures
D692	Specification for Coarse Aggregate for Bituminous Paving Mixtures
D979	Methods of Sampling Bituminous Paving Mixtures
D995	Specification for Mixing Plants for Hot-Mixed, Hot Laid Bituminous Paving Mixtures
D1073	Specification for Fine Aggregate for Bituminous Paving Mixtures
D1074	Test Method for Compressive Strength of Bituminous Mixtures
D1559	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

D2041	Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures
D2172	Quantitative Extraction of Bitumen From Bituminous Paving Mixtures
D2493	Viscosity-Temperature Chart for Asphalts
D2726	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
D2851	Test for Determining the Percentage of Fractured Particles in Coarse Aggregate
D2950	Density of Bituminous Concrete in Place by Nuclear Methods
D3203	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
D3515	Standard Specification for Hot Mixed, Hot-Laid Bituminous Paving Mixtures
D4125	Asphalt Content of Bituminous Mixtures by the Nuclear Method
D4791	Test for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

328.2.2 American Association of State Highway and Transportation Officials (AASHTO) (Latest Edition):

MP2	Specification for Superpave™ Volumetric Mix Design
PP-28	Superpave™ Volumetric Design for HMA
TP 4	Preparation of Compacted Specimens of Modified and Unmodified Hot Mix Asphalt by Means of SHRP Gyratory Compactor
PP 2	Short and Long-term Aging of Bituminous Mixes
T53	Quantitative Analysis of Bitumen From Bituminous Paving Mixtures. Ignition Oven Method
T245	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
T283	Resistance of Bituminous Mixture To Moisture Induced Damage
T304	Uncompacted Void Content of Fine Aggregate

328.2.3 This publication:

SECTION 13	WARRANTY AND GUARANTEE; TESTS AND INSPECTIONS; CORRECTIONS, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK
SECTION 112	ASPHALT BINDER
SECTION 113	EMULSIFIED ASPHALTS
SECTION 118	HYDRATED LIME
SECTION 336	ASPHALT CONCRETE PAVEMENT

328.3 MATERIALS:

328.3.1 The asphalt binder shall be performance grade binder PG76-28 and comply with the requirements of Section 112.

328.3.2 Aggregates shall be crushed stone, crushed gravel, and natural or manufactured sand. Coarse aggregate(s) shall comply with the requirements of ASTM D692 and this specification. Fine aggregate(s) shall comply with the requirements of ASTM D1073 and this specification. Aggregates shall be certified to comply with the requirements of this specification and authorized for use by The ENGINEER before the materials may be incorporated into the construction. Prior to delivery of the aggregates or material containing the aggregates, The CONTRACTOR may be required to furnish samples of the aggregates to The ENGINEER for testing. Daily production aggregates gradations shall be submitted to the ENGINEER, upon request.

328.3.3 Mineral filler shall comply with the requirements of ASTM D242, Mineral Filler for Bituminous Paving Mixtures and as specified herein. Mineral filler shall be certified to comply with the requirements of this Specification and approved for use by the ENGINEER before the materials may be incorporated in the construction. Prior to either delivery of the mineral filler or material containing the mineral filler, The CONTRACTOR may be required to furnish samples of the mineral filler to The ENGINEER for testing.

328.3.4 Quiet asphalt concrete shall comply with the minimum requirements of TABLE 328.C. Moisture susceptibility, % retained strength at 22% air voids, AASHTO T283, with freeze cycle. Admixtures to reduce moisture susceptibility in a quiet asphalt concrete mix shall be either hydrated lime, portland cement, liquid admixture, or a modified asphalt binder as directed by the ENGINEER.

328.4 PROPORTIONING

328.4.1 The CONTRACTOR shall be solely responsible for the quiet asphalt concrete job mix formula (jmf) proportions and quiet asphalt concrete either batched at and/or delivered to the site. Quiet asphalt concrete shall be proportioned in accordance with the requirements of this Specification.

328.4.2 Quiet asphalt concrete material shall be proportioned to comply with the requirements of TABLE 328.A, 328.B, and 328.C of this specification, AASHTO MP2, Specification for Superpave™ Volumetric Mix Design, and PP-28, Superpave™ Volumetric Design for HMA. Quiet asphalt concrete job mix formula shall be

designed under the direct supervision of a New Mexico Registered Professional Engineer who has completed a certified SUPERPAVE Mixture Design & Analysis" Short Course.

328.4.3 Quiet asphalt concrete design and analysis shall be performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, under the direct supervision of a New Mexico Registered Professional Engineer.

328.4.4 The testing equipment used in the performance of design development testing shall be (1) certified to comply with the specifications, and (2) calibrated annually with standards traceable to the National Bureau of Standards, as specified by the manufacturer. Certificates of calibration and equipment standards shall be maintained at the laboratory for review and shall be submitted to the ENGINEER upon request.

328.4.5 Aggregates and mineral anti strip admixture, if required, shall be proportioned to provide a combined aggregate gradation that complies with the requirements specified in Tables 328.A and 328.B. The target gradation shall have a similar shape characteristic gradation curve as the specification limits when graphically plotted on a standard "0.45 POWER" gradation chart. The gradation shall be reported to the nearest whole per cent for material passing sieves above the 0.075 mm (no. 200) sieve, and to the nearest 0.1 per cent for material passing the 0.075 mm (no. 200) sieve. The theoretical maximum density gradation curve shall be the curve represented by a straight line drawn from the intersection of the ordinate and abscissa of the graph to the one hundred percent passing point for the nominal maximum size aggregate.

328.4.6 The asphalt binder content shall be proportioned to comply with the requirements defined in TABLE 328.C. The percentage of binder shall be determined based on laboratory testing complying with the requirements of this specification, submitted by the Contractor, and authorized by the ENGINEER. The percentage asphalt binder production tolerance shall be ± 0.3 percent as determined by the tank strap method, and ± 0.5 percent for laboratory quantitative analysis methods.

328.4.7 The materials specified in a job mix formula shall be the same source and type for all quiet asphalt concrete batched, delivered, placed and compacted, under the identification code defined for the authorized job mix formula.

TABLE 328.A - GRADATION

Sieve Designation		Percent by Weight Passing Sieve		[A]
in.	(mm)	Min	Max	%,
0.75	(19.00)	100	100	
5/8	(16.00)	92	98	8
1/2	(12.50)	70	85	8
3/8	(9.50)	40	60	8
no.4	(4.75)	15	25	7
no.16	(2.36)	5	15	5
no.50	(0.30)	3	12	5
no.200	(0.08)	2.0	6.0	2.0

A. Production Tolerance

TABLE 328.B- COMBINED AGGREGATE DESIGN PROPERTIES

CHARACTERISTIC	AGGREGATE TYPE		PROCEDURE
	Coarse	Fine	
1. Coarse aggregate angularity, material > 4.75 mm	95[1] 90[2]		ASTM D 5821
2. Fine aggregate angularity as air voids, %, min	-	45	AASHTO TP 33
3. Flat and elongated particles, 3:1 or greater dimension, material > 4.75 mm, %	20 max		ASTM D 4791
4. Clay content, min %	-	45	ASTM D 2419
5. Deleterious material, max %	1	1	ASTM C 142
6. LA Abrasion, material > 2.36 mm, max loss, %	40	40	ASTM C 131
7. Soundness, max loss after 5 cycles, %	15	15	ASTM C 88

[1] coarse aggregate has one or more fractured faces

[2] coarse aggregate has two or more fractured faces

TABLE 328.C - QUIET ASPHALT CONCRETE DESIGN SPECIFICATIONS

Characteristics @ Nd	Specification
A. Binder Content, PG76-28, %	5.5 to 6.5
B. Air voids, %	19.5 - 20.5
C. Voids filled with asphalt, VFA, minimum	35 - 45
D. Gyratory Compactive Effort	
Compaction, % [1]	
< 75	Gyrations Ni (initial) 7
78 - 82	Nd (design) 95
< 85	Nm (max) 150
E. Moisture susceptibility, min % retained strength @ 22 % air voids, AASHTO T283	80

[1] As % of maximum theoretical specific gravity / density, Gmm.

[2] The bulk specific gravity (Gmb) of a molded briquette at Nm shall be determined based on mass (m) measured to the nearest 0.01g, and the volume (V) calculated to the nearest 0.1 cc. The volume shall be calculated based on measurements of the diameter and height of the briquette. The height (h) and diameter (d) of a briquette shall be measured to the nearest 0.001 in. The volume shall be calculated from the average of at least four (4) measurements of the height and diameter, $PI=3.1415927$, $1\text{ in}=25.4\text{ mm}$, and the formula $V=0.25PId^2h$. The bulk specific gravity shall be calculated as the mass divided by the volume, $Gmb@Nm=m/V$, reported to 0.001. For English units, $Gmb'=Gmb@Nm \times 62.245\text{ pcf}$.

328.5 SUBMITTALS:

328.5.1 A job mix formula submittal shall include but not be limited to the information specified in Table 328.D.

TABLE 328.D - SUBMITTAL INFORMATION

I. Identification
A. Asphalt concrete supplier
B. Laboratory that performed design/development tests
C. Date of Submittal
D. Unique mix code identification number
E. Aggregate sample date
II. Job Mix Formula (jmf)
A. City type/application of asphalt concrete
B. Component material target proportions to include combined aggregate gradation and asphalt content, specifications, and production tolerances
C. 0.45 power gradation plot of combined aggregate gradation with specification and production limits
D. Temperature viscosity relationship of binder
E. Recommended mixing, compaction, and release to traffic maximum temperatures.
F. Tabulation of job mix formula performance characteristics defined in TABLE, at the proposed design proportions, with reference specification limits and production limits (if specified), maximum theoretical specific gravity/density (as pcf), and bulk specific gravity/density (pcf).
G. Reference daily production gradation, see Section 116
III. Certifications of Compliance
A. Compliance of job mix formula by NM Registered Professional Engineer in direct charge of design/development;
B. Design Laboratory Certification.
C. Component materials testing and certification by supplier/manufacture with supporting test data for materials used in design development
D. Certification and laboratory test results of asphalt binder used in job mix formula design development, see Section 112.
IV. Design Development (Tables and graphs, with specifications limits of the following:)
1. Trial Designs: Aggregate gradations, 3 minimum required, and trial asphalt binder content (%)
a) Table of Aggregate Gradations and 0.45 power plot, with specification limits
b) Trial design % asphalt content
c) Trial designs volumetric analysis for each gradation, VMA, Va, VFA, graph not required
d) Trial designs compaction analysis @ Ni, Nd, and Nm, for each gradation
e) Dust ratio for each trial design, graph not required.
2. Job Mix Formula Design, (design development with a minimum of 4 asphalt binder contents required, and the recommended design characteristic bracketed by a minimum of two test points for the design binder content + 0.5%)
a) Table of design aggregate gradation and 0.45 power plot, with specification limits and production targets
b) Compaction analysis G_{mb} as % G_{mm} at Ni, Nd, and Nm, vs asphalt content (separate graphs for Ni, Nd, and Nm)
c) Volumetric analysis of VMA, Va, VFA, and dust ratio at design gradation, @Nd, vs % asphalt content
d) Gyration compaction tables as height of sample versus gyration, for each asphalt content, G_{mb} @ NM, and bulk specific gravity/density correction factor(s) (graphs not required)
e) Maximum theoretical specific gravity/density (as pcf), G_{mm} , vs %asphalt content
f) Corrected bulk specific gravity/density (as pcf), G_{mb} , vs % asphalt content
e) dust ratio vs.% asphalt content
f) Recommended gyration sample mass(g) for 115 mm sample height at Nm
C. Ignition Correction Factor: Correction for material losses during asphalt content ignition oven analysis
The correction factor shall be determined as the average value for three samples, design % asphalt content, design - 1.0%, and design +1.0%, developed in an ignition oven complying with the requirements of AASHTO T53, Method A.

328.5.2 A job mix formula submittal shall be accepted or rejected within ten (10) working days of receipt by the ENGINEER. A submittal shall be rejected if it does not include the specified information.

328.6 CONSTRUCTION METHOD

328.6.1 Quiet Asphalt Concrete shall be batched in accordance with the requirements of ASTM D3515, the requirements of this Specification, as authorized by the ENGINEER. Batching facilities shall comply with the requirements of ASTM D995, and this Specification. A batch plant shall be certified annually by a New Mexico Registered Professional Engineer, to comply with the requirements of this Specification and Section 13. Certification shall be completed within 12 months prior to submittal of a job mix formula to be produced at the plant. The batch plant shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certificates of calibration and production certifications shall be maintained at the plant for review and shall be submitted to the ENGINEER upon request.

328.6.2 The mineral aggregate mixing temperature shall be not less than nor greater than the mixing temperature range specified in the authorized job mix formula

328.6.3 Asphalt binder mixing shall be not less than nor greater than the mixing temperature range specified in the authorized job mix formula when introduced into the mixture.

328.6.4 Quiet Asphalt Concrete shall be batched and placed at the design proportions specified in the authorized job mix formula within the specified production tolerances for combined aggregate gradation and asphalt binder content. Asphalt concrete placed at a project, sampled and tested in accordance with this specification, shall have a gradation that complies with the authorized design gradation \pm the production tolerance(s) specified in the authorized job mix formula. Asphalt concrete placed at a project, sampled and tested in accordance with this specification, shall have an asphalt content that complies with the design asphalt content \pm 0.5% (laboratory analysis).

328.7 DELIVERY

328.7.1.1 Quiet Asphalt Concrete shall be delivered in trucks free of fluid leaks. Trucks detected to have leaks shall not be allowed on the project. Subgrade, base course, and asphalt concrete surfaces contaminated by uncontrolled equipment fluids shall be removed and replaced with complying material. Contaminated material shall be disposed of as specified. When hauling time from the mixing plant to the job site exceeds two hours or when

inclement weather prevails, bituminous mixtures shall be covered with tarpaulins while being hauled. The tarpaulins shall completely cover the load and be firmly tied down. Mixtures shall be delivered to site of the work and placed without segregation of the ingredients and within the temperature range specified in the authorized job mix formula. Diesel fuel or other petroleum based solvents shall not be used in the bed of transport vehicles as a release agent to prevent build up of the asphalt material. Material contaminated with diesel fuel or other petroleum based solvents shall be removed and replaced with complying material by the CONTRACTOR, as directed by the ENGINEER, at no cost to the OWNER.

328.7.1.2 The CONTRACTOR shall provide to The ENGINEER with each load of quiet asphalt concrete batched at and/or delivered to the job site, before unloading at the site, a delivery ticket on which is printed, stamped or written, the information defined in Table 329.D. A copy of the ticket shall be available for the ENGINEER and a copy shall be available for quality assurance sample reference. Diesel fuel or other petroleum based solvents shall not be used in the bed of transport vehicles as a release agent to prevent build up of the SUPERPAVE asphalt material. If the use of diesel is detected, the load shall be rejected.

TABLE 328.E - DELIVERY TICKET INFORMATION

Name of Asphalt Concrete Supplier
Date of Delivery
Delivery Ticket Number Contractor
Project Name (optional)
Job Mix Formula Number
Weight of Load (tons)
Time loaded

328.7.1.3 Quiet asphalt concrete shall be delivered to a project at a temperature that allows for placement and start of compaction in the range specified in the authorized job mix formula.

328.7.2 Prior to placing quiet asphalt concrete, all foreign matter shall be swept cleaned from the surface of the existing pavement.

328.7.3 A tack coat shall be applied to provide a uniform and complete coverage, as directed by the ENGINEER. Tack shall consist of either SS-1 or SS1h emulsified asphalt, diluted with an equal volume of water, at the rate of 0.03 to 0.12 gal/yd². The exact quantities being determined by the ENGINEER. Tack shall not be puddled.

328.8 PLACEMENT AND COMPACTION:

328.8.1 Quiet Asphalt Concrete may be placed when the

pavement temperature is 60 °F and rising, and the weather is favorable to construction, as authorized by the Engineer. Asphalt concrete may not be placed in either wet weather, or on a wet or damp surface, or on frozen supporting material

328.8.2 In either narrow, or irregular sections, or intersections, or turning radiuses, or turnouts, where it is impractical to spread and finish the base and level the surface mixtures by machine methods, the CONTRACTOR may use placement equipment and/or acceptable hand methods, as authorized by the Engineer.

328.8.3 Quiet asphalt concrete shall be placed in a uniform compactor lift, equal or greater than 1 inch and less than or equal to 1.5 inch, by means of a bituminous paver conforming to the requirements of Section 336. The temperature of the mixture shall neither less than nor greater than the compaction temperature range specified in the authorized job mix formula after placement on the road, behind the lay down machine.

328.8.4 Compaction shall begin when the quiet asphalt concrete temperature is in the compaction temperature range specified in the authorized job mix formula. Compaction shall be completed before the temperature of the material cools to less than 200 °F. The material shall be compacted to a density of at least 78 % but not greater than 82 % of the maximum theoretical density as determined by ASTM D2041.

328.8.5.1 Compaction equipment may be steel wheeled, pneumatic wheeled, and hand plate tampers, free of fluid leaks, selected by the CONTRACTOR, and authorized by the ENGINEER. Compaction equipment detected to have leaks shall not be allowed on the project.

328.8.5.2 Compaction may be either static or dynamic (vibratory). All equipment shall be ballasted and operated as recommended by the manufacturer. Motorized wheeled dynamic (vibratory) compaction equipment shall have the frequency rate and amplitude setting readily available for review by the ENGINEER. Frequency rate and amplitude adjustability shall be operable on so equipped motorized wheeled dynamic (vibratory) compaction equipment. Motorized compaction equipment with inoperable frequency rate and amplitude adjustment features shall not be used on the project.

328.8.5.3 Motorized compaction equipment shall be equipped with automatic wheel spray systems to apply release agents to prevent tracking of asphalt concrete. Diesel fuel or other petroleum based solvents shall not be used as a release agent to prevent build up of the asphalt material. Material contaminated with diesel fuel or other

petroleum based solvents shall be removed and replaced with complying material by the CONTRACTOR, as directed by the ENGINEER, at no cost to the OWNER.

328.8.5.4 Repair and replacement of damaged adjacent property and structures, resulting from the use of vibratory rolling equipment, shall be the responsibility of the CONTRACTOR, at no cost to the OWNER.

328.8.6 The surface shall be finished smooth, true to the dimensions shown on the plans, and be free of any irregularities in excess of 3/16 inch in 10 feet, when tested with a 10 feet long straight edge resting on any two (2) supports of equal height.. Any defective areas shall be immediately corrected removing the defective areas, replacing them with new material to conform to the remainder of the pavement, as directed by the ENGINEER. Such work shall be done by the CONTRACTOR at no cost to the owner.

328.9 SAMPLING AND TESTING

328.9.1.1 A quality assurance asphalt concrete material field sample shall be taken in accordance with the requirements of ASTM D979 for each job mix delivered. The materials shall be sampled at the greater rate of either one sample for each 250 tons, or one sample per day, for each type of material placed on a project, as directed by the ENGINEER. The sample shall be of such size to provide material for all tests specified and a split sample to perform verification/referee tests for gradation and binder content, if required. Tests shall be performed under the direct supervision of a New Mexico Registered Professional Engineer who has completed a certified "SUPERPAVE Mixture Design & Analysis" Short Course, in accordance with the requirements of this Specification the Supplemental Technical Specifications, or as directed by The ENGINEER.

328.9.1.2 Quality assurance asphalt concrete analysis shall be (1) performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, and (2) under the direct supervision of a New Mexico Registered Professional Engineer.

328.9.1.3 Testing equipment used in the performance of specified testing shall be calibrated annually with calibration standards traceable to the national Bureau of Standards. Certification records shall be maintained at the Laboratory for review by The ENGINEER. A copy of the certifications shall be submitted to The ENGINEER upon request.

328.9.2 A sample shall be tested for but not limited to the properties of combined aggregate gradation, asphalt binder content, and maximum theoretical specific gravity/density, and as required in TABLE 328.F.

TABLE 328.F - FIELD SAMPLE LABORATORY TESTS

-
- I. Analysis (sample aging is not required)
 - Analysis at authorized jmf gyrations, N_i (initial), N_d (design), and N_m (max). (1) Two briquettes required. (2) Report average of test results of two briquette tests.
 - A. Compaction analysis with authorized design, and specifications (if applicable)
 - 1 Bulk specific gravity/density, G_{mb} , @ N_i , N_d , and N_m
 - 2 Maximum theoretical specific gravity/density, G_{mm}
 - 3 Compaction: G_{mb} as % G_{mm} at N_i , N_d , and N_m
 - 4 Sample height, mm. at N_d
 - B. Volume characteristics of compacted briquettes @ N_d , with design value and specification
 - 1 VMA, voids in mineral aggregate
 - 2 V_a , voids in asphalt concrete
 - 3 VFA, voids filled with asphalt binder
 - II. Asphalt binder content, with design value and authorized production range
 - III. Dust ratio with design value and specification
 - IV. Extracted Combined Aggregate, with design value(s) and authorized production range
 - A. Gradation
 - B. Coarse aggregate angularity, material > 4.75 mm, coarse aggregate has two or more fractured faces
 - C. Flat and elongated particles, 3:1 or greater dimension, material > 4.75 mm, %
-

328.9.3 A CONTRACTOR may challenge production material test results, binder content and aggregate gradation, and request that the retained split asphalt concrete sample of record be released to his assigned laboratory and tested for compliance, as authorized by the ENGINEER. Notification of challenge shall be made in writing to the ENGINEER by the CONTRACTOR within 28 calendar days from date of sampling. Challenge test results shall be submitted to the ENGINEER for evaluation no later than 42 calendar days from date of sampling. Challenge test results will be evaluated in accordance with the "multi laboratory" precision tolerances specified, T53 for binder content, ASTM C117 and C136 for aggregate gradation. Challenge and record test results that comply with precision tolerances will be averaged with the companion test results of record and the material pay factor, PF_M , recalculated, as directed by the ENGINEER. Challenge and record test results that do not comply with the precision tolerances will direct the disqualification of the challenged sample, as directed by the ENGINEER. Cut/core sample(s) will be taken from the area(s) represented by the disqualified challenge sample(s) and evaluated by the lab of record under the observation of the CONTRACTOR, in accordance with the requirements of this specification and replace the disqualified sample test results. Analysis of the replacement cut/core sample(s) may not be challenged. The CONTRACTOR will submit

challenge test results in writing to the ENGINEER for each split sample released to his assigned laboratory of record. Challenges filed after the time limitations will not be considered. The OWNER shall pay for all complying tests.

328.9.4.1 Quality assurance in place field compaction tests shall be conducted in accordance with the requirements of this specification, as directed by the Engineer.

328.9.4.2 In place field density shall be measured in accordance with the requirements of ASTM D2950, at the greater rate of either three tests per 500 sy and fraction thereof placed in a day, or three samples per day, as directed by The ENGINEER. Compaction shall be calculated as the bulk specific gravity/density, divided by the average of the maximum theoretical density (G_{MM}) of the samples taken for that day's placement, reported to the nearest one tenth of a percent, xxx.x%. The maximum theoretical specific gravity/density (G_{MM}) shall be determined in accordance with ASTM D2041, and reported to the nearest x.xxx / 0.01 pound per cubic foot. The bulk specific gravity (G_{mb}) of a core shall be determined based on the mass (m) measured to the nearest 0.1 g, and the volume (V) calculated to the nearest 0.1 cc. The core volume shall be calculated based on the height (h) and diameter (d) measured to the nearest 0.001 in. The volume shall be calculated using the average

of at least four (4) measurements of the height and diameter, $PI=3.1415927$, $1 \text{ in} = 24.4 \text{ mm}$, and the formula $V=0.25PI d^2 h$. The bulk specific gravity shall be calculated as the mass divided by the volume, $G_{mb}=m/V$, reported to 0.001. For english units, $G_{mb}'=G_{mb} \times 62.245 \text{ pcf}$. A core shall be drilled with a core barrel having an inside diameter equal or greater than 6 inches.

328.9.4.3 A reference density test of the support material, for the asphalt concrete roadway lift to be construction, shall be taken prior to the placement of the fresh asphalt concrete lift, or defined from previous test results. The density of the support material shall be used as reference in performing the density test of a fresh asphalt concrete lift in accordance with the requirements ASTM

D2950, placed over the support material. A density test of the support material shall be taken at the rate of one (1) test for each 500 sy of surface or less to be paved over in a day, as directed by the Engineer. The density of the support material shall be reported as "reference support material density" in the compaction test report of the constructed asphalt concrete pavement over the area represented by the support material compaction test.

328.9.4.5 Compaction tests shall be taken at random locations, as directed by The ENGINEER. The three (3) general areas in which tests are to be taken are the free edge of a mat, mat interior, and the joints. The number of tests taken in each area will vary but the total number of tests taken on any project shall be in the following ranges.

TABLE 328.G - FIELD IN PLACE DENSITY PROPORTIONS

Location	% of total tests
Free Edge of Mat ¹	20 to 33
Mat Interior	33 to 60
Joints ²	20 to 33

NOTES:

- 1 The free Edge of Mat test shall be taken in the area between one (1) foot and two (2) feet in from a free edge of a lift.
- 2 Joints shall include the longitudinal and transverse butt joints between adjacent lifts of asphalt having the same finish elevation. Tests may be taken on material placed against a cold joint edge of formed surface.

328.9.4.6 Samples of the compacted quiet asphalt concrete pavement shall be sampled by the lab of record and tested to determine compaction at the request of the CONTRACTOR, as directed by the ENGINEER. A minimum of three (3) six (6") inch diameter cores shall be taken at random to represent material placed in a day, at the greater rate of one core for each 250 tons, or fraction thereof, or three cores per day, as directed by the ENGINEER. Compaction shall be calculated as the average measured bulk specific gravity/ density of the core, divided by the average of the maximum theoretical specific gravity/ density (G_{MM}) of the samples taken for that day's placement, reported to the nearest one tenth of a percent, xxx.x %. The bulk specific gravity (G_{mb}) of a core shall be determined based on the mass (m) measured to the nearest 0.1g, and the volume (V) calculated to the nearest 0.1cc. The core volume shall be calculated based on the height (h) and diameter (d) measured to the nearest 0.001 in. The volume shall be calculated using the average of at least four (4) measurements of the height and diameter, $PI=3.1415927$, $1 \text{ in} = 24.4 \text{ mm}$, and the formula $V=0.25PI d^2 h$. The bulk specific gravity shall be calculated as the mass divided by the volume, $G_{mb}=m/V$, reported to 0.001. For english units, $G_{mb}'=G_{mb} \times 62.245 \text{ pcf}$. A core shall be drilled with a core barrel having an inside diameter equal or greater than 6 inches. The maximum theoretical specific gravity/density (G_{MM}) shall be determined in accordance with ASTM

D2041, and reported to the nearest one-thousandth (0.001) and one-tenth pound per cubic foot. Compaction determined from cores shall supersede tests results determined under ASTM D2950. The CONTRACTOR shall be responsible for asphalt concrete material replacement at cores holes, at no cost to the OWNER, where samples are removed. The OWNER shall pay for all complying quality assurance compaction sampling and tests.

328.9.4.7 Full depth cores shall be taken, as directed by the Engineer, to determine the depth of structure and determine the depth pay factor, PF_D , defined in TABLE 328.J. A minimum of three full depth cores, having a minimum outside diameter of four (4) inches, shall be taken at random for each 1000 sy, or fraction thereof placed. Cores shall be evaluated in accordance with the requirements of 328.9.7. The core length, depth of the pavement, shall be determined based on the average of three measurements of the length of the core, measured from circular ends of a sample. All measurements shall reported to the nearest 0.125" (1/8 inch).

328.9.5.1 Test reports shall include but not be limited to the information specified in TABLE 328.H - TEST REPORT.

328.9.5.2 Test results shall be reported to The ENGINEER, CONTRACTOR, Supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, in writing, within 7 working days of completion of the sampling of the asphalt and/or the field testing. Non-complying tests shall be reported to The ENGINEER, CONTRACTOR, supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, within 1 working day of completion of the test.

328.9.5.3 The New Mexico Registered Professional Engineer in direct charge of the laboratory shall certify on a quality assurance test report that the test procedures used to generate the report complied with the specifications

TABLE 328.H TEST REPORT

A.	Field Data and Test Results:
1	Date of Sampling/Test
2	City of Albuquerque Project Number or Permit Number
3	Project Title
4	Asphalt Concrete Supplier
5	Delivery Ticket Number (asphalt concrete sample-only)
6	Job Mix Formula Number
7	Location of sample/test as defined by Contract Documents
8	LOT/SUBLOT reference, as directed by the ENGINEER
9	Time of field sampling/testing
10	Material temperature at time of sampling, °F
B.	Laboratory Test Results
1	Laboratory results as defined in TABLE 328.F
2	Field test results with reference specification limits for each LOT
C.	Recommended Pay Adjustment Factor for a LOT
1	C_{LM} , material factor, see TABLE 328.H
2	C_{LC} , placement/compaction factor, see TABLE 328.I
3	PF_D , depth factor defined in TABLE 336.F, see 328.J

328.10 MEASUREMENT AND PAYMENT:

328.10.1 Quiet asphalt concrete shall be measured by the square yard/lift, material delivered, placed, compacted, and finished at the project, as specified in the CONTRACT DOCUMENTS. It shall be measured in a LOT, as directed by the ENGINEER. A LOT shall be each 1000 square yard/lift, or fraction thereof, or as specified in the supplemental technical specifications. Quality assurance materials sampling and testing for a LOT shall be taken for each subplot of 250 tons placed, or fraction thereof, as directed by the Engineer. Compaction testing shall be taken for each subplot of 500 sy in accordance with this Section.

328.10.2 Quiet asphalt concrete pavement shall be paid at the adjusted CONTRACT unit price, adjusted for payment by the equation below, as authorized by the ENGINEER.

328.10.3.1 Quiet asphalt concrete pavement placed in an area of 10 feet or more in width and 100 feet or more in length (requiring machine lay down) shall be divided into

LOTS and paid at the adjusted CONTRACT unit price, specified in this section, as authorized by the ENGINEER.

328.10.3.2 Quiet asphalt concrete pavement placed in an irregular area complying with 328.7.2 shall be divided into LOTS and paid at the adjusted CONTRACT unit price, specified in this section, as authorized by the ENGINEER.

328.10.4.1 A LOT shall be paid at a unit price equal to the sum of the adjusted CONTRACT unit price, adjusted for deviation of full depth of structure from CONTRACT specification. The unit price for a LOT shall be calculated in accordance with the equation below.

$$UP' = PF_D \times F_N \times UP$$

F_N , $0.5 \times (C_{LM} + C_{LC})$, LOT adjustment factor
 C_{LM} , material factor, see TABLE 328.H
 C_{LC} , placement/compaction factor, see TABLE 328.I
 PF_D , depth factor defined in TABLE 328.J
 UP , CONTRACT unit price

328.10.4.2 The material factor, C_{LM} , is the material

acceptance factor for a LOT determined in accordance with TABLE 328.H, based on the absolute value of the deviation of the average value, or arithmetic mean (M), of the daily acceptance sample(s) test results of the sublots for the LOT, deviation from the CONTRACT authorized job mix formula targets (T), for either combined aggregate gradation or binder content. Acceptance samples shall be sampled and tested in accordance with the requirements of this specification.

328.10.4.3 If the deviation is equal or less than the allowable deviation, D' , the corresponding material pay factor, C_{LM} , shall be used.

TABLE 328.H MATERIAL FACTOR, C_{LM} , FOR GRADATION & ASPHALT BINDER CONTENT

Number of Daily Samples	D' , Maximum Allowable Deviation [1, 2, 3]		
	1.40D	1.20D	D
1	D + R	D + 0.37R	D - 0.10R
2	D + 0.30R	D + 0.07R	D - 0.14R
3	D + 0.16R	D - 0.01R	D - 0.17R
4	D + 0.11R	D - 0.03R	D - 0.20R
5	D + 0.09R	D - 0.05R	D - 0.22R
6	D + 0.07R	D - 0.07R	D - 0.24R
7	D + 0.06R	D - 0.08R	D - 0.25R
8	D + 0.05R	D - 0.09R	D - 0.26R
9	D + 0.04R	D - 0.10R	D - 0.27R
10 or more			
Material Factor, C_{LM} [3]	0.85	0.95	1.00

- [1] D, production tolerance \pm %, specified in the authorized job mix formula;
R, range of test values, maximum - minimum values; M, average test value of a LOT's acceptance samples test results;
T, target value specified in authorized job mix formula.
- [2] The material factor, C_{LM} , shall be the lowest factor selected for $|T-M| \leq D'$ calculated for either (a) the combined aggregate gradation and material passing the nominal maximum size aggregate screen, 3/8 inch (9.5 mm), and smaller screens of the project authorized job mix formula, or (b) the asphalt binder content.
- [3] If the absolute value of the deviation of the daily mean from the target exceeds the maximum allowable deviation for a LOT, $|T-M| \geq D'$, the LOT shall be removed and replaced with material complying with this specification, at no cost to the OWNER, as directed by the ENGINEER. If it is determined by the ENGINEER to be more practical to accept the LOT material, it may be accepted under written agreement between the OWNER and the CONTRACTOR, at an assigned pay factor, $C_{LM} = 0.70$, for a LOT having a compaction factor, $C_{LC} \geq 0.85$, as directed by the ENGINEER.

328.10.5 The LOT placement/compaction factor, C_{LC} , shall be defined in accordance with TABLE 328.I, as directed by the ENGINEER. The factor is determined based on the average of the compaction tests taken for a LOT, with no single test neither less than 77.0 % nor greater than 84.0 %. Acceptance compaction tests shall be performed in

accordance with the requirements of this specification. A LOT having a average compaction either less than 77.0 % or greater than 84.0 % shall be evaluated, as directed by the ENGINEER.

TABLE 328.I - PLACEMENT/COMPACTION FACTOR, C_{LC}

Average Test Results	Factor, C_{LC}
84.1 % and greater	[1]
83.1 to 84.0	0.85
82.1 to 83.0	0.90

78.0 to 82.0	1.00
77.0 to 77.9	0.85
less than 77.0%	[1]

- [1] The lift defined for the LOT shall be removed and replaced by the CONTRACTOR with asphalt concrete pavement complying with this specification at no cost to The OWNER, as directed by the ENGINEER. If it is determined by the ENGINEER to be more practical to accept the LOT, it may be accepted under written agreement between the OWNER and the CONTRACTOR at an assigned compaction pay factor, $C_{Lr} = 0.50$, for the LOT, if the LOT has a material pay factor, $C_{lm} \geq 0.85$, as authorized by the ENGINEER.

328.10.6 The depth factor, PF_D , shall be defined in accordance with TABLE 328.J, based on the layer thickness of quiet asphalt concrete measured from cut samples taken from full depth cores of the construction pavement section taken at random in accordance with 328.9.4.7. The pay factor PF_D shall be determined based on the deviation of the average layer thickness (d_A) from the specified lift thickness (D_S), of a minimum of three (3) wafers cut from full depth cores. The average thickness of the wafers shall be measured to the nearest 0.125 (1/8) in. The thickness of any single wafer shall not be less than the

specified section depth, minus 0.25 in. If an individual wafer thickness is identified with a thickness less than the specified depth, minus 0.25 in, additional cores may be taken to verify the condition, as directed by the ENGINEER. If the deficient condition is verified for a LOT, the depth deficient quiet asphalt concrete pavement shall be removed and replaced with complying pavement by the CONTRACTOR at no cost to the OWNER, as directed by the ENGINEER. Cores and cut wafers shall be maintained at the laboratory for a period of four weeks from date of sampling for review by the CONTRACTOR.

TABLE 328.J DEPTH FACTOR, PF_D

Deficient Pavement Depth				PF_D
0.00 in	\leq	$D_S - d_A$	0.25 in	1.00
0.25 in	$<$	$D_S - d_A$	\leq 0.50 in	$(d)^2 / (D)^2$
		$D_S - d_A$	$>$ 0.50 in	[A], [B]
Excessive Pavement Depth, $d - D$				PF_D
		$D_S - d_A$	$<$ 0	1.00

NOTES:

- D_S specified depth for the pavement structure of a Lot.
- d_A average depth of the pavement structure as determined in accordance with 338.8.4.7
- [A] CONTRACTOR shall correct deficiencies, constructing the pavement to the depth, grade, crown, and cross slope drainage, specified in the CONTRACT documents, at no cost to the OWNER, as directed by the ENGINEER.
- [B] If determined by the ENGINEER to be more practical to accept the pavement, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR, at an assigned pay factor of $PF_D = (d)^2 / (D)^2$, for LOT(s), as authorized by the ENGINEER.

SECTION 329

PLANT MIXED SEAL COAT CONSTRUCTION

- 329.1 GENERAL: Plant mixed seal coat (PMSC) construction shall be used on all streets with a posted speed of 40 mph and greater, and consist of proportioning, mixing in a central plant, aggregate, bituminous materials, admixtures as required, transporting, placing, and compaction, in substantial compliance with this specification, at the areas/volumes and dimensions specified in the CONTRACT plans and specifications. The CONTRACTOR shall be solely responsible for the PMSC materials and construction. A job mix formula used for PMSC shall be certified in accordance with the requirements of Section 13 of these specifications. Each job mix formula submitted and authorized for use under this specification shall be identified by a number, unique to that job mix formula and production plant. If either a change in material(s) or material supplier(s) from that specified in the job mix formula occurs during a project, authorized use of the job mix formula on the project may be canceled as directed by the ENGINEER. A job mix formula shall not be used on a project without written approval of the Engineer. A job mix formula, upon request by a supplier, may be authorized by the Public Works Department Construction Division for use on City and City related projects for a period of 14 months, from the date of sampling of aggregates used in the job mix formula. Plant mix seal coat shall be used on all streets with a posted speed of 40 mph and greater.
- 329.2 REFERENCES:
- 329.2.1 American Society For Testing and Materials (ASTM):
- C88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
 - C117 Method for Material Finer Than 0.75 um (No.200) Sieve In Mineral Aggregates by Washing
 - C131 Test Method for Resistance to Degradation of Small-size Coarse Aggregate by Abrasion and Impact in a Los Angeles Machine
 - C136 Method for Sieve Analysis of Fine and Coarse Aggregate
 - D242 Specifications for Mineral Filler for Bituminous Paving Mixtures
 - D692 Specification for Coarse Aggregate for Bituminous Paving Mixtures
 - D979 Methods of Sampling Bituminous Paving Mixtures
 - D995 Specification for Mixing Plants for Hot-Mixed, Hot Laid Bituminous Paving Mixtures
 - D1073 Specification for Fine Aggregate for Bituminous Paving Mixtures
 - D1074 Test Method for Compressive Strength of Bituminous Mixtures
 - D1559 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
 - D2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures
 - D2493 Viscosity-Temperature Chart for Asphalts
 - D2726 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
 - D2851 Test for Determining the Percentage of Fractured Particles in Coarse Aggregate
 - D2950 Density of Bituminous Concrete in Place by Nuclear Methods
 - D3203 Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
 - D3515 Standard Specification for Hot Mixed, Hot-Laid Bituminous Paving Mixtures
 - D4791 Test for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
- 329.2.2 American Association of State Highway and Transportation Officials (AASHTO) (Latest Edition):
- MP2 Specification for Superpave™ Volumetric Mix Design
 - PP-28 Superpave™ Volumetric Design for HMA
 - TP 4 Preparation of Compacted Specimens of Modified and Unmodified Hot Mix Asphalt by Means of SHRP Gyratory Compactor
 - PP 2 Short and Long-term Aging of Bituminous Mixes
 - T53 Quantitative Analysis of Bitumen From Bituminous Paving Mixtures, Ignition Oven Method A
 - T245 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
 - T283 Resistance of Bituminous Mixture To Moisture Induced Damage
 - T304 Uncompacted Void Content of Fine Aggregate
- 329.2.3 This publication:
- SECTION 13 WARRANTY AND GUARANTEE; TESTS AND INSPECTIONS; CORRECTIONS, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK
- SECTION 112 ASPHALT BINDER
- SECTION 113 EMULSIFIED ASPHALTS

SECTION 118 HYDRATED LIME
SECTION 336 ASPHALT CONCRETE PAVEMENT

329.3 MATERIALS:

329.3.1 AGGREGATE:

329.3.1.1 Aggregates shall be crushed stone, crushed gravel, and natural or manufactured sand. Coarse aggregate(s) shall comply with the requirements of ASTM D692, Coarse Aggregate for Bituminous Paving Mixtures and this specification. Fine aggregate(s) shall comply with the requirements of ASTM D1073, Fine Aggregate for Bituminous Paving Mixtures and this specification. Aggregates shall be certified to comply with the requirements of this Specification and authorized for use by The ENGINEER before the materials may be incorporated in the construction. Prior to delivery of the aggregates or material containing the aggregates, The CONTRACTOR may be required to furnish samples of the aggregates to The ENGINEER for testing. Daily production aggregates gradations shall be submitted to the ENGINEER, upon request.

329.3.2 ASPHALT BINDER

The asphalt binder shall be the performance grade binder PG76-28 and shall comply with the requirements of SECTION 112.

329.4 PROPORTIONING

329.4.1 The CONTRACTOR shall be solely responsible for a plant mixed seal coat job mix formula (jmf) proportions either batched at and/or delivered to a project. PMSC shall be proportioned with a "performance grade binder" in accordance with the procedures defined in 'Preparation of Compacted Specimens of Modified and Unmodified Hot Mix Asphalt by Means of SHRP Gyratory Compactor and requirements of the SHRP-A-407, *The SUPERPAVE Mix Design Manual for New Construction and Overlays*, Level 1 SUPERPAVE Design Mix' and TABLE 329B, and TABLE 329.C. A job mix formula shall be designed under the direct supervision of a New Mexico Registered Professional Engineer who has completed a certified "SUPERPAVE Mixture Design & Analysis" Short Course.

329.4.1.2 Asphalt concrete design and analysis shall be performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, under the

direct supervision of a New Mexico Registered Professional Engineer.

329.4.1.3 The testing equipment used in the performance of design development testing shall be (1) certified to comply with the specifications, and (2) calibrated annually with standards traceable to the National Bureau of Standards, as specified by the manufacturer. Certificates of calibration and equipment standards shall be maintained at the laboratory for review and shall be submitted to the ENGINEER upon request.

329.4.2 Aggregates, mineral filler, and anti strip admixture if required, shall be proportioned to provide a combined aggregate gradation that complies with the requirements specified in Table 329.A and 329.B, and have the same or similar shape characteristic gradation curve as the specification limits when graphically plotted on a standard "0.45 POWER" gradation chart. The gradation shall be reported to the nearest whole per cent for material passing sieves above the 0.075 mm (no. 200) sieve, and to the nearest 0.1 per cent or material passing the 0.075 mm (no. 200) sieve. The theoretical maximum density gradation curve shall be the curve represented by a straight line drawn from the intersection of the ordinate and abscissa of the graph to the one hundred percent passing point for the nominal maximum size aggregate.

TABLE 329.A - GRADATION

Sieve Designation in. (mm)	Percent by Weight Passing Sieve		Production Tolerance %
	Min	Max	
3/4 (19.0)	100	100	
5/8 (16.0)	92	98	8
1/2 (12.5)	70	85	8
3/8 (9.5)	40	60	8
no.4 (4.75)	15	25	7
no.16 (2.36)	5	15	5
no.50 (0.30)	3	12	5
no.200 (0.075)	2.0	8.0	2.0

TABLE 329.B - AGGREGATE PROPERTIES

	Specification	Procedure
Fractured Faces Material > no.4 (4.75 mm)	75%, min w/2 frac faces	Visual
Clay content, min %	0.0	ASTM D 2419
Deleterious material, max %	1.0	ASTM C 142
LA Abrasion, material > no.8 (2.36 mm)	40 % max loss	ASTM C 131
Soundness	15 % max loss, after 5 cycles	ASTM C 88

329.4.3 The job mix formula asphalt binder content shall be proportioned to comply with the requirements defined in TABLE 329.C. The percentage of binder shall be determined based on laboratory testing complying with the requirements of this specification, submitted by the CONTRACTOR, and authorized by the ENGINEER. The production tolerance of an asphalt binder shall be ± 0.3 per cent as determined by the tank strap method and ± 0.5 per cent as determined by laboratory quantitative analysis methods.

329.4.4 The materials specified in a job mix formula shall be the same source and type for all plant mix seal coat batched, delivered, placed and compacted, under the identification code defined for the authorized job mix formula.

TABLE 329.C - QUIET ASPHALT CONCRETE DESIGN SPECIFICATIONS

Characteristics @ Nd			Specification
A. Binder Content, PG76-28, %			5.5 to 6.5
B. Voids in Mineral Aggregate (VMA), min %			25
C. Air voids, %			17 - 19
D. Voids filled with asphalt, (VFA), min %			30
E. Gyrotory Compactive Effort @ compaction temperature[2]			
Gyrations	N	Compaction, % [1]	
Ni (initial)	7	<75	
Nd (design)	95	81-83	
Nm (max)	150	<85	
F. Moisture susceptibility, min % retained strength @ design % air voids, AASHTO T283			80

[1] As % of maximum theoretical specific gravity / density, Gmm.

[2] Specific by asphalt binder certification

329.4.5 The materials specified in a job mix formula shall be the same source and type for all quiet asphalt concrete batched, delivered, placed and compacted, under the identification code defined for the authorized job mix formula.

329.4.6 SUBMITTALS

329.4.6.1 A job mix formula submittal shall include but not be limited to the information specified in Table 328.D.

TABLE 329.D - SUBMITTAL INFORMATION

-
- I. Identification
 - A. Asphalt concrete supplier
 - B. Laboratory that performed design/development tests
 - C. Date of Submittal
 - D. Unique mix code identification number
 - E. Aggregate sample date
 - II. Job Mix Formula (jmf)
 - A. City type/application of asphalt concrete
 - B. Component material target proportions to include combined aggregate gradation and asphalt content, specifications, and production tolerances
 - C. 0.45 power gradation plot of combined aggregate gradation with specification and production limits
 - D. Temperature viscosity relationship of binder
 - E. Recommended mixing, compaction, and release to traffic maximum temperatures.
 - F. Tabulation of job mix formula performance characteristics defined in TABLE, at the proposed design proportions, with reference specification limits and production limits (if specified), maximum theoretical specific gravity/density (as pcf), and bulk specific gravity/density (pcf).
 - G. Reference daily production gradation, see 116.3.2
 - III. Certifications of Compliance
 - A. Compliance of job mix formula by NM Registered Professional Engineer in direct charge of design/development;
 - B. Design Laboratory Certification.
 - C. Component materials testing and certification by supplier/manufacture with supporting test data for materials used in design development
 - D. Certification and laboratory test results of asphalt binder used in job mix formula design development, see 112.4.1.2.
 - IV. Design Development (Tables and graphs, with specifications limits of the following:)
 - 1. Trial Designs: Aggregate gradations, 3 minimum required, and trial asphalt binder content (%)
 - a) Table of Aggregate Gradations and 0.45 power plot, with specification limits
 - b) Trial design % asphalt content
 - c) Trial designs volumetric analysis for each gradation, VMA, Va, VFA, graph not required
 - d) Trial designs compaction analysis @ Ni, Nd, and Nm, for each gradation
 - e) Dust ratio for each trial design, graph not required.
 - 2. Job Mix Formula Design, (design development with a minimum of 4 asphalt binder contents required, and the recommended design characteristic bracketed by a minimum of two test points for the design binder content $\pm 0.5\%$)
 - a) Table of design aggregate gradation and 0.45 power plot, with specification limits and production targets
 - b) Compaction analysis G_{mb} as % G_m , at Ni, Nd, and Nm, vs asphalt content (separate graphs for Ni, Nd, and Nm)
 - c) Volumetric analysis of VMA, Va, VFA, and dust ratio at design gradation, @Nd, vs % asphalt content
 - d) Gyration compaction tables as height of sample versus gyration, for each asphalt content, G_{mb} @ NM, and bulk specific gravity/density correction factor(s) (graphs not required)
 - e) Maximum theoretical specific gravity/density (as pcf), G_{mm} , vs %asphalt content
 - f) Corrected bulk specific gravity/density (as pcf), G_{mb} , vs % asphalt content
 - e) dust ratio vs.% asphalt content
 - f) Recommended gyration sample mass(g) for 115 mm sample height at Nm
 - C. Ignition Correction Factor: Correction for material losses during asphalt content ignition oven analysis

The correction factor shall be determined as the average value for three samples, design % asphalt content, design - 1.0%, and design +1.0%, developed in an ignition oven complying with the requirements of AASHTO T53, Method A.

329.4.6.2 A job mix formula submittal shall be accepted or rejected within ten working (10) days of receipt by the ENGINEER. A submittal shall be rejected if it does not include the specified information.

329.5 CONSTRUCTION METHOD:

329.5.1.1 PMSC shall be batched in accordance with the requirements of ASTM D3515, the requirements of this Specification, or as authorized by the ENGINEER. Batching facilities shall comply with the requirements of ASTM D995, and this Specification. A batch plant shall be certified annually by a New Mexico Registered professional Engineer, to comply with the requirements of this Specification and Section 13. Certification shall be completed within 12 months prior to submittal of a job mix formula to be produced at the plant. The batch plant shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certificates of calibration and production certifications shall be maintained at the plant for review and shall be submitted to the ENGINEER upon request.

329.5.1.2 The mineral aggregate mixing temperature shall be not less than nor greater than the mixing temperature range specified in the authorized job mix formula

329.5.1.3 Asphalt binder mixing temperature shall be not less than nor greater than the mixing temperature range specified in the authorized job mix formula when introduced into the mixture.

329.5.1.4 The mineral aggregate and asphalt binder shall be proportioned as specified in the authorized job mix formula and mixed until all aggregate particles are thoroughly and uniformly coated with asphalt binder.

329.6 DELIVERY

329.6.1.1 Plant mixed seal coat shall be delivered in trucks free of fluid leaks. Trucks detected to have leaks shall not be allowed on the project. Subgrade, base course, and asphalt concrete surfaces contaminated by uncontrolled equipment fluids shall be removed and replaced with complying material. Contaminated material shall be disposed of as specified. When hauling time from the mixing plant to the job site exceeds two hours or when inclement weather prevails, bituminous mixtures shall be covered with tarpaulins while being hauled. The tarpaulins shall completely cover the load and be firmly tied down. Mixtures shall be delivered to site of the work and placed without segregation of the ingredients and within the temperature range specified in the authorized job mix formula. Diesel fuel or other petroleum based solvents shall not be used in the bed of transport vehicles as a release agent to prevent build up of the asphalt material. Material contaminated with diesel fuel or other petroleum based solvents shall be removed and replaced with complying

material by the CONTRACTOR, as directed by the ENGINEER, at no cost to the OWNER.

329.6.1.2 The CONTRACTOR shall provide to The ENGINEER with each load of plant mixed seal coat, a delivery ticket with the information contained in Table 329.D. A copy of the ticket shall be available for the ENGINEER and a copy shall be available for quality assurance sample reference. Diesel fuel or other petroleum based solvents shall not be used in the bed of transport vehicles as a release agent to prevent build up of the SUPERPAVE asphalt material. If the use of diesel is detected, the load shall be rejected.

TABLE 329.D - DELIVERY TICKET
INFORMATION

Name of Asphalt Concrete Supplier
Date of Delivery
Delivery Ticket Number Contractor
Project Name (optional)
Job Mix Formula Number
Weight of Load (tons)
Time loaded

329.6.1.3 PMSC shall be delivered to project at a temperature that allows for placement and start of compaction in the compaction temperature range specified in the authorized job mix formula.

329.7 PLACEMENT AND COMPACTION:

329.7.1.1 Plant mixed seal coat shall not be placed before March 1 or after September 31 of a calendar year, except as herein provided. The CONTRACTOR may be granted special permission to place Plant Mix Seal Coats after September 30, as authorized by the ENGINEER. However, under no conditions will the Contractor be permitted to place a Plant Mix Seal Coat on wet pavements, or when the ambient temperature is less than 60°F, or under other conditions of weather that would preclude satisfactory results.

329.7.1.2 Plant mixed seal shall be constructed only when the surface is dry, when the mat surface temperature on which it is to be placed is 60°F or above, when the weather is not foggy, rainy, or stormy; and when the weather is favorable to obtain the desired results.

329.7.1.3 Prior to placing plant mixed seal coat, all foreign matter shall be swept cleaned from the surface of the existing pavement.

329.7.1.4 A tack coat shall be applied to provide a uniform and complete coverage, as directed by the ENGINEER. Tack shall consist of either SS-1 or SS1h emulsified asphalt, diluted with an equal volume of water, at the rate of 0.03 to 0.12 gal/yd². The exact quantities being determined by the ENGINEER. Tack shall not be puddled.

329.7.2 Plant mixed seal coat shall be placed in a compacted layer equal or greater than nominal maximum size of the aggregate and/or equal or less than 3/4 of an inch, by means of a bituminous paver conforming to the requirements of Section 336. The temperature of the mixture shall be not less than nor greater than the compaction temperature range specified in the authorized job mix formula after placement on the road, behind the lay down machine.

329.7.3.1 The surface shall be finished smooth, true to the dimensions shown on the plans with a minimum of three passes with a self propelled steel wheeled roller having a minimum rated capacity of 20 tons.

329.7.3.2 Finish rolling shall begin when the quiet asphalt concrete temperature is in the compaction temperature range specified in the authorized job mix formula. Finish rolling shall be completed before the temperature of the material cools to less than 200 °F.

329.7.3.3 Finish rolling equipment shall be steel wheeled, free of fluid leaks, selected by the CONTRACTOR, and authorized by the ENGINEER. Equipment detected to have leaks shall not be allowed on the project.

329.7.3.4 Finish rolling equipment may be either static or dynamic (vibratory). All equipment shall be ballasted and operated as recommended by the manufacturer. Motorized wheeled dynamic (vibratory) equipment shall have the frequency rate and amplitude setting readily available for review by the ENGINEER. Frequency rate and amplitude adjustability shall be operable on so equipped motorized wheeled dynamic (vibratory) equipment. Motorized wheeled dynamic (vibratory) equipment with inoperable frequency rate and amplitude adjustment features shall not be used on the project.

329.7.3.5 Finish rolling equipment shall be equipped with automatic wheel spray systems to apply release agents to prevent tracking of asphalt concrete. Diesel fuel or other petroleum based solvents shall not be used as a release agent to prevent build up of the asphalt material. Material contaminated with diesel fuel or other petroleum based solvents shall be removed and replaced with complying

material by the CONTRACTOR, as directed by the ENGINEER, at no cost to the OWNER.

329.7.3.6 Repair and replacement of damaged adjacent property and structures, resulting from the use of vibratory rolling equipment, shall be the responsibility of the CONTRACTOR, at no cost to the OWNER.

329.7.4 The surface shall be finished smooth, true to the dimensions shown on the plans. It shall be free of any surface irregularities in excess of 3/16 inch in 10 feet, when tested with a 10 feet long straight edge resting on any two (2) supports of equal height. Any defective areas shall be immediately corrected removing the defective areas, replacing them with new material to conform to the remainder of the pavement, as directed by the ENGINEER. Such work shall be done by the CONTRACTOR at no cost to the owner.

329.8 SAMPLING AND TESTING

329.8.1.1 Plant mixed seal coat material shall be sampled at the greater rate of one sample for each 250 tons, or fraction thereof, placed each day as directed by the ENGINEER. Tests shall be performed under the direct supervision of a New Mexico Registered Professional Engineer who has completed a certified "SUPERPAVE Mixture Design & Analysis" Short Course, in accordance with the requirements of this Specification the Supplemental Technical Specifications, or as directed by The ENGINEER.

329.8.1.2 Quality assurance asphalt concrete analysis shall be (1) performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, and (2) under the direct supervision of a New Mexico Registered Professional Engineer.

329.8.1.3 Testing equipment used in the performance of specified testing shall be calibrated annually with calibration standards traceable to the national Bureau of Standards. Certification records shall be maintained at the Laboratory for review by The ENGINEER. A copy of the certifications shall be submitted to The ENGINEER upon request.

329.8.2 A plant mixed seal coat sample shall be tested for but not limited to the properties combined aggregate gradation, asphalt binder content, and maximum theoretical specific gravity/density, and reported as required in 329.E.

TABLE 329.E
FIELD SAMPLE LABORATORY TESTS

- | | |
|------|---|
| I. | Analysis |
| A. | Analysis at authorized jmf gyrations, N_i (initial), N_d (design), and N_m (max). (1) Two briquettes required. (2) Report average of test results of two briquette tests. (3) Sample aging is not required. |
| B. | Volume characteristics of compacted briquettes with authorized jmf production specifications @ N_i , N_d , and N_m . |
| | 1 VMA, voids in mineral aggregate; |
| | 2 Va, voids in asphalt concrete; |
| | 3 VFA, voids filled with asphalt binder; |
| | 4 Gmb, bulk specific gravity and density, with authorized jmf target |
| II. | Gmm, maximum theoretical specific gravity and density, with authorized jmf target |
| III. | Asphalt binder content (Ignition oven ASHTO T53, method A) |
| IV. | Extracted Combined Aggregate |
| A. | Gradation |
| B. | Coarse aggregate angularity, material > 4.75 mm |
| C. | Flat and elongated particles, 3:1 or greater dimension, material > 4.75 mm, % |
| D. | Fractured Faces, material > 4.75 mm |

329.8.3 A CONTRACTOR may challenge production material test results, binder content and aggregate gradation, and request that the retained split asphalt concrete sample of record be released to his assigned laboratory and tested for compliance, as authorized by the ENGINEER. Notification of challenge shall be made in writing to the ENGINEER by the CONTRACTOR within 28 calendar days from date of sampling. Challenge test results shall be submitted to the ENGINEER for evaluation no later than 42 calendar days from date of sampling. Challenge test results will be evaluated in accordance with the "multi laboratory" precision tolerances specified, T53 for binder content, ASTM C117 and C136 for aggregate gradation. Challenge and record test results that comply with precision tolerances will be averaged with the companion test results of record and the material pay factor, PF_m , recalculated, as directed by the ENGINEER. Challenge and record test results that do not comply with the precision tolerances will direct the disqualification of the challenged and record samples, as directed by the ENGINEER. Cut/core sample(s) will be taken from the area(s) represented by the disqualified challenge sample(s) and evaluated by the lab of record under the observation of the CONTRACTOR, in accordance

with the requirements of this specification and replace the disqualified sample test results. Analysis of the replacement cut/core sample(s) may not be challenged. The CONTRACTOR will submit challenge test results in writing to the ENGINEER for each split sample released to his assigned laboratory of record. Challenges filed after the time limitations will not be considered. The OWNER shall pay for all complying tests.

329.8.4 Test results shall be reported to The ENGINEER, CONTRACTOR, Supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, in writing, within 7 working days of completion of the sampling of the asphalt and/or the field testing. Non-complying tests shall be reported to The ENGINEER, CONTRACTOR, supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, within 1 working day of completion of the test.

329.8.5 The New Mexico Registered Professional Engineer in direct charge of the laboratory shall certify on a quality assurance test report that the test procedures used to generate the report complied with the specifications.

329.9 MEASUREMENT AND PAYMENT:

Plant mixed seal coat shall be measured separate by either the ton or square yard of materials placed on a project, measured complete, in place, and accepted, as specified in the CONTRACT. Unit of payment will be at the adjusted CONTRACT unit price(s) as specified in 329.9.1, as authorized by the ENGINEER.

329.9.1 Plant mixed seal coat shall be paid at the adjusted CONTRACT unit price, adjusted for payment by the equation below and TABLE 329.F, as authorized by the ENGINEER. The material factor, PF_m , is the acceptance factor for material placed on a project each day. It shall be defined in accordance with TABLE 329.F, based on the deviation of the average value or arithmetic mean (M) of the daily acceptance sample(s) test results, for either combined aggregate gradation or binder content, from the reference target (T), as specified in the authorized job mix formula. If the deviation of the daily mean (average), M , from the target, T , exceeds the maximum allowable deviation, D' , for a LOT, $|T-M| > D'$, the LOT shall be removed and replaced with material complying with this specification, at no cost to the OWNER, as directed by the ENGINEER. If it is determined by the ENGINEER to be more practical to accept the material, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR, at an assigned pay factor of $PF_m = 0.70$.

$$UP' = PFm \times UP$$

UP', adjusted CONTRACT unit price, \$/ton

UP, CONTRACT unit price, \$/ton

Pfm, PAY FACTOR (see TABLE 329.E)

TABLE 329.F - MATERIAL FACTOR, PFm, FOR GRADATION & BINDER CONTENT

Number of Daily Samples	For $ T-M \leq D'$, [1, 2]		
	D', Maximum Allowable Deviation [3]		
1	1.40D	1.20D	D
2	D + R	D + 0.37R	D - 0.10R
3	D + 0.30R	D + 0.07R	D - 0.14R
4	D + 0.16R	D - 0.01R	D - 0.17R
5	D + 0.11R	D - 0.03R	D - 0.20R
6	D + 0.09R	D - 0.05R	D - 0.22R
7	D + 0.07R	D - 0.07R	D - 0.24R
8	D + 0.06R	D - 0.08R	D - 0.25R
9	D + 0.05R	D - 0.09R	D - 0.26R
10 OR MORE	D + 0.04R	D - 0.10R	D - 0.27R
PFm [3]	0.85	0.95	1.00

[1] D, production tolerance +/- %, and the authorized job mix formula.

R, range of test values, maximum - minimum values, M, average test value of a LOT's samples test results,
T, target value specified in authorized job mix formula.

[2] If the deviation of the daily mean from the target exceeds the maximum allowable deviation for a LOT,
 $|T-M| > D'$, the LOT shall be removed and replaced with material complying with this specification, at no cost
to the OWNER, as directed by the ENGINEER. If determined by the ENGINEER to be more practical to accept
the material, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR, at
an assigned pay factor $PFm = 0.70$.

[3] The material factor, PFm, shall be the lowest of the factors calculated for either the combined aggregate gradation
of material passing any of the nominal size aggregate screen, 3/8 inch, and smaller screens, or, the binder content.

SECTION 330

ASPHALT EMULSION SLURRY SEAL

330.1 GENERAL

The slurry seal surface shall consist of a mixture of emulsified asphalt; mineral aggregate, and water, properly portioned, mixed, and spread evenly on the surface. The cured slurry shall have a homogenous appearance, fill all cracks, adhere firmly to the surface, and have a skid resistant texture.

330.2 REFERENCES

- 330.2.1 This publication:
SECTION 113
SECTION 336

330.3 MATERIALS

330.3.1 ASPHALT EMULSION: The emulsified asphalt shall be of the type specified by or shown on the plans and shall conform to the requirements of Section 113.

330.3.2 AGGREGATE: Mineral aggregates shall consist of natural or manufactured sand, slag, crusher fines, or a combination thereof complying to the requirements of Section 115.

330.3.3 WATER: All water used with the slurry mixture shall be potable and free from harmful soluble salts.

330.4 JOB-MIX DESIGN

A job-mix formula for the asphalt emulsion slurry seal shall be determined by an approved testing laboratory from representative samples of graded aggregate produced and stockpiled by the CONTRACTOR and meeting all of the specified requirements. The job-mix design shall specify the asphalt content, and, if required, the amount of mineral filler to be used.

330.5 EQUIPMENT

All equipment, tools, and machines used in the performance of this work will be maintained in satisfactory working order at all times.

330.5.1 SLURRY MIXING EQUIPMENT:

330.5.1.1 The slurry mixing machine will be a continuous flow mixing unit and be capable of delivering accurately a predetermined proportion of aggregate, water, and asphalt emulsion to the mixing chamber and to discharge the thoroughly

mixed product on a continuous basis. The aggregate shall be prewetted immediately prior to mixing with the emulsion. The mixing unit of the mixing chamber shall be capable of thoroughly blending all ingredients together. No violent mixing shall be permitted.

330.5.1.2 The mixing machine shall be equipped with an approved fines feeder that provides an accurate metering device or method to introduce a predetermined proportion of mineral filler into the mixer at the same time and location that the aggregate is introduced.

330.5.1.3 The mixing machine shall be equipped with a water pressure system and fog type spray bar adequate for complete fogging of the surface preceding the spreading equipment with a maximum application of 0.05 gallon per square yard.

330.5.1.4 Sufficient machine storage capacity to mix properly and apply a minimum of 5 tons of the slurry shall be provided.

330.5.2 SLURRY SPREADING EQUIPMENT: Attached to the mixer machine shall be a mechanical type squeegee distributor equipped with flexible material in contact with the surface to prevent loss of slurry from the distributor. It shall be maintained so as to prevent loss of slurry on varying grades and crown by adjustments to assure uniform spread. There shall be steering device and a flexible strike-off. The spreader box shall have an adjustable width. The spreader box shall be kept clean and build up of asphalt and aggregate on the box shall not be permitted. The use of burlap drags or other drags shall be approved by the ENGINEER.

330.5.3 CLEANING EQUIPMENT: Power brooms, power blowers, air compressors, water flushing equipment, and hand brooms shall be suitable for cleaning the surface and cracks of the old surface.

330.5.4 AUXILIARY EQUIPMENT: Hand squeegees, shovels, brooms, and other equipment shall be provided as required to perform the work.

330.6 PREPARATION OF EXISTING SURFACE

330.6.1 Immediately prior to applying the slurry, the surface shall be cleaned of all loose material, silt spots,

vegetation, and other objectionable material. Any standard cleaning method used to clean pavements will be accepted, except water flushing will not be permitted in areas where large cracks are present in the pavement surface. The prepared surface shall be approved by the ENGINEER prior to application of any surface treatment.

330.6.2 If the slurry seal is being applied over a brick or concrete surface, highly absorbent asphalt surface, or a surface where the aggregate has become exposed and is polished and slick, a 1 part emulsion to 3 parts water tack coat of the same asphalt emulsion type and grade as specified for the slurry shall be applied to the existing surface after it is cleaned and approved. The tack coat shall be applied with an approved asphalt distributor. The rate of the diluted emulsion shall be between 0.05 to 0.15 gallon per square yard as directed by the ENGINEER.

330.7 COMPOSITION AND RATE OF APPLICATION OF THE SLURRY MIX

The amount of asphalt emulsion to be blended with the aggregate shall be that amount as determined by the lab mix design and any final adjustment made in the field and approved by the ENGINEER. The rate of application shall be the rate, in pounds of per square yard, as shown on the plans or as otherwise approved by the ENGINEER.

330.8 WEATHER LIMITATIONS

The slurry seal surface shall not be applied if either the pavement or air temperature is 60 degrees F or below and falling but may be applied when both the air and pavement temperature is 55 degrees F or above and rising. The mixture shall not be applied if high relative humidity prolongs the curing beyond a reasonable period of time as determined by the ENGINEER.

330.9 APPLICATION OF THE SLURRY SURFACE

330.9.1 GENERAL: The surface shall be fogged with water directly preceding the spreader. The slurry mixture shall be of the desired consistency when deposited on the surface, and no additional materials shall be applied. Total time of mixing shall not exceed 4 minutes. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that complete coverage is obtained. No lumping, balling, or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate shall be

permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate will be permitted. If the coarse aggregate settles to the bottom of the mix, the slurry will be removed from the pavement. Excessive breaking of the emulsion will not be allowed in the spreader box. No streaks such as caused by oversized aggregate will be left in the finished pavement.

330.9.2 JOINTS: No excessive build-up nor unsightly appearance shall be permitted on longitudinal or transverse joints.

330.9.3 HAND WORK: Approved squeegees shall be used to spread slurry in non-accessible areas to slurry mixer. All hand work shall be done by experienced and skilled workmen.

330.9.4 CURING: Treated areas will be allowed to cure until such time as the ENGINEER permits their opening to traffic.

330.9.5 ROLLING: When rolling is specified, the paved surface will be rolled with a 5 ton roller. The paved area will be covered with a minimum of 5 passes of the roller. If a pneumatic roller is used, it will be operated at a tire pressure of 50 pounds per square inch.

330.10 MEASUREMENT AND PAYMENT

The quantity of slurry seal coat applied shall be measured by square yards of slurry seal coat placed and accepted. Payment will be as specified in the Bid Proposal.

SECTION 331

ASPHALT CONCRETE OVERLAY

331.1 GENERAL

Asphalt concrete overlay consists of the placing and compacting of plant mix asphalt concrete over existing pavement structure. The thickness of the overlay shall be as shown on the drawings or as specified in the Supplementary Specifications.

331.2 REFERENCES

- 331.2.1 This publication:
- | | |
|---------|-----|
| SECTION | 116 |
| SECTION | 118 |
| SECTION | 336 |

331.3 MATERIALS

331.3.1 The aggregate gradation and percentage of asphalt binder shall be as specified by the job mix formula as described in Section 116.

331.3.2 Hydrated lime mineral filler may be an additive to the asphalt concrete overlay aggregate as a coating material. Material, mixing and proportioning shall conform to requirements contained in Section 118.

331.3.3 The tack coat, the asphalt concrete mix, and transportation of the mix shall be as specified in Section 336.

331.4 PREPARATION OF SURFACES

331.4.1 When shown on the plans or specified in the Contract, surfaces shall be prepared as follows:

331.4.1.1 Before placing asphalt concrete overlay, severely raveled, cracked, uneven areas of pavement shall be patched prior to the resurfacing operation. Over-asphalted areas or rough high spots shall be removed by burning or blading. Large cleavage cracks shall be filled with asphaltic sealing compound approved to the ENGINEER. The entire surface shall be cleaned. Raveled areas that do not require removing shall be cleaned.

331.4.1.2 After surfaces have been prepared to the satisfaction of the ENGINEER, the entire surface shall be thoroughly cleaned and shall receive a tack coat, if required, as specified in Subsection 336.

331.5 METHODS

Placing and rolling of the asphalt concrete and the smoothness of the surface shall be as specified in Section 336.

331.6 MEASUREMENT AND PAYMENT

Asphalt concrete overlay will be measured by the ton or square yard. Unit of payment will be as specified in the Bid Proposal.

SECTION 332

HEATER-REMIK RESURFACING AND HEATER-REPAVING

332.1 GENERAL

332.1.1 Heater-Remix Resurfacing consists of a "Paving Train" operation, involving heating of the existing asphaltic concrete surface to softening temperature, "soft" milling or mechanical scarification, addition (where specified) of selected aggregates to achieve a desired gradation; addition of an approved liquid rejuvenating agent, mechanical leveling of the processed material, followed by rolling and compacting of the remixed material. This process may be followed by a standard plant-mixed bituminous pavement overlay, of specified thickness and mix design.

332.1.2 Heater-Repaving consists of a single-machine operation which performs the following tasks: Preheating and final heating of existing pavement to achieve pavement surface temperatures of 225°F or greater; mechanical scarification and mechanical leveling of the existing, heated pavement material; immediate direct application of new, hot plant mixed bituminous surface course at specified rate(s), thermally bonding it to existing heated, processed pavement material and using standard "laydown" equipment consisting of pugmill and heated, vibratory screed with approved elevation-sensing devices and mechanical screed adjustment.

A tandem, steel-wheel pavement roller (10-12 Ton rated capacity) is used in addition, to achieve desired finish and degree of compaction.

332.3 REFERENCES

332.2.1 This publication
SECTION 117
SECTION 336

332.3 COORDINATION

332.3.1 Heater-Remix Resurfacing, when followed by a hot-mixed bituminous overlay, shall be performed under a single contact, to include both the heater-remixing and the bituminous overlay, to ensure close coordination between phases of the project and to expedite the work.

332.3.2 Heater-Repaving shall be performed as described in (332.1.2), above. The Heater-Repaving operation does not

include furnishing of hot-mixed bituminous overlay material and may also not include transportation of material to the job site; therefore, it will be the responsibility of the CONTRACTOR to coordinate the schedules of both the production of paving materials and the transportation of these materials to the job site.

332.4 SURFACE PREPARATION

The existing pavement scheduled for treatment, shall be flushed, swept or otherwise cleaned to remove all trash, debris and other deleterious substances which might affect the quality of either Heater-Remix or Heater-Repaving operations.

332.5 WEATHER RESTRICTIONS

332.5.1 Heater-Remix Resurfacing shall not be performed when rain, or the threat of rain is present. No work of this nature shall be performed, when the ambient temperature is below 50°F.

332.5.2 Heater-Repaving shall not be performed when rain, or the threat of rain is present. No work of this nature shall be performed, when the ambient temperature is below 50°F.

332.6 REJUVENATING AGENTS

Rejuvenating agents shall be as specified in the supplemental specifications and shall comply with SECTION 117 and shall only be used in conjunction with Heater-Remix operations, where so specified. Rejuvenating agents shall not be used in any Heater-Repaving operations.

332.7 HEATING AND REMIXING

The existing surface shall be uniformly heated and remixed to a depth specified by the ENGINEER. The remixed surface shall be left in an evenly-spread condition and aggregate shall not be pulverized; broken or spalled. This requirement applies to both Heater-Remix Resurfacing and Heater-Repaving. In addition, where Heater-Repaving is used, the surface temperature of the scarified, level mix shall not be less than 225°F to ensure a thermal bond with the overlay material which is placed immediately thereafter.

332.8 PROTECTION OF PAVEMENT

332.8.1 Heater-Remix Resurfacing work, where a bituminous overlay is included in the project, may be opened to Traffic after completion of the Heater-Remix portion of the work, to permit additional traffic compaction prior to placement of a hot-mixed, bituminous overlay. If requested by the CONTRACTOR and if approved by the ENGINEER, the treated pavement may be opened to traffic for a period not to exceed seven (7) calendar days before placement of the overlay material. If, in the opinion of the ENGINEER a tack coat is then warranted for the Heater-Remixed pavement, prior to overlay, the tack coat will be provided by the CONTRACTOR at no additional cost to the owner.

332.8.2 Heater-Repaving work will be opened to traffic as soon as is practicable after the finish-rolling of the mixture has been completed and the pavement has "cured" sufficiently, in the opinion of the ENGINEER, to receive normally-anticipated traffic loads. The "curing" period will never be less than 30 minutes from completion of rolling to opening for traffic.

332.9 MEASUREMENT AND PAYMENT

332.9.1 Heater-Remix Resurfacing will be measured by the square yard. Asphalt rejuvenating agent will be measured by the gallon based on rate of application specified by the ENGINEER. The CONTRACTOR will not be compensated for applications exceeding the approved rate in gallons per sq. yd. Bituminous overlay when specified, will be measured by the square yard.

332.9.2 Heater-Repaving will be measured by the square yard, complete, in place; including placement and compaction of overlay. Furnishing of hot mix and Transportation of hot mix are not normally a part of the Heater-Repaving Contract.

332.9.3 Payment for Heater-Remix Resurfacing and Heater-Repaving will be at the unit cost per unit of measurement, as specified in the Bid Proposal.

SECTION 333

FOG SEAL COATS

333.1 GENERAL

Fog seal coats on bituminous-paved surfaces shall consist of the application of asphaltic material as specified in the Contract and a sand blotter when directed by the ENGINEER.

333.2 REFERENCES

333.2.2 This publication:
SECTION 113

333.3 TIME OF APPLICATION AND WEATHER CONDITIONS

333.3.1 Fog seal shall not be applied to asphaltic concrete surfaces unless called for by the ENGINEER for the correction of asphalt deficiencies or for the rejuvenation of old asphaltic concrete surfaces.

333.3.2 Asphaltic material shall be applied when the surface is dry or damp but not wet and when there is no threat of rain. The ambient temperature shall be at least 60 degrees F and rising and the application shall cease when the temperature is 60 degrees F and falling.

333.4 MATERIALS

Asphaltic materials shall be of the type, grade, and amount specified or shown on the plans and shall conform to the requirements of Section 113.

333.5 PREPARATION OF SURFACES

Immediately before applying the fog seal the area to be surfaced shall be cleaned of dirt and loose material. The fog seal shall not be applied until an inspection of the surfaces has been made by the ENGINEER and he has determined that the surfaces are suitable for application of the fog seal.

333.6 APPLICATION OF ASPHALTIC MATERIAL

The asphalt material, diluted to a minimum of one part emulsion and one part water, shall be applied at the rate of approximately 1 gallon per square yard. The exact amounts will be determined by the ENGINEER.

333.7 SAND BLOTTER

If there is an excess of asphalt, the treated area shall be covered with sand blotter applied in sufficient quantity to absorb such excess. After the treated

area has been opened to traffic, any excess asphaltic material that comes to the surface shall be immediately covered with additional sand.

333.8 PROTECTION TO ADJACENT PROPERTY

The fog seal shall be protected by barricades until the ENGINEER directs that the street is to be opened to traffic.

333.9 MEASUREMENT AND PAYMENT

333.9.1 Measurement for asphaltic material in place shall be measured by the square yard.

333.9.2 Measurement for sand blotter in place shall be measured by the square yard. The ENGINEER reserves the right to increase or to omit all or any part of the sand blotter.

333.9.3 Unit of payment will be as specified in the Bid Proposal.

SECTION 334

SEAL COATS

334.1 GENERAL

334.1.1 Seal coat and chips on bituminous paved surfaces shall consist of the application of asphaltic material and aggregate.

334.1.2 Precoated chip seal coat surfacing shall consist of the application of a bitumen together with a bitumen covered material aggregate to an existing asphaltic concrete surface.

334.2 REFERENCES

334.2.1 ASTM:

C 131
C 136

334.2.2 AASHTO:

T 96
T 104

334.2.3 This Publication:
SECTION 113

334.3 MATERIALS

334.3.1 ASPHALTIC MATERIAL:

The asphaltic material shall be a rapid setting emulsified asphalt of the type, grade, and amount specified, or shown on the plans, and shall conform to the requirements of Section 113.

334.3.2 AGGREGATE

334.3.2.1 Mineral Aggregate: Mineral aggregate shall consist of crushed stone or crushed gravel, free from adherent fills of clay, and shall not be of such nature that a thorough coating of the bituminous material used in the work will not strip off upon contact with water.

334.3.2.2 Fractured Faces: Crushed gravel used as the seal coat aggregate shall have a minimum of 75 percent by weight of the plus No. 4 mesh aggregate with two or more crushed fractured faces.

334.3.2.3 Percent Wear: When tested in accordance with ASTM C 131 or AASHTO T 96, the percentage of wear shall not exceed 30.

334.3.2.4 Soundness: When tested in accordance with AASHTO T 104, the loss after 5 continuous cycles of the plus No. 4 mesh aggregate based on the gradation of aggregate as received shall be 15 or less.

334.3.2.5 Gradation of Aggregates: The gradation of the aggregates for seal coat and chips or precoated chip seal coat shall be determined by ASTM C 136. The following gradations will apply:

334.3.2.5.1 For Streets and Parking Lots:

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
3/8"	100
No. 4	0-10
No. 10	0-2

334.3.2.5.2 For Median Surfaces:

Sieve Designation	Percent by Weight Passing Square Mesh Sieves
5/8"	100
No. 4	0-12
No. 10	0-2

334.3.3 PRECOATED CHIPS: The aggregate specified shall be coated with asphaltic material, using 1 1/4 percent plus or minus 1/2 percent by total weight, as approved by the ENGINEER. Precoating shall be done by running the aggregate through a suitable pug mill where the aggregate and asphaltic material will be mixed.

334.4 EQUIPMENT

334.4.1 BITUMINOUS DISTRIBUTOR: The distributor shall have pneumatic tires of such width and number that the load produced on the surface shall not exceed 650 pounds per inch of the tire width. It shall be so designed and equipped as to distribute the bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rates ranging from 0.05 to 2.0 gallons per square yard, with a pressure range of from 25 to 75 pounds per square inch with an allowable variation from any specified rate not exceeding 5%. The distributor equipment shall include an independently operated bitumen pump, tachometer, pressure gauges, volume measuring devices, a thermometer for reading the temperature of tank content, and a hose attachment suitable for applying bituminous material to spots missed by the distributor. The distributor shall be equipped for circulation and agitation of the bituminous material during the heating process.

334.4.2 STORAGE TANKS: In the event storage tanks are used, an armored thermometer with a range from 100 degrees F

to 400 degrees F shall be fixed to the tank so that the temperature of the bituminous material may be determined at all times.

334.4.3 MECHANICAL SPREADERS: Self-propelled mechanical spreaders shall be used. Mechanical spreaders shall be adjustable and capable of spreading aggregate at controlled amounts per square yard.

334.4.4 BROOM DRAGS: The broom drags shall consist of brooms of the street type, mounted in a frame in such a manner as to spread the aggregate uniformly over the surface of the area to be treated. The drags shall be equipped with the plates for towing. Towing equipment shall be pneumatic-tired.

334.4.5 POWER BROOMS AND POWER BLOWERS: Brooms and blowers of the power type shall be suitable for cleaning effectively the surfaces to be treated. For crack cleaning, a compressor of not less than 210 cfm shall be furnished complete with necessary tools.

334.4.6 RUBBER-TIRED ROLLERS: Rubber-tired rollers shall be of the self-propelled type weighing no less than 4 tons or more than 10 tons without ballast and consist of 2 axles on which are mounted not less than 9 pneumatic-tired wheels in such manner that the rear group of tires will not follow in the tracks of the forward group. The axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. The tires shall be uniformly inflated. The rollers shall be weighed as directed by the ENGINEER.

If required, one 10-12 ton tandem steel wheel roller shall be provided.

334.5 APPLICATION REQUIREMENTS

334.5.1 TIME OF APPLICATION AND WEATHER CONDITIONS:

Surface treatment materials shall be applied only when the surface is dry and when there is no rain or threat of rain. The ambient temperature at the time of application of surface treatment materials shall be at least 60 degrees F and rising, and the application of the bituminous seal coat shall cease when the temperature is 60 degrees F and falling. Application of the bituminous coat shall be controlled to the extent that any area to which it is applied can be completely covered by the required amount of aggregate while the seal coat is still hot.

334.5.2 PREPARATION OF SURFACES:

Immediately before applying the bituminous surface treatment, cracks shall be treated as shown on the plans and specifications. In all cases, care shall be taken to remove all dirt, clay, and other loose or foreign matter. After the cleaning operation has been completed and prior to the application of any bituminous material, the area to be treated shall be inspected by the ENGINEER to determine its fitness for receiving the treatment and seal.

334.5.3 APPLICATION OF BITUMINOUS COAT:

The asphalt shall be applied as soon as possible after preparation of surfaces. At the time of application, temperatures of the asphalt shall be as directed by the ENGINEER. The asphalt shall be applied by means of a pressure distributor and shall be so applied that uniform distribution is obtained at all points of the surface to be sealed. Unless the distributor is equipped so as to obtain satisfactory results at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application so that flow through the sprays may be started and stopped on the paper and so that all sprays will be operating at full force on the surface to be treated. Immediately after the application, the building paper shall be removed. Any spots missed by the distributor shall be properly treated with a hand spray. Bitumen shall be applied as soon as possible after preparation of surfaces and at a rate of 0.30 to 0.45 gallon per square yard. The bituminous material shall be applied by means of a bituminous distributor. The bituminous material shall be applied at the pressure and in the amounts, within the limits specified, as determined by the ENGINEER. The bituminous material shall be so applied that uniform distribution is obtained over all points of the surface to be treated. Longitudinal laps may be made from 6 to 12 inches in width. The lapping or feathering of transverse joints will not be permitted. Metal sheets, building paper, or other approved methods shall be used in making transverse joints to provide a smooth uniform surface. Any method of applying bituminous materials or aggregate which produces ridges, grooves, or other uneven surfaces will not be permitted. All spots missed by the distributor shall be properly treated with bituminous material as directed by the ENGINEER. The length of application of bituminous material shall be that which can be completely

covered by the required amount of aggregate before the asphalt emulsion has set.

334.5.4 APPLICATION OF AGGREGATE:

The aggregate shall be uniformly spread over the asphalt as soon as possible after application of the asphalt and before the temperature of the asphaltic material drops below the recommended spraying temperature. The aggregate shall be uniformly placed in quantities shown on the plans or as directed by the ENGINEER. Areas having insufficient cover shall be back-spotted or sprinkled with additional aggregate by hand during the operations whenever necessary. Aggregate shall be applied at a rate of 15 to 25 pounds per square yard.

334.5.5 BROOMING: After the finish rolling, excess aggregate shall be broomed to a smooth and uniform surface by the use of drag brooms. The loosening of embedded material by the operation of drag brooms will not be permitted.

334.5.6 PNEUMATIC-TIRED ROLLERS: Rolling with pneumatic-tired rollers shall begin immediately after application of the aggregate. The entire surface of the aggregate shall be rolled not less than 4 times. The pneumatic rollers shall operate at a speed not to exceed 8 miles per hour and shall be as specified in Subsection 335.7.1.

334.5.7 OTHER COMPACTION: In all places not accessible to the roller, the aggregate shall be adequately compacted with hand tampers. Hand tampers shall weigh not less than 25 pounds and shall have a tamping face area of not more than 50 square inches.

334.5.8 WORK COORDINATION: The rate of placement of materials and rolling operations shall be coordinated to produce a satisfactory surface treatment. The ENGINEER may suspend the work when any phase of the operation is being jeopardized. The work shall not be resumed until the CONTRACTOR has complied with the requirements provided and as authorized by the ENGINEER.

334.5.9 CLEANING, PROTECTING, AND SWEEPING: Any aggregate that becomes coated or mixed with dirt or any other foreign material shall be removed, replaced with clean aggregate, and rerolled, as directed by the ENGINEER. All surplus aggregate shall be swept off the surface and gutters and removed and the final cleanup shall include the cleaning out of all storm water catch basins and inlets adjacent to any seal coating operations.

Such basins and inlets shall be covered during spraying and chip spreading operations. The CONTRACTOR will be required to maintain brooming and rolling operations throughout the job to insure coverage, prevent or correct bleeding, as may be required for a complete job. The CONTRACTOR shall clean splattered or splashed asphalt from all curb and gutter and other improvements and shall protect or coat traffic plates, manholes, valve boxes, and other surfaces not to receive seal coat.

334.6 PROTECTION TO ADJACENT PROPERTY

Care shall be taken to prevent the spraying of asphalt upon adjacent pavements and that portion of the street being used for traffic or structures, guard rails, guide posts, markers, trees, shrubs and adjacent property, improvements, and facilities of all kinds. All structures, such as detector boxes, manhole covers, etc., within the paved area shall be protected by the application of paper or oil treatment.

334.7 MEASUREMENT AND PAYMENT

334.7.1 SEAL COAT AND CHIPS: Seal coat and chips shall be measured by the square yard as applied and accepted. Unit of payment will be as specified in the Bid Proposal.

334.7.2 PRECOATED CHIP SEAL COAT:

334.7.2.1 Precoated chips shall be measured by the ton. No separate measurement or payment will be made for bituminous materials used for precoating chips.

334.7.2.2 Asphalt material for seal coat shall be measured by the ton as applied and accepted.

335.7.2.3 Unit of payment will be as specified in the Bid Proposal.

SECTION 335

PAVING FABRIC INSTALLATION

335.1 GENERAL

This work shall consist of placing a paving fabric as part of a pavement rehabilitation project in compliance with the construction plans and these specifications.

335.2 REFERENCES

335.2.1 This publication
SECTION 119

335.3 MATERIALS

335.3.1 PAVING FABRIC: The paving fabric shall comply with Section 119.

335.3.2 TACK COAT: Tack coat may be 85-100 or 120-150 penetration asphalt, CSS-1 or SS-1 emulsified asphalt, or AC-5 or AC-10 asphalt.

335.4 CONSTRUCTION REQUIREMENTS

335.4.1 WEATHER LIMITATIONS: Paving fabric and tack coat shall not be placed if paving is not permitted and if the ambient air temperature is not at least 50°F and rising or at least 55°F.

335.4.2 FABRIC HANDLING EQUIPMENT: Mechanical laydown equipment shall be capable of laying the fabric smoothly without excessive wrinkles or folds.

335.4.3 SURFACE PREPARATION: Prior to tack coat application all cracks wider than 0.50 inches shall be sealed with an asphalt rubber crack sealant. All joints shall be cleaned out and sealed as specified on the plans.

335.4.4 APPLICATION AND PLACEMENT OF MATERIALS:

335.4.4.1 TACK COAT: Tack coat shall be applied in accordance with fabric manufacturer's recommendations. Tack coat width shall be equal to the fabric width. Additional tack coat equal to the optimum asphalt content required by the fabric shall be uniformly applied on the overlapped fabric joints.

335.4.4.2 PAVING FABRIC:

335.4.4.2.1 The CONTRACTOR shall have qualified, manufacturer-trained representatives to supervise placement of the paving fabric.

335.4.4.2.2 The paving fabric shall be stretched, aligned, and placed entirely on the tack coat with a minimum of wrinkles and folds. Hand and mechanical brooming shall be effected to maximize the fabric contact with the tacked roadway surface. If folds in excess of 1/2 inch occur, the fabric shall be slit to remove the fold or wrinkle then overlapped in the direction of the paving.

335.4.4.2.3 All cutting or slitting of paving fabric shall be effected by a method approved by the ENGINEER. When cutting or slitting is employed, the ENGINEER will determine the additional amount of tack coat to be applied, to assure adhesion of the double fabric layer.

335.4.4.2.4 If manual placement methods are used, the fabric shall be unrolled, stretched, aligned, and placed in increments not exceeding 30 feet.

335.4.4.2.5 The fabric shall be rolled when required to seat the fabric to prevent movement and assure fabric saturation. Care shall be taken to avoid tracking plant mix bituminous pavement material onto fabric and to avoid distorting the fabric during rolling.

335.4.4.2.6 If necessary, a small quantity of plant mix bituminous pavement material may be spread over the top of the fabric immediately in advance of the paving operation to prevent the fabric from being picked up by construction equipment.

335.4.4.2.7 No vehicle shall be allowed on the fabric, except rolling equipment (if fabric seating is necessary), equipment needed to spread the small quantity of plant mix bituminous pavement material on top of the fabric, paving equipment, and cross traffic. Prior approval by the ENGINEER shall be received before cross traffic is permitted.

335.4.5 PAVING OPERATIONS: Paving operations shall follow placement of the paving fabric within an hour or within 1/4 mile whichever is less.

335.5 MEASUREMENT AND PAYMENT

Measurement for paving fabric shall be by the square yard of area covered, and shall include installation and tack coat. No extra.

SECTION 336

ASPHALT CONCRETE PAVEMENT

336.1.1 GENERAL: Asphalt concrete pavement shall consist of a mixture of mineral aggregate and asphalt binder, placed and compacted on either a prepared subgrade, or base, or asphalt concrete pavement, in conformity with the lines, grades, and dimensions shown on the plans or as specified in the supplementary Specifications, and this specification. The asphalt concrete including materials, mixing, and hauling shall comply with the requirements of SECTION 116, SECTION 328, and SECTION 329, as applicable, and the supplementary technical specifications. The CONTRACTOR shall be solely responsible for the asphalt concrete pavement supplied under this specification, materials, proportioning, placement, and compaction.

336.1.2 For construction and reconstruction street projects requiring asphalt concrete pavement placement equal or greater than either 500 tons of asphalt concrete per day, the CONTRACTOR shall have a full time asphalt pavement construction supervisor on site to direct the asphalt concrete pavement construction during test sections and pavement construction operations. The supervisor shall be certified under the New Mexico State Highway and Transportation Department/Associated Contractors of New Mexico Technical Training and Certification Program for ASPHALT and SUPERPAVE.™ The supervisor shall be identified by the CONTRACTOR at the prepaving conference and shall be the contact person for the ENGINEER during asphalt concrete pavement construction. Supervisor certification shall be made available to the ENGINEER upon request.

336.1.3 At the direction of the ENGINEER, a Pre-Paving Conference shall be held no later than seven calendar days prior to the start of asphalt concrete pavement construction. The meeting agenda/assigned responsibilities shall be accomplished at the conference.

I. ENGINEER/OWNER

- A. Scope of the project.
- B. Identify construction management team and contact telephone numbers.
- C. Review CONTRACT requirements for asphalt pavement construction.
- D. Review Quality Assurance Program.

II. CONTRACTOR

- A. Review pavement construction schedules.
 1. Test strip location and placement schedules.
 2. Proposed pavement construction schedule for duration of the project.

- B. Identify construction personnel and contact telephone numbers.

1. Contractor Staff
2. Sub-Contractor (s)
3. Supplier (s)
4. Safety Manger

- C. Present construction placement procedure plans.

1. Equipment Schedule
2. Asphalt Concrete Job Mix Formula
3. Paving methodology
4. Traffic Control Plan
5. Quality Control Plan

III. DISCUSSION AND COMMENT

336.2 REFERENCES:

336.2.1 This Publication:

SECTION 13 WARRANTY AND GUARANTEE;
TESTS AND INSPECTIONS;
CORRECTIONS, REMOVAL, OR
ACCEPTANCE OF DEFECTIVE WORK.

SECTION 112 ASPHALT BINDER

SECTION 116 ASPHALT CONCRETE

SECTION 304 LIME TREATED SUBGRADE

SECTION 305 CEMENT TREATED BASE
CONSTRUCTION

SECTION 307 PLANT MIXED BITUMINOUS
TREATED BASE CONSTRUCTION

SECTION 328 QUIET ASPHALT CONCRETE
PAVEMENT

SECTION 329 PLANT MIXED SEAL COAT
CONSTRUCTION

SECTION 333 FOG SEAL COATS

336.3 MATERIALS

336.3.1 ASPHALT CONCRETE

Asphalt concrete shall be placed at the design proportions specified in the authorized job mix formula, within the specified production tolerances for combined aggregate gradation and asphalt binder content. Asphalt concrete placed at a project, sampled and tested in accordance with this specification, shall have a gradation that complies with the authorized design gradation \pm the production tolerance(s) specified in the authorized job mix formula. Asphalt concrete placed at a project, sampled and tested in accordance with this specification, shall have an asphalt content that complies with the design asphalt content \pm 0.5% (laboratory analysis).

336.3.2 PRIME AND TACK COAT

336.3.2.1 Prime coat shall comply with the requirements of Section 113. It shall be applied to subgrade, aggregate base course, and concrete treated base course a minimum of 12 hours prior to placing the asphalt concrete pavement, as directed by the Engineer. Traffic shall not be permitted on the prime coat prior to construction of the asphalt concrete pavement.

336.3.2.2 Immediately prior to prime coat application, an inspection of the surface shall be made by the Engineer. The surface to be primed shall be in a uniform and well compacted condition, true to grade and cross section. All loose and foreign material shall be removed by light sweeping prior to application. Loose material shall not be mixed with asphalt concrete.

336.3.2.3 Prime coat shall be applied uniformly at the rate of 0.10 to 0.30 gallon per square yard. It shall be applied when the air temperature is 40°F and rising, as authorized by the Engineer.

336.3.2.4 In order to prevent lapping at the joint of two applications, the distributor shall be promptly shut off. A hand spray shall be used to touch up all spots missed by the distributor.

336.3.2.5 The pressure distributor used for applying prime coat material shall be equipped with pneumatic tires and shall be so designed and operated as to distribute the prime material in a uniform spray without atomization, in the amount and between the limits of temperature specified. It shall be equipped with a speed tachometer registering feet per minute and so located as to be visible to the truck driver to enable him to maintain the constant speed required for application at the specified rate.

336.3.2.6 The pressure distributor shall be equipped with a tachometer registering the pump speed pressure gauge, and a volume gauge. The rates of application shall not vary from the rates specified by more than 10 percent. Suitable means for accuracy indicating at all times the temperature of the prime material shall be provided. The thermometer well shall be so placed as not to be in contact with a heating tube.

336.3.2.7 The distributor shall be so designed that the normal width of application shall be not less than 6 feet, with provisions for the application "of lesser width" when necessary. If the distributor is equipped with heating attachments, the prime coat material shall be circulated or agitated to provide the application temperature specified by the manufacturer.

336.3.2.8 If the prime coat has not been completely absorbed prior to the start of placing the asphalt concrete pavement, sufficient sand shall be spread over the surface to blot the excess and prevent tracking under traffic. Sand shall be applied as directed by the Engineer. Prior to placing the asphalt concrete pavement, loose or excess sand shall be swept from the base. If a sand cover is specified in the Supplementary Specifications or noted on the drawings to cover a prime coat, it shall be applied within 4 hours after the application of prime coat, as authorized by the Engineer.

336.3.2.9 A prime coat shall be prevented from spraying upon adjacent pavements, structures, guard rails, guide posts, culvert markers, trees, and shrubbery that are not to be removed; adjacent property and improvements; and other facilities or that portion of the traveled way being used by traffic.

336.3.2.10 The Contractor shall protect a prime coat against all damage and markings, both from foot and other traffic. Barricades shall be placed where necessary to protect a prime coat. Damaged prime coat shall be repaired by the CONTRACTOR, at his expense. Asphalt concrete pavement shall not be placed until a prime coat has been accepted by the Engineer.

336.4 TACK COAT:

336.4.1 If the asphalt concrete pavement is being constructed directly upon an existing hard surfaced pavement, a tack coat shall be evenly and uniformly applied to existing pavement preceding the placing of the asphalt concrete, as directed by the ENGINEER. The surface shall be free of water, all foreign material, or dust when the tack coat is applied. No greater area shall be treated in any one day than will be covered by the asphalt concrete during the same day. Traffic will not be permitted over tack coat.

336.4.2 Tack coat shall consist of cationic emulsified asphalt as specified in Section 113. Application rate shall be 0.03 to 0.12 gallon per square yard.

336.4.3 A tack coat shall be applied to the surface of any course if, in the opinion of the Engineer, the surface is such that a satisfactory bond cannot be obtained between it and the succeeding course.

336.4.4 The contact surfaces of all cold pavement joints, curbs, gutters, manholes, and the like shall be painted with a tack coat immediately before the adjoining asphalt concrete is placed. Surfaces where a tack coat is required shall be cleaned of all loose material before the tack coat is applied.

336.5 PLACEMENT

336.5.1 Asphalt concrete may be placed when the ground temperature is 40°F and rising and the weather is favorable, as authorized by the Engineer. Quiet asphalt concrete and plant mixed seal coat may be placed when the pavement temperature is 60 °F and rising, and the weather is favorable to construction, as authorized by the Engineer. Materials may not be placed in either wet weather, or on a wet or damp surface, or on frozen supporting material.

336.5.2 An asphalt concrete pavement lift shall be placed uniformly, at a temperature within the compaction range specified in the authorized job mix formula, without segregation, to such a depth that after compaction it will comply with the specified cross section and grade, specified in the plans and specifications. The temperature of the mat shall be in a uniform range of 15 °F transverse the mat after placement behind the paver. Asphalt concrete shall be placed and compacted in uniform layers/lifts, + 3/16 inch in 10 feet of the lift finish grade. The compacted thickness of a layer/lift shall be equal or greater than two (2) times the maximum size aggregate but less than or equal 4.0 inches for a SP-II aggregate gradations. The compacted thickness of a layer/lift shall be equal or greater than two (2) times the maximum size aggregate, but less than or equal to 3 inches for Types SP-III, SP-IV, B, C, and D aggregate gradations. Pavement lift thickness' shall be selected to use the maximum size aggregate. Lift thickness(s) and asphalt concrete type, designating the maximum nominal size aggregate, shall be either specified in the CONTRACT documents, or as directed by the ENGINEER. SP-II gradation mixes shall not be used for the surface course.

336.5.3 Placement shall be continuous, without interruption. No greater amount of the mixture shall be delivered in any one day than can be placed, compacted and finished that same day.

336.5.4 No asphalt concrete surface course shall be placed which cannot be finished within daylight hours of the same day it is laid unless authorized by the Engineer.

336.5.5 In narrow, deep, irregular sections, intersections, turning radiuses, turnouts, cul de sacs, or driveways, where it is impractical to spread and finish the base and level the surface mixtures by machine methods, the CONTRACTOR may use placement equipment or acceptable hand methods, as authorized by the Engineer. The CONTRACTOR shall place material in lifts a specified and not exceed the limits of depth of the compaction equipment. Hand placed and compacted material shall be placed in lifts not greater than 2 inches maximum compacted depth. The finish surface shall be checked with a 10 feet straight edge, true and level to the adjacent asphalt concrete pavement. Humps shall be

milled true and level and depressions shall be filled and finished to comply with this specification.

336.5.6 Pavement cuts of 10 feet or more in width and 100 feet or more in length must be paved with an approved bituminous paving machine. Asphalt concrete should be placed with a paving machine for all sections if a paver is available.

336.5.7 Depositing and spreading of the asphaltic concrete shall be accomplished by means of a bituminous paver except as specified in 336.5.4. Bituminous pavers shall be self contained, self propelled units, provided with a automated leveling activated screed or a strike off assembly, with heating capabilities, and capable of spreading and finishing courses of bituminous plant mix material in lane widths applicable to the lifts and thickness specified in the plans and specifications. Pavers shall be free of fluid leaks. Pavers detected to have leaks shall not be allowed on the project.

336.5.8 The paver shall be equipped with a receiving hopper having sufficient capacity for uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The hopper shall be operated at 50% or greater capacity during paving operations. Paving shall not be allowed when the hopper is at less than 50% capacity.

336.5.9 The screed or strike off assembly shall effectively produce a uniform surface and texture without tearing, shoving or gouging the mixture. The paver shall be operated at a forward speed consistent with satisfactory laying of the mixture.

336.5.10 The paver shall be operated with an automatic leveling device controlled from an external guide, approved by the ENGINEER. The screed shall be zeroed by the CONTRACTOR on a template or blocks set to the same depth as the loose mat behind the paver, prior to start of placement of each lift of a material, as directed by the ENGINEER. Verification of the target loose lift thickness shall be made at regular intervals during the placement. The loose lift thickness, lift thickness behind the paver shall be defined by the CONTRACTOR and reported to the ENGINEER for reference prior to startup of a lift placement. Broadcasting of excess edge material over the surface of a precompact lift shall not be permitted.

336.6 COMPACTION:

336.6.1 Asphalt concrete compaction shall begin when the asphalt concrete temperature is in the compaction temperature range specified in the authorized job mix formula. Compaction shall be completed before the

temperature of the material cools to less than 200°F. Compaction may be allowed on material with a temperature less than 200°F and greater than 185°F, as authorized by the ENGINEER. Compaction on a lift shall not be allowed when the temperature of the lift is less than 185°F. The material shall be compacted to a density of at least 93% and not greater than 97% of the theoretical maximum density as determined by ASTM D2041. The CONTRACTOR shall be responsible for the development and implementation of the compaction program. A reference compaction program shall be defined by the CONTRACTOR and reported in writing to the ENGINEER for each job mix formula/lift thickness to be used on a project. Changes in the compaction program shall be reported to the ENGINEER as they may occur. Repair and replacement of damaged adjacent property and structures, resulting from the use of vibratory rolling equipment, shall be the responsibility of the CONTRACTOR, at no cost to the OWNER. A CONTRACTOR may construct a test strip, a minimum of 10 feet wide and 250 feet long, to establish the rolling pattern for an asphalt mix and lift thickness to be placed on the project, as directed by the ENGINEER. The test strip shall be paid for in accordance with the requirements of the CONTRACT, as authorized by The ENGINEER.

336.7 JOINTS

336.7.1 Care shall be exercised in connection with the construction of joints to insure that the surface of the pavement is true to grade and cross section across the joint. Periodically, joints shall be tested with a 10 feet straight edge to verify the smoothness of the surfaces of adjacent material(s). A 10 feet long straight edge shall be placed perpendicular to the joint extending equally on both sides of the joint. The smoothness of the surfaces across the joint shall comply with the requirements of this specification.

336.7.2 After Construction of a joint along any adjoining edge such as a curb, gutter, or an adjoining pavement lift free edge, and after the hot mixture is placed by the finishing machine, sufficient hot material shall be carried back to fill any space left open. This joint shall be properly "SET UP" with the back of a rake at proper height and level to receive the maximum compaction. The work of "setting up" this joint shall be performed by competent workmen who are capable of making a correct, clean, and neat joint. Excess material shall be removed. Broadcasting excess material onto the adjacent asphalt concrete pavement surface will not be allowed. Excess material at an edge joint shall be removed and discarded if not required for compaction.

336.7.3 Longitudinal and transverse joints shall be made in a careful manner. Well bonded and sealed joints are required. Joints between old and new pavements or

between successive day's work shall be carefully made in such a manner as to insure a thorough and continuous bond between the old and new surfaces. In the case of surface course, the edge of the old surface course shall be cut back for its full depth so as to expose a fresh surface and, if necessary to obtain a well bonded joint, shall be painted with a tack coat after which the hot surface mixture shall be placed in contact with it and raked to a proper depth and grade. Before placing mixture against contact surfaces of curbs, gutters, headers, manholes, etc., they shall be painted with a tack coat. Joints shall be tested with a 10 feet straight edge to verify the smoothness of the surfaces transition of adjacent material(s). A 10 feet long straight edge shall be placed perpendicular to the joint extending equally on both sides of the joint. The smoothness of the surfaces across the joint shall comply with the requirements of this specification. Longitudinal and transverse joints shall be compacted parallel to the joint. Transverse and longitudinal joints shall be staggered a minimum of 1 foot offset from the joint of a lift either below or above, and completely bonded.

336.8 PAVEMENT PENETRATIONS, MANHOLES AND VALVE COVERS: Manhole frames and valve covers shall be adjusted as per the Standard Drawings, or as directed by the ENGINEER. The finish surface at the top of all asphalt concrete pavement penetrations, to include but not be limited to manhole frames and valve covers, shall be constructed to and be parallel in all directions the finish surface of the surrounding asphalt concrete pavement prior to placing the surface course.

336.9 SMOOTHNESS: Upon completion, the pavement shall be true to grade and cross section. Except any changes of grade, when a 10 foot straight edge is laid on the finished surface of the roadway, the surface shall not vary from the edge of the straightedge more than 3/16 inch. After the completion of final rolling, the smoothness of the course shall be checked, and the irregularities that exceed the specified tolerances and or retain water on the surface shall be corrected by the CONTRACTOR at the no cost to the OWNER, as directed by the Engineer.

336.10 SAMPLING AND TESTING

336.10.1 Asphalt concrete tests shall be performed in accordance with the requirements of this specification, the Supplemental Technical Specifications, or as directed by The ENGINEER. Asphalt concrete analysis shall be performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition. Testing equipment used in the performance of specified testing shall

be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certification records shall be maintained at the Laboratory for review by The ENGINEER. A copy of the certifications shall be submitted to The ENGINEER upon request. The sampling and testing shall be performed by a technician certified under the New Mexico State Highway and Transportation Department/Associated Contractors of New Mexico Technical Training and Certification Program for ASPHALT and SUPERPAVE.™

336.10.2 Material Sampling: A quality assurance asphalt concrete material field sample shall be taken in accordance with the requirements of ASTM D979 for each job mix delivered. The materials shall be sampled at the greater rate of either one sample for each 250 tons, or one sample per day, for each type of material placed on a project, as directed by the ENGINEER. The sample shall be of such size to provide material for all tests specified and a split sample to perform verification/referee tests for gradation and binder content, if required.

336.10.3 Material Testing

336.10.3.1 Asphalt concrete quality assurance sampling and testing shall be performed in accordance with the requirements of this Specification, the Supplemental Technical Specifications, or as directed by The ENGINEER.

336.10.3.2 An quality assurance asphalt concrete sample shall be sampled, tested, and reported in accordance with the requirements and procedures of SECTION 116- ASPHALT CONCRETE, 116.10 SAMPLING AND TESTING.

336.10.3.3 A CONTRACTOR may challenge production material test results, binder content and aggregate gradation, and request that the retained split asphalt concrete sample of record be released to his assigned laboratory and tested for compliance, as authorized by the ENGINEER. A challenge notification shall be made in writing to the ENGINEER by the CONTRACTOR within 28 calendar days from date of sampling. Challenge test results shall be submitted to the ENGINEER for evaluation no later than 42 calendar days from date of sampling. Challenge test results will be evaluated in accordance with the "multi laboratory" precision tolerances specified, T53 for binder content, ASTM C117 and C136 for aggregate gradation. Challenge and record test results that comply with precision tolerances will be averaged with the companion test results of record and the material pay factor, Pm_p , recalculated as directed by the ENGINEER. Challenge and record test results that do not comply with the precision tolerances will direct the disqualification of the challenged and record samples, as

directed by the ENGINEER. Cut/core sample(s) will be taken from the area(s) represented by the disqualified challenge sample(s) and evaluated by the lab of record under the observation of the CONTRACTOR, in accordance with the requirements of these specification and replace the disqualified sample test results. Analysis of the replacement cut/core sample(s) may not be challenged. The CONTRACTOR will submit challenge test results in writing to the ENGINEER for each split sample released to his assigned laboratory of record. Challenges filed after the time limitations will not be considered. The OWNER shall pay for all complying tests.

336.10.4 COMPACTION TESTING

336.10.4.1 Asphalt concrete pavement quality assurance compaction sampling and testing shall be performed in accordance with the requirements of this specification, the Supplemental Technical Specifications, as directed by The ENGINEER. Each lift, for each type of asphalt concrete pavement placed each day, shall be tested for compaction.

336.10.4.2 An asphalt concrete pavement compaction test shall be performed in accordance with the requirements of this specification, as directed by the Engineer. A test shall determine the compaction at a location of a fresh constructed asphalt concrete roadway lift. Compaction shall be calculated as the field density at a location of a LOT lift, determined by either 336.11.4.3 or 336.11.4.4, divided by the average of the maximum theoretical density (G_{mm}) of the acceptance sample(s) taken for that day's placement, reported to the nearest one tenth of a percent, xxx.x%. A maximum theoretical density (G_{mm}) shall be determined in accordance with ASTM D2041.

336.10.4.3 The field density at a location for a lift of SP-II material shall be determined from a core sample. One core sample shall be taken for each lift of 250 tons, or fraction thereof, placed each day, but not less than 3 cores per day, as directed by the Engineer. The density of a core shall be determined in accordance with the requirements of D2726 and reported to the nearest one-tenth pound per cubic foot.

336.10.4.4.1 The field compaction at a location for Type B, C, D, E, SP-III, and SP-IV materials, shall be measured in accordance with the requirements of ASTM D2950 Density of Bituminous Concrete in Place by Nuclear Methods, at the minimum rate of three tests per lift of 500 sy, or fraction thereof, for each type of asphalt material placed in a day, as directed by the ENGINEER.

336.10.4.4.2 A reference density test of the support material, for the asphalt concrete roadway lift to be constructed, shall be taken prior to the placement of the

fresh asphalt concrete lift, or defined from previous test results. The density of the support material shall be used as reference in performing the density test of a fresh asphalt concrete lift in accordance with the requirements ASTM D2950, placed over the support material. A density test of the support material shall be taken at the rate of one (1) test for each 500 sy of surface or less to be paved over in a day, as directed by the Engineer. The density of the support material shall be reported as "reference support material density" in the compaction test report of the constructed asphalt concrete pavement over the area represented by the support material compaction test.

336.10.4.4.3 Core samples of the compacted asphalt pavement of SP-III, SP-IV, B, C, D, and E asphalt concrete, may be taken and tested to determine conformance of the finished pavement with the specified requirements either as requested by the CONTRACTOR, as directed by the ENGINEER. Samples shall be taken and tested in accordance with the requirements of 336.11.4.3, at the rate of three (3) core samples per LOT lift, as directed by the ENGINEER, and paid by the OWNER. Compaction determined from cores shall supersede tests performed in accordance with the requirements ASTM D2950. The CONTRACTOR shall be responsible for asphalt concrete pavement replacement at no cost to the OWNER where core samples are taken. The OWNER shall pay for all complying tests.

336.10.4.5 Field compaction tests shall be taken at random locations on an asphalt concrete pavement lift, as directed by the ENGINEER. Three (3) general areas at which a test should be taken are either adjacent to the free edge of the mat, or the mat interior, or adjacent to a joint. The number of tests taken will vary but the total number of tests taken on any project shall be in the approximate proportions specified in TABLE 336.A.

336.10.4.6 Sampling and testing of quiet asphalt concrete, and measurement and payment shall conform to the requirements of SECTION 328.

TABLE 336.A - Asphalt Concrete Pavement Lift
Compaction Test Location Proportions

Location	% of total tests
Free Edge of Mat ¹	20 to 33
Mat Interior	33 to 60
Joints ²	20 to 33

NOTES:

- 1 The free Edge of Mat test shall be taken in the area between one (1) foot and two (2) feet in from a free edge of a lift.
- 2 Joints shall include the longitudinal and transverse butt joints between adjacent lifts of asphalt having the same finish elevation. Tests may be taken on material placed against a cold joint edge of formed surface.

336.10.5 Full depth cores of asphalt concrete shall be taken to determine the depth of structure and the depth pay factor, PF_{10} , defined in TABLE 336.E, as directed by the Engineer. A minimum of three cores, having an outside diameter equal or greater than four (4) inches, shall be taken at random for each 1000 sy, or fraction thereof, placed. Cores shall be evaluated in accordance with the requirements of 336.12.2.3.4. The core length, depth of the pavement, shall be determined based on the average of three measurements of the length of the core, measured from circular ends of a sample. All measurements shall reported to the nearest 0.125" (1/8 inch). Plant mixed seal coat shall not be included in the depth of structure.

336.10.6.1 Test reports shall include but not be limited to the information specified in TABLE 336.B.

TABLE 336.B - TEST REPORT(s)

- A. Field Data and Test Results:
 - 1 Date of Sampling/Test
 - 2 City of Albuquerque Project Number or Permit Number
 - 3 Project Title
 - 4 Asphalt Concrete Supplier
 - 5 Delivery Ticket Number (asphalt concrete sample-only)
 - 6 Job Mix Formula Number
 - 7 Location of sample/test as defined by Contract Documents
 - 8 Time of Sampling/testing
 - 9 Material temperature at time of sampling, oF
 - 10 Ambient temperature at time of sampling, oF
 - 11 Field test results with reference specification limits (compaction test)
- B. Laboratory Test Results
 - 1 Laboratory results as defined in TABLE 116.F (asphalt concrete material)
 - 2 Field Test Data as required in 336.11.4 (compaction reports)
 - 3 Pavement Structure Depth (individual cores and average depths for Lot)
- C. Recommended Pay Adjustment Factor for a LOT
 - 1 C_{LM} , material factor, see TABLE 336.C
 - 2 C_{LC} , placement/compaction factor, see TABLE 336.D
 - 3 PF_{10} , depth factor, see TABLE 336.E

336.10.6.2 Test results shall be reported to The ENGINEER, CONTRACTOR, Supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, in writing, within 7 working days of

completion of the sampling of the asphalt and/or the field testing. Non-complying tests shall be reported to The ENGINEER, CONTRACTOR, supplier and Materials and Testing Laboratory, Construction Division, Public Works Department, within 1 working day of completion of the test.

336.10.6.3 The New Mexico Registered Professional Engineer in direct charge of the laboratory shall certify on a quality assurance test report that the test procedures used to generate the report complied with the specifications.

336.11 MEASUREMENT AND PAYMENT:

336.11.1 Measurement: Asphalt concrete pavement shall be measured by the square yard of full depth pavement including each type and lift of material delivered, placed, compacted, and finished at the project, as specified in the CONTRACT DOCUMENTS. Asphalt concrete pavement shall be measured in a LOT, as directed by the ENGINEER. A LOT shall be 500 square yards, or fraction thereof, or as specified in the supplemental technical specifications, of constructed asphalt concrete pavement specified in the CONTRACT documents, to full depth over supporting materials of either subgrade, base course, treated base course, or existing asphalt concrete pavement, as directed by the ENGINEER. Each LOT shall be divided into SUBLOT(s) for each lift thickness of asphalt concrete in the pavement.

336.11.2 PAYMENT

336.11.2.1.1 Asphalt concrete pavement placed in an area of 10 feet or more in width and 100 feet or more in length (requiring machine laydown) shall be divided into LOTS and paid at the adjusted CONTRACT unit price, specified in this section, as authorized by the ENGINEER.

336.11.2.1.2 Asphalt concrete pavement placed in an area less than 10 feet in width and/or less than 100 feet in length shall be paid at the CONTRACT unit price specified in the CONTRACT documents, adjusted in accordance with the requirements of this section, as authorized by the ENGINEER.

336.11.2.1.3 A LOT of asphalt concrete pavement shall be paid at a unit price equal to the sum of the CONTRACT unit prices of its SUBLOTS, each lift of asphalt in a LOT, the sum adjusted for deviation of full depth of structure from CONTRACT specification. The unit price for a LOT shall be calculated in accordance with the equation below.

$$UP' = PF_D \times UP_{SUBLOTS}$$

UP', LOT unit price
PF_D, depth factor defined in TABLE 336.D

UP_{SUBLOTS}, UP'_{SL1} + UP'_{SL2} + ... + UP'_{SLK}, sum of SUBLOTS' unit prices, see 336.12.2.2

336.11.2.2 A SUBLOT, a lift of asphalt concrete in a LOT, shall be paid at the adjusted CONTRACT unit price determined in accordance with the equation below.

$$UP'_{SLN} = F_N \times UP_{SLN}$$

F_N, 0.5 x (C_{LM} + C_{LC}), SUBLOT adjustment factor
C_{LM}, material factor, see TABLE 336.C
C_{LC}, placement/compaction factor, see TABLE 336.D
UP_{SLN}, CONTRACT unit price for a SUBLOT

336.11.2.2.2 The material factor, C_{LM}, is the material acceptance factor for a SUBLOT determined in accordance with TABLE 336.C, based on the absolute value of the deviation of the average value, or arithmetic mean (M), of the daily acceptance sample(s) test results for the SUBLOT, deviation from the CONTRACT authorized job mix formula targets(T), for either combined aggregate gradation or binder content.

336.11.2.2.3 If the deviation is equal or less than the allowable deviation, D', the corresponding material pay factor, C_{LM}, shall be used.

336.12.2.2.4 The SUBLOT placement/compaction factor, C_{LC}, shall be defined in accordance with TABLE 336.D, as directed by the ENGINEER. The factor is determined based on the average of the compaction tests taken for a SUBLOT, with no single test neither less than 90.0 % nor greater than 97.9 %. Acceptance compaction tests shall be performed in accordance with the requirements of 336.11.4. A SUBLOT having a compaction test(s) either less than 90.0 % or greater than 97.9 % shall be evaluated and an appropriate pay factor assigned, as directed by the ENGINEER.

336.12.2.3.5 The depth factor, PF_D, shall be defined in accordance with TABLE 336.E, based on the average depth of a minimum of three full depth cores taken at random for each 1000 sq. yd. or fraction thereof, with no single core less than the specified section depth less 0.75 in. (19 mm), as directed by the ENGINEER. If a core(s) are identified at a depth of the specified depth less 0.75 in. (19 mm), additional cores shall be taken to verify the condition. The condition shall be evaluated and either an appropriate pay factor assigned or the asphalt concrete pavement removed and replaced with complying pavement, as directed by the ENGINEER.

TABLE 336.C - MATERIAL FACTOR, C_{LM} , FOR GRADATION & ASPHALT BINDER CONTENT

NUMBER OF DAILY SAMPLES	D', MAXIMUM ALLOWABLE DEVIATION [1, 2, 3]		
1	1.40D	1.20D	D
2	D + R	D + 0.37R	D - 0.10R
3	D + 0.30R	D + 0.07R	D - 0.14R
4	D + 0.16R	D - 0.01R	D - 0.17R
5	D + 0.11R	D - 0.03R	D - 0.20R
6	D + 0.09R	D - 0.05R	D - 0.22R
7	D + 0.07R	D - 0.07R	D - 0.24R
8	D + 0.06R	D - 0.08R	D - 0.25R
9	D + 0.05R	D - 0.09R	D - 0.26R
10 OR MORE	D + 0.04R	D - 0.10R	D - 0.27R
MATERIAL FACTOR, C_{LM} [3]	0.85	0.95	1.00

[1] D, production tolerance \pm %, see 336.5.1.2, and authorized job mix formula; R, of test values, maximum - minimum values; M, average test value of a SUBLOT's acceptance samples test results; T, target value specified in authorized job mix formula.

[2] The material factor, C_{LM} , shall be the lowest factor selected for $|T-M| \leq D'$ calculated for either (a) the combined aggregate gradation and material passing the nominal maximum size aggregate screen, 3/8 inch (9.5 mm), and smaller screens of the project authorized job mix formula, or (b) the asphalt binder content.

[3] If the absolute value of the deviation of the daily mean from the target exceeds the maximum allowable deviation a SUBLOT, $|T-M| \geq D'$, the SUBLOT shall be removed and replaced with material complying with this specification, at no cost to the OWNER, as directed by the ENGINEER. If it is determined by the ENGINEER to be more practical to accept the SUBLOT material, it may be accepted under written agreement between the OWNER and the CONTRACTOR, at an assigned pay factor, $C_{LM} = 0.70$, for a SUBLOT having a compaction factor, $C_{LC} = 0.90$, as directed by the ENGINEER.

TABLE 336.D - SUBLOT PLACEMENT/COMPACTION FACTOR, C_{LC}

Average Test Results	Factor, C_{LC}
98.0 % and greater	[1]
97.1 to 97.9	0.85
93.0 to 97.0	1.00
92.0 to 92.9	0.95
91.0 to 91.9	0.90 [2]
90.0 to 90.9	0.85 [2]
less than 90.0%	[1], [2]

[1] The lift defined for the SUBLOT shall be removed and replaced by the CONTRACTOR with asphalt concrete pavement complying with this specification at no cost to The OWNER, as directed by the ENGINEER. If it is determined by the ENGINEER to be more practical to accept the SUBLOT, it may be accepted under written agreement between the OWNER and the CONTRACTOR at an assigned compaction pay factor, $C_{LC} = 0.50$, for the SUBLOT, if the SUBLOT has a material pay factor, $C_{LM} \geq 0.85$, as authorized by the ENGINEER.

[2] When the lift accepted at this factor is a final surface course of a street having a posted speed limit less than 40 mph, the lift shall have a FOG SEAL applied and sanded by the CONTRACTOR in accordance with SECTION 333, at no cost to the OWNER, as directed by the ENGINEER.

TABLE 336.E DEPTH FACTOR, PF_D

Deficient Pavement Depth					PF_D
0	\leq	$D_S - d_A$	\leq	0.25 in (6 mm)	1.00
0.25 in (6 mm)	$<$	$D_S - d_A$	\leq	0.50 in (12.5 mm)	$(d)^{-2} / (D)^{-2}$
		$D_S - d_A$	$>$	0.50 in (12.5 mm)	[A]
Excessive Pavement Depth, d-D					PF_D
		$D_S - d_A$	$<$	0	1.00

NOTES:

- d_A , average depth of the pavement structure as determined by field cores.
 D_S , specified depth of the pavement structure of a Lot.
[A] Correct deficiencies at no cost to the OWNER, as directed by the ENGINEER, constructing the pavement to the depth, grade, crown, and cross slope drainage, specified in the CONTRACT documents.

SECTION 337

PORTLAND CEMENT CONCRETE PAVEMENT

337.1 GENERAL: Portland cement concrete pavement shall consist of a mixture of portland cement, coarse and fine aggregate, class F fly ash, entrained air, and admixtures, placed and finished on either a prepared subgrade, or base in conformity with the lines, grades, depths and dimensions shown on the plans or as specified in the supplementary Specifications, and this specification. The CONTRACTOR shall be solely responsible for the portland cement concrete pavement construction supplied under this specification, materials, proportioning, placement, finish and curing. This work shall consist of constructing a pavement composed of portland cement concrete, in one course, with or without reinforcement as specified, in compliance with the specifications, lines, grades, depths, and typical cross sections shown on the plans or directed by the Engineer.

337.1.1 For construction and reconstruction street projects requiring pavement placement equal or greater than either 200 cy, concrete per day, the CONTRACTOR shall have a full time portland cement concrete construction supervisor on site to direct the pavement construction. The supervisor shall be certified as either an ACI certified Concrete Field Testing Technician Grade I, or the equivalent National Institute for Certification of Engineering Technologies Technician, with Specialty Concrete Work Elements Level I 82001, 82002, and Level II 84002, 84003, 84004, 84010. The supervisor shall be identified by the CONTRACTOR at the prepaving conference and shall be the contact person for the ENGINEER during portland cement concrete pavement construction.

337.1.2 Pre-Paving Conference

At the direction of the ENGINEER, a Pre-Paving Conference shall be held no later than seven calendar days prior to the start of pavement construction. The meeting agenda/assigned responsibilities shall be accomplished at the conference.

I. ENGINEER/OWNER

- A. Scope of the project.
- B. Identify construction management team and contact telephone numbers.
- C. Review CONTRACT requirements for pavement construction.
- D. Review Quality Assurance Program.

II. CONTRACTOR

- A. Review pavement construction schedules.

Proposed pavement construction schedule for duration of the project.

- B. Identify construction personnel and contact telephone numbers.
 1. Contractor Staff
 2. Sub-Contractor (s)
 3. Supplier (s)
 4. Safety Manager
- C. Present construction placement procedure plans.
 1. Equipment Schedule
 2. Portland Cement Concrete Design Mix
 3. Paving methodology
 4. Traffic Control Plan
 5. Quality Control Plan

III. DISCUSSION AND COMMENT

337.2 REFERENCES

337.2.1 American Society for Testing and Materials (Latest Edition) (ASTM):

- C31 Making & Curing of Concrete Test Specimens in the Field
C39 Test for Compressive Strength of Cylindrical Concrete Specimens
C94 Specification for Ready-Mixed Concrete

337.2.2 This Publication:

SECTION 101 PORTLAND CEMENT CONCRETE
SECTION 102 STEEL REINFORCEMENT
SECTION 105 CONCRETE CURING COMPOUND
SECTION 107 JOINT FILLER AND SEALANT MATERIAL
SECTION 302 BASE COURSE
SECTION 305 CEMENT TREATED BASE
SECTION 307 PLANT MIX BITUMINOUS TREATED BASE
SECTION 349 CONCRETE CURING

337.3 MATERIALS:

337.3.1 The Portland cement concrete used in the pavement constructed under this section shall conform to the requirements of Section 101 or as specified by the plans and/or the Supplemental Technical Specifications.

337.3.2 Steel reinforcement used in the concrete constructed under this section shall conform to the

requirements of Section 102 or as specified by the plans and/or the Supplemental Technical Specifications and the approved shop drawings of the steel reinforcement.

337.3.3 Expansion joint material, fillers, and sealants used on the concrete constructed under this section shall conform to the requirements of Section 107 or as specified by the plans and/or the Supplemental Technical Specifications and the approved shop drawings, if required.

337.3.4 Liquid membrane forming compounds for curing concrete if used on the concrete constructed under this section shall conform to the requirements of Section 105 or as specified by the plans and/or Supplemental Technical Specifications.

337.4 PROPORTIONING:

337.4.1 Proportioning of Portland cement concrete used in pavements shall be as specified in Section 101 and specified in the plans and/or Supplemental Technical Specifications. The specific proportioning shall be specified in the mix design submittal provided by the Contractor to the Engineer and the concrete supplied to the project.

337.4.2 (Empty)

337.5 STRENGTH REQUIREMENTS:

337.5.1 Portland Cement Concrete Pavement shall comply with the requirements specified in the plans and/or specified in the Supplemental Technical Specification.

337.5.2 Portland cement concrete pavement may be opened to traffic after it has obtained 85% of the design strength specified or after 14 days, whichever comes first. The 85% of the design strength shall be verified in accordance with Section 101 by field cured concrete cylinders cured in the field the same as the concrete they represent.

337.6 CONSTRUCTION EQUIPMENT:

337.6.1 GENERAL: Equipment and tools necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved.

337.6.2 SLIP FORM PAVERS:

337.6.2.1 Machines for placing and finishing concrete

pavement shall be mechanical self propelled and self leveling, of approved types and shall be capable of compacting and finishing concrete as required. Slip form pavers shall be equipped with an adjustable template or reciprocating screed or screens arranged to strike off the pavement surface to the roadway crown or slope shown on the plans. The paver shall be equipped with vibratory assemblies, with or without tamping bars which operate over the full width of the surface being placed. When the forward motion of the paver is stopped, vibratory and tamping mechanisms shall also be stopped.

337.6.2.2 For pavers of the adjustable template type, with or without reciprocating screens, the vibratory assembly shall consist of internal spud type units spaced not more than 30 inches apart across the width of the paver under the leading edge of the fixed screed. Each vibratory unit shall be operated at a minimum rate of 7,000 impulses per minute.

337.6.3 CONCRETE SAW: The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing with a water cooled diamond edge saw blade or an abrasive wheel to the required dimensions and at the required time and rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operation. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.

337.6.4 FORMS: Straight side forms shall be made of a metal having a thickness of not less than 7/32 inch and shall be furnished in sections not less than 10 feet in length. Forms shall have a depth equal to the specified, without horizontal joint, and a base width not less than 0.8 of the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of 100 foot radius or less. Flexible or curved forms shall be of a design acceptable to the Engineer. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than 2/3 the height of the form. Forms with battered top surfaces and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. Built up forms shall not be used except where the total area of pavement of any specified depth on the project is less than 100 cy. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the upstanding leg shall not vary more than 1/4

inch. The forms shall contain provisions for locking the ends of abutting form sections together tightly, and for secure setting.

337.6.5 JOINT SEALING APPLICATORS: Applicators for sealing materials shall be equipped with devices to mix, heat and apply joint sealers as required by the recommendations of the manufacturers of the material being used. Applicators shall be equipped with pressure type devices with adequate hose and a nozzle so that the specified shape factor may be constructed.

337.7 PREPARATION OF GRADE:

337.7.1 After the roadbed has been graded and compacted, the grade shall be trimmed to finish grade and cross section, extending the work at least 2 feet beyond each edge of the proposed concrete pavement.

337.7.2 The subgrade or aggregate base upon which the pavement is to be placed shall not vary more than ± 0.10 foot of the finish grade elevation and cross section specified prior to placing concrete. When cement or asphalt treated bases are used, finish grading shall be done at the time the base material is placed and shall be maintained to true section and grade until concrete placement is completed. The Contractor shall set reference lines, approved by the Engineer, parallel to the established grade as a means of grade control for subsequent finish grading operations.

337.8 SETTING FORMS:

337.8.1 BASE SUPPORT: The foundation under the forms shall comply with the requirements of Section 301, 302, 305, and 307 and the supplemental technical specifications, as applicable, so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade which at the form line is found below established grade shall be filled to grade with granular material in lifts of inch or less for a distance of 18 inches on each side of the base of the form, and thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

337.8.2 FORM SETTING: Forms shall be set sufficiently in advance of the point where concrete is being placed to permit checking the forms for line and grade. After the forms have been set to correct elevations, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with not less than 3 pins for each 10 foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not

deviate from true line by more than \pm one inch at any point. No excessive settlement or springing of forms under the finishing machine will be tolerated. Forms shall be cleaned and oiled prior to the placing of concrete.

337.8.3 GRADE AND ALIGNMENT: The alignment and grade elevations of the forms shall be checked, and corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any grade is found unstable, the form shall be reset and rechecked.

337.8.4 CONDITIONING OF SUBGRADE OR BASE COURSE:

337.8.4.1 When side forms have been securely set to grade the distance from top of form to top of subgrade or base course shall be checked in all areas to be not less than the specified pavement depth nor greater than the pavement depth plus 0.5 in. and brought to proper cross section. High areas shall be trimmed. Low areas may be filled and compacted to a condition similar to that of surrounding grade.

337.8.4.2 Unless treated base course material is specified, the subgrade or base course shall be maintained in the specified compaction moisture range when pavement is to be placed within 24 hours of completion of subgrade preparation or aggregate base course construction. If the time to pavement construction exceeds 24 hours, the prepared subgrade or aggregate base course shall be prime coated by the Contractor at no cost to the OWNER.

337.9 PLACING CONCRETE:

337.9.1 Concrete shall be placed on the prepared subgrade or aggregate base in uniform depth for the full width of the lane or area to be paved, without segregation, and to provide a minimum of redistribution. The placing of concrete in windrows or other methods which require excessive redistribution will be permitted for slip form pavement construction only. Placing concrete shall be continuous between transverse joints without the use of intermediate bulkheads.

337.9.2 When concrete pavement is to be placed adjoining newly constructed concrete pavement, the loading placed on the previously constructed pavement shall be limited to the following.

337.9.2.1 Light loading will be permitted 3 days after placement or when the pavement has reached 50% of its design strength, whichever comes first. Light loading is the placing and operating of the placement/finishing screed and

other finishing bridges.

337.9.2.2 Heavy loads will not be permitted until 14 days after placement or until the concrete has reached 85% of its design strength, whichever comes first. Heavy loads are vehicles of any size.

337.9.3 Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 15 seconds in any one location.

337.9.4 Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

337.9.5 Should any concrete materials fall on or be worked into the surface of a completed slab, the material shall be removed immediately by approved methods.

337.10 TEST SPECIMENS: The Contractor shall furnish the concrete for casting cylinders and other required tests. Concrete testing shall comply with the requirements of SECTION 101, as directed by the Engineer. The Engineer or an independent testing laboratory designated by the Engineer shall fabricate and test specimens. Results shall be reported to the Engineer, Contractor, supplier of the concrete, and Owner. Sampling and testing of smaller quantities of concrete used in minor paving work will be done as required by the Engineer.

337.11 JOINTS:

337.11.1 GENERAL: Joints shall be constructed of the type and dimensions, and at the locations required by the plans. Unless otherwise specified on the plans or approved by the Engineer, transverse and longitudinal contraction joints shall be constructed to the dimensions specified in the Contract Documents and at the locations shown on authorized joint plan prepared by the Contractor and authorized by the ENGINEER. Joints shall be complete from edge of slab to edge of slab. Where integral curb is constructed, the joint shall extend through the curb and have a depth not less than the sum of the height of the integral curb and one-third the depth of the pavement slab.

337.11.2 LONGITUDINAL JOINTS:

337.11.2.1 When required, deformed steel tie bars and

load transfer smooth dowel bars, of specified length, size, spacing and material shall be placed perpendicular to the longitudinal joints; they shall be placed by approved equipment or rigidly secured by chairs or other approved supports to prevent displacement during concrete placement and finishing. Deformed tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves. When adjacent lanes of pavement are constructed separately, steel side forms shall be used which will form a key way along the construction joint. Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed or, in lieu of bent tie bars, approved two piece connectors may be used.

337.11.2.2 Longitudinal formed joints shall consist of a groove, or cleft, extending downward from, and normal to, the surface of the pavement. These joints shall be effected or formed by an approved mechanically or manually operated device to the a depth of not less than one-third the depth of the associated pavement, by not greater than one-quarter inch width, and line specified in the authorized joint plan, while the concrete is in a plastic state. The groove, or cleft, shall be filled with either a premolded strip or an approved sealer. Joints shall be complete from edge of slab to edge of slab. Where integral curb is constructed, the joint shall extend through the curb and have a depth not less than the sum of the height of the integral curb and one-third the depth of the pavement slab.

337.11.2.3 The longitudinal formed joint filler material shall be installed so that its ends are in contact with the transverse joints filler material, if any.

337.11.2.4 Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth of not less than one-third the depth of the associated pavement, by not greater than one-quarter inch width, and line specified in the authorized joint plan. Suitable guide lines or devices shall be used to assure cutting the longitudinal joint on the true line as shown on the authorized joint plans. The sawed area shall be thoroughly cleaned and cured immediately after sawing.

337.11.3 TRANSVERSE EXPANSION JOINTS:

337.11.3.1 The preformed expansion joint filler shall be continuous from form to form, shaped to the subgrade and to the keyway along the form. Preformed joint filler shall be furnished in lengths equal to the width of one traffic lane, except that when ramp or lane width is more than 12 feet, two pieces may be used provided the minimum length installed is six feet. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

337.11.3.2 The preformed expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than one half inch in the horizontal alignment from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

337.11.4 TRANSVERSE CONTRACTION JOINTS:

337.11.4.1 Transverse contraction joints shall consist of planes of weakness created by forming or cutting grooves in the surfaces of the pavement, and, when shown on the plans, shall include load transfer assemblies. Joints shall be complete from and through edge of slab to edge of slab. Where integral curb is constructed, the joint shall extend through the curb and have a depth not less than the sum of the height of the integral curb and one-third the depth of the pavement slab.

337.11.4.2 Preformed Transverse strip contraction joints shall be formed by installing a parting strip to be left in place. The strip shall form a groove or cleft to a depth not less than one third the depth of the pavement and not wider than one-fourth inch.

337.11.4.3 Formed groove contraction joints shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place until the concrete has attained its initial set and shall then be removed without disturbing the adjacent concrete, unless the device is designed to remain in the joint. The groove shall be to a depth not less than one-third the depth of the pavement and not wider than one-fourth inch.

337.11.4.4 Sawed contraction joints shall be created by sawing grooves in the surface of the pavement of the dimensions and at the spacing and lines shown on the plans with an approved concrete saw. After each joint is sawed, the saw cut and adjacent concrete surface shall be immediately cured. The saw cut shall be to a depth not less than one-third the depth of the pavement and not wider than one-fourth inch.

337.11.4.5 All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. All

contraction joints in lanes adjacent to previously constructed lanes shall be sawed before uncontrolled cracking occurs. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, a contraction joint groove shall be formed prior to initial set of concrete as provided in Subsections 337.11.4.2 or 337.11.4.3.

337.11.4.6 Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive joint edge raveling, before transverse shrinking cracks occur.

337.11.4.7 Transverse formed joints shall comply with the requirements of Subsection 337.11.2.2 for the longitudinal formed joints.

337.11.4.8 Transverse construction joints shall be constructed at specified transverse joint locations specified in the authorized joint plan when there is an interruption of more than 30 minutes in the concreting operation. No transverse joint shall be constructed within 10 feet of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10 feet long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed by the Engineer.

337.11.5 JOINT CURING:

337.11.5.1 All joints sawed in concrete pavement shall be cured after the removal of resulting dust or slurry in accordance with the following optional methods.

337.11.5.2 A strip of curing paper, polyethylene or other suitable moisture retention material, at least six inches in width, shall be centered over the joint, weighted down for its full length with soil, sand or other material to hold it in place.

337.11.5.3 A filler of paper, jute rope, or other suitable material shall be forced into the joint and sprayed with curing compound.

337.11.5.4 A tape, at least 2-1/2 inches wide, made from curing paper, polyethylene or other suitable moisture retention material and provided with adhesive material near each edge which will seal the tape to the pavement, shall be centered over the joint, and at the slab edges extend the tape 2 inches below the saw cut.

337.11.5.5 The adhesive material shall be of a type which can readily be removed from the pavement upon completion of the curing.

337.11.5.6 Alternate or other methods for curing joints may be used when approved by Engineer. Methods shall satisfactorily prevent the escape of moisture from the concrete at the joint and leave no detrimental residue adhering to the pavement or joint surfaces. The Contractor shall clean joints of deleterious material by flushing with water, cleaning with air jets of adequate pressure, or by resawing, at his expense, prior to placing the sealing material.

337.11.5.7 Regardless of the type of materials or methods used curing joints, the material or methods selected shall be applied to the joint immediately after the joint is sawed and shall remain in place for a minimum of 48 hours after which the joint shall be cleaned and sealed, as provided in Subsection 337.17.

337.11.6 LOAD TRANSFER DEVICES:

337.11.6.1 Dowels, when used, shall be held in position parallel to the surface and center line of the slab by a metal device that is left in the pavement. Dowels shall be located at the mid depth of a pavement slab, perpendicular and centered on the joint, aligned parallel to the longitudinal centerline of the pavement.

337.11.6.2 One-half the length of each dowel painted with one coat of lead or tar paint shall be thoroughly coated with asphalt MC 70, or an approved lubricant, to prevent the concrete from binding to that portion of the dowel. An approved dowel Cap or sleeve conforming to the requirements shall be furnished for each dowel bar used with the expansion joints. The caps or sleeves shall fit the dowel bar tightly and the closed end shall be water tight. The sleeved end of the dowel shall be lubricated as specified above.

337.11.6.3 In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

337.12 FINISHING:

337.12.1 SEQUENCE: The sequence of finishing operations shall be strike off and consolidation, floating, straight edging, and final surface texturing. The addition of water to the surface of the concrete to assist in finishing operations will not be permitted. The humidity above the fresh concrete surface may be allowed to be improved with a fine fog spray generated by means of approved fogging equipment.

337.12.2 FINISHING AT JOINTS:

337.12.2.1 The concrete adjacent to formed joints shall be compacted or firmly placed without voids or segregation against the joint material, also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated.

337.12.2.2 After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints.

337.12.3 MACHINE FINISHING: Vibrators for full width vibration of concrete paving slabs shall meet the requirements in Subsection 337.6.2. If uniform and satisfactory density of concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and methods which will produce pavement conforming to the specifications. During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length.

337.12.4 HAND FINISHING:

337.12.4.1 Hand finishing methods will not be permitted except under the following conditions:

337.12.4.2 In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when breakdown occurs. Hand tools shall have a length of not less than 3 feet and shall be floats or darbies only. Trowels, 'fresno's', and slicks shall not be used.

337.12.4.3 Narrow widths or areas of irregular dimensions where operations of the mechanical equipment is impractical may be finished by hand methods. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used.

337.12.4.4 The screed for the surface shall be at least 2 feet longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape without deflection, and be constructed either of metal or of other suitable material shod with metal. Prior to operating a hand screed, the screed shall be set on the forms and the distance from the bottom of the screed and the top of finish subgrade or base, full width of the formed pavement section, shall be checked to be at least equal to the depth of the pavement slab to be constructed and not greater than the sum of the depth of the pavement slab plus one-half inch. If a uniform cross section cannot be attained

by the screed, it may not be used for the construction.

337.12.4.5 Consolidation shall be attained by the use of a suitable internal type vibrator or other approved equipment.

337.12.4.6 In operation the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking surface is of uniform texture, true to grade and cross section, and free from porous areas. Vibratory and roller screeds shall be drawn forward in the vibrating and rolling off process. If necessary, this shall be repeated until the action mode. Transverse movement is not required for vibratory and roller screeds.

337.12.5 FLOATING:

337.12.5.1 After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated by means of a longitudinal float, using one of the following methods as specified or permitted. A transverse and or longitudinal float shall be required for all pavement whether finishing is accomplished by hand methods, with a slip form machine or with fixed forms, except as hereinafter provided.

337.12.5.2 The requirements for floating may be waived for the slip form method of placement if it is successfully demonstrated that a satisfactory surface is being obtained by other means.

337.12.5.3 Hand Method: The hand operated transverse float shall be not less than 12 feet in length and 6 inches in width, properly stiffened to prevent flexibility and warping. The float shall be worked with a sawing motion transverse the slab from edge to edge. Movement ahead along the center line of the pavement shall be in successive advances of not more than one half of the length of the float.

337.12.5.4 Mechanical Method: The mechanical float shall be of a design approved by the Engineer, and shall be in good working condition. The tracks from which the float operates shall be accurately adjusted to the required finish pavement surface profile. The forward speed shall be adjusted so that the float will lap the distance as directed by the Engineer. The float shall pass over each area of pavement until the surface is uniformly closed.

337.12.5.5 Alternative Mechanical Method: As an alternative to the mechanical method above, the Contractor may use a machine composed of a cutting and smoothing

float, or floats, suspended from and guided by a rigid frame. The frame shall be carried by four or more visible wheels or tracks. When strike off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long handled float. Care shall be taken not to work the crown out of the pavement during the operation.

337.12.6 STRAIGHTEDGE TESTING AND SURFACE CORRECTION: After the floating has been completed, but while the concrete is still plastic, the surface of the concrete shall be trued with a 10 foot (3.0 m) straight edge. For this purpose the Contractor shall furnish and use an accurate 10 foot (3.0 m) straightedge. The straightedge shall be drawn transverse across the surface of the concrete pavement from edge to edge. Advance along the road shall be in successive stages of not more than $\frac{1}{2}$ the length of a straightedge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge trueing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross section. If a slip form paver is used, the maximum deviation from a true cross section within the area bounded by lines 6 inches from the edges of the pavement shall be $\frac{1}{4}$ inch. Additional floating, edging and surface work, except texturing shall not be allowed after the surface has been trued with the straight edge.

337.12.7 FINAL FINISH: The final finish shall be one of the following:

337.12.7.1 The surface texture is to be a longitudinal drag finish except at intersections, and approaches and departures to intersections. A drag shall consist of a seamless strip of damp burlap, cotton fabric or other material approved by the Engineer, which shall produce a uniform surface of gritty texture after dragging it longitudinally along the full width of pavement. The dimensions of the drag shall be such that a strip of burlap or fabric at least 3 feet wide is in contact with the full width of the pavement surface while the drag is used. The drag shall consist of not less than 2 layers of burlap with the bottom layer approximately 6 inches wider than the upper layer. The drag shall be maintained in such condition that the resultant surface is of uniform appearance and reasonably free from grooves over $\frac{1}{16}$ inch in depth. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted.

337.12.7.2 The surface texture at intersections, and a minimum of 100 feet of approaches and departures to intersections shall be a transverse rake tine grove or similar finish as authorized by the ENGINEER. The grove shall be at one eighth to one quarter inch wide by one eighth to three sixteens inch deep. The groves shall be spaced not less than two times the grove width and not more than 6 times the grove width. A tine float shall not be used. Transverse tine grooving of the highest traffic street shall be carried through the intersection.

337.12.8 EDGING AT FORMS AND JOINTS:

337.12.8.1 Edging shall be completed prior to straight edge trueing of the surface, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to the radius required by the plans. A well defined and continuous radius shall be "produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.

337.12.8.2 At all joints, all tool marks appearing on the slab adjacent to the joints shall be eliminated by texturing. The rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed.

337.12.8.3 All joints shall be trued with a straightedge bisected by and drawn parallel to the joint before the concrete has set, and correction made if one side of the joint is higher than the other, or if they are higher or lower than the adjacent slabs. The joint shall be straight edge trued after correction and prior to texturing.

337.13 CONCRETE PAVEMENT SLIP FORM METHOD:

337.13.1 GENERAL: Pavement may be constructed without the use of fixed forms by the slip form method as authorized by the Engineer.

337.13.2 GRADE: After the grade or base has been placed and compacted to the required density, the areas which will support the paving machine shall be cut to the proper elevation by means of a properly designed machine. The grade on which the pavement is to be constructed shall then be brought to the proper profile by means of a properly designed machine. If the density of the base is disturbed by the grading operations, it shall be corrected by additional compaction before concrete is placed. The grade should be

constructed sufficiently in advance of the placing of the concrete. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately ahead of the placing of the concrete.

337.13.3 ALIGNMENT: The horizontal alignment of full width slabs shall not deviate from the line shown on the plans or established by the Engineer by more than one half (½) inch at any point.

337.13.4 PLACING CONCRETE: The concrete shall be placed with an approved slip form paver designed to spread, consolidate, screed, and float finish the freshly placed concrete in one complete pass of the machine or machines in such manner that a minimum of hand finish will be necessary to provide a dense and homogeneous pavement in conformance with the plans and specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibration shall be accomplished with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The concrete shall be held at a uniform consistency, having a slump which lies within the range of 1 to 2 1/2 inches. The slip form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

337.13.5 FINISHING: The surface smoothness and texture shall meet the requirements of Subsection 337.12.7.

337.14 SURFACE TEST:

337.14.1 The pavement surface shall be tested with a 10 foot straightedge or other device approved by the Engineer. Areas showing high spots of more than 1/8 inch but not exceeding ½ inch in 10 feet shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show deviations in excess of 1/8 inch when tested with a 10 foot straightedge. Where the departure from correct cross section exceeds ½ inch, or where irregularities in the finished surface of the pavement vary more than ½ inch above or ½ inch below the grade elevation established by the Engineer, the pavement shall be removed and replaced by the Contractor at no expense to the Owner.

337.14.2 Any area or section so removed shall be

removed as a panel from transverse joint to transverse joint, the full width of the lane involved.

337.15 CURING: Immediately after the finishing operations have been completed the Contractor shall initiate the curing of the concrete as specified in Section 349 and/or as approved by the Engineer.

337.16 REMOVING FORMS: Unless otherwise provided, forms shall not be removed from freshly placed concrete until it has been set for at least 12 hours, except auxiliary form used temporarily in widening areas. Forms shall be removed carefully so as to avoid damage to pavement. After the forms have been removed, the sides of the slabs shall be cured as outlined in Section 349. Honeycombed areas will be considered as defective work and shall be removed and replaced. Any area or section so removed shall be removed as a panel from transverse joint to transverse joint, the full width of the lane involved.

337.17 SEALING JOINTS:

337.17.1 Joints shall be filled with joint sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound and the joint faces shall be clean and surface dry when the seal is applied.

337.17.2 The sealing material shall be applied to each joint opening to conform to the details shown on the plans and the manufacturer's recommendation for the authorized sealant.. The placing shall be done in such a manner that the material will not be spilled on the driving surfaces of the concrete. Any excess material on the driving surface of the concrete pavement shall be removed immediately and the pavement surface cleaned. The use of sand or similar material as a cover for the seal will not be permitted. Joint sealing material shall not be placed when the air temperature in the shade is less than 50°F., unless approved in writing by the Engineer. A backer rod or form shall be used and placed at the specified depth as the bottom form for the sealant. The backer rod shall be compatible with the sealant material and maintain its shape and cross section after placement of sealant.

337.17.3 The joint sealant detail shall be used at all sawed/embedded traffic control devices. The joints and sealants shall be constructed as specified.

337.18 PROTECTION OF PAVEMENT:

337.18.1 The Contractor shall protect the pavement and its

appurtenances against both public traffic and traffic caused by his own employees and agents. This include watchmen and the erection and maintenance of warning signs, lights, pavement bridges, or crossovers, etc.

337.18.2 Any damage to the pavement, occurring prior to final acceptance, shall be repaired or the pavement replaced by the Contractor at no expense to the Owner, as directed by the Engineer.

337.19 OPENING TO TRAFFIC: The pavement will not be opened to traffic until the pavement has met the strength requirements of Subsection 337.5. The pavement shall be cleaned of all loose material and debris, striped for traffic control prior to opening to traffic.

337.20 PROTECTION AGAINST RAIN: In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

337.21 DISCONTINUE PAVING OPERATIONS: When the surface finish of completed pavement is not in accordance with Subsection 337.14 or an excessive number of surface irregularities are detected when the completed pavement is tested in accordance with Subsection 337.14, or the edge of the pavement slumps more than 1/4 inch below the established cross section, or other recurring defects are apparent on successive working days, paving operations shall be discontinued as directed by the ENGINEER. Suitable equipment and methods shall be provided by the CONTRACTOR to correct the deficiencies at no cost to the OWNER.

337.22 TOLERANCE IN PAVEMENT THICKNESS:

337.22.1 Full depth cores shall be drilled by the CONTRACTOR and submitted to the ENGINEER, in pavement to verify constructed pavement depth. Cores shall be drilled at not less than two nor more than four locations for each Lot, 100 cy, as directed by Engineer. Pavement depth for a lot will be the average of the cores taken in the Lot. The depth of the pavement at a core location shall be the average of four measurements of the homogeneous length of the core taken at right angles around the core circumference, as directed by the Engineer. The CONTRACTOR shall patch the core holes with the authorized design mix placed in the surrounding pavement.

337.22.2 Where the structural strength of the concrete is seriously affected by the deficiency in thickness, the Engineer may order the removal and replacement of the work so affected at no additional expense to the Owner.

337.23 STRENGTH TEST REQUIREMENTS

Minimum strengths which must be achieved for acceptance are those set forth in Subsection 337.5, STRENGTH REQUIREMENTS.

337.24.1 MEASUREMENT: Portland cement concrete pavement shall be measured by the square yard per each thickness specified on the plans and in the bid proposal.

337.24.2 PAYMENT: The payment for Portland Cement Concrete Pavement shall be at the adjusted contract unit price per square yard for each pavement thickness specified, complete in place, adjusted in accordance with the following equation, and this specification, as authorized by the ENGINEER. Payment shall include all material, equipment and labor required in placing, finishing, curing, backfilling and cleanup.

$$UP' = PF_M \times PF_D \times UP$$

UP', adjusted contract unit price
UP, contract unit price
PF_M, material price adjustment,
see SECTION 101.16.2
PF_D, see 327.24.3

337.24.3 The depth factor, PF_D, shall be defined in accordance with TABLE 337.24.3.A, based on the average of a minimum 3 full depth cores taken in each lot of 1000 cy, as directed by the ENGINEER. The depth of the pavement at a core location shall be the average of three measurements of the homogeneous length of the core taken at right angles around the core circumference, as directed by the Engineer.

TABLE 337.24.1 DEPTH FACTOR, PF_D

Deficient Pavement Depth, D-d				PF _D
0	/	D-d	< / = 0.25 in	1.00
0.25 in	<	D-d	< / = 0.50 in	(d) ² / (D) ²
0.50 in	<	D-d	< / = 1.00 in	[A] or [B], [C]
		D-d	> 1.00 in	[A]
Excessive Pavement Depth, D-d				PF _D
0	<	d-D	< / = 1.00 in	1.00
		d-D	> 1.00 in	[E] or [F]

NOTES:

- d, average depth of the pavement structure of a Lot as determined by field cores.
- D, specified depth for the pavement structure of a Lot.
- A. Remove and replace at no cost to the OWNER, as directed by the ENGINEER.
- B. If determined by the ENGINEER to be more practical to accept the pavement, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR, at an assigned pay factor.
 $PF_D = (d)^2 / (D)^2$, for LOT(s), as directed by the ENGINEER.
- C. No single core height less than the specified depth less 1.25 in.
- E. Remove and replace at no cost to the OWNER, if excessive uncontrolled cracking is observed, as directed by the ENGINEER.
- F. If determined by the ENGINEER to be more practical to accept the pavement, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR, at an assigned pay factor of $PF_D = 1.00$, as directed by the ENGINEER.

SECTION 340

PORTLAND CEMENT CONCRETE CURBS, GUTTERS, WALKS, DRIVEWAYS, ALLEY INTERSECTIONS, SLOPE PAVING, AND MEDIAN PAVING

340.1 GENERAL:

340.1.1 Portland cement concrete curbs, walks, gutters, cross gutters, valley gutters, driveways, alley intersections, slope paving and median paving constructed of concrete having a minimum compressive strength as specified in Section 101, unless otherwise noted on the plans or specified in the Supplementary Technical Specifications.

340.1.2 Subgrade preparation for concrete curbs, gutters, walks, driveways, alleys, intersections, and slope paving conform to the requirements of Section 301, unless otherwise noted on the plans or specified in the Supplementary Technical Specifications.

340.1.3 Unless otherwise specified or indicated on the plans and except as otherwise prescribed in Subsection 340.8, the minimum thickness of walks shall be 4 inches. The minimum thickness of gutters, driveway aprons, and alley intersections shall be 6 inches unless otherwise shown on the plans. The height and thickness of the curb section including other details of construction for items in Section 340 will be shown on the plans, or Standard Detail Drawings.

340.2 REFERENCES:

340.2.1 American Society for Testing and Materials
(Latest Edition) (ASTM):

D1557 Test Method for Laboratory Compaction
Characteristics of Soil Using Modified Effort

340.2.2 This Publication:

SECTION 101 PORTLAND CEMENT CONCRETE
SECTION 102 STEEL REINFORCEMENT
SECTION 105 CONCRETE CURING COMPOUND
SECTION 107 JOINT FILLER AND SEALANT
MATERIAL
SECTION 301 SUBGRADE PREPARATION
SECTION 337 PORTLAND CEMENT CONCRETE
PAVEMENT
SECTION 349 CONCRETE CURING

340.3 FORMS:

340.3.1 Form material shall be free from warp, with

smooth and straight upper edges and, if used for the face of curb, shall be surfaced on the side against which the concrete is to be placed. Timber forms may be used for forming curved sections but shall not be used for straight work unless authorized in writing by the Engineer. Metal forms for such work being of a gauge that will provide proper rigidity and strength for the purpose for which they are intended. Wood forms used on curb returns shall be not less than 3/4 of an inch in thickness, cut in the length and radius as shown on the plans and held rigidly in place by the use of metal stakes and clamps. The curb face forms shall be cut to conform exactly with the curb face batter, as well as being cut to the required length and radius. In every case, however, the forms shall be of sufficient rigidity and strength and shall be so supported as to adequately resist springing or deflection as a consequence of the placing and consolidation of the concrete.

340.3.2 All formed curb and combined curb and gutter shall be divided into blocks or stones in lengths not to exceed 12 feet long using metal templates' not less than 1/16 inch thick cut to the same cross section as the curb or curb and gutter being constructed. Templates shall be securely attached to forms to prevent movement during concrete placement.

340.3.3 Form material shall be thoroughly clean at the time it is used and shall be given a coating of light oil or other suitable material immediately prior to the placing of the concrete.

340.3.4 Forms, except curb back planks, shall be set with the upper edges thereof flush with the specified grade of the finished surface of the adjacent portion of the work and shall be not less than a depth equivalent to the full specified depth of thickness of the concrete to be supported thereby.

340.3.5 Back forms shall be held securely in place by means of stakes driven in pairs, one at the front form and one at the back, at intervals not to exceed 4 feet; clamps, spreaders, and braces being used in connection therewith to such extent as may be necessary to insure proper rigidity of the forms. Forms for walks, gutters, and similar work shall be firmly secured by means of stakes driven flush with the upper edge of the forms at intervals not to exceed 5 feet. The stakes shall be of sufficient size and shall be so driven as to properly and adequately support the forms.

340.3.6 Form clamps, specifically designed and manufactured for the curb and gutter to be constructed, may be used if, in the opinion of the Engineer, they fulfill the requirements above specified for curb and gutter forms.

340.4 PLACING CONCRETE:

340.4.1 The concrete shall be placed on a thoroughly dampened subgrade sufficiently moist to insure that no moisture will be absorbed from the fresh concrete.

340.4.2 Surfaces of structures in sidewalks, curbs, and gutters shall be adjusted as necessary prior to placing of concrete to meet the contiguous sidewalk surfaces.

340.4.3 Concrete shall be placed in horizontal layers not to exceed 6 inches each in thickness, each layer being spaded along the forms and thoroughly consolidated. However, if the section is more than 6 inches in depth, the concrete may be placed to provide the thickness shown or specified, if mechanical internal vibrators are used or if, in the opinion of the Engineer, the spading and tamping is sufficient to consolidate the concrete for its entire depth.

340.4.4 After the concrete has been placed between the side forms, a strike off shall be used to bring the surface to the proper section to be compacted. It shall then be spaded along the form faces.

340.4.5 After the concrete has been placed and consolidated, the upper surface shall be struck off uniformly smooth and true to the specified grade.

340.5 EXPANSION JOINTS:

340.5.1 Expansion joints shall be constructed in curbs, walks, and gutters as hereinafter specified, being filled with premolded joint filler strips conforming with the requirements prescribed therefor in Section 107. No such joints shall, however, be constructed in cross gutters, alleys, intersections, or driveway aprons.

340.5.2 Spacing: Unless otherwise shown on the plans or authorized by the Engineer, the location and spacing of expansion joints shall be as specified in the Standard Detail Drawings and herein.

340.5.2.1 Expansion joints in all types of curb and gutters shall be placed at both ends of returns except where cross gutters are being constructed, and at regular intervals not to exceed 200 feet between expansion joints. Expansion joints shall be placed at both ends of the cross gutter transitions.

340.5.2.2 Expansion joints in all types of sidewalk shall be placed where the sidewalk abuts Wheel Chair Ramps and driveways; at regular intervals not exceeding 18 feet between expansion joints; between the walk and any building or structure; around utility pads and light foundations; and between the walk and water meter areas.

340.5.2.3 Expansion joints at wheel chair ramps and driveways shall be placed between these items of work and the back of the curb and gutters and the adjoining sidewalks.

340.5.2.4 Expansion joint filler strips shall be vertical and shall extend to the full depth and width of the work in which they are installed, being constructed at right angles or radially to the line of the curb or gutter as the case may be. The filler strips shall completely fill these joints at least to within 1/4 of an inch of any surface of the concrete that will be exposed upon completion of the work and must fully extend at least to those surfaces that will not be exposed. However, before the work will be accepted, any joint filler that protrudes beyond a surface that will not be exposed or beyond 1/4 of an inch below a surface that is exposed shall be trimmed off to the specified dimension in a neat and workmanlike manner. During the placing and consolidation of the concrete, the filler strip shall be held rigidly and securely in proper position.

340.5.3 CONTRACTION JOINTS

340.5.3.1 Contraction joints shall be constructed in slip formed curbs, curb and gutter, walks, and gutters as hereinafter specified. The joint shall be either cut or tooled to a minimum depth of 1 inch at curb, curb and gutter, and gutter, and the greater of either 1 inch or 1/4 the actual depth of the concrete at sidewalks and slabs on grade. The contraction joint shall be tooled at all exposed faces of the fresh placed concrete.

340.5.3.2 Spacing: Unless otherwise shown on the plans or authorized by the Engineer, the location and spacing of contraction joints shall be as specified in the Standard Detail Drawings and herein.

340.5.3.3 Contraction joints in extruded curb, curb and gutter, and gutters shall be placed at regular intervals not to exceed 12 feet.

340.5.3.4 Contraction joints shall be placed in all types of sidewalk at regular intervals not less than the width of the sidewalk nor greater than 6 feet.

340.6 FINISHING: Surfaces of the various items of work shall be finished as specified herein. Edges of

concrete at expansion joints shall be rounded to 1/4 inch radius. Upon completion, the finished surface shall be true to line and grade and free from irregularities.

340.6.1 CURB:

340.6.1.1 The front forms may be stripped as soon as the concrete has set sufficiently but must be removed before the expiration of 6 hours after pouring. Immediately following the stripping of these forms, Class A mortar, as prescribed therefor in Section 106 thinned to the consistency of grout, shall be applied to the curb face. If monolithic curb and gutter is being constructed, this mortar shall be applied to the full exposed face; otherwise, it shall extend for an additional 2 inches below the gutter.

340.6.1.2 The face and top of the curb shall then be carefully troweled with a "steel mule" shaped to match the profile of the curb, curb and gutter, to a smooth and even finish, the top being finished to a transverse slope of 1/4 of an inch toward the front, with both edges rounded to a radius of 3/4 of an inch. Contraction joints, perpendicular to the flow line and in returns radial to the curve, shall be placed in the curb top and face and in the gutter. The surface shall be finished with a fine hair broom parallel with the line of the flow line.

340.6.2 SIDEWALK:

340.6.2.1 Following the placing of concrete, the surface shall be struck and floated to a true and even grade, free from waves and irregularities. After the floating contraction joints shall be made to a depth of 1 inch. The work shall then be carefully floated to a smooth and even finish, with the contraction joint and expansion joint edges rounded to a radius of 1/8 of an inch. The finished surface shall be given a fine hair broom finish, applied transverse the direction of travel of the sidewalk.

340.6.2.2 Contraction joints or block joints shall not exceed intervals of 6 feet. On straight work, the joints shall be parallel with and at right angles to the line of the work; at curves the joints shall, in general, be along lines concentric with the curve radius. The contraction joint shall be made with jointer tools that will round the edges to a radius of 1/8 of an inch, with a depth of not less than 1 inch. The finished joint opening, exclusive of radii, shall not be not less than 1/8 inch nor greater than 3/16 inch. The Contractor will be required to have a sufficient number of jointer tools on the job to accomplish the above specified requirements.

340.6.2.3 The concrete shall be cured in accordance with the requirements of SECTION 349.

340.6.3 GUTTER:

340.6.3.1 After the concrete has been thoroughly consolidated the surface shall be worked to a true and even grade by means of a float. Contraction joints shall be sawed or tooled at intervals not to exceed 6 feet, perpendicular to the flow line. The finished surface shall be textured longitudinally with a fine hair broom finish.

340.6.3.2 Side forms shall remain in place until the concrete is sufficiently set, after completion of the gutter, but must be removed before the work will be accepted. The concrete shall be cured in accordance with the requirements of SECTION 349.

340.6.3.3 Valley gutter or cross gutter sections reinforcement steel and steel placement shall be constructed accordance with the plans and detail drawings. The reinforcement steel shall be in accordance with Section 102. The finished surface shall conform to the required roadway section as to both line and grade. The gutter sections will not be opened to traffic until specimen cylinders have attained a compressive strength of not less than 85% of its design strength or after 14 days or as authorized by the Engineer.

340.6.4 CONCRETE SLOPE PAVEMENT:

340.6.4.1 All subgrade preparation required for this item shall be done in accordance with applicable provisions of Section 301 with the exception that minimum density requirements will be 90% of maximum density as determined by ASTM D1557 or ASTM D698.

340.6.4.2 Reinforcement shall be included where shown on the plans or as specified.

340.6.4.3 Thickness of concrete shall be as specified or as shown on the plans. Concrete shall be screeded and finished with ten foot straight edge, lapped at 1/2 its length or equivalent, to a plane surface having no variation when measured with a 10 foot straight edge in excess of 1/4 inch, unless a curvilinear surface is designated for a particular job. All concrete work shall be in accordance with Sections 101 and 349.

340.7 CURING:

340.7.1 GENERAL: Immediately after the operations have been completed on all concrete, the Contractor shall initiate the curing of the concrete as specified in Section 349 and/or as approved by the Engineer.

340.8 DRIVEWAY ENTRANCES:

340.8.1 Driveway entrances shall be provided in new curbs at all existing driveways along the line of the work and at locations shown on the plans or as directed by the Engineer.

340.8.2 The location and construction details for driveways shall conform to the construction plans or Standard Detail Drawings, or as authorized by the Engineer.

340.8.3 Where walks are to be constructed across driveways, the thickness of the walk shall be not less than 6 inches, unless otherwise specified or shown on the plans.

340.9 DRAINAGE OUTLETS THROUGH CURB: The Contractor will be required to construct suitable outlets through the new curb for all existing building drains along the line of the work, as per Standard Detail Drawings.

340.10 MISCELLANEOUS TYPES OF CURB, GUTTERS, SIDEWALKS: Extruded type concrete curb and gutter, precast curb and gutter sections, cut stone curbs, brick sidewalks, flagstone " sidewalks, etc., will permitted where approved by the Engineer and in accordance with the plans and Supplementary Technical Specifications.

340.11 REPAIRS AND REPLACEMENTS:

340.11.1 New work that is found to be defective or damaged prior to acceptance and/or existing work damaged by the Contractor's operation shall be repaired or replaced by the Contractor at no expense to the Owner. Defective or damaged concrete areas shall be repaired by neatly saw cutting at right angles to the face of curb and removing and replacing the effected area. Removals of defective concrete shall be either the entire area between existing joints or if a minimum of 6 feet can be maintained to an existing joint, an intermediate saw cut may be permitted when approved by the ENGINEER.

340.12 TESTS: Testing procedures shall be as provided for in SECTION 101.

340.13 BACKFILLING AND CLEANUP: Backfilling and compaction to the finished surface of the newly constructed improvement must be completed before acceptance of the work.

340.14 MEASUREMENT AND PAYMENT:

340.14.1 MEASUREMENT:

340.14.1.1 Concrete curbs and gutters shall be measured by the linear foot per each type of curb and gutter.

340.14.1.2 Concrete sidewalks, driveways, valley gutters, gutters alley intersections shall be measured by the square foot per each type of improvement.

340.14.2 PAYMENT:

340.14.2.1 The payment for concrete curb and gutter shall be at the contract unit price and SECTION 101 per linear foot per each type of curb and gutter, complete in place, which shall include all materials, equipment and labor required in the final grading, subgrade preparation (subgrade compaction), placing, finishing, curing, backfilling and cleanup.

340.14.2.2 The payment for concrete sidewalks, drivepads, valley gutters, gutters and alley intersections shall be at the contract unit price and SECTION 101 per square foot per each type of improvement, complete in place, which shall include all materials, equipment and labor required in the final grading, subgrade preparation (subgrade compaction), steel reinforcement (when and where required), placing, finishing, curing, backfilling and cleanup.

SECTION 341

EXTRUDED ASPHALT CURB

341.1 GENERAL

341.1.1 The work covered by this section consists of furnishing all plant, labor, equipment, materials, and in performing all operations in connection with the construction of asphalt curbs in accordance with these specifications.

341.2 REFERENCES

341.3 MATERIALS

341.3.1 The asphaltic concrete for asphaltic concrete curb construction shall be produced with 60-70 penetration asphalt or AC-20 viscosity grade asphalt and in accordance with an approved job mix formula.

341.4 EQUIPMENT

341.4.1 All equipment, tools, and machines used in the performance of the work covered by this section of the specifications shall be subject to the approval of the ENGINEER and shall be maintained in a satisfactory working condition at all times.

341.5 CONSTRUCTION METHODS

341.5.1 Asphalt curbs shall be machine laid. The machine shall be approved by the ENGINEER and shall be of a type in which the asphalt material is extruded or pushed out through a mold form under compaction pressure by a horizontal conveyor screw. A tack coat, as approved by the ENGINEER, shall be applied to the portion of the pavement to which the curb is to be affixed prior to extrusion.

341.6 MEASUREMENT AND PAYMENT

341.6.1 Asphalt curb shall be measured by the linear foot. Measurement shall be made along the bottom edge of the street side of the curb. Asphalt curb shall be paid for at the contract unit price per linear foot bid, which price and payment shall be full compensation for furnishing all material, labor, equipment, and in performing all operations and incidentals necessary to complete the work, including placement of a tack coat on existing pavement beneath base of curb.

SECTION 342

SOIL STERILIZATION

342.1 GENERAL

342.1.1 The work covered by this section of the specifications consists of furnishing all materials, labor, and equipment and in performing all operations in connection with the application of soil sterilant type herbicide, complete, in strict accordance with this section of the specifications and applicable drawings and subject to the terms and conditions of the Contract.

the fact that the weed killers require a certain amount of moisture to be effective.

342.6 MEASUREMENT AND PAYMENT

Soil sterilization will be measured by the square yard. Measurements will be taken parallel to the ground. The accepted quantities of soil sterilization will be paid for at the contract unit price per square yard complete in place.

342.2 REFERENCES

342.3 MATERIALS

Herbicide soil sterilants shall be an aqueous solution of:

342.3.1 Dupont 85% CMU weed killer

342.3.2 Telvar

342.3.3 Sodium TCA-90

342.3.4 Monobor-chlorate

342.3.5 Polybar-chlorate

342.3.6 Hyvar XL

342.3.7 Or approved equal

342.4 EQUIPMENT

All equipment, tools, and machines used in the performance of the work required by this section of the specifications shall be subject to the approval of the ENGINEER and shall be maintained in satisfactory working condition at all times.

342.5 CONSTRUCTION METHODS

Soil Sterilization--It is anticipated that certain areas, as determined by the ENGINEER, will need soil sterilization to insure pavement protection from weed growth. After the curb and gutter has been placed and grading is complete to subgrade, the subgrade shall be thoroughly scarified to a depth of 6 inches and watered to near optimum moisture content. Then an aqueous solution of an approved herbicide soil sterilant shall be applied to the subgrade at the rate recommended by the manufacturer. Compaction of the subgrade shall then be handled in the usual manner with the provision that the prime coat be applied before the subgrade has a chance to dry out. This provision is necessary due to

SECTION 343

REMOVAL AND DISPOSAL OF EXISTING PAVEMENTS, CURB AND GUTTER, SIDEWALK, DRIVEPADS, AND SLOPE PAVEMENT

343.1 GENERAL

343.1.1 The work covered by this section consists of furnishing all labor, equipment, materials, and incidentals necessary for the removal and disposal of existing pavement, curb and gutter, sidewalk, and drivepads as specified herein. Pavement removal and replacement in connection with trenching operations is covered in Section 801 of these specifications.

343.1.2 Removal of existing pavement, curb and gutter, sidewalk, and drivepads shall only be performed at the locations within the limits shown on the drawings or as directed by the ENGINEER.

343.2 REFERENCES

343.2.1 This Publication:
SECTION 801

343.3 REMOVAL METHODS

343.3.1 CURB AND GUTTER: Existing Portland cement concrete curb and gutter, median curbs, curbs, alley curbs, laydown curbs, or valley gutters shall be removed by such means as required to prevent damage to any adjacent structures designated to remain in place. Existing asphalt curb shall be removed by means that prevent damage to the pavement on which the curb is situated. When any curb cannot be removed without damaging the adjacent pavement, the pavement may be cut to allow a maximum of 1 foot clearance parallel to the edge of the curb adjacent to the pavement.

343.3.2 SIDEWALK, DRIVEPADS, AND SLOPE PAVEMENT: Existing Portland cement concrete sidewalk and drivepads shall be removed by means and methods such that no adjacent structures to remain in place are damaged.

343.3.3 PAVEMENT:

343.3.3.1 Prior to any cutting of pavement, the perimeter of the proposed cut shall be suitably outlined and shall consist of smooth, regular lines approved by the ENGINEER.

343.3.3.2 The pavement shall be cut along the marked perimeter of the area to

be removed with such equipment as to produce a cut carried in a vertical plane through the pavement along a smooth horizontal line. For bituminous pavement removal, a power saw or steel-type cutter mounted on a motor grader or an air hammer equipped with a suitable cutting spade or other approved equipment which will score a smooth continuous line in the pavement to correct depth shall be used. Saw cutting only may be required by the ENGINEER if other methods of cutting leave an irregular or unsightly cut line.

343.3.3.3 The depth of cut made in asphalt pavement shall be sufficient to permit removal without damaging adjacent pavement. For Portland cement concrete pavement, a concrete saw which will score a continuous line in the pavement to a minimum depth of from 1 1/2 to 1 inches shall be used. Any unnecessary irregular breakage caused by the CONTRACTOR through inexperience or careless workmanship or otherwise shall be replaced by the CONTRACTOR at no additional expense. Any irregular breakage regardless of the cause shall be trimmed back as directed by the ENGINEER.

343.3.3.4 After the perimeter cut is made, any convenient and effective equipment may be used to break up and remove the pavement within, provided the following conditions are met:

343.3.3.4.1 The surrounding pavement and pavement perimeter shall not be damaged.

343.3.3.4.2 Any existing structures at the perimeter and/or within the vicinity of pavement removal shall not be damaged, whether they be surface or subsurface, as indicated on the drawings.

343.3.3.4.3 The normal functions of any utilities which may exist at the perimeter and/or within the area of pavement removal shall not be damaged, whether they be surface or subsurface, as indicated on the drawings.

343.4 DISPOSAL

The CONTRACTOR shall be responsible for disposing of all removed pavement, curb and gutter, sidewalk, drivepads, and

slope pavement in accordance with local regulations and as directed by the ENGINEER.

343.5 MEASUREMENT AND PAYMENT

343.5.1 Measurement shall be made as follows:

343.5.1.1 Removal and Disposal of Existing Pavement--Measurement shall be made to the nearest square yard on the top surface of the pavement removed as directed by the ENGINEER. Pavement shall be defined as Portland cement concrete surfacing or asphaltic concrete surfacing together with the respective underlying base course of whatever character. Oil mats or dust pallative treated surfaces will be considered ordinary excavation for which no separate payment will be made for removal.

343.5.1.2 Removal and Disposal of Existing Curb and Gutter or Asphalt Curbs--Measurement shall be made to the nearest linear foot along with the face of the curb at the gutter line, at the pavement surface for curbs, at the flow line of valley gutters, or along the centerline of alley curbs as applicable.

343.5.1.3 Removal and Disposal of Existing Sidewalk, Drivepads, and Slope Pavement--Measurement shall be made to the nearest square yard on the top surface of the sidewalk or drivepad or slope pavement removed.

343.5.2 Payment will be made at the contract unit price per unit for the applicable item of removal, which payment shall be full compensation for performing all removal and disposal of the item and for furnishing all labor, equipment, and incidentals necessary to complete the work in the manner specified.

343.6 ALTERNATE METHOD OF MEASUREMENT AND PAYMENT

If a removal item does not appear as a bid item in the Bid Proposal, then no direct payment will be made for removal and disposal of existing pavement, curbs, gutters, sidewalks, and drivepads. All costs for such work shall be included in the lump sum price for site preparation.

SECTION 344

COLD MILLING OF PAVEMENT SURFACES

344.1 GENERAL

Cold milling shall consist of the removal of nominal thicknesses of asphalt or concrete pavement surfaces, as designated by the ENGINEER by approved roto-milling equipment. The cold milled material shall be removed from the pavement surface and transported to:

344.1.2 Areas within one mile of the job site as designated by the ENGINEER.

344.1.3 Salvage or disposal areas provided by the CONTRACTOR.

344.2 REFERENCES

344.3 COLD MILLING OF CONCRETE PAVEMENTS

Cold milling of concrete pavement surfaces shall consist of the removal of thicknesses as designated by the ENGINEER. The thicknesses of pavement removal shall be described as a nominal thickness for payment. The nominal thickness for concrete pavement removal is described as follows:

344.3.1 Nominal 3/4 inch cut: 3/4 inch average of cuts ranging from 0 to 1 1/2 inches.

344.3.2 The milled surface shall be cleaned of all milled material. The milled material shall be transported to:

344.3.2.1 Areas within one mile of the job site as designated by the ENGINEER.

344.3.2.2 Salvage or disposal areas as provided by the CONTRACTOR.

344.4 COLD MILLING OF ASPHALT PAVEMENTS

The cold milling of asphalt pavement surfaces shall consist of the removal of surface thicknesses as designated by the ENGINEER. For payment, the thickness of pavement removal shall be described as a nominal thickness. The ranges in nominal thickness are described as follows:

344.4.1 Nominal 1 inch cut: 1 inch average of cuts ranging from 0 to 2 inches. Nominal 1 1/2 inch cut: 1 1/2 inch average of cuts ranging from 0 to 3 inches. Nominal 2 inch cut: 2 inch average of cuts ranging from 0 to 4 inches.

344.4.4.2 The milled surface shall be cleaned of all milled material. The milled material shall be transported to:

344.4.4.2.1 Areas within one mile of the job site as designated by the ENGINEER.

344.4.2.2 Salvage or disposal areas provided by the CONTRACTOR.

344.5 MEASUREMENT AND PAYMENT

Payment for cold milling shall be per square yard of the applicable material, to the nominal depth, as designated by the ENGINEER. Payment shall include transportation of the milled material as specified in the Bid Proposal.

SECTION 346
TEXTURED CONCRETE

346.1 GENERAL

346.1.1 The work covered by this section consists of furnishing all plant, labor, equipment, materials, and in performing all operations in connection with the construction of colored or non-colored textured concrete in accordance with these specifications, the plans and/or as modified by the Supplemental Specification, and as authorized by the ENGINEER.

346.2 REFERENCES

346.2.1 This publication:
Section 101 Portland Cement Concrete
Section 105 Concrete Curing Compound
Section 107 Joint Filler & Sealant Material
Section 111 Colored Portland Cement Concrete

346.3 MATERIALS

346.3.1 The cement, aggregates, water, fly ash, and admixtures used in the concrete used in the work constructed under this section shall conform to the requirements of Section 101 or as modified herein or by the plans and/or the Supplemental Specifications and the approved concrete mix design(s).

346.3.2 If required, colored concrete used in the work constructed under this section shall conform to the requirements of Section 111 or as modified by the plans and/or the Supplemental Specifications and the approved concrete mix design(s).

346.3.3 Aggregates

346.3.3.1 When an exposed aggregate textured is specified, a specific size, shape and/or color of aggregate shall be specified on the plans and/or in the Supplemental Specifications.

346.3.3.2 When a stamped texture is specified the maximum nominal size of coarse aggregate shall not be greater than 1/2 inch.

346.4 SUBMITTALS

346.4.1 Along with the normal concrete mix design(s) submittals, the CONTRACTOR shall submit the procedure he will use to remove the cement paste to expose the aggregate when exposed aggregate texture is required. This procedure shall be in accordance with the suppliers' recommendations.

346.4.2 If required by the ENGINEER, whether colored concrete is used or not, a sample of texture shall be made in accordance with Section 111 as modified by the plans and/or Supplemental Specifications.

346.5 CONSTRUCTION REQUIREMENTS

346.5.1 All textured concrete shall have a minimum gradient of 1.5% unless modified on the plans and/or Supplemental Specifications. All textured concrete shall be placed so that the finish lowest elevation of the exposed aggregate or the embedment shall daylight (drain freely) and not trap water.

346.5.2 The forms used for exposed aggregate concrete will need to be raised above the final grade the same height as the height of the concrete past to be removed to insure free drainage.

346.5.3 Patterned concrete shall be consolidated, struck-off to grade and the surface floated to attain a uniform surface. The concrete shall then be stamped, scribed or embossed with the pattern specified here in or called for in the plans and/or Supplemental Specifications, or as approved by the ENGINEER. The depth of the pattern into the concrete surface shall be uniform throughout the entire area and shall not exceed 3/8 inch. All pattern placement shall be completed before the concrete takes its initial set. The pattern tools shall be as manufactured by Bomivite, Impresco, or approved equal.

346.6. TEXTURED CONCRETE CURING

When the textured concrete is covered as part of the curing process, the CONTRACTOR shall use and place the covering in such a manner that the textured finish is not damaged or marred in any way. When colored concrete is used and the curing compound is used, it shall be as specified in Section 111.

346.7 MEASUREMENT AND PAYMENT

Unless modified in the Supplemental Specifications and/or the Bid Proposal textured concrete shall be measured by the square foot for each type and thickness and be paid for at the contract unit price per square foot, which price shall include the subgrade preparation to a depth of two feet (2'), materials, labor, and equipment needed in the placement, consolidation, finishing, and texturing of the concrete.

SECTION 347

BRICK SIDEWALK

347.1 GENERAL

The sidewalk bricks and their installation, specified in this section, are intended for use as a surface material to support pedestrian traffic.

347.2 REFERENCES

347.2.1 ASTM

C 33
C 902
D 1557

347.2.2 This Publication: SECTION 101 SECTION 108

347.3 CERTIFICATION

Before installation of the paving bricks the ENGINEER will be furnished with a certification from the brick manufacturer that the paving brick meets these specifications.

347.4 MATERIALS

347.4.1 SAND: Sand for the setting bed shall conform to ASTM C 33 for fine aggregate.

347.4.2 BRICK: Classification of pedestrian and light traffic paving brick shall conform to Class SX for weather and Type I for traffic, as defined in ASTM C 902 and Section 108. Color and size of the brick shall be designated on the construction plans.

347.4.3 CONCRETE: Concrete for dividers and footings shall be 3000 psi and shall conform to the specifications in Section 101.

347.5 MATERIAL HANDLING

347.5.1 Sand shall be stored in stock piles on dry ground and shall be segregated from other materials to prevent mixing.

347.5.2 Brick shall be stored on dry ground or on pallets and shall be protected during storage and handling to prevent chipped edges.

347.6 INSTALLATION

347.6.1 SUBGRADE: The subgrade will be graded and shaped to the lines shown on

the construction plans. Compaction of the subgrade shall be 90 percent of maximum density, as determined in ASTM D 1557, for a depth of 6 inches.

347.6.2 EDGE CURBS:

347.6.2.1 Either concrete or soldier course brick headers may be used along the longitudinal and transverse edges of the sidewalk to confine the sand and bricks.

347.6.2.2 Soldier course brick shall be embedded 4 inches into a concrete footing. Dimensions of footing will be shown on the construction plans.

347.6.3 BEDDING:

347.6.3.1 Sand Setting Bed: The sand bedding shall be confined by the headers and shall be 4 inches thick after compaction and grading. Sand bed material shall be compacted to a maximum density of 90 percent as determined by ASTM D 1557.

3.4.7.6.3.2 Concrete Bedding: The concrete portion of the bedding shall conform to Section 101 for sidewalks and shall be 4 inches thick. The brick may then be placed in fresh mortar (1/2 inch thick) or asphalt paving material (1/4 inch to 3/8 inch thick). Mortaring between the brick surfaces is optional and should be shown on the plans as a requirement.

347.6.4 BRICK: Brick shall be laid on a smooth sand setting bed, with side surfaces in close contact. Lay brick flat in running bond, parallel to curbs or headers, except where otherwise shown. Joints in the vicinity of cut brick shall be adjusted such that no units smaller than half-brick shall be used. After an area of brick is laid, the brick shall be tamped into the sand bed to obtain a uniform top surface, over compacted sand bed. Top surface shall accurately match the lines and grades of curbs, headers and other construction. After the surfaces are uniform and compact, fine sand shall be swept over the surface, repeating this operation until joints are filled and all brick are firmly bedded.

347.6.5 CROSS-SLOPE OF SIDEWALK: The cross-slope of the brick sidewalk shall be the same as for concrete sidewalks, namely 1/4 of an inch per foot.

347.7 MEASUREMENT AND PAYMENT

Brick sidewalks shall be measured by the square foot. Payment shall be made at the unit price per square foot as specified in the Bid Proposal, and shall include subgrade and sand bedding preparation, headers and brick with installation. Or if required, concrete bedding and setting material shall be included in the unit price.

SECTION 348

BRICK PAVEMENT FOR VEHICULAR TRAFFIC

348.1 GENERAL

The paving brick and its installation, specified in this section, are intended for the use as a surface material for vehicular traffic.

348.2 REFERENCES

348.2.1 ASTM

C 902

348.2.2 This Publication:

SECTION 101	SECTION 305
SECTION 108	SECTION 337
SECTION 115	SECTION 340
SECTION 301	

348.3 CERTIFICATION

Before installation of the paving bricks the ENGINEER will be furnished with a certification from the brick manufacturer that the bricks meet these specifications.

348.4 MATERIALS

348.4.1 CONCRETE: Concrete for brick foundation and containment walls shall meet the requirements as per Section 101 for concrete pavement, drivepads, or walls.

348.4.2 ASPHALT SETTING MATERIAL: The asphalt setting material will be a mixture of sand and bituminous material and shall conform to the requirements of Section 115.

348.4.3 BRICK: The brick to be used for street or drivepad surface course shall conform to the requirements of Section 108.

348.5 MATERIAL HANDLING

Brick shall be stored on dry ground or on pallets and shall be protected during storage and handling to prevent chipped edges.

348.6 INSTALLATION

348.6.1 SUBGRADE AND TREATED BASE COURSE: The subgrade preparation and the installation of the cement treated base course shall comply to the requirements of Sections 301 and 305, respectively. Thickness of these materials are shown on the Standard Detail Drawings. Drivepads do not require treated base course.

348.6.2 CONTAINMENT OR CUT-OFF WALLS: The containment or cut-off walls shall comply with the Standard Detail Drawings or with the construction plans.

348.6.3 PORTLAND CEMENT CONCRETE BRICK FOUNDATION: The construction of the concrete foundation shall conform to the requirements of Section 337 and 340. For arterial, collector and industrial street areas the foundation will be 4,000 psi compressive strength and will be a minimum of 8 inches thick. For residential streets and drivepads the foundation will be 4,000 psi and 3,000 psi compressive strength, respectively, and will be a minimum of 6 inches thick. The surface of the concrete foundation shall be screeded to grade and then finished with a wood float.

348.6.4 EXPANSION JOINT MATERIAL: Expansion joint material shall be installed between the concrete foundation and the containment walls and the curb and gutter. This material shall extend from the bottom of the concrete foundation to the top surface of the brick.

348.6.5 ASPHALT SETTING MATERIAL: Prior to the application of the asphalt setting material and the setting of the bricks the surface shall be kept moist for proper concrete curing. Curing compounds will not be used. The asphalt setting material will be applied to the foundation surface to a thickness of 3/8 inch minimum to 5/8 inch maximum. Immediately after application to the setting material the bricks will be installed.

348.6.6 BRICK INSTALLATION: Brick patterns and surface trueness requirements will be as follows:

348.6.6.1 Pedestrian Crosswalks: The bricks shall be laid in a running bond pattern with no less than half bricks being used. The long dimension of the brick shall be perpendicular to the normal flow of traffic.

348.6.6.2 Entire Street Intersections or Other Large Areas: The bricks shall be laid in accordance with the City approved construction plans. No less than half bricks shall be used.

348.6.6.3 Trueness: A 10-foot straight-edge shall be used to test the trueness

of the pavement surface. The straight-edge shall be held in contact with the brick surfaces in all directions from a point. Adjustments shall immediately be made to conform to the straightedge. The CONTRACTOR shall furnish the straightedge.

348.7 OPENING TO TRAFFIC

There will be no difference in the opening to traffic requirements for the concrete foundation as there is for concrete pavement as per Section 337.

348.8 DRIVEPAD CONFIGURATIONS:

Prior to the installation of a brick surfaced drivepad, the construction plans, showing the configuration, shall be submitted to the ENGINEER for approval. Brick surfacing shall not be used in the street gutter area.

348.9 MEASUREMENT AND PAYMENT

348.9.1 Brick surfaced street pavement and drivepad shall be measured by the square yard and shall include subgrade preparation, cement treated base course, concrete foundation, asphalt setting material and brick, both material and installation. Payment will be made at the unit price per square yard as specified in the Bid Proposal.

348.9.2 Measurement for concrete containment walls may be by the lineal foot or by the cubic yard. Payment will be the unit price per unit of measurement as defined in the Bid Proposal.

SECTION 349
CONCRETE CURING

349.1 GENERAL

The work covered in this section consists of furnishing all plant, labor, materials, and equipment, and in performing all operations in connection with the curing of all concrete placed in accordance with these specifications, or as modified by the plans and/or the Supplemental Specifications, and as authorized by the ENGINEER.

349.2 REFERENCES

349.2.1 American Society for Testing and Materials (Latest Editions)(ASTM)

C-31 Making and Curing of Concrete Test Specimens in the Field

C-39 Test for Compressive Strength of Cylindrical Concrete Specimens

C-42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

C-171 Specification for Sheet Materials for Curing Concrete

349.2.2 American Concrete Institute (Latest Editions)(ACI)

ACI 305 Hot Weather Concreting
ACI 306 Cold Weather Concreting

349.2.3 This Publication:

Section 105 Concrete Curing Compound
Section 111 Colored Portland Cement Concrete

349.3 CURING

Curing is defined as the process of maintaining a satisfactory moisture content and temperature in the constructed concrete so that the specified compressive strength is attained before the concrete is placed into full service. The curing process starts with the concrete placement.

349.4 PLACEMENT

349.4.1 The placement of all concrete shall be in accordance with the following guidelines unless otherwise authorized by the ENGINEER.

349.4.1.1 Concrete shall not be placed on frozen ground nor in forms that have frost, snow, or ice in or on the forms, reinforcement and/or embedment items.

349.4.1.2 Concrete shall not be placed in standing or running water.

349.4.1.3 Concrete shall not be placed on mud or uncompacted subgrade. Unstable subgrade shall be removed and replaced with suitable, compacted material.

349.4.1.4 Concrete shall not be placed in wooden forms that have not been sealed or treated with form oil or a form release agent.

349.4.1.5 The subgrade on which concrete is to be placed shall be moistened immediately before the concrete is placed.

349.5 MOISTURE CONTROL

349.5.1 The CONTRACTOR shall minimize the loss of moisture from the plastic concrete by evaporation during the placement and finishing of the concrete. When the estimated evaporation rate, as determined from Chart 349.1 is greater than 0.20 lb/sf/hr., the CONTRACTOR shall either take steps to reduce the evaporation below the specified rate, or discontinue the placement. The CONTRACTOR shall confer with the ENGINEER when weather conditions are such that the specified evaporation rate is reached on the protection method he is planning to use to be able to continue the placement of the concrete.

349.5.2 Moisture shall not be applied to the surface of the concrete to aid the surface finishing. If plastic or surface shrinkage cracks develop either prior to or during the finishing, that concrete shall be removed and replaced.

349.5.3 After completion of the finishing of the concrete, the CONTRACTOR shall initiate immediately the final curing of the concrete. The final curing method used by the CONTRACTOR shall be as specified in this section and as approved by the ENGINEER.

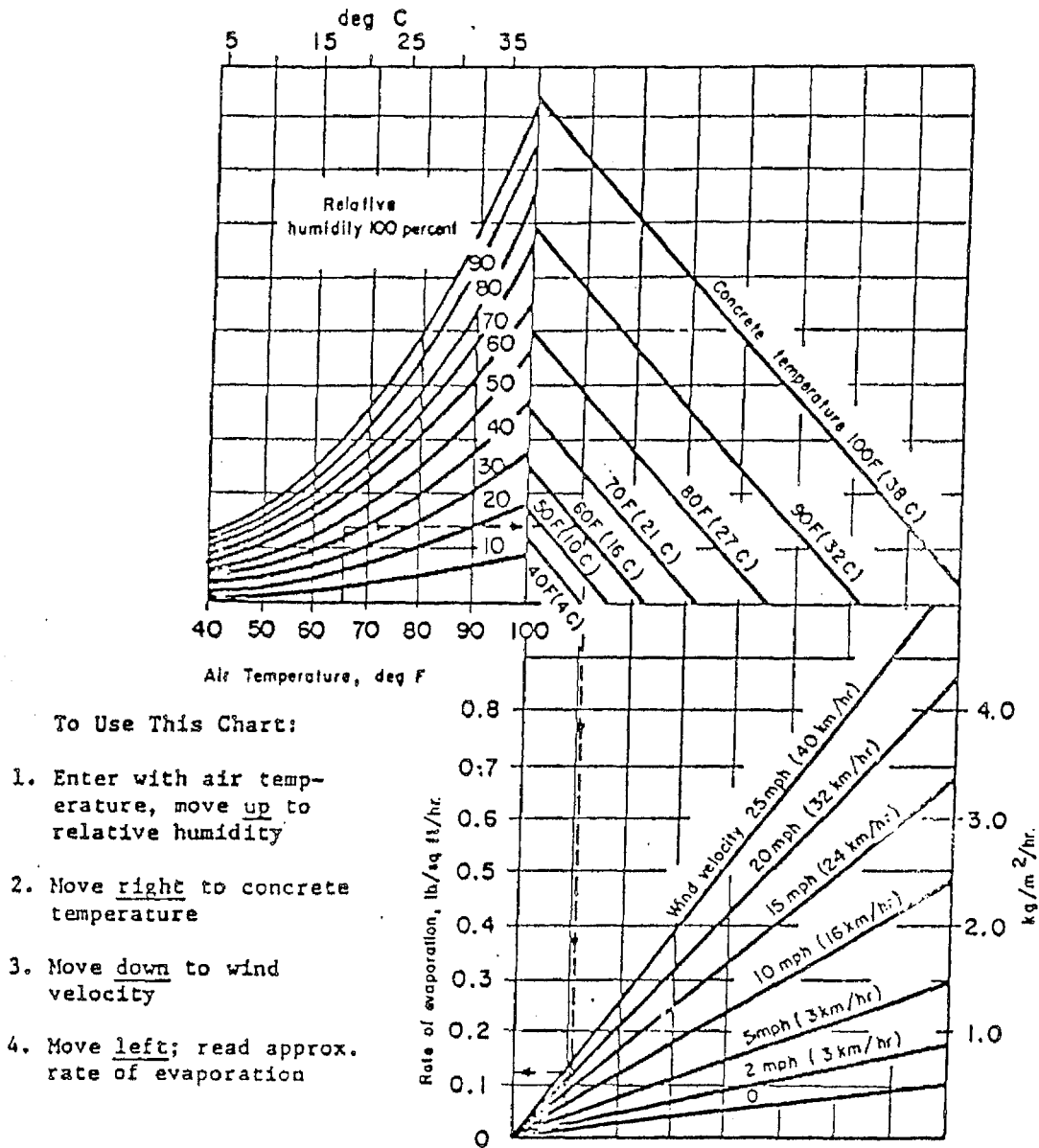
349.5.4 When forms are removed prior to the completion of the curing period specified herein, the CONTRACTOR shall protect the formed concrete surfaces by the same curing method used on the exposed surfaces of the concrete.

349.6 TEMPERATURE CONTROL

349.6.1 The temperature of all concrete placed shall be a minimum of 50°F(10°C) and a maximum of 90°F (32.2°C). The water, aggregates, and sand can be heated to maintain the minimum temperature and ice can be used to replace some of the water to maintain the concrete under the maximum temperature as long as the specified water to cementitious material ratio is not exceeded.

349.6.2 After completion of the finishing of the concrete, the CONTRACTOR shall initiate immediately the final curing of the concrete. Temperature control during and for the duration of the curing period is essential to provide a satisfactory temperature to assure hydration of the portland cement to achieve the specified compressive strength of the concrete.

EVAPORATION RATE



Effect of concrete and air temperatures, relative humidity, and wind velocity on the rate of evaporation of surface moisture from concrete. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use the chart, follow the four steps outlined above. If the rate of evaporation approaches 0.2 lb per sq ft per hr (1.0 kg/m²/hr), precautions against plastic shrinkage cracking are necessary.

349.6.2.1 During cold weather, the CONTRACTOR shall maintain the temperature of all newly constructed concrete at not less than 50°F (10°C) for the curing period by the use of insulated blankets, an outside heating source, or other methods approved by the ENGINEER.

349.6.2.2 During hot weather, the CONTRACTOR may find it necessary to cover or shade newly constructed concrete to reduce the temperature build up and moisture loss (flash setting) in the concrete.

349.6.3 The ENGINEER shall monitor and record the high and low temperature of the concrete for every 24-hour period during the curing period when temperature protection is used by the CONTRACTOR, or at intervals deemed necessary by the ENGINEER. High-low thermometers or other temperature monitoring/recording systems may be used by the ENGINEER. The ENGINEER will notify the CONTRACTOR when the temperature of the newly constructed concrete reaches a low temperature of 53°F (11.7°C) or a high temperature of 100°F (37.8°C) so that the CONTRACTOR can modify his method of curing to maintain the proper curing temperature.

349.7 CURING METHODS

349.7.1 Immediately after the finishing operation has been completed and as soon as marring of concrete will not occur, the CONTRACTOR shall initiate the final curing of the concrete by one (1) or a combination of the following methods or a method the CONTRACTOR has submitted and received authorization from the ENGINEER to use.

349.7.1.1 Curing Compound: All curing compounds used shall be in accordance with Section 105 or Section 111 if applied to colored concrete.

349.7.1.2 Waterproof Paper: Waterproof paper shall comply with ASTM C-171. The Paper shall be new and unused. The paper shall be placed so as to cover the entire area of concrete plus two (2) feet in all directions, with an 18" overlap at each joint and be weighed down at all joints and along all edges. Any area that is damaged during the curing period shall be repaired or replaced the same day.

349.7.1.3 Plastic Film - Polyethylene Sheeting: The sheeting shall be a minimum of 4 mils thick; clear, white or black and comply with ASTM C-171. The sheeting shall be placed in the same manner as the waterproof paper. Black sheeting should only be used when there is a need to retain heat in the new concrete.

349.7.1.4 Ponding, immersion, fog spraying, or sprinkling: Any one of these four (4) curing methods can be used directly on the new concrete surface only

when the CONTRACTOR submits to the ENGINEER as part of his curing program a plan that addresses these items:

- A. Water source.
- B. Equipment to be used and backup.
- C. Plan to ensure continuous application of water throughout the curing period.
- D. Protection against erosion of the concrete surface.
- E. Disposal of the water used and protection of the supporting and surrounding areas.

These methods can only be used if approved by the ENGINEER.

349.7.1.5 Burlap, Cotton Mats, or Rugs: Burlap or other materials must be free of sizing or any substances that are injurious to portland cement or causes discoloration. The sections shall be lapped one-half (1/2) their width and 12" at each end. The sections shall be placed so as to extend two (2') feet beyond the edge of the concrete in all directions. The material shall be kept moist and not be allowed to become dry at any time during the curing period.

349.7.1.6 Earth or Sand: The use of earth or sand as a curing cover will not be permitted on any concrete placed in any channel. Earth or sand used as a curing cover shall have particles larger than one inch (1") and shall be free of any organic matter. Earth or sand shall be placed on the new concrete in a minimum thickness of two inches (2") and extend one foot (1') beyond the edge of the concrete. The earth or sand shall be kept moist and not be allowed to become dry at any time during the curing period.

349.7.1.7 Straw or Hay: The use of straw or hay as a curing cover will not be permitted on any concrete placed in any channel. Straw or hay shall be placed on the new concrete in a minimum thickness of six inches (6") and held in place by wire or a cover to protect against the wind relocating the material. The straw or hay shall be kept moist and not be allowed to become dry at any time during the curing period.

349.8 CURING PERIOD

349.8.1 It is the CONTRACTOR'S responsibility to place and cure all concrete in a manner that will ensure that the specified concrete strength is reached. The curing period that is required for a particular volume of concrete will depend on the concrete mix that is placed, the location that it is placed in, how the CONTRACTOR controls the moisture loss and temperature in the concrete, and the weather conditions during placement and curing. The CONTRACTOR is responsible for providing active curing as

listed above and/or passive curing for any length of time that it takes for all constructed concrete to reach its specified strength.

of the concrete to which it is applied. No separate measurement or payment will be made for concrete curing.

349.8.2 The minimum active curing period for all construction concrete shall be based on minimum strength gained or Strength-Maturity Relations Analysis or minimum time table, whichever is the shortest, or as authorized by the ENGINEER.

349.8.2.1 Minimum Strength: Active curing may be discontinued when the average strength of two (2) field cured concrete cylinders or three (3) drilled cores is 85% or higher of the specified concrete strength.

349.8.2.1.1 The field cured cylinders shall be standard concrete cylinders molded in accordance with ASTM C-31, cured the same as the concrete they represent and tested in accordance with the requirements of ASTM C-39.

349.8.2.1.2 The drilled cores shall be sampled in accordance with ASTM C-42 and tested in accordance with the requirements of ASTM C-39, with no single core test strength being less than 75% of the specified concrete strength.

349.8.2.2 Strength-Maturity Relationship: The active curing may be discontinued at the end of the period defined by a Strength-Maturity Relationship Analysis prepared by a Registered Professional Engineer in accordance with ACI 306 and approved by the ENGINEER.

349.8.2.3 Minimum Time Table:

<u>Weather</u>	<u>Min. Curing Days</u>
Warm to Hot	10
Cold	14

Cold weather is defined as when the temperature reaches or goes below 35°F (1.7°C) for one (1) hour during any 24-hour period during the curing period.

349.9 SUBMITTALS:

When required in Section 1502 of the Supplemental Technical Specification or requested by the ENGINEER, the CONTRACTOR shall submit along with the concrete mix design(s) a curing plan for each strength and application of concrete on the project. The plan shall outline which curing method(s) the CONTRACTOR is proposing to use, where each method(s) will be used and the estimated period of active curing each location or type of structure will require.

349.10 MEASUREMENT AND PAYMENT

The measurement and payment for all materials, labor and equipment required in the curing process of the concrete constructed shall be included in the cost

SECTION 400

TRAFFIC CONTROL

400.1 GENERAL

This section contains specifications which are relative to the protection of the public with respect to traffic control, such as: concrete wall and metal barrier, barrier posts, fencing, traffic signal equipment, street lighting equipment, signing and markings

400.2 CONTENTS

<u>SECTION No.</u>	<u>Title</u>
401	Concrete Wall and Metal Barriers
410	Fences
420	General Clauses for Traffic Signal and Street Lighting Systems
421	Signal and Lighting Service Systems
422	Signal and Lighting Standards
423	Foundations for Signal and Lighting Installations
424	Electrical Conduit
425	Pull Boxes, Splice Cabinets and Manholes
426	Wiring
427	Signal Assemblies
428	Vehicle, Pedestrian, and Emergency Vehicle Detectors
429	Traffic Signal Controllers
430	Removal of Traffic Signal Pressure Detector
431	Beacons and Special Signal Equipment
432	Luminaries
440	Reflectorized Painted Pavement Markings
441	Retroreflective Preformed Plastic Pavement Markings
443	Pavement Marking Removal
450	Traffic Signs and Sign Structures

SECTION 401

CONCRETE WALL AND METAL BARRIERS

401.1 GENERAL

For the protection of the public, either in a vehicle or as a pedestrian, there is a necessity for the construction of approved concrete wall and metal barriers along hazardous locations. This section specifies the requirements for the installation of these barriers.

401.2 REFERENCES

New Mexico State Highway Department.
Specifications for Road and Bridge
Construction

401.3 MATERIALS AND CONSTRUCTION

401.3.1 The materials and construction of concrete wall and metal barriers shall conform to Section 606 of the N.M.S.H.D. Specifications for Roads and Bridge Construction and to the N.M.S.H.D. Standard Detail Drawings, some of which have been included in these specifications.

401.3.2 Location of concrete wall barriers and specific anchorage details will be shown on the construction plans.

401.4 MEASUREMENT AND PAYMENT

401.4.1 Measurement for metal barriers and appurtenances shall be by the linear foot of barrier (including rail, posts and installation) or by the unit, such as end section or individual posts. Payment shall include all materials and labor necessary for the installation, as specified in the Bid Proposal.

401.4.2 Measurement for concrete wall barriers shall be by the linear foot along center line of barrier (including jointing and necessary anchoring). Payment shall include all materials and labor associated with the installation, as specified in the Bid Proposal.

SECTION 410

FENCES

410.1 GENERAL

This work shall consist of the construction of fences and gates in substantial compliance with the specifications, lines, and grades shown on the plans or established by the ENGINEER.

410.2 REFERENCES

410.2.1 ASTM:

A 1	A 153
A 36	A 392
A 116	A 499
A 120	A 525
A 121	A 569
A 123	B 209

410.2.2 AASHTO:

M 111
M 133
M 181

410.3 MATERIALS

410.3.1 GENERAL:

410.3.1.1 The CONTRACTOR shall submit the required number and type of test certificates to the ENGINEER certifying that the fencing materials conform with the requirements herein provided. When the locations of manufacturing plants allow, the plants will be inspected periodically for compliance with specified manufacturing methods, and material samples will be obtained for laboratory testing for compliance with materials quality requirements. This can be the basis for acceptance of manufacturing lots as to quality. All materials will be subject to inspection for acceptance as to condition at the latest practicable time the ENGINEER has the opportunity to check for compliance prior to or during incorporation of materials in the work.

410.3.1.2 All materials shall be new and without flaws or defects of any type.

410.3.2 WIRE FENCE

410.3.2.1 WIRE:

410.3.2.1.1 Barbed wire shall conform to ASTM A 121, Class 3, coating and shall consist of two strands of 12-1/2 gauge wire with 4-point 14-gauge round barbs spaced approximately 5 inches apart. In

lieu of Class 3 galvanizing, the wire may be coated with aluminum alloy at the rate of not less than 0.30 ounce per square foot of wire surface and the barbs at the rate of not less than 0.25 ounce per square foot of wire surface.

410.3.2.1.2 Woven wire shall conform to ASTM A 116, design number 832-6-11 (shown in Appendix Table) or as shown on the plans, Class 3 coating or coated with aluminum alloy at the rate of not less than 0.25 ounce per square foot of wire surface. The height shall be 32 inches.

410.3.2.1.3 Staples for fastening fence wire to wood posts shall be galvanized 9 gauge, 1 1/2 inches long.

410.3.2.1.4 Brace wire shall be 9 gauge, galvanized and shall be used in the construction of braces and intermediate braces when wood posts are used.

410.3.2.1.5 Tie wires for fastening barbed wire or woven wire to steel posts shall be not less than 12-1/2 gauge and galvanized. Eleven gauge or heavier wire fasteners or metal clamps may be used in lieu of tie wires when approved by the ENGINEER. Aluminum tie wires will not be accepted.

410.3.2.1.6 Stays for barbed wire fences shall be not less than 9-1/2 gauge galvanized wire conforming with ASTM A 116 and of length and spacing shown on the plans.

410.3.2.2 POSTS: Corner, brace, intermediate brace, gate, and line posts shall be metal or wood and of the type, size, and length shown on the plans and as herein provided.

410.3.2.2.1 Metal posts and braces shall be fabricated from rail, billet, or commercial grade steel conforming with any of the following ASTM Designations: A 1, A 499, and ASTM A 120 (for pipe posts) and shall be galvanized or painted as required. Galvanizing shall conform with ASTM A 123 and painting shall conform with the requirements shown on the plans. Corner, gate, and intermediate brace posts shall be tubular, section, or angles of the type and dimensions shown on the plans. Corner, gate and intermediate brace posts and braces shall be set in concrete as shown on the plans. Line

posts shall have a minimum weight of 1.33 pounds per foot exclusive of anchor plates. A minus tolerance of not to exceed 5 percent of the minimum weight of each post will be permitted. A plus tolerance of 2 inches and a minus tolerance of 1 inch in the length of each post will be permitted. Line posts may be I-beam, T-beam, U-beam, Y-bar, or H-column section. Line posts shall be provided with corrugations, lugs, ribs, or notches spaced approximately 1 inch on centers to engage the required fence wire in designated spaces. Posts with punched tabs intended to be crimped around the wire will not be accepted. Anchor plates shall have an area of not less than 19 square inches, shall weight not less than 0.64 pound each, and shall be securely welded, bradded, or riveted to each line post.

410.3.2.2.2 Wood corner, brace, intermediate brace, gate and line posts shall be southern yellow pine, lodgepole pine, or ponderosa pine and of the length and dimensions shown on the plans. Posts shall be cut from live trees and shall be straight and free from decay and other defects. Line posts may have a single crook in one direction but shall not vary more than 1 1/2 inches from a straight line connecting both ends of the post. All bark shall be peeled and the posts trimmed and smooth of all knots and projections, and both ends of the posts shall be sawed off perpendicular to the centerline.

410.3.2.2.3 Wood corner, brace, intermediate brace, and gate posts shall be of the length shown on the plans. The average nominal diameter of the top of each post shall be not less than 6 inches. The circumference of corner, brace, intermediate brace, and gate posts shall be measured 6 inches below the top of post and shall not be less than 19 inches. The average nominal diameter of the top of each line post shall be not less than 3 inches. The circumference of line posts shall be measured 6 inches below the top of the post and shall be not less than 9 1/2 inches.

410.3.2.2.4 Wood posts shall be pressure treated with standard creosote oil or petroleum-pentachlorophenol consisting of not more than 95 parts by weight of petroleum and not less than 5 parts by weight of pentachlorophenol. The empty cell process shall be used. The amount of creosote oil retained shall be not less than 6 pounds per cubic foot of wood, and the amount of pentachlorophenol retained shall be not less than 0.3 pound

of dry salt per cubic foot of wood. Wood preservatives shall conform with AASHTO M 133.

410.3.2.2.5 Braces for wood posts shall be coast region Douglas fir, New Mexico red spruce or fir and shall conform with dimensions shown on the plans.

410.3.2.3 GATES: Gates shall be only tubular steel frame or tubular steel frame with filters of wire fabric, metal panel, chain link, or barbed wire, conforming with the dimensions and details shown on the panels. Materials and galvanizing shall be in conformity with the requirements of ASTM A 116 Class 3, A 120, A 392, A 525, and A 123 where applicable. Aluminum panel gates shall conform to ASTM B 209, and shall be installed if specifically required by the construction plans. Aluminum gates will not be arbitrarily substituted for tubular steel frame gates.

410.3.2.4 FITTINGS: All fittings, hardware, and appurtenances for fences and gates shall be commercial quality steel, malleable iron or wrought iron and shall be galvanized in accordance with the requirements of ASTM A 153.

410.3.3 CHAIN LINK FENCE:

410.3.3.1 Post shall be galvanized steel, tubular or H-column, conforming with the lengths, dimensions and weights shown on the plans. Tubular posts, braces, and top rails shall conform with the requirements of ASTM A 120 for galvanized standard weight pipe, except that the pipe shall not be threaded nor subjected to hydrostatic test. H-column posts shall conform to ASTM A 36. The galvanizing shall conform to the requirements of AASHTO M 111 (ASTM A 123).

410.3.3.2 Post tops, stretcher bars, hardware, and other required fittings shall be of commercial quality steel, malleable iron or wrought iron and the galvanizing shall conform with the requirements of ASTM A 153.

410.3.3.3 Tie wires for fastening chain link fence to posts and rails shall be 9 gauge and galvanized. Galvanized steel or noncorrosive metal bands or fasteners may be used in lieu of tie wires when approved by the ENGINEER. Aluminum tie wires will not be accepted.

410.3.3.4 Compression braces shall conform with the same requirements as top rails. Tension truss rods shall be not less than 3/8 inch round galvanized rods

with drop-forged turnbuckles or other approved tension device.

410.3.3.5 Chain link fabric shall conform to the requirements of AASHTO M 181. Unless otherwise provided, the wire shall be No. 9 gauge galvanized wire and the fabric shall be 2 inch mesh.

410.3.3.6 Gates may be double drive, single drive, or single walk and shall conform with the dimensions and details shown on the plans. Gate frames shall be fabricated from galvanized steel pipe conforming with ASTM A 120 and A 123. Chain fabric filler shall conform to the requirements herein provided for chain link fabric.

410.3.3.7 Corner posts shall be 3 inches O.D. with a minimum weight of 5.8 lb. per ft. Line posts shall be 2-1/2 inches O.D. with a minimum weight of 3.66 lb. per ft. Top rail and braces shall be 1-5/8 inches O.D. with a minimum weight of 2.27 lb. per ft.

410.3.3.8 At the option of the CONTRACTOR, posts, rails, braces, and gate framing members may be pipe manufactured from steel conforming to ASTM A 569, cold rolled, and coated with a minimum of 0.9 ounces of zinc per square foot, a minimum of 15 micrograms of zinc chromate per square inch and a minimum of 3 mils cross-linked polyurethane acrylic exterior coating, in lieu of fencing members conforming to the requirements specified above and in Subparagraph F below, except the that outside diameter of the pipe shall be as specified above, and with thickness and weight as per Table 410.3.3.8.

410.3.3.9 When outriggers with barbed-wire are installed the lowest strand shall not be less than 8 feet high measured from ground level. The same clearance distance will be required for coiled security wire.

410.4 CONSTRUCTION REQUIREMENTS

410.4.1 CONSTRUCTION METHODS: The CONTRACTOR shall perform such clearing and grubbing as may be necessary to construct the fence to the required grade and alignment. At locations where breaks in a run of fencing are required or at intersections with existing fences, appropriate adjustment in post spacing shall be made to conform to the requirements for the type of closure indicated. When the plans require that posts, braces, or anchors be embedded in concrete, the CONTRACTOR shall install temporary guys or braces as may be required to hold the

posts in proper position until such time as the concrete has set sufficiently to hold the posts. Unless otherwise permitted, no materials shall be installed on posts or strain placed on guys and bracing set in concrete until 7 days have elapsed from the time of placing of the concrete. The tops of all posts shall be set to the required depth and alignment. Cutting of the tops of posts shall be allowed only with the approval of the ENGINEER and under the conditions specified by him. Wire or fencing of the size and type required shall be firmly attached to the posts and braced in the manner indicated. All wire shall be stretched taut and be installed to the required elevations. At each location where an electric transmission, distribution, or secondary line crosses any of the types of fences covered by these specifications, the CONTRACTOR shall furnish and install a ground conforming to the drawings shown on the plans.

410.4.2 WIRE FENCE:

410.4.2.1 Wire fences shall be constructed in conformity with the details and at locations shown on the plans or staked by the ENGINEER. All posts shall be set plumb and to the depth and spacing shown on the plans. Excavations for footings and anchors shall be to dimensions shown on plans or established by the ENGINEER. Metal line posts may be driven. Post hole backfill shall be placed in thin layers and each layer solidly compacted. Posts set in rock shall be placed as per construction plans.

410.4.2.2 Fence wire shall be stretched by mechanical stretcher or other device designated for such use. Stretching by motor vehicle will not be permitted. The length between pull posts shall not exceed 995 feet for barbed wire and 660 feet for woven wire.

410.4.2.3 Intermediate braces shall be placed at intervals not to exceed 1000 feet and shall be spaced evenly between corner and gate posts or cattle guards.

410.4.2.4 A corner post and brace shall be placed at the intersection of cross fences with the right-of-way fence. Cross fence wires shall be stretched and firmly attached to the corner posts.

410.4.2.5 Right-of-way fences shall be attached to roadway structures when shown on the plans.

410.4.2.6 Fence materials of the same manufacture, type or process, conforming with the details shown on the plans shall

TABLE 410.3.3.8

FENCE PIPING DIMENSIONS AND WEIGHTS

<u>Fence Industry O.D. (in)</u>	<u>Nominal Pipe Size I.D. (in)</u>	<u>Decimal Equivalent O.D. (in)</u>	<u>Minimum Wall Thickness (in)</u>	<u>Minimum Weight Lbs Per Foot</u>
1-5/8	1-1/4	1.660	0.111	1.836
2-1/2	2	2.375	0.130	3.117
3	2-1/2	2.875	0.160	4.640

be used throughout the Work unless otherwise authorized in writing by the ENGINEER.

410.4.3 CHAIN LINK FENCE:

410.4.3.1 Chain link fences shall be constructed in conformity with the details and at locations shown on the plans or staked by the ENGINEER. Posts shall be spaced at not more than 10 foot intervals. The intervals shall be measured from center to center of post. All posts shall be set in concrete footings conforming with the dimensions and details shown on the plans. Posts set in rock shall be approved by the ENGINEER. Chain link fabric shall not be attached to posts until the concrete footings have completely set. Pull posts shall be line posts braced to adjacent line posts as shown on the plans. Pull posts shall be spaced at intervals not to exceed 500 feet. End posts shall be not less than 2.875 inches in outside diameter and braced in the same manner as corner posts. Braced tension rods or cables, hardware, and appurtenances shall be installed as shown on the plans.

410.4.3.2 Chain link fabric shall be stretched by mechanical stretcher or other device designed for such use. Stretching by motor vehicle will not be permitted.

410.5 REMOVING AND REBUILDING FENCE

As shown on the construction plans or directed by the ENGINEER existing fences may require removal and re-erected. Such fences shall be reconstructed to the same condition as the original fence or better. The materials in existing fences to be removed and rebuilt shall be salvaged and incorporated in the rebuilt fences. Fence materials damaged beyond reuse during removal or rehandling shall be replaced by the CONTRACTOR at his expense. Posts shall be firmly reset to the line shown on the plans. The spacing of the posts and the material to be strung and secured to the posts shall be the same as the original fence. New tie material or staples shall be used to fasten the fence material to the posts and shall be furnished by the CONTRACTOR at his expense.

410.6 MEASUREMENT AND PAYMENT

410.6.1 For new fences the measurement and payment will be by one of the following methods:

410.6.1.1 By the linear foot. Measurement will be along the top of the fence

from outside to outside of end posts for each continuous run of fence. The accepted quantities of fence will be paid for at the Bid Proposal's unit price per linear foot complete in place for the specified type of fence.

410.6.1.2 By the square foot. Measurement will be the horizontal distance of the fence from outside to outside of end posts for each continuous run multiplied by the vertical measurement of the material; the product area shall be designated in square feet. Payment will be made on the Bid Proposal's unit price per square foot complete in place for the specified type of fence.

410.6.1.3 Regardless of which method is used, payment shall include the cutting, removal, and replacement of any concrete or asphalt surfacing associated with the fence installation.

410.6.2 Removal and rebuilding of a fence shall be measured by the linear foot of fence removed and rebuilt and payment will be made on the unit price per linear foot for the type of fence as specified in the Bid Proposal.

410.6.3 Removal and disposal of a fence shall be measured by the linear foot of fence removed and disposed of by the CONTRACTOR. Payment will be made on the unit price per linear foot for the type of fence as indicated in the Bid Proposal.

410.6.4 Measurement and payment for gates will be the unit price per each for the type of fencing material specified in the Bid Proposal.

SECTION 420

GENERAL CLAUSES FOR TRAFFIC SIGNAL AND STREET LIGHTING SYSTEMS

420.1 GENERAL: The work performed under this specification shall consist of furnishing and installing complete and functioning traffic signal and street lighting systems in compliance with the specifications, details shown on the plans, and Standard Drawings at locations shown on the plans or as established by the ENGINEER.

420.2 DEFINITIONS: The following definitions pertain only to traffic signal and street lighting systems:

420.2.1 Beacon - A flashing signal indication used for hazard identification or intersection control, normally post or span wire mounted.

420.2.2 Breakaway - The ability of a standard to yield at a predetermined impact force.

420.2.3 Controller Cabinet - An outdoor housing which contains a traffic actuated controller and all other associated equipment to perform the necessary switching of illuminated signal indications.

420.2.4 Detector - A device by which vehicles or pedestrians are enabled to register their presence with a controller.

420.2.5 Foundation - A concrete structure, embedded in the ground, which supports and anchors a standard, controller cabinet, or splice cabinet.

420.2.6 Installation - The work completed, in place, and in proper operation.

420.2.7 Lighting Control Cabinet - An outdoor housing which contains contactors, photo electric controllers, switches, and other auxiliary equipment to control lighting systems.

420.2.8 Luminaire - A lighting device designed to illuminate the surface of a specific area from a mounting on a standard; includes the housing, optical control, lamps, and any necessary ballasts.

420.2.9 Overlap - The allocation of right of way to a special traffic movement during two or more phases.

420.2.10 Phase - The ability of a controller to allocate time (right of way) to any traffic movement(s) which may occur during one or more intervals (period of unchanged

indications) of a complete cycle.

420.2.11 Service - The connection of a signal or lighting system to an electrical utility distribution system, mounted on a pole or enclosed in a cabinet, and including the necessary protection device, meter enclosure, and any required switching devices.

420.2.12 Signal Assembly - A housing containing the required illuminated traffic signal indications (vehicular and pedestrian) mounted on a standard.

420.2.13 Splice Cabinet - An outdoor housing which contains terminal blocks for connecting communication cables.

420.2.14 Standard - A pole type structure which supports and positions signal and lighting devices including arms, mounting hardware, and breakaway devices as required.

420.2.15 System Master - An electronic device normally installed in a controller cabinet which is capable of supervising an interconnected network of local controllers, providing coordinated traffic movement. System masters in turn may be controlled by a computerized traffic control system.

420.2.16 Traffic Actuated Controller - An electronic timing device which controls the timing and sequence of traffic phases in accordance with the varying demands of traffic registered by detectors.

420.2.17 Traffic Control System - A complete system of signalized intersections with a remote computer including all communications devices, peripheral equipment and sampling detectors.

420.2.18 Traffic Engineer - The City of Albuquerque Traffic Engineer is responsible for acceptance and maintenance of the signal and lighting system. Contact the Traffic Operations Engineer in case of Traffic Operations emergencies.

420.2.19 Traffic Signal - The complete installation of a traffic control system at a roadway intersection, including the illuminated signal indications, supports, electrical controls, and distribution system.

420.3 REFERENCES

- 420.3.1 Aluminum Association Standards, Latest Edition
- 420.3.2 American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications, Latest Edition
- 420.3.3 American National Standards Institute (ANSI) Standards, Latest Edition
- 420.3.4 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition
- 420.3.5 Federal Highway Administration (FHWA) Standards, Latest Edition
- 420.3.6 Government Services Administration (GSA) Standards, Latest Edition
- 420.3.7 Institute of Transportation Engineers (ITE) Publications, Latest Edition
- 420.3.8 International Municipal Signal Association (IMSA) Standards, Latest Edition
- 420.3.9 Manual on Uniform Traffic Control Devices (MUTCD), Latest Edition
- 420.3.10 National Electrical Code (NEC), Latest Edition
- 420.3.11 National Electrical Manufacturers Association (NEMA) Standards, Latest Edition
- 420.3.12 Rural Electrification Administration (REA) Standards, Latest Edition
- 420.3.13 This Publication, Latest Edition
- 420.3.14 Underwriters Laboratories Standards, Latest Edition
- 420.3.15 United States Standards, Latest Edition

420.4 MATERIALS.

420.4.1 SIGNAL AND LIGHTING MATERIALS:

420.4.1.1 GENERAL

420.4.1.1.1 Materials shall be new unless provided otherwise on the plans or in the specifications. In addition to the requirements shown on the plans or in the specifications, electrical materials shall conform to NEMA standards and NEC requirements and to any applicable state

or local ordinances or requirements. In the event revisions to NEMA and/or NEC requirements create a conflict with material requirements in these specifications, the latest NEMA and/or NEC requirements shall apply.

420.4.1.1.2 Signal and lighting systems shall be complete with all necessary accessories for proper operation. Disconnect devices, protective devices, and other devices and materials shall be thoroughly coordinated to secure the required results with the greatest assurance of protection to life and property consistent with these specifications and the NEC. The plans indicate the extent and general arrangement of signal and lighting systems. Incidental parts not shown on the plans or included in the specifications which are necessary to complete new systems or modify existing systems shall be furnished and installed as though such parts are shown on the plans or provided for in the specifications.

420.4.1.2 MATERIAL APPROVALS: Within fifteen (15) calendar days after notice to proceed is issued, the CONTRACTOR shall submit for approval to the ENGINEER a list of signal and lighting materials he proposes to furnish and the source of supply for these materials. Materials which are identified on the plans or in the specifications by performance characteristics shall be included on this list. The list shall include the name of the manufacturer, size, and catalog number of each item and shall be supplemented by other performance data when required on the plans and/or specifications. Submittals for all standards (poles) shall include complete shop drawings and material certifications. The CONTRACTOR shall submit sample articles of the material he proposes to use when requested by the ENGINEER or called for on the plans or as specified in Section 1502 - Submittals.

420.4.1.3 PREQUALIFICATION: All traffic actuated controllers, controller cabinets, signal monitors, vehicle detectors, load switches, signal standards, lighting standards, and luminaires to be provided by the CONTRACTOR shall be pretested and accepted by the Traffic Engineer. The list of pretested and acceptable signal items is available from the Traffic Engineer. Each acceptable item will be listed as to manufacturer and model (or identification) number. Sample items may be submitted (or resubmitted) at any time before or after the opening of bids by the manufacturer or its representative to the Traffic Engineer. However, the CONTRACTOR shall take full responsibility to assure him or herself that all CONTRACTOR furnished traffic signal and street lighting items are prequalified and included on the Traffic Engineer's list of pretested and acceptable traffic signal and street lighting items prior to submitting a bid for the work. The City of Albuquerque reserves the right for up to thirty

(30) days of evaluation before notification of results. Acceptance under these specifications for prequalification shall be at the discretion of the Traffic Engineer.

420.4.1.4 EXCEPTIONS TO THE SPECIFICATIONS: Any changes in the specifications must be in writing as an addendum issued prior to the opening of bids. Verbal explanations or instructions given prior to opening of bids will not be binding.

420.4.1.5 WARRANTY: Guarantees and warranties shall be in accordance with Section 13 - Warranty and Guarantee, Tests and Inspections, Corrections, Removal, or Acceptance of Defective Work. All manuals, drawings, shop drawings, wiring diagrams, etc. furnished by the electrical equipment manufacturer shall be transferred to the ENGINEER.

420.4.2 BACKFILL MATERIALS

420.4.2.1 Backfill materials for signal and lighting system excavations within the roadway prism or for foundations shall be suitable for compaction as required under Section 510-Concrete Structures.

420.4.2.2 Excavation for conduit or drilling pits outside the roadway prism and in natural ground may be backfilled with the material originally removed except that it shall be free of large stones (over 4 inches in diameter), large pieces of concrete, vegetation, and other extraneous substances.

420.4.2.3 The CONTRACTOR shall provide sources for suitable backfill material.

420.4.3 PAVEMENT AND SIDEWALK MATERIAL:

420.4.3.1 Pavement and sidewalk replacements for signal and lighting system excavations shall conform to the existing material removed. If the original pavement design or concrete mix cannot be determined, the pavement design shall be determined by the ENGINEER and the sidewalk shall be in accordance with Section 340-Portland Cement Concrete Curbs, Gutters, Walks, Driveways, Alley Intersections, and Median Paving.

420.4.3.2 Commercial sources may be used when approved by the ENGINEER. The CONTRACTOR shall submit material specifications and sample material when requested by the ENGINEER and as specified in Section 1502 - Submittals.

420.5 CONSTRUCTION REQUIREMENTS.

420.5.1 GENERAL

420.5.1.1 Electrical work shall conform to NEC requirements and to any applicable local ordinances. The CONTRACTOR shall obtain a permit from the State Electrical Board (or equivalent state or local agency) prior to constructing the traffic signal or street lighting systems or any other electrical installations required by the contract and provide proof to the ENGINEER before work begins. Only licensed electricians shall be employed to perform electrical work and install electrical materials required by the contract. In addition, the CONTRACTOR shall obtain approval from the electric utility for the exact location of the electric service before its installation. Prior to final inspection of the project, the CONTRACTOR shall submit evidence to the ENGINEER that all electrical work and installations have been inspected and approved by an authorized representative of the State Electrical Board. All systems shall be complete and in operation to the satisfaction of the ENGINEER and the Traffic Engineer at the time the work is accepted.

420.5.1.2 It shall be the CONTRACTOR'S responsibility to know the requirements of the NEC (and all local requirements) and to notify the ENGINEER promptly of any conflicts with these specifications and/or the plans. In the event revisions to NEC requirements create a conflict with requirements in these specifications and/or the plans, the NEC requirements shall apply.

420.5.2 EXCAVATION AND BACKFILL

420.5.2.1 Excavation required for the installation of conduit, foundations, and other items shall be done so as to cause the least possible damage to streets and highways. Excavating shall not be done until immediately before installation of conduit and foundations and shall be approved by the ENGINEER.

420.5.2.2 There shall be no cutting of existing pavement unless approved by the ENGINEER.

420.5.2.3 Excavations within the roadway prism, including sidewalk areas, paved driveways and median areas and all standard (pole) foundations, shall be in accordance with Section 510-Concrete Structures.

420.5.2.4 Backfill of excavations in natural ground or out of defined roadway prism may be of original material, mechanically tamped, and neatly leveled to original grade. For excavations in grassed (landscaped) areas, the CONTRACTOR shall carefully remove sod prior to excavation and replace it after backfilling.

420.5.2.5 Fine grained material, all of which passes a 3/8 inch sieve, shall be placed a minimum of two (2) inches on

the sides and above all conduit for the width of the trench to prevent damage to conduit during backfilling. This material shall also be placed as a two (2) inch cushion below the conduit when the bottom of the trench contains rocks or material determined unsuitable by the ENGINEER.

420.5.3 EXISTING AND TEMPORARY TRAFFIC SIGNALS AND LIGHTING SYSTEMS

420.5.3.1 The CONTRACTOR shall furnish, install, and maintain temporary traffic signals and lighting systems when shown on the plans or provided for in the specifications. The CONTRACTOR shall provide the ENGINEER and the Traffic Engineer access to all power disconnects and control equipment during this period. Timing plans for temporary traffic signals shall be as determined by the Traffic Engineer, or his designee. Unless otherwise called for on the plans or specifications, this temporary equipment will be retained by the CONTRACTOR after removal.

420.5.3.2 Existing signal and lighting systems shall be kept in operation until the new material is installed and ready for operation, unless otherwise permitted as noted on the traffic control plan. In this event, the CONTRACTOR shall not proceed with any work which will cause the existing signals to become inoperative until he has all materials for the new installation on hand, and the specified regulatory signing or temporary signals are in place and approved by the ENGINEER and the Traffic Engineer.

420.5.3.3 The scheduling of shutdowns shall be in accordance with the construction traffic control plan; the CONTRACTOR shall notify construction coordination, the ENGINEER, and the Traffic Engineer in writing at least two (2) working days in advance. In the event of construction problems making this not feasible, the ENGINEER shall be notified and the work performed as he directs.

420.5.3.4 Existing signal material which is called for on the plans for removal and salvage shall be handled carefully to avoid damage and shall be delivered by the CONTRACTOR to Traffic Engineering Operations Division, Pino Yard, Albuquerque, New Mexico or as called for on the plans. Prior to beginning removals, the CONTRACTOR shall meet with Traffic Engineering personnel at the project site to inventory and video tape existing equipment. The CONTRACTOR shall provide VHS format video camera and tape for the inventory. The original video tape shall be given to Traffic Engineering Operations personnel.

420.5.3.5 Salvaged lighting material will be removed by the electric utility unless otherwise noted on the plans. In

this event, the CONTRACTOR shall remove and deliver the material to the location called for on the plans.

420.5.3.6 When the work requires additions or modifications to existing signal or lighting systems, the CONTRACTOR shall give the ENGINEER and the Traffic Engineer at least two (2) working days advance written notice of any interruptions and the Traffic Engineer shall be given the opportunity to inspect all work before and after re-energizing.

420.5.3.7 The electrical energy costs, maintenance and operational responsibility for existing signal and lighting systems undergoing contract modifications shall remain with the City of Albuquerque or as otherwise designated on the plans. The CONTRACTOR shall retain responsibility for workmanship and all new material per this Section 420. Damage to existing equipment as a result of the construction activities shall be repaired immediately by the CONTRACTOR at no additional cost. If Traffic Engineering Operations responds on an emergency basis to ensure public safety, the CONTRACTOR shall be responsible for all costs associated with the repair of the signal. All electrical energy costs for new signal and lighting systems shall be the responsibility of the City of Albuquerque. The CONTRACTOR shall ensure that the City of Albuquerque is the customer of record for the electric utility.

420.5.3.8 New signal and lighting systems or modifications to existing systems shall require a thirty (30) day installation test per this Section 420. Maintenance of new signals and lighting systems shall be the responsibility of the CONTRACTOR until partial acceptance is granted as defined in this Section 420. Upon granting of final acceptance, Traffic Engineering Operations Division will be responsible for the signal and lighting systems.

420.5.3.9 After the signal has been placed in operation and prior to final acceptance, the CONTRACTOR shall ensure that the signal remains fully operational. The CONTRACTOR shall notify the ENGINEER and the Traffic Engineer immediately if the signal malfunctions or is otherwise disabled. Traffic Engineering Operations Division may respond on an emergency basis to ensure safe operation of the signal system. If Traffic Engineering Operations Division responds to such an emergency, the CONTRACTOR will be responsible for all costs associated with the repair of the signal.

420.5.3.10 Repairs or replacement of damaged signal and lighting systems shall be done in accordance with Section 13-Warranty and Guarantee, Tests, and Inspections, Corrections, Removal, or Acceptance of Defective Work.

420.5.4 TESTING.

420.5.4.1 WIRING TEST

420.5.4.1.1 Before acceptance of the work, the CONTRACTOR shall make the following tests on all lighting and signal circuits:

1. Test for continuity of each circuit.
2. Test for grounds in each circuit.
3. A megger test on each circuit between the circuit and ground; the insulation resistance for all vehicle loops, direct burial wire or cable.
4. When requested by the ENGINEER, a functional test to demonstrate that all parts of the system functions as specified or intended.

420.5.4.1.2 The initially applied voltage for the tests shall not be greater than the rated voltage of the cables, and the rate of increase shall be approximately uniform and not more than 100 percent in 10 seconds or less than 100 percent in 60 seconds.

420.5.4.1.3 Any fault in materials or in any part of the installation revealed by these tests shall be replaced or repaired by the CONTRACTOR in a manner satisfactory to the ENGINEER and the Traffic Engineer, and the same test shall be repeated until no fault appears.

420.5.4.1.4 Tests shall be performed under the surveillance of the ENGINEER and the Traffic Engineer. The CONTRACTOR shall furnish all instruments and personnel required for the test.

420.5.4.2 OPERATION TESTS

420.5.4.2.1 A thirty (30) day operational test period is required and will start when the traffic signal is completely installed and fully operational, including loop detectors. The CONTRACTOR shall request approval to start the thirty (30) day operational test period in writing to the ENGINEER and the Traffic Engineer. Partial acceptance of the system will be granted upon satisfactory completion of the thirty (30) day operational test period. Final acceptance will be in accordance with Section 14-Payments to the CONTRACTOR and Completion.

420.5.4.2.2 Shop testing of the controllers shall be in accordance with Section 429-Traffic Signal Controllers. This special testing is in addition to the thirty (30) day installation tests.

420.5.4.2.3 Timing for signal controllers during the installation test period shall be determined by the Traffic Engineer. No signal shall be placed in operation until the Traffic Engineer has verified the time settings and the correctness of all signal indication outputs. The CONTRACTOR shall provide access to the signal controller for the ENGINEER and Traffic Engineer during the test period.

420.5.5 TECHNICAL ASSISTANCE

420.5.5.1 Traffic Engineering Operations Division electronic technicians or electricians are available to answer CONTRACTOR'S technical questions on electrical equipment on an as needed basis.

420.5.5.2 The CONTRACTOR shall make any requests for assistance to the ENGINEER and Traffic Engineer. The ENGINEER and Traffic Engineer will then make the determination as to need. Assistance will be limited to verbal explanations on lab testing failures, deficiencies, wiring diagrams, electronic schematics, controller, related equipment hook-up, and trouble shooting procedures. City of Albuquerque employees will not perform any physical labor for rewiring, repairs or modifications during the test period or prior to final acceptance, except when required to maintain public safety.

420.6 MEASUREMENT AND PAYMENT: Measurement and payment of furnishing and installing traffic signal and street lighting systems will be as specified in the bid proposal.

SECTION 421

SIGNAL AND LIGHTING SERVICE SYSTEMS

421.1 GENERAL: This work shall consist of furnishing and installing service poles, service connections, and lighting control cabinets in compliance with the specifications, details shown on the plans, and Standard Drawings at the locations shown on the plans, or as established by the ENGINEER.

421.2 REFERENCES

421.2.1 American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications, Latest Edition

M133 Preservative and Pressure Treatment Process for Timber

421.2.2 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition

A36 Structural Steel

A307 Carbon Steel Bolts and Studs; 60,000 psi Tensile

421.2.3 National Electrical Code (NEC), Latest Edition

421.2.4 National Electrical Manufacturers Association (NEMA) Standards, Latest Edition

421.2.5 Underwriters Laboratories

421.2.6 This Publication, Latest Edition

SECTION 101 PORTLAND CEMENT CONCRETE

SECTION 102 STEEL REINFORCEMENT

SECTION 420 GENERAL CLAUSES FOR TRAFFIC SIGNAL AND STREET LIGHTING SYSTEMS

SECTION 501 EXCAVATIONS AND BACKFILL FOR STRUCTURES

SECTION 701 TRENCHING, EXCAVATION, AND BACKFILL

SECTION 1502 SUBMITTALS

421.3 MATERIALS.

421.3.1 SERVICE POLE

421.3.1.1 Materials for service poles shall conform with the details shown on the plans and the requirements in the special provisions. Timber poles treated in conformity with the requirements of AASHTO M 133 shall be provided.

The pole shall be of the size called for on the plans and as a minimum shall be butt treated.

421.3.1.2 Normal service requirements for traffic signals shall be 120/240-volt, 60-cycle, 3-wire solid neutral power, and for multiple lighting systems shall be 240/480-volt, 60-cycle, 3-wire solid neutral power, unless otherwise specified in the plans or special provisions.

421.3.1.3 Service switches, when required, shall be a circuit breaker type or a disconnect switch, type HD, with fuses, with capacity and ratings as shown on the plans or in the special provisions. The service switch shall be enclosed in a NEMA raintight housing with a hinged cover. The cover shall stay in position when open and shall have a hasp for a padlock. The switch and housing shall be approved by UL.

421.3.2 SERVICE RISER: Materials for service risers shall conform with the requirements of this Section 421 and details shown on the plans, when electrical service is to be installed on an existing pole.

421.3.3 METER PEDESTAL

421.3.3.1 Materials for meter pedestals shall conform with the details shown on the plans, the requirements of the NEC, and the following requirements:

421.3.3.2 Meter pedestals shall be constructed of 14 gauge steel with corrosion resistant finish.

421.3.3.3 Meter socket shall have a minimum rating of 100 amp and be factory wired in separate wireway from terminal block to meter socket.

421.3.3.4 For services larger than 100 amp, a factory-rated 200 amp pedestal shall be used.

421.3.3.5 Insulated stud terminal blocks or bus pads shall be used to accommodate connectors.

421.3.3.6 Pedestal bonding lug grounding conductors must be continuous to the breaker panel grounding terminal.

421.3.3.7 Termination section shall have a removable raintight cover with provision for padlocking over captive pentahead bolt. All other removable portions of termination section must be sealable.

421.3.3.8 Meter pedestal shall be anchored securely to concrete foundation. Concrete foundation and anchoring system shall conform with the details shown on the plans or as shown herein.

421.3.4 SERVICE CONNECTION: Service connections (connection to existing service pole, service riser, transformer, or meter pedestal) shall conform with the details shown on the plans and the requirements of the NEC.

421.3.5 LIGHTING CONTROL CABINET

421.3.5.1 Materials for lighting control cabinets shall conform with the details shown on the plans, the requirements of the NEC, and the following requirements:

421.3.5.2 Cabinets shall be fabricated from 14 gauge steel with a durable finish consisting of a corrosion resistant durable finish.

421.3.5.3 Cabinets shall be REA approved, ground mounted, tamper proof, and lockable.

421.3.5.4 Cabinets shall be suitable for 25KV systems with ground nut and ground lug.

421.3.5.5 Cabinet hardware shall be stainless steel including hinges.

421.3.5.6 Mounting brackets shall be furnished for attaching contactors, photo electric cells, junction boxes and other auxiliary equipment.

421.3.5.7 Lighting Control Cabinet shall be anchored securely to concrete foundation. Concrete foundation and anchoring system shall conform with details shown on the plans.

421.3.6 PHOTOELECTRIC CONTROLLER

421.3.6.1 Materials for photoelectric controllers shall comply with the details shown on the plans.

421.3.6.2 The photoelectric unit shall consist of a light-sensitive element connected directly to an internal control relay without intermediate amplifications. The unit may be either the horizontal-sensing or zenith-sensing type and shall have turn-on at 1.5 +0.5 horizontal footcandles and a turn-off at a maximum of 5.6 footcandles with a minimum difference of 0.8 footcandle between turn-on and turn-off. The load rating shall be 1800 watts minimum (HID load).

421.3.6.3 The base of the unit shall be provided with a

three-prong, EET-NEMA standard, twist-lock type plug mounting which will enable the unit to be mounted directly on luminaires or by the use of an adapter base on pole tops or sides. The controllers shall normally work in conjunction with external auxiliary load relays for handling required lighting loads.

421.3.6.4 Unless otherwise specified, the supply voltage rating shall be the same as the system voltage noted on plans. The minimum operating temperature range shall be -40 degrees F to 140 degrees F. The power consumption of the controller shall be less than 12 watts.

421.3.6.5 When the north sky illumination in the area falls to a preset value, the lighting load shall be turned on. A potentiometer to vary the turn-on value within the operating range shall be easily accessible for adjustment. A time delay shall be incorporated into the circuit to prevent street lights from being turned off at night by transient lights which might be focused on the controller. The controlled lighting load shall remain on or become energized in the event of any functional failure of the electronic circuit. The controller shall be equipped with a lightning arrestor capable of handling 500V at 35,000 amps.

421.3.7 AUXILIARY CONTACTOR

421.3.7.1 The contactor shall work in conjunction with a photoelectric controller and the specified lighting loads. The contactor shall be normally open and shall be double-pole, unless otherwise specified.

421.3.7.2 The contactor shall be of the electrically held type, designed to withstand lamp load inrush current and to carry full rated current on a continuous basis. The operating voltage and load rating shall be as noted on the plans.

421.3.7.3 A three position switch to permit manual operation of the lighting circuit shall be provided. The switch shall be furnished and installed with an indicating nameplate reading "PHOTO-OFF-MANUAL." The switch shall be toggle or rotary type, double-pole, triple-throw, center-off position, and shall be rated as required on the plans.

421.4 CONSTRUCTION REQUIREMENTS.

421.4.1 GENERAL

421.4.1.1 Service points shown on the plans are approximate. The CONTRACTOR shall obtain the exact location from the electric utility. The ENGINEER shall approve the final location before any service installation work is started. In the event a major change in location

from that shown on the plans is required, the ENGINEER will determine the final location and the service run will be adjusted as per the contract unit price.

421.4.1.2 The CONTRACTOR shall obtain all necessary permits and electrical inspections required for service attachment. Approval of the ENGINEER shall be given before hook-up.

421.4.1.3 The CONTRACTOR shall have the City of Albuquerque shown as the customer of record for the electric utility in accordance with Section 420-General Clauses for Traffic Signal and Street Lighting Systems.

421.4.2 SERVICE POLE

421.4.2.1 Conduit shall be attached to the pole as shown on the plans. Where necessary, condulets, covers, and gaskets shall be provided and installed.

421.4.2.2 Conduit used in the service installation above ground shall be rigid steel, galvanized-type of the size specified on the plans or in the special provisions. In areas where rigid steel conduit is coupled to rigid PVC conduit used for the underground portion of the service run, joining of the conduits shall take place underground from two (2) inches to ten (10) inches below the surface. The conduit shall be securely bonded to the surface pole and the service pole ground system as required by the NEC.

421.4.2.3 Conduit, switches, and other necessary material shall be mounted on the service pole as shown on the plans. When called for, the backing board shall be 3/4-inch thick Douglas Fir Grade B-B or better exterior type plywood. The plywood shall be painted two coats of approved exterior grey paint for weatherproofing. Special care shall be taken to insure that the edges of the plywood are well sealed against moisture and general weathering.

421.4.2.4 The layout, connections, and mounting details of the various switches and associated equipment shall be as shown on the plans or as indicated in the special provisions. All switches, fittings, and necessary equipment shall be furnished and installed.

421.4.2.5 Meter sockets as required by the service utility company shall be furnished and installed as shown on the plans. The service utility company will supply and install meters.

421.4.3 SERVICE RISER: Service risers shall be installed on existing poles at locations shown on the plans. The installation of service risers shall conform to the requirements of this Section 421 and details shown on the

plans. Service risers shall be installed on the quadrant of the existing pole as shown on the plans or as designated by the service utility company.

421.4.4 METER PEDESTAL: Meter pedestals shall be installed at locations shown on the plans and a minimum of ten (10) feet from the service pole. The installation of meter pedestals shall conform to the details shown on the plans.

421.4.5 SERVICE CONNECTION: Service connections shall be installed at an existing service pole, service riser, meter pedestal, or at a location shown on the plans. The installation of service connections shall conform to the details shown on the plans.

421.4.6 LIGHTING CONTROL CABINETS: Lighting control cabinets shall be installed at locations shown on the plans or determined by the ENGINEER. The cabinets shall be installed plumb on a concrete foundation with necessary grout or caulking to provide a weather resistant, dust tight installation. The installation of lighting control cabinets shall conform to the details shown on the plans.

421.5 MEASUREMENT AND PAYMENT.

421.5.1.1 Measurement of service poles including all materials shown on the plans, either with or without meter sockets and disconnect switches, will be measured by the unit complete in place.

421.5.1.2 Measurement of service risers including all materials shown on the plans, either with or without meter sockets and disconnect switches, will be measured by the unit complete in place.

421.5.1.3 Measurement of meter pedestals including concrete foundation will be measured by the unit complete in place.

421.5.1.4 Measurement of service connections will be measured by the unit complete in place.

421.5.1.5 Measurement of lighting control cabinets, including concrete foundation and all materials shown on the plans, will be measured by the unit complete in place.

421.5.2 The accepted quantities of service poles, service risers, meter pedestals, service connections, and lighting control cabinets will be paid for at the contract price per unit of measurement for each of the pay items listed as shown on the bid proposal.

SECTION 422

SIGNAL AND LIGHTING STANDARDS

422.1 GENERAL: This work shall consist of furnishing and installing traffic signal standards, street lighting standards, and anchor bolts, in compliance with the specifications, details shown on the plans, and Standard Drawings at the locations shown on the plans, or as established by the ENGINEER.

422.2 REFERENCES.

422.2.1 Aluminum Association Standards, Latest Edition

422.2.2 American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications, Latest Edition

422.2.3 American National Standards Institute (ANSI) Standards, Latest Edition

SECTION 300 Stainless Steel

422.2.4 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition

A36 Structural Steel

A123 Zinc Coating on Product Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips

A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

A307 Carbon Steel Bolts and Studs; 60,000 psi Tensile

A325 High-Strength Bolts for Structural Steel Joints

B108 Aluminum-Alloy Permanent Mold Castings

B221 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

M314 Steel Anchor Bolts

422.2.5 National Electrical Manufacturers Association (NEMA) Standards, Latest Edition

422.2.6 National Electrical Code (NEC), Latest Edition

422.2.7 This Publication, Latest Edition:

SECTION 101 PORTLAND CEMENT CONCRETE

SECTION 102 STEEL REINFORCEMENT

SECTION 501 EXCAVATION AND BACKFILL FOR STRUCTURES

SECTION 701 TRENCHING, EXCAVATION , AND BACKFILL

SECTION 1502 SUBMITTALS

422.3 MATERIALS.

422.3.1 STANDARD: A standard will consist of a shaft with a base, anchor bolts, mast arms (if required), and other hardware required to support the traffic signal and highway lighting apparatus.

Types of standards are as follows:

(a) Type I. A pedestal type support for traffic signals, controller cabinets, and splice cabinets.

(b) Type II. A mast arm traffic signal support including shaft, arm, and hardware.

(c) Type III. A combination mast arm traffic signal and roadway luminaire support.

(d) Type IV. A post top luminaire support.

(e) Type V. A mast arm luminaire support.

422.3.1.1 Type I Standard

422.3.1.1.1 The pedestal type support shall be a threaded pole and a threaded (female) square cast aluminum base assembly with set screw(s) as detailed on the plans. The aluminum base shall be a break-away design approximately 15 inches high and shall have a covered hand hole of 8 inches x 8" inches minimum dimension.

422.3.1.1.2 The pole may be fabricated from steel and may be either 4-inch nominal diameter pipe, Schedule 40, or a tapered steel shaft of equal or greater wall thickness.

422.3.1.1.3 Type I Standard, Two Foot: shall be designed to support a post top mounted traffic signal controller or splice cabinet weighing 150 pounds with a projected area of 5 square feet.

422.3.1.1.4 Type I Standard, Ten Foot: shall be designed to support an assembly of traffic signals and signing mounted at the top of the support weighing 150 pounds with a projected area of 15 square feet.

422.3.1.1.5 Type I Standard, Thirteen Foot: shall be designed to support an assembly of traffic signals and signing mounted at the top of the support weighing 150 pounds with a projected area of 15 square feet.

422.3.1.1.6 Type I Standard, Fifteen Foot: shall be designed to support an assembly of traffic signals and signing mounted at the top of the support weighing 150 pounds with a projected area of 15 square feet.

422.3.1.2 Type II Standard

422.3.1.2.1 Standards shall be a "trombone" truss arm design fabricated from either steel or aluminum as designated on plans, in conformance to details on the plans and these specifications. Standards shall in addition conform to the member attachment and size details in the plans for interchange ability and standardization between fabricators.

422.3.1.2.2 Design Requirements

423.3.1.2.2.1 The standard installation shall be designed to support traffic signal heads, back plates, and signing as designated on the Standard Drawings.

423.3.1.2.2.2 Structures shall be designed according to the requirements of the latest edition of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

422.3.1.2.3 Shaft

422.3.1.2.3.1 Steel shafts shall be fabricated from a weldable grade hot rolled steel, having a yield point, after fabrication, of not less than 55,000 pounds per square inch and a wall thickness not less than No. 7 U.S. Standard Gauge (0.1793 inch). The shaft may be round in cross section and tapered at a constant rate. After fabrication, the steel shaft shall be hot dip galvanized according to the requirements of ASTM A 123 and shall be cleaned to provide a uniform and stain free surface. Scratches shall be repaired in the field with an approved paint.

422.3.1.2.3.2 Aluminum shafts shall be fabricated from seamless round tapered tubing of alloy 6063-T6 or 6005-T5 conforming to the requirements of ASTM B 221, having a thickness not less than 0.188 inch. The shaft shall have no welds except at the lower end joining the shaft to the flange base. The shaft shall be finished by mechanical means providing a uniform appearance and shall not require any surface preparation at the time of installation.

422.3.1.2.3.3 A removable pole top cap or mast arm hand hole with cover shall be provided to allow access for the pulling of cable through the shaft.

422.3.1.2.4 Arm

422.3.1.2.4.1 "Trombone" truss arms for Type II standards shall be fabricated from either steel or aluminum as designated on the plans. Material and finish shall be as specified for the shaft except that steel members shall all have a minimum thickness of No. 11 U.S. Standard Gauge (0.1196 inch) and aluminum tubing used in the fabrication shall have a minimum thickness of 0.156 inch.

422.3.1.2.4.2 Length and position of arms shall be as shown on the plans. Arms shall be attached securely to shafts in accordance with details in the plans.

422.3.1.2.5 Transformer Base

422.3.1.2.5.1 Steel transformer bases shall be fabricated from hot rolled mild steel having a yield point of not less than 33,000 pounds per square inch and side wall thickness of not less than No. 7 U.S. Standard Gauge (0.1793 inch). The steel transformer base shall be galvanized after fabrication to the requirements of ASTM A 123.

422.3.1.2.5.2 Aluminum transformer bases shall be a one-piece casting of aluminum alloy 356-T6 complying with the requirements of ASTM B 108.

422.3.1.2.5.3 The bases shall be not less than 20 inches in height and shall have a hand hole with cover of not less than 8 x 12 inches in size, in one side. The transformer bases shall be designed to permit the shaft to be rotated a full 360 degrees and to be aligned irrespective of anchor bolts placement, in conformance to details in the plans.

422.3.1.2.6 Hardware: Hardware must be either steel or stainless steel. Steel hardware shall conform to the requirements of ASTM A 307 or A 325 and shall be galvanized in accordance with the requirements of ASTM A 153. Stainless steel hardware shall conform to ANSI 300 series stainless steel.

422.3.1.2.7 Anchor Bolts

422.3.1.2.7.1 Four anchor bolts shall be furnished with each standard. The bolts may be fabricated from high strength steel bars with a guaranteed minimum yield strength of 55,000 pounds per square inch or steel meeting the requirements of AASHTO M 314. Unless otherwise detailed in plans, the bolts shall be of sufficient size and length to support the structure with the design loads, in accordance to the AASHTO Specifications.

422.3.1.2.7.2 The top of each bolt shall be threaded no less than 8 inches, and the full thread plus 6 inches shall be hot dipped galvanized. Each anchor bolt shall have an "L" bend at the bottom. One leveling nut and one hold-down

nut shall be provided with each bolt.

422.3.1.3 Type III Standard: Type III standards shall be fabricated from steel and shall conform to the requirements for Type II standards. In addition, Type III standards shall support a luminaire by means of a shaft extension and arm in accordance with the details shown on the plans. Each arm shall be designed to support a luminaire of 75 pounds and a projected area of 3.3 square feet. The shaft extensions shall conform to the requirements for Type II standards, except that steel shaft extensions may have a minimum thickness of No. 11 U.S. Standard Gauge (0.1196 inch).

422.3.1.4 Type IV Standard

422.3.1.4.1 Unless otherwise specified on the plans or in the special provisions, Type IV standards shall comply with the requirements for Type V standards, except that a mast arm will not be included on Type IV standards. The shaft shall include a tenon for luminaire mounting.

422.3.1.4.2 When laminated wood, concrete, and fiberglass standards are called for in the plans, only that material shall be used for fabrication, in conformance to the plans and special provisions.

422.3.1.5 Type V Standard

422.3.1.5.1 Standards shall be tapered shafts with davit type mast arm (unless otherwise called for on the plans) and in conformance with the dimensions and details on the plans. Unless otherwise called for in the plans or these specifications, breakaway bases shall be provided.

422.3.1.5.2 Design Requirements

422.3.1.5.2.1 The installation shall be designed according to the requirements of the latest edition of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. Each arm shall be designed to support a luminaire weighing 60 pounds and a projected area of 3.3 square feet.

422.3.1.5.2.2 The following tolerance for straightness of poles shall not be exceeded:

TOTAL MOUNTING HEIGHT (FEET)	STRAIGHTNESS (INCHES)
20	0.75
30	1.00
35	1.25
40	1.50
50	1.75

422.3.1.5.2.3 Dead load deflection should be limited in accordance to AASHTO Specifications.

422.3.1.5.2.4 The standard may be fabricated of spun aluminum, or galvanized steel as designated on the plans.

422.3.1.5.3 Spun Aluminum.

422.3.1.5.3.1 Shaft: Shafts shall be one-piece, seamless tapered tubes of aluminum alloy 6063 and shall have a final mechanical strength of not less than T6 temper after fabrication. The shaft shall have a wall thickness of not less than 0.188 inch for 40-foot mounting height or less than 0.219 inch for a mounting height greater than 40 feet. The shaft shall have no longitudinal welds and only two circumferential welds which will be located at the lower end for joining the shaft to the anchor base. A one-piece cast aluminum anchor base of aluminum alloy 356-T6 shall be secured to the base. All exposed edges of the plate which make up the base assembly shall be finished smooth, and each base shall be furnished with four bolt covers. The shaft shall be rotary sand polished and wrapped for protection during handling and shipping.

422.3.1.5.3.2 Mast Arm: Mast arms shall consist of seamless aluminum tubing, aluminum alloy 6063-T6, of the length and shape shown on the plans. Arms shall be attached to the shaft by means of a slip fitter and held in place by bolts as designated on the Standard Drawings. Davit arms shall be installed per manufacturer's recommendations to prevent rotation under wind loads. If arms rotate after erection, the Contractor shall lower the Type V standard, reassemble the arm, and reinstall the Type V standard with the arm in the proper position.

422.3.1.5.3.3 Hardware: Hardware shall be stainless steel.

422.3.1.5.3.4 Welding: Welding shall conform to the requirements of "Specifications for Aluminum Bridge and Other Highway Structures" published by the Aluminum Association.

422.3.1.5.4 Galvanized Steel.

422.3.1.5.4.1 Shaft

422.3.1.5.4.1.1 Shafts shall be fabricated from steel having a yield strength of not less than 40,000 pounds per square inch after fabrication, with a minimum wall thickness of No. 10 U.S. Standard Gauge (0.1345 inch), except that shafts with an after fabrication yield strength of 55,000 pounds per square inch or greater may have a minimum wall thickness of No. 11 U.S. Standard Gauge

(0.1196 inch). The shaft shall be round in cross section and tapered at a constant rate.

422.3.1.5.4.1.2 The shaft shall be one section, except that for mounting heights greater than 50 feet, a two section design with a top section that will slipfit over the bottom section a minimum length of 1½ times the diameter at the point of overlap will be accepted. The shaft section(s) shall be formed into a continuous weld. The shaft shall be attached by two circumferential welds to a baseplate. The base shall be either a one-piece steel casting or fabricated from steel plate with a minimum yield strength of 36,000 pounds per square inch, conforming to any details on the 4 plans.

422.3.1.5.4.2 Galvanizing and Finishing: All exposed welds except fillet welds shall be ground flush with the base metal. All steel poles shall be fully galvanized after fabrication to the requirements of ASTM A 123. After galvanizing, the poles shall be cleaned to provide a uniform and stain-free surface. All scratches due to erection and handling shall be repaired in the field with an approved paint.

422.3.1.5.4.3 Mast Arm: Arms shall be fabricated from the same material as the shaft and shall have a wall thickness of no less than No. 11 U.S. Standard Gauge (0.1196 inch). The separate section davit arm shall be attached by a slip fitter fixed into the shaft or arm and held by stainless steel screws, in conformance to any details in the plans. Davit arms shall be installed per manufacturer's recommendations to prevent rotation under wind loads. If arms rotate after erection, the Contractor shall lower the Type V standard, reassemble the arm, and reinstall the Type V standard with the arm in the proper position.

422.3.1.5.4.4 Anchor Bolts: Four steel anchor bolts shall be furnished with each Type V standard and shall be fabricated from steel meeting AASHTO M 314 or from other steel with a minimum yield point of 55,000 pounds per square inch. The top of the anchor bolts shall be threaded for approximately 9 inches and shall be galvanized for a minimum of 12 inches. Each anchor bolt shall be furnished with nuts and washers as required for breakaway base utilized or one nut, washer and shim(s) if anchor type base.

422.3.1.5.4.5 Breakaway Bases

422.3.1.5.4.5.1 Unless otherwise noted on the plans, all Type V standards shall be designed to meet requirements for dynamic performance under vehicle impact as specified in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic

Signals. All bases shall be designed for a 16-inch diameter anchor bolt circle, unless otherwise noted on plans.

422.3.1.5.4.5.2 Type V standards located behind a barrier or bridge rail and so noted on the plans shall have an anchor base for direct, rigid mounting.

422.3.1.5.4.5.3 Steel standards may utilize a steel slip base or breakaway couplings conforming to the details in the plans. If the total weight of the standard and the luminaire assembly exceeds 600 pounds the Contractor shall furnish evidence of compliance in the form of test data obtained in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

422.3.1.5.4.5.4 Aluminum standards may utilize either a cast aluminum base or breakaway coupling, conforming to details in the plans. When requested by the ENGINEER, the Contractor shall furnish evidence of compliance in the form of test data obtained in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. The cast aluminum base shall be inserted a minimum of 12 inches into the shaft and shall be bonded to the shaft with weatherproof structural adhesive to fully develop the required strength.

422.3.1.5.4.5.5 Breakaway couplings shall be designed to be placed between the anchor bolts and the pole base, and of a frangible material that will breakaway under impact (shear). The coupling shall conform to the design and material detailed on the plans. The tensile or compressive strength of the coupling shall equal or exceed that required for the design wind loading of the furnished Type V standard.

422.3.1.5.4.5.6 The coupling installation shall include a "skirt" base cover of a material and design conforming to details on the plans.

422.4 CONSTRUCTION REQUIREMENTS.

422.4.1 Installation shall include the erection of standards complete as shown on the plans, leveling of standards, any required grouting between standard bases and foundations, and the installation of anchor bolts in foundations.

422.4.2 All threaded holes and hubs shall be retapped and sealed against rust by heavy grease or other type of preservative. Required field-made holes (such as for mounting pedestrian push buttons) shall be neatly drilled. Use of a cutting torch will not be permitted.

422.4.3 When torque values are called for on the plans for anchor bolt nuts, breakaway couplings or slip bolts, the Contractor shall make all adjustments with an approved torque wrench. No other values shall be used unless approved by the ENGINEER.

422.4.4 New foundations for signal and lighting standards will be constructed in accordance with Section 423 - Foundations for Signal and Lighting Installations.

422.4.5 Existing signal and lighting standards to be relocated shall not be removed until new foundations are in place and are accepted by the ENGINEER. The Contractor shall give the ENGINEER and the Traffic Engineer at least five working days notice before removing and resetting designated signal and lighting standards. All shop drawings and other documents of record on the existing in-place signal and lighting standards will be made available to the Contractor. All work and material required for rewiring relocated signal and lighting standards shall be included in this work.

422.4.6 Remove and Reset Street Lighting Standard & Luminaire: The Contractor shall construct new foundations for the Type V standards. The Contractor shall then remove the existing standards and luminaires and relocate standards and luminaires to the new foundations.

422.4.7 Remove and Reset Signal & Mast arms: The Contractor shall construct new foundations for the existing Type I or II Standards. The Contractor shall then remove existing Type I or II standards, traffic signals, and mast arms and relocate the standards, traffic signals, and mast arms to the new foundations.

422.4.8 Remove Existing Foundations: Existing foundations for traffic signal equipment and luminaire standards shall not be removed until the new foundation and conduit system is complete in place and are functioning. The foundation to be removed shall be completely removed or removed to a minimum of 12 inches below grade and backfilled in accordance with Section 701-Trenching, Excavation, and Backfill or as shown on the plans or approved by the ENGINEER.

422.4.9 City of Albuquerque Furnished Standards, Mast arms & Roadway Luminaires. When indicated on the plans for the material to be furnished by the City, the Contractor shall load, haul, and install City furnished lighting standards, mast arms, and roadway luminaires of the types and at the locations designated on the plans in compliance with the Standards Specifications, and as directed by the ENGINEER.

422.5 MEASUREMENT AND PAYMENT.

422.5.1 Signal and lighting standards with anchor bolts will be measured by the unit complete in place.

422.5.2 Removing and resetting street lighting standard and luminaire will be measured by the unit complete in place.

422.5.3 Remove and reset signal standard and mast arm will be measured by the unit complete in place.

422.5.4 Installing City furnished standards, mast arms, and roadway luminaires will be measured by unit complete in place.

422.5.5 Anchor bolts will be measured by the unit complete in place, only when specifically designated on the plans and when signal and lighting standards are being furnished by others.

422.5.6 The accepted quantities of signal and lighting standards will be paid for at the contract unit price per unit of measurement for each of the pay items listed as shown on the bid proposal.

SECTION 423

FOUNDATIONS FOR SIGNAL AND LIGHTING INSTALLATIONS

423.1 GENERAL: This work shall consist of constructing concrete foundations for support of traffic signal standards, luminaire standards, control cabinets, and ground mounted transformers, in compliance with the specifications, details shown on the plans, Standard Drawings, and at the locations shown on the plans, or as established by the ENGINEER.

423.2 REFERENCES

423.2.1 American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications, Latest Edition

423.2.2 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition

A36 Structural Steel

A307 Carbon Steel Bolts and Studs; 60,000 psi Tensile

423.2.3 National Electrical Code (NEC), Latest Edition

423.2.4 This Publication, Latest Edition

SECTION 101 PORTLAND CEMENT CONCRETE

SECTION 102 STEEL REINFORCEMENT

SECTION 501 EXCAVATION AND BACKFILL FOR STRUCTURES

SECTION 510 CONCRETE STRUCTURES

SECTION 701 TRENCHING, EXCAVATION, AND BACKFILL

SECTION 1502 SUBMITTALS

423.3 MATERIALS:

423.3.1 Concrete design including cement, air entrainment, and other admixtures, water and aggregate shall conform with the requirements of Section 101 Portland Cement Concrete.

423.3.2 Concrete installation shall conform with the requirements of Section 510 - Concrete Structures. The design mix shall be provided to the ENGINEER for approval.

423.3.3 Steel reinforcement shall conform with the requirements of Section 102 - Steel Reinforcement.

423.4 CONSTRUCTION REQUIREMENTS.

423.4.1 Concrete foundations may be cast in place or precast. Foundations shall be placed on firm ground. Forms shall be true to line and grade, rigid, and securely braced. The concrete for each foundation shall be placed in one operation. Exposed portions of cast-in-drilled-hole foundations shall be formed to present a neat appearance. The forms and ground shall be thoroughly moistened before concrete placement.

423.4.2 Ground rods shall be installed as shown on the Standard Drawings.

423.4.3 A template shall be used to insure that conduit stubs and anchor bolts are held in proper position during concrete placement until the concrete has set. After placement and before setting of concrete, anchor bolts shall be raised and lowered individually to eliminate air pockets and distribute aggregate, and shall be aligned properly.

423.4.4 Exposed surfaces of concrete foundations shall receive a finish that is smooth, straight, and free of form marks.

423.4.5 Concrete foundations shall be backfilled according to the requirements of Section 501 - Excavation and Backfill for Structures and details in the plans. Proper drainage shall be provided on slopes. Backfilling will be considered incidental to the completion of the work and no measurement or direct payment will be made therefore.

423.4.6 When it is discovered during excavation for a concrete foundation that the location shown on the plans conflicts with existing underground or overhead utilities, a new location will be determined by the ENGINEER if possible. The ground surface at plans locations shall be restored to its original elevation. If the location cannot be changed, a new foundation design or utility relocation will be done as authorized by the ENGINEER.

423.4.7 Foundations shall be constructed as designated on the Standard Drawings unless the plans show otherwise or the ENGINEER directs otherwise. Foundations located in sidewalks shall be level with the surface of the sidewalk and shall conform with the "Americans with Disabilities Act". Expansion material shall be placed between the foundation and the sidewalk.

423.4.8 Foundations for standards with mast arms shall be carefully positioned so that the standards may be oriented as shown on the plans.

423.4.9 Foundations shall cure for a minimum of 7 days after concrete placement before signal and lighting standards are installed.

423.5 MEASUREMENT AND PAYMENT.

423.5.1 The accepted quantities of portland cement concrete and steel reinforcement for concrete foundations for signal standards, controller cabinets, and splice cabinets complete in place will be measured by the unit complete in place as shown on the bid proposal.

423.5.2 Concrete foundations for luminaries (including portland cement concrete and reinforcing steel) will be measured by the unit complete in place as shown on the bid proposal.

423.5.3 The accepted quantity of foundations for signal standards, controller cabinets, splice cabinets, and luminaries will be paid for at the contract unit price per unit of measurement for each of the pay items listed as shown on the bid proposal.

SECTION 424

ELECTRICAL CONDUIT

424.1 GENERAL: This work shall consist of furnishing and installing electrical conduit in compliance with the specifications, the details shown on the plans, and Standard Drawings at the locations shown on the plans, or as established by the ENGINEER.

424.2 REFERENCES.

424.2.1 American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications, Latest Edition

424.2.2 American National Standards Institute (ANSI) Standards, Latest Edition

C80.1 Rigid Steel Conduit - Zinc Coated

424.2.3 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition

A36 Structural Steel

A307 Carbon Steel Bolts and Studs; 60,000 psi Tensile

D1248 Polyethylene Plastics Molding and Extrusion Materials

D1785 Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120

424.2.4 National Electrical Code (NEC), Latest Edition

424.2.5 Underwriters Laboratories Standards, Latest Edition

UL6 Safety Rigid Metal Conduit

UL651 Safety Schedule 40 & 80 Rigid PVC Conduit

UL1242 Safety Intermediate Metal Conduit

424.2.6 This Publication, Latest Edition

SECTION 501 EXCAVATION AND BACKFILL FOR STRUCTURES

SECTION 701 TRENCHING, EXCAVATION, AND BACKFILL

424.3 MATERIALS

424.3.1 NONMETALLIC CONDUIT: Nonmetallic conduit shall be high-impact poly vinyl chloride (PVC) pipe, Schedule 40, Designation PVC 2110, conforming to the requirements of ASTM D 1785 or high density, Type III polyethylene conduit conforming to ASTM D 1248-6.

Conduit and fittings shall comply with the requirements of UL standards (Publication UL 651) and shall be stamped "UL approved." Nonmetallic conduit shall be used only for underground installations.

424.3.2 METALLIC CONDUIT

424.3.2.1 Metallic conduit may be either rigid steel conduit (GRC) or intermediate metallic conduit (IMC). Rigid steel (GRC) shall conform to Underwriters Laboratories UL-6 specification, ANSI C 80.1 and Federal Specification WW-C-581E. Intermediate metallic conduit (IMC) shall conform to Underwriters Laboratories UL 1242 and Federal Specification WW-C-581E. Metallic conduit shall be hot-dipped galvanized to provide a corrosion resistant coating. Fittings shall be watertight and of the same material as the conduit. All conduit installed above ground shall be metallic.

424.3.2.2 Approved expansion couplings shall be provided for all metallic conduit. Expansion couplings shall be as recommended by the manufacturer, designed to compensate for linear thermal expansion of a run of metallic conduit. All expansion couplings shall make a watertight joint.

424.4 CONSTRUCTION REQUIREMENTS.

424.4.1 GENERAL

424.4.1.1 Electrical cable and wire shall be run in conduit except where run inside poles or where the plans show otherwise. All conduit used for underground installations shall be nonmetallic except where encased in concrete, such as bridge decks, or when called for on the plans. The CONTRACTOR may use conduit of a larger size than shown on the plans at no increase in cost provided the larger size is used for the entire run from outlet to outlet. Reducing couplings will not be permitted.

424.4.1.2 The CONTRACTOR shall plan the trenching and conduit placement operation to minimize the open trench and exposed conduit left overnight.

424.4.1.3 Routings of conduit runs shown on the plans are tentative and may be changed by the ENGINEER to avoid underground obstructions. Accurate records of any change from conduit locations shown on the plans shall be kept for preparation of as-built drawings, and the details of altered conduit runs shall be submitted to the ENGINEER

before final acceptance of the project.

424.4.1.4 Excavation (trenching) and backfill for all conduit shall be in accordance with the requirements of Section 701. Conduit shall be laid not less than 30 inches below the finished surface in street and driveway areas, top of curb in sidewalk areas, or natural ground line in unpaved areas. When approved by the ENGINEER, the conduit may be placed at not less than 18 inches below the surface elevation in unpaved median areas, open (natural ground) areas where little future development is expected, or where underground utility conflicts occur at the 30-inch depth.

424.4.1.5 A permanently marked warning tape to indicate the presence of traffic signal conduit shall be placed approximately 12" above the conduit in the backfill.

424.4.1.6 Conduit shall be terminated, stubbed, and capped when required, as shown on the plans or as directed by the ENGINEER. Metallic conduit ends shall be threaded and capped with standard conduit caps until wiring is started. Insulated metal ground bushings shall be provided for threaded ends when caps are removed, electrically connected per the requirements of the NEC. Nonmetallic conduit ends shall be capped until wiring is started.

424.4.1.7 Conduit terminating in pole, cabinet, or pedestal bases shall extend a minimum of 2 inches to a maximum of 4 inches vertically above the bases. Conduit entering a pull box shall terminate 1 inch to 3 inches inside the box wall and 2 inches to 3 inches above the top of gravel sump. Conduit entering through the bottom of a pull box shall be located near the sides and ends of the box so that the major portion of the box will be clear. Conduit shall enter from the direction of the run at all terminal points. Conduit shall enter boxes freely to allow for expansion and contraction. All metallic conduit terminations shall be installed with bushings to prevent wire insulation damage during its installation.

424.4.1.8 Conduit bends, except factory bends, shall have a radius not less than 6 times the inside diameter of the conduit. Where factory bends are not used, conduit shall be bent without crimping or flattening, using the longest radius practical. Metallic bends shall be used for difficult or long conduit runs to prevent damage to the conduit caused by pulling cables.

424.4.1.9 Conduit leading to walls, lights, or to fixtures below the grade of a pull box shall be sealed by a sealing conduit and an approved compound to prevent water from flowing into the fixture.

424.4.1.10 Existing underground metallic conduit to be

incorporated into a new system shall be cleaned with a mandrel and blown out with compressed air. Existing nonmetallic conduit shall be blown out with compressed air. If excess amounts of foreign debris are encountered, conduit shall be flushed out with clean water and then air blown as directed by the ENGINEER.

424.4.2 NONMETALLIC CONDUIT

424.4.2.1 GENERAL

424.4.2.1.1 Nonmetallic conduit shall be straight cut, and ends shall be squared and trimmed after cutting to remove rough edges. Connections shall be of the solvent weld type except for connections to metallic conduit where the coupling shall be threaded on the metallic conduit side. Solvent weld connections shall be made according to the recommendations of the conduit manufacturer.

424.4.2.1.2 A bare No. 8 AWG copper conductor shall be run continuously in all nonmetallic conduit for bonding and grounding purposes. This bare conductor shall be installed in accordance with Seciton 426 - Wiring, and be considered incidental to the cost of the conduit.

424.4.2.2 BENDING: One of the following methods may be used to bend nonmetallic conduit:

424.4.2.2.1 An even heat, not to exceed 300 degrees F is applied to a portion of the conduit wrapped in aluminum foil until the desired flexibility is attained. Charring of the conduit shall be kept to a minimum.

424.4.2.2.2 The conduit is inserted into a 4-foot long water-filled steel pipe heated to the temperature required to render the conduit pliable after 30 seconds or longer. The conduit is removed from the hot water, bent as desired, and held in a jig for a cooling period of about 20 seconds.

424.4.2.2.3 The CONTRACTOR may use factory-made bends.

424.4.2.2.4 Bending radii and number of bends shall comply with the applicable requirements of NEC and local codes.

424.4.2.3 EXPANSION COUPLINGS: Expansion couplings shall be installed according to the manufacturer's diagrams and instructions.

424.4.3 METALLIC CONDUIT.

424.4.3.1 GENERAL

424.4.3.1.1 Conduit ends shall be reamed to remove burrs and rough edges. Field cuts shall be true and square so that ends to be joined will butt together for the full circumference. Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used, an approved weatherproofed, threaded coupling shall be used. Non-threaded couplings shall be used only when approved by the ENGINEER.

424.4.3.1.2 Conduit threads shall be thoroughly painted with an approved rust-preventive paint before couplings are made up. Couplings shall be tightened until conduit ends are brought together and a good electrical connection is made throughout an entire conduit run. Conduit stubs, caps, exposed threads, and conduit surface areas damaged during handling or installation shall be painted with an approved bituminous or other paint suitable for the purpose.

424.4.3.2 WRAPPED GALVANIZED STEEL CONDUIT

424.4.3.2.1 Galvanized metallic conduit shall be wrapped for rust protection when required by the special provisions or the details shown on the plans. Rust protection shall be applied according to the following requirements:

424.4.3.2.1.1 Conduit surfaces shall be hand wire brushed to remove loose rust and scale, dust, and dirt. Oil and grease shall be removed with a suitable solvent. The surfaces to be coated shall be warmed with a torch to remove moisture.

424.4.3.2.1.2 An approved primer shall be brush-applied to the conduit surface before it has cooled. The protective coating shall not be applied until the primed surface has dried to a tacky consistency.

424.4.3.2.1.3 Tape shall be applied spirally to the conduit.

424.4.3.2.1.4 Galvanized metallic conduit with a PVC jacket coating of 0.025-inch minimum thickness may be furnished in lieu of wrapped galvanized steel. Conduit joints or couplings shall be painted with an approved bituminous paint and wrapped after installation with a minimum of 3 layers of pipe insulation tape of 0.010-inch minimum thickness and covered with mastic compound. Torn, cracked, or scuffed rust protection shall be repaired to the satisfaction of the ENGINEER as specified above. Repair material shall be applied to extend at least 6 inches on each side of the damaged area.

424.4.4 INSTALLATION UNDER EXISTING

PAVEMENT

424.4.4.1 Metallic conduit shall be installed under existing pavement by approved jacking or drilling methods. Nonmetallic conduit shall not be installed by jacking. Nonmetallic conduit may be installed by drilling if a hole slightly larger than the conduit is pre-drilled and the conduit is hand-installed. Jacking or drilling pits shall be at least 2 feet from the edge of any type of pavement, measured from the side of the pit nearest to the pavement. Excessive use of water that might undermine pavement or soften subgrade will not be permitted.

424.4.4.2 The ENGINEER may approve relocation of conduit runs or pavement cutting when there is insufficient room for jacking or drilling pits or when underground obstacles are encountered.

424.4.5 CONDUIT FOR STRUCTURES AND FOUNDATIONS

424.4.5.1 GENERAL: An approved coupling as per this Section 424 shall be installed outside the concrete for future connections or removal on a metallic conduit run to a structure or foundation. Non-threaded couplings will not be accepted. If a pull box is located within 24 inches of a foundation, a coupling will not be required outside the foundation. Metallic conduit shall be rust-protected to a minimum of 6 inches inside a concrete structure or foundation. Rust protection will not be required for nonmetallic conduit.

424.4.5.2 BRIDGE STRUCTURES

424.4.5.2.1 Conduit in bridge structures shall be installed as shown on the plans. Conduit to be embedded in concrete for abutments, piers, or bridge decks shall be metallic. This conduit shall be securely attached to the reinforcing steel by approved methods at intervals not to exceed 4 feet. Conduit passing through abutment concrete shall be wrapped with 2 layers of 10-pound asphalt felt building paper, securely taped or wired in place. Conduit leading to soffits, walls, or light fixtures below the pull box shall be sealed by sealing said conduit or other light fixtures with an approved sealing compound. Conduit runs on structure surfaces shall be secured by galvanized malleable iron clamps spaced no more than 5 feet apart.

424.4.5.2.2 EXPANSION FITTINGS: Expansion fittings as detailed on the plans shall be installed where conduit crosses a structure joint. The tubing shall be the same size as the conduit. Expansion fittings shall have a bonding jumper of No. 6 AWG flexible wire or approved equal. Where the ENGINEER determines that expansion

fittings or flexible tubing are not feasible, the conduit shall be installed in a watertight metal sleeve. The clearance between the outside of the conduit and the inside of the metal sleeve shall be ½ inch to 1 inch.

424.4.5.2.3 FLEXIBLE CONDUIT: Liquid-tight flexible conduit may be used between structure sections to accommodate for movement when called for on the plans. The liquid-tight flexible conduit shall be of an extruded polyvinyl jacket over a flexible hot-dipped galvanized core (Type UAG), UL listed and meeting NEC requirements. Liquid-tight flexible conduit may be installed within a concrete pour when approved by the ENGINEER.

424.5 MEASUREMENT AND PAYMENT.

424.5.1 Electrical conduit including expansion fittings and flexible conduits, will be measured by the linear foot complete in place. Measurement will be made parallel to the center line of the installed conduit. Bends and sweeps will be considered incidental.

424.5.2 The accepted quantities of electrical conduit will be paid for at the contract unit price per unit of measurement for each of the pay items listed as shown on the bid proposal.

SECTION 425

PULL BOXES, SPLICE CABINETS, AND MANHOLES

425.1 GENERAL: This work shall consist of furnishing and installing pull boxes, splice cabinets and traffic signal manholes in compliance with the specifications, the details shown on the plans, and Standard Drawings at the locations shown on the plans, or as established by the ENGINEER.

425.2 REFERENCES.

- 425.2.1 American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications, Latest Edition
- 425.2.2 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition
- 425.2.3 National Electrical Code (NEC), Latest Edition
- 425.2.4 National Electrical Manufacturers Association (NEMA) Standards, Latest Edition
- 425.2.5 This Publication, Latest Edition

SECTION 101 PORTLAND CEMENT CONCRETE

SECTION 102 STEEL REINFORCEMENT

SECTION 501 EXCAVATION AND BACKFILL FOR STRUCTURES

SECTION 701 TRENCHING, EXCAVATION, AND BACKFILL

425.3 MATERIALS.

425.3.1 GENERAL

425.3.1.1 Electrical pull boxes shall be polymer mortar reinforced with heavy weave fiberglass unless otherwise approved or called for on the plans, and shall conform to the specifications and details in the plans. Electrical pull boxes are normally used in sidewalk, median and natural ground areas and shall have open bottoms installed with provisions for drainage. All electrical pull boxes shall be designed for light vehicular traffic, AASHTO H 10 loading (minimum).

425.3.1.2 Metal pull boxes shall be enclosed, watertight boxes to be installed in bridge decks and other areas only when specifically designated on the plans. All metal pull boxes shall be designed to support, in place, an AASHTO H 20 loading (minimum).

425.3.2 REINFORCED POLYMER MORTAR ELECTRICAL PULL BOX

425.3.2.1 Reinforced Polymer Mortar Electrical Pull Box. Pull box materials shall be an aggregate consisting of sand and gravel bound together with a polymer and reinforced with a heavy-weave fiberglass. The material shall have a minimum strength of 11,000 psi in compression, 1,700 psi in tension and 7,500 psi flexural strength.

425.3.2.2 The minimum acceptance criteria for material retention of 75% of control specimen values for load and deflection, no more than 2% change in weight or any dimension, no visual cracking, crazing, checking, blistering, or surface pitting. Changes in color will be permitted only if the change does not indicate degradation of material and will not be detrimental to the overall appearance of the product. In addition to the standard tests the material must have been tested at - 50°F and 140°F and have met the minimum criteria stated above.

425.3.2.3 The covers shall be made of heavy duty reinforced polymer mortar, unless otherwise shown on the plans, and shall be designed for a minimum for 15,000 pounds over a 10" square with a minimum test load 22,568. Covers shall be provided with flush lifting eye(s) and two openings for bolting the cover down.

425.3.3 METAL PULL BOX

425.3.3.1 Metal pull boxes shall be of external recess flanged, closed bottom type designed for flush mounting in concrete, conforming to the dimensions shown on the plans. All metal boxes shall be designed for vehicular traffic (AASHTO H20 loading), except installations in sidewalk areas where the plans specify a minimum of AASHTO H10 loading. All metal boxes shall be fabricated from cast iron with a hot-dipped galvanized finish.

425.3.3.2 Covers shall be of galvanized cross-ribbed cast iron or ductile iron, designed for the required loading. The covers shall be fastened to the boxes with stainless steel or brass screws, sealed with a neoprene gasket providing a water tight (NEMA 4) enclosure. The covers shall have a checkered (non-slip) surface with prybar slots.

425.3.3.3 Conduit entrances may be made in the field by a hole saw or as approved by the ENGINEER.

425.3.4 COVER INSCRIPTION: Pull box covers shall be inscribed or embossed "DANGER ELECTRICAL" or "ELECTRICAL" as detailed on the plans. In addition, a

bead weld or other type of permanent lettering approved by the ENGINEER shall follow this inscription to designate the specific circuit as follows:

HV High Voltage Lighting (600 Volts or Greater)
L Low Voltage (Lighting and Rest Area Electrical)
TS Traffic Signal
SL Street Lighting

If a bead weld is used on a galvanized box the effected area shall be painted with a zinc-rich paint.

425.3.5 SPLICE CABINET

425.3.5.1 The CONTRACTOR shall furnish splice cabinets meeting NEMA 4x with steel back panel, hasp and staple for pad locking splice bar, and Type I standard. Fabrication of splice cabinets shall be as shown on the plans.

425.3.5.2 The splice cabinet shall be new, approximately 20"x30"x8" weather tight fabricated from 14 gauge steel or 0.125 inch minimum thickness aluminum. Splice cabinets shall be furnished with a low voltage splice bars having 50 units to the foot, six connectors per unit with each unit consisting of two (2) each, three-connector non-interconnected terminals, Bell Systems Part Number 66B33-50 or approved equal. The splice cabinet shall be mounted on a Type I standard on a pedestal foundation.

425.3.6 TRAFFIC SIGNAL MANHOLES: Traffic signal manhole, rings, covers, and concrete collars shall be the type, size, and material as shown on the Standard Drawings.

425.4 CONSTRUCTION REQUIREMENTS.

425.4.1 GENERAL

425.4.1.1 Each electrical pull box shall be installed so that the cover is flush with the curb or sidewalk grade and no part of the box or attaching screws protrudes above the surface. When no grade is established, covers shall be placed 1" higher than the surrounding ground to provide drainage away from the pull box. Metal pull boxes in bridge decks and pavement shall be installed flush with the pavement surface.

425.4.1.2 Electrical pull box extensions shall be installed to provide additional volume as detailed on the plans and according to the details thereon.

425.4.1.3 The CONTRACTOR may install more pull boxes than shown on the plans to facilitate his work at his expense with approval from the ENGINEER.

425.4.2 SUMPS

425.4.2.1 With the exception of metal pull boxes installed in concrete, all pull boxes and traffic signal manholes shall have an 18-inch deep sump below the pull box or manhole. When pull box extensions are used with pull boxes to provide extra depth, sumps shall be 30 inches deep. The rock fill shall be 2-inch maximum size. Excavation for boxes shall be of sufficient width to allow a minimum 6-inch clearance on the sides of the boxes and extensions, with rockfill provided around outside walls.

425.4.2.2 Pull boxes shall be adequately supported by solid building blocks evenly spaced around the base. Thirty-pound felt paper shall be inserted between backfill and rock fill on vertical walls. Each pull box shall include a concrete collar.

425.5 MEASUREMENT AND PAYMENT.

425.5.1 Pull boxes, pull box extensions, traffic signal manholes, and splice cabinets will be measured by the unit complete in place.

425.5.2 The accepted quantities of pull boxes, pull box extensions, traffic signal manholes, and splice cabinets will be paid for at the contract unit price per unit of measurement for each of the pay items listed as shown on the bid proposal.

SECTION 426

WIRING

426.1 GENERAL: This work shall consist of furnishing and installing wiring for traffic signal and highway lighting systems in compliance with the specifications, the details shown on the plans, and Standard Drawings at the locations shown on the plans, or as established by the ENGINEER.

426.2 REFERENCES.

426.2.1 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition

B3 Soft or Annealed Copper Wire

B8 Concentric-Lay-Standard Copper Conditions, Hard, Medium-Hard, or Soft

D2220 Poly (Vinyl Chloride) Insulation for Wire and Cable

426.2.2 International Municipal Signal Association (IMSA) Standards, Latest Edition

426.2.3 National Electrical Code (NEC), Latest Edition

426.2.4 National Electrical Manufacturers Association (NEMA) Standards, Latest Edition

426.2.5 Rural Electrification Administration (REA), Standard Specification, Latest Edition

426.2.6 Underwriters Laboratories Standards, Latest Edition

UL83 Thermoplastic-Insulated Wires

426.3 MATERIALS.

426.3.1 GENERAL: Wire and cable shall conform to the requirements of the appropriate sections of IMSA Wire and Cable Specifications and the National Electrical Code and shall carry the UL label. The specified trade size for conductors is copper. Only copper conductors of the trade size specified shall be furnished except as provided by the provisions of this Section 426.

426.3.2 MULTI-CONDUCTOR

426.3.2.1 Multi-conductors shall be polyethylene insulated, poly vinyl chloride or polyethylene jacketed, solid wire signal cable complying with the requirements of IMSA Official Wire and Cable Specification 19-1 or 20-1. (Special multi-conductor cable for direct burial or self-

supporting applications shall be furnished conforming to the description and requirements on the plans.)

426.3.2.2 Conductor color coding shall be in accordance with IMSA Official Wire and Cable Specification 19-1 or 20-1 for unpaired conductor cables. Conductors shall be No.14 AWG size copper or as called for on the plans. Tracer color shall be molten dyed polyethylene co-extruded with the base color.

426.3.3 SINGLE CONDUCTOR

426.3.3.1 GENERAL: Single conductors shall be moisture and heat resistant thermoplastic-Insulated electrical cable rated at 600 volts for installation in conduit and pipe.

426.3.3.2 CONDUCTORS

426.3.3.2.1 Conductors of No. 12 AWG size or smaller shall be solid copper complying with the requirements of ASTM B 3. The wire shall be uncoated unless otherwise specified. Conductors of No. 10 AWG size or larger shall be stranded copper complying with the requirements of ASTM B 8, Class B.

426.3.3.2.2 For conductors specified as No. 3 AWG or smaller, only copper will be acceptable. For multiple lighting circuits and service feeds where No. 2 AWG size copper or larger conductors are specified, the CONTRACTOR may substitute aluminum conductors. Each aluminum conductor shall have an equivalent resistance or less than that of the copper conductor it replaces, and shall be a minimum of two trade sizes larger than the specified copper size. (No. 2 Cu = 1/0 AL, No. 1 Cu = 2/0 AL, 1/0 Cu = 3/0 AL.)

426.3.3.2.3 When the substitution of aluminum for copper conductors requires a larger conduit size to meet NEC requirements than that specified, the larger size conduit shall be provided at no increase in cost to the Owner.

426.3.3.3 INSULATION

426.3.3.3.1 COMPOUND: Conductors shall be insulated with THHN or THWN thermoplastic complying with the requirements of UL-83 Standard for Thermoplastic-Insulated Wires.

426.3.3.3.2 THICKNESS: Thickness of insulation shall conform to the requirements of ASTM D 2220 and the National Electric Code.

426.3.3.3.3 TESTING: Conductor shall be factory tested to determine compliance to U-83 Standard for Thermoplastic-Insulated Wire.

426.3.3.3.4 IDENTIFICATION: Conductors shall have distinctive, permanent markings on the outer surface for the entire length showing manufacturer, type of insulation, size of conductor, and voltage rating. Insulation shall be solid color or of basic colors with a permanent colored stripe the entire length of the conductor in accordance with the specifications or as indicated on the plans or in the special provisions.

426.3.4 COMMUNICATION CABLE: Communication Cable shall be paired polyethylene insulated, polyethylene jacket communication cable with electrical shielding, rated 300 volts, suitable for use in underground conduit. All communication cable shall conform to REA specification PE-39. The conductors shall be solid No. 19 AWG unless otherwise specified on the plans.

426.4 CONSTRUCTION REQUIREMENTS.

426.4.1 GENERAL

426.4.1.1 Wiring shall conform to the appropriate requirements of the NEC and state and local requirements. Wiring within cabinets, pull boxes, and pole bases shall be neatly arranged and laced.

426.4.1.2 Powdered soapstone, talc, or other inert lubricant may be used for inserting conductors into conduit. Bushings shall be installed on all metallic conduit ends before pulling wire to prevent damage to the wire insulation.

426.4.1.3 Conductor splices will be permitted only inside of pull boxes, cabinets, and transformer bases with wiring access. Connections of wiring within standards shall be made at the appropriate terminals. No splicing of suspended cable used on span wire installations will be permitted.

426.4.1.4 For each conductor or cable, a minimum of 4 feet of slack shall be left at each signal or lighting standard and a minimum of 2 feet of slack shall be left at each pull box.

426.4.1.5 Ends of spare conductors shall be taped.

426.4.2 IDENTIFICATION

426.4.2.1 The phase or function of signal cable conductors shall be identified according to the insulation colors shown on the plans. Lighting circuit and signal service conductors shall be identified by black insulation. Two ungrounded multiple lighting conductors shall have black or red insulation. Neutral and common wiring shall have white insulation.

426.4.2.2 Identification tags shall be installed at cabinet, pull box, and pole locations where two or more conductors or cables for different functions have the same insulation colors. Permanent tags of fiber or PVC shall be used for tagging wires.

426.4.2.3 All low voltage circuits for pedestrian push buttons shall be separate from 115 volt function conductors in a separate multiconductor cable as identified at each splice point.

426.4.2.4 Communication cables shall be used for signal interconnect systems. Splicing shall be at splice cabinet or controller cabinet terminals or as shown on the plans. No other splicing shall be permitted.

426.4.3 TERMINALS: Cable wires shall be secured to screw-type terminals in traffic signal heads, pedestrian push buttons, and traffic controllers or as shown on the plans. Spade tongue type connectors shall be affixed to conductors using a tool specifically designed for connecting connectors to conductors.

426.4.4 SPLICES

426.4.4.1 Soldered connections will not be permitted for splicing. Splices shall be wrapped with all-weather plastic electrical tape. The entire splice shall be weatherproof. When cables are pulled into conduit, the cable ends shall be taped to exclude moisture. The ends shall remain taped until splices are made or terminal appliances attached. One of the following types of connector shall be used for splicing 600-volt-maximum connectors:

426.4.4.1.1.1 Spring-Type Connector. The wire ends shall be joined with an insulated spring-type connector without soldering. A two-component, self-curing epoxy resin shall be furnished in a double compartment plastic envelope. The splice insulation shall be made by thoroughly mixing the two components in the envelope and, after cutting open one end of the envelope, inserting the wire connection into the epoxy resin and taping shut the open end of the envelope. Sufficient epoxy resin shall be provided to completely cover the connector and exposed

bare wires at the connector.

426.4.4.1.1.2 Single-component, 3M SCOTCHGUARD or approved equal splice insulation may be used in lieu of a two-component mixture. It shall be placed in accordance with the manufacturer's instructions.

426.4.4.1.2.1 Pin and Receptacle Locking-type Connector. The waterproof connector shall be capable of being disconnected without damage. The pin shall be of medium-hard copper material with the portion to be crimped on to the conductor fully annealed. The receptacle shall be of copper material fully annealed. The connector shall be of a size to provide not less than 90 percent ampacity of the conductor being spliced. The connector shall be applied to the conductor using a tool recommended by the connector manufacturer. Soldering will not be permitted. The pin and receptacle shall each have centrally located, recessed locking areas which shall match complementary areas of the housings.

426.4.4.1.2.2 The receptacle shall establish contact pressure with the pin through use of a copper beryllium sleeve spring. The receptacle and pin shall lock together so that the connection will be maintained when a 20-pound tension pull is applied to the attached conductors.

426.4.4.1.2.3 Separate housings shall be provided for the pin and receptacle. The housing shall be made of water-resisting synthetic rubber suitable for direct burial in the ground or installation where subject to direct sunlight. Each housing shall have an interior arrangement complementary to and suitable to receive and securely retain the applicable pin or receptacle. A water seal section shall be provided between the housings at the point of disconnection. A small slot or vent shall be provided along each housing to permit air exclusion. Silicon-type insulating compound sufficient to fill all voids in the assembly shall be placed in the housings before installation of the pin and receptacle.

426.4.5 FUSED SPLICE CONNECTOR

426.4.5.1 A fused disconnect splice connector shall be installed at each ungrounded conductor in Type V luminaire standard bases between the line and load sides on multiple lighting circuits. A similar unfused disconnect connector shall be installed between the load and line sides on the neutral when a neutral is used. Connectors shall be readily accessible from the standard base handhole. Required fused splice connectors shall be considered part of the wiring installation and no separate payment will be made therefor.

426.4.5.2 The splice connector shall enclose the fuse completely and shall be waterproof. The connector shall

separate with the fuse held in the load side when the pole is dislodged. A receptacle-type design shall be used for the line side housing to maintain insulation between the line side electrode and surrounding ground planes. Fused splice connectors may be single or dual housings.

426.4.5.3 Splice connector terminals shall be rigidly crimped on to line and load connectors, using a tool recommended by the connector manufacturer. Terminals shall be insulated and made waterproof in accordance with the connector manufacturers recommendations.

426.4.5.4 Fuses shall be standard midget ferrule type. Fusing for 400-watt lamps shall be 3- ampere for 480-volt and 240-volt circuits and 6-ampere for 120-volt circuits. Fusing for 1000-watt lamps shall be 6-ampere for 480-volt and 240-volt circuits and 10-ampere for 120-volt circuits.

426.4.6 BONDING AND GROUNDING

426.4.6.1 Metallic cable sheaths, metal conduit service equipment, and metal poles and pedestals shall be made mechanically and electrically secure to form a continuous system and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire or copper strip of at least the same cross sectional area as No. 8 AWG. Standards and pedestals shall be bonded by a bonding strip attached to the lower portion of the shaft or base.

426.4.6.2 For nonmetallic conduit systems, a bare copper wire of No. 8 AWG size or larger shall be run in and through all conduit runs, through all pull boxes, and to all poles. These wires shall be spliced at termination points and shall tie into neutral bars at service facilities or control cabinets to become true and functioning common bonds. In addition a ground rod may be installed at each pole or standard on a multiple lighting circuit when called for on the plans. Required ground rods shall be considered part of the wiring installation and no separate payment will be made therefor.

426.4.6.3 A ground rod (electrode) shall be installed at each multiple service point, each traffic signal standard, each cabinet foundation, and each luminaire foundation. Ground rods shall be hard drawn, high-conductivity electrolytic copper fluted rods or bare, round, hard-drawn copper covered steel rods. Ground rods shall be 3/4 inch nominal diameter 10 feet in length, installed as shown on details in the plans. Service equipment shall be bonded to the ground rod by a No. 6 AWG size copper wire enclosed in a 1/2-inch diameter rigid conduit. The portions of ground rods to be encased in concrete shall be wrapped with 3 layers of pipe insulation tape (0.01 inch min. thickness) or placed through one-inch diameter PVC conduit.

426.4.6.4 Metallic conduit in nonmetallic pull boxes shall be bonded by insulated grounding bushings and bonding jumpers. Metallic conduit in metal pull boxes shall be bonded by locknuts. (One locknut shall be used inside and one locknut shall be used outside of each box when the box is not threaded.)

426.5 MEASUREMENT AND PAYMENT.

426.5.1 Wiring and cable will be measured by the linear foot complete in place.

426.4.2 The accepted quantities of wiring and cable will be paid for at the contract unit price per unit of measurement for each of the pay items listed as shown in the bid proposal.

SECTION 427

SIGNAL ASSEMBLIES

427.1 GENERAL: This work shall consist of furnishing and installing traffic and pedestrian signal assemblies on signal poles and attaching back plates and directional louvers to traffic signals in compliance with the specifications, details shown on the plans, and Standard Drawings at the locations shown on the plans, or as established by the ENGINEER.

427.2 REFERENCES.

427.2.1 American National Standards Institute (ANSI) Standards, Latest Edition

427.2.2 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition

B209 Aluminum and Aluminum-Alloy Sheet & Plate

427.2.3 Institute of Transportation Engineers (ITE) Publications, Latest Edition

Adjustable Face Vehicular Traffic Control Signal Heads

427.2.4 Manual on Uniform Traffic Control Devices (MUTCD), Latest Edition

427.2.5 National Electrical Code (NEC), Latest Edition

427.2.6 National Electrical Manufacturers Association (NEMA) Standards, Latest Edition

427.2.7 This Publication, Latest Edition

427.3 MATERIALS.

427.3.1 TRAFFIC SIGNAL ASSEMBLY

427.3.1.1 GENERAL

427.3.1.1.1 The number of signal faces (sections) in each traffic signal assembly will be shown on the plans. Signal faces shall be standard 12-inch lens size.

427.3.1.1.2 Signal assemblies shall meet the requirements of the latest edition of ITE Publication "Adjustable Face Vehicular Traffic Control Signal Heads," in addition to the requirements contained herein.

427.3.1.1.3 Signal assemblies shall be the adjustable, colored flat black, vertical or horizontal type with the number, color and type of lights (faces) shown on the plans and shall be adjustable through 360 degrees about the axis. Signal assemblies shall be mounted at the location and in the manner shown on the plans.

427.3.1.1.4 Signal assemblies shall be fabricated from polycarbonate resin material. The housing and door shall be fabricated from the same material. Polycarbonate resin material shall be flame resistant, ultra-violet stabilized, and shall withstand minimum of 70 foot-pounds of impact without fracture or permanent deformation.

427.3.1.1.5 All signal assemblies shall be designed so that back plates may be mounted.

427.3.1.2 OPTICAL UNITS

427.3.1.2.1 An optical unit shall consist of a lens, a reflector, and a lamp holder with lamp. The optical units shall conform to ITE Standards and ANSI Standards.

427.3.1.2.2 Lenses shall be of the color shown on the plans, circular, with a visible diameter of 12 inches. The design shall produce outward and downward light distribution, with a minimum of light distributed above the horizontal. Lenses shall be true color, and constructed of polycarbonate resin material, free from imperfections, and of high illumination transmission. The lens shall be capable of withstanding the heat associated with continuous illumination of 150 watt traffic signal lamp.

427.3.1.2.3 A reflector shall be one-piece alzak aluminum. An opening shall be provided in the back of each reflector for the lamp holder. This opening shall be designed so that there will be no dark spots cast on the lens.

427.3.1.2.4 Reflectors, lenses, and hoods shall be designed to reduce sun phantom to a minimum.

427.3.1.2.5 Lamp holders shall have a heat-resistant molded phenolic housing and be designed to accommodate a 150-watt standard A-21 traffic signal lamp. The holder shall be capable of positioning the lamp at the exact focal point of the reflector. The lamp holder shall provide proper lamp filament orientation without affecting lamp focus.

427.3.1.3 HOUSING

427.3.1.3.1 A signal housing shall consist of an assembly of separate sections without tie rods, substantially secured together in a watertight manner to form the number of units required and provide an acceptable appearance. Each section shall house an individual optical unit.

427.3.1.3.2 The housing of each section shall be a one-piece, polycarbonate resin material with sides, top, and bottom integrally molded. Polycarbonate housing shall be a minimum of 0.090 inch thick and ribbed to produce the strongest possible assembly consistent with light weight, and must pass ITE wind load testing.

427.3.1.3.3 Each section shall include a one-piece hinged door, with mounting for the lens, and other parts of the optical system, watertight gaskets, and a simple non-corrosive door locking device. The optical system shall be mounted so that the various parts may be readily accessible or removable. Sections shall be interchangeable and constructed so that they can be removed or added. A round opening shall be provided in the top and bottom of each head to receive a 1½-inch supporting pipe frame.

427.3.1.3.4 Each door shall be hinged and held securely to the body of the housing by two stainless steel hinge pins, eye bolt, washer and wing nut. Exposed screws and fasteners shall be non-corrosive. Interior screws and fasteners shall be fabricated from corrosion-resistant nonferrous materials.

427.3.1.3.5 A locking boss with 72 teeth shall be integrally cast or molded into the signal housing at both openings. The angle of the teeth shall be 90 degrees, and the depth of the teeth shall be 3/64 inch. The locking boss, when used with other locking fittings of the same mesh or with or without use of an adaptor, shall provide positive positioning of the entire signal head to eliminate rotation or misalignment.

427.3.1.3.6 The reflector and lamp holder shall be held in place by an aluminum reflector ring, pivoting so that it is independent of the door. The unit shall be designed so that the lamp may be replaced without the use of tools.

427.3.1.3.7 Weather-resistant neoprene gasketing shall be provided so that the inside of the lens and reflector are sealed from dust and moisture.

427.3.1.3.8 A terminal block shall be mounted in the back of the middle section of the signal assembly. The terminal block for all signal assemblies shall be a 4-position, 8-terminal, barrier-type strip at a minimum. The signal section leads shall be attached to the left of each terminal block. The opposite terminals shall be for the field wires.

427.3.1.3.9 Wiring from each lamp holder shall be provided by two-coded leads with NEMA quick disconnect tabs. A white wire shall be connected to the shell of the lamp holder. A black or colored wire shall be connected to the bottom or end terminal of the lamp holder. For identification, color coded leads shall be colored the appropriate red, yellow, or green, (yellow or green tracer for arrow indications), or, if black wires are used, the terminals to which the leads are attached shall be permanently marked as to the indication. Leads shall be No. 18 AWG size, Type TFF.

427.3.1.4 VISORS: A 12-inch nominal long tunnel visor shall be provided for each signal section. Visors shall be fabricated from polycarbonate resin material. Tunnel visors shall encircle the lens for 300 degrees with a four (4) inch open slot on the bottom. The visor shall have four (4) twist-on attaching ears for installation to the signal door by four (4) non-corrosive screws. The vertical outer face of the door shall have four threaded holes equally spaced about the circumference of the lens opening and 45 degrees from the horizontal or vertical axes so as to permit a vertical or horizontal installation of the signal assembly.

427.3.1.5 FRAMEWORK OR MOUNTING BRACKETS

427.3.1.5.1 Mounting brackets shall consist of assemblies of 1½-inch nominal size standard steel pipe and malleable iron, ductile iron, or brass pipe fittings. Securely assembled members shall provide plumb or level support.

427.3.1.5.2 Conductors shall be concealed within framework, poles, and signal assemblies. Conductors entering assemblies from poles shall be supported and protected by cable guides. Threads shall be coated with grease during field assembly.

427.3.1.6 FINISH: The finish color for all signal assembly components shall be flat black. The flat black color shall be completely impregnated in the resin material, and scratches shall not expose uncolored material.

427.3.2 OPTICALLY PROGRAMED SIGNAL ASSEMBLY

427.3.2.1 Optically programmed traffic signal assemblies will be used instead of standard traffic signal assemblies at locations shown on the plans where it is necessary to limit the visibility zone of the indication. Optically programmed assemblies shall have the same general appearance and shall be mounted in the same manner as the standard assemblies shown on the plans and specified in this Section 427 except that lens faces shall

appear square when not illuminated. The object lens shall provide a round signal indication when illuminated. Sufficient optical masking tape shall be supplied with each assembly to allow proper aiming of each section. Aiming of signal sections shall be done under the Traffic Engineer's supervision.

427.3.2.2 Optically programmed signal assemblies shall conform to the requirements for traffic signal assemblies, except as follows:

427.3.2.2.1 Optically programmed assemblies shall permit the visibility zone of the indication to be determined optically and shall require no hoods or louvers. The projected signal may be visible or selectively veiled anywhere within 15 degrees of the optical axis. No indication shall result from external illumination nor shall one indication illuminate a second indication.

427.3.2.2.2 The components of the optical system shall consist of a lamp, a circulet reflector, an optical limiter-diffuser, and an objective lens. The lamp shall be mated to the diffusing element by a circulet reflector with a specular inner surface. The optical limiter-diffuser shall be composed of heat resistant glass. The limiter-diffuser shall provide an imaging surface, at focus on the optical axis for objects 900 feet to 1200 feet distance, and shall permit an effective veiling system to be variously applied as determined by the desired visibility zone. The limiter-diffuser shall have a positive means of indexing.

427.3.2.2.3 The objective lens shall be a high resolution planar incremental lens hermetically sealed with a flat laminate of weather resistant acrylic.

427.3.2.2.4 Visors shall be 9½ inch-long cutaway type, finished in flat black.

427.3.2.2.5 The lens shall be symmetrical in outline and shall be capable of being rotated to any 0-degree orientation about the optical axis.

427.3.2.2.6 Exteriors of the signal case, lamp housing, and mounting flanges shall be finished in accordance to this Section 427.

427.3.2.2.7 Lamp fixtures shall consist of a separately accessible housing and integral lamp support, a ceramic socket, and self-aligning, quick-release lamp retainer. The electrical connection between case and lamp holder shall be an interlock assembly which disconnects the lamp holder when open. Coded No. 16 AWG size lead wires of a length sufficient to permit solderless connection to line wires external to the signal shall be used.

427.3.2.2.8 The assembly shall mount to standard 1½-inch fittings as a signal section or a multiple section face or in combination with other signals. A rigid connection shall be provided that will permit the signal section to tilt from at least 9 degrees above to 9 degrees below the horizontal while maintaining a common vertical line through couplers and conduit. The assembly shall be mountable with ordinary tools and shall be serviceable without tools.

427.3.3 PEDESTRIAN SIGNAL

427.3.3.1 GENERAL: Pedestrian signals shall be one-way signals in weatherproof vandal resistant and dust-tight housing, designed to display the alternating symbol messages "HAND" in Portland Orange or "WALKING PERSON" in Lunar White. The assemblies shall be neon.

427.3.3.2 PEDESTRIAN SIGNAL - NEON

427.3.3.2.1 GENERAL

427.3.3.2.1.1 The signal shall be a one section signal assembly with symbols "HAND" and "WALKING PERSON," capable of displaying the alternate messages and conforming to the details in the plans and to the MUTCD.

427.3.3.2.1.2 The signal shall be internally illuminated. The message shall be formed by painting (blankout) the message plate except for the area occupied by the 11-inch high and 6-inch minimum wide symbols.

427.3.3.2.1.3 The messages shall blank out when not energized.

427.3.3.2.2 HOUSING

427.3.3.2.2.1 The housing shall be a one-piece corrosion-resistant aluminum alloy casting with integrally cast top, bottom, sides, and back. An opening shall be provided in the top and bottom of the housing to accommodate standard 1½-inch pipe brackets. A shurlock boss shall be integrally cast into the housing at the bottom opening. Four integrally cast hinge lug pairs, top and bottom, shall be provided for the door mounting.

427.3.3.2.2.2 The housing door shall be a one-piece corrosion-resistant aluminum alloy casting with integrally cast hinges. The door shall be attached to the housing by stainless steel spring pins. The door shall pivot or swing downward when opened. A gasket shall be provided between the door and the housing. Latching shall be by two noncorrosive hinged bolts with captive wing nuts and washers.

427.3.3.2.2.3 The complete housing (assembly) shall be 18 to 19 inches wide, 18 to 19 inches high and 9 to 10 inches deep with the visor.

427.3.3.2.3 MESSAGE MODULE

427.3.3.2.3.1 A message module shall consist of neon tubes, a molded, white, acrylonitrile butadiene styrene or polycarbonate plastic tubing housing, and a screened message lens. The message lens shall be an integral assembly with the tubing housing, fitted with a neoprene gasket around its perimeter.

427.3.3.2.3.2 Two compartments shall be formed in the front of the module, enclosing and protecting the two neon tube light sources. The material may be white or the inside of the tubing compartments shall be painted with white acrylic paint to provide a protective background.

427.3.3.2.3.3 The tubing for the "HAND" symbol shall be a minimum of 10 mm diameter and shall be coated on the inside with fluorescent material producing the desired Portland Orange output. Tubing for the "WALKING PERSON" symbol shall be a minimum of 9 mm and coated on the inside for the desired Lunar White output.

427.3.3.2.3.4 The tubing housing shall hold neon tubing in a positive location relative to the message plate so that a clearly readable message is provided. The tubing housing shall require no tools for removal or replacement.

427.3.3.2.3.5 The tubing housing shall be provided with electrical contacts which will plug directly into recessed contacts or connect to flexible high tension leads by snap-on connectors. To reduce corona effects, flexible leads shall be of the minimum length necessary to allow the door to swing open.

427.3.3.2.4 MESSAGE LENS

427.3.3.2.4.1 The message lens shall be one of the following:

427.3.3.2.4.1.1 Ultraviolet stabilized polycarbonate plastic with external prismatic pattern, 1/8-inch minimum thickness.

427.3.3.2.4.1.2 Ultraviolet stabilized acrylic plastic with prismatic pattern, 3/16-inch minimum thickness.

427.3.3.2.4.2 For both types, the first coating of blankout paint shall be black and the second coating shall be white to reflect internal light.

427.3.3.2.5 TRANSFORMERS

427.3.3.2.5.1 Solid state circuitry shall be assembled on one or two printed circuit boards, energizing two high voltage flyback transformers for the respective neon tubes. The transformers and circuitry shall be in an enclosure behind the tube compartments providing protection from water penetration and physical damage.

427.3.3.2.5.2 The "Hand" and "Walking Person" circuits shall require approximately 30 watts with a voltage range of 105 to 130 V.A.C. Each circuit shall be internally fused. Quick disconnect lugs shall be provided inside the housing for easy removal. A three-terminal pair (6-position) screw type terminal block shall be provided for termination of field wires.

427.3.3.2.6 SCREENS

427.3.3.2.6.1 One of the following types of screens (visor) shall be provided for each signal:

427.3.3.2.6.1.1 Z crate type screen shall consist of a minimum of 20 straight horizontal louvers and 21 horizontal louvers formed in a zig zag pattern. Every other formed louver shall be reversed so as to form cells 1 inch square, rotated 45 degrees from the horizontal (diamond shaped cells). Each diamond shall then be bisected by insertion of a straight louver interspersed between each pair of formed zig zag louvers. Where each apex of each formed louver contacts a straight louver, the entire length of the joint shall be chemically welded.

427.3.3.2.6.1.1.2 The material shall be nominally 0.030 inch thick, black polycarbonate plastic with a flat finish on both sides. The screen shall be enclosed in a 0.040 inch minimum thickness aluminum or polycarbonate plastic frame. The frame shall be 1½ inches deep and contain mounting holes for insertion in the door frame.

427.3.3.2.6.1.2.1 Eggcrate type screen, 1½ inch deep, of 0.020 inch minimum thickness aluminum of 3003 H14 alloy conforming to the requirements of ASTM B 209 or polycarbonate of 0.036-inch nominal thickness. The assembly shall be mounted on an aluminum alloy or polycarbonate frame of 0.040-inch minimum thickness.

427.3.3.2.6.1.2.2 The spacing between horizontal members shall be ½ inch (beginning near the top of the symbol) and supported by a minimum of 15 vertical members.

427.3.3.2.7 FINISH: The inside and outside surfaces of the housing, doors, and visor screens shall be finished in a

factory applied, environmentally safe, electrostatically applied, ultra violet resistant powder coating of the color flat black, which will then be oven-cured. Pretreatment of all exposed metal parts excluding stainless steel attachment hardware shall utilize current industry standards of multi-stage pretreatment.

427.3.3.2.8 All exposed screws and fasteners shall be of ANSI Type 304 stainless steel. Interior screws shall be made of noncorrosive materials or be cadmium plated.

427.3.4 BACKPLATES: Backplates shall be provided for signal faces with vehicular signal indications when shown on the plans. Backplates shall be one (1) piece polycarbonate and shall be of a size to provide a 5-inch border around the perimeter of the signal. Backplates shall be finished in accordance with the requirements of this Section 427.

427.3.5 DIRECTIONAL LOUVERS: Directional louvers shall be installed in signal visors at locations shown on the plans. Louvers shall be sheet aluminum and shall be made to fit snugly in the signal visors. Louvers shall be 1 1/8 inches in diameter and 8 1/2 inches long and shall have a degree of cutoff from either side of the center axis of the light beam of 10 1/2 degrees. Louvers shall be finished in accordance with the requirements of this Section 427.

427.3.6 TRAFFIC SIGNAL LAMPS

427.3.6.1 All incandescent lamps for signal assemblies shall be clear, ANSI designation A21, horizontal with medium base, 8000-hour rated life traffic signal lamps. All 12-inch signal assemblies shall be furnished 150-watt, 1770 average minimum initial lumens lamps.

427.3.6.2 Each lamp socket and lamp furnished shall be designed to position the lamp filament accurately within the reflector. (Light center length: 150-watt--3 inches.)

427.4 CONSTRUCTION METHODS.

427.4.1 Vehicular signal assembly faces shall be covered after installation until the controller and intersection signals are placed into operation. The covering shall be such so as not to permit any misunderstanding by the general public that the signal may be in operation.

427.4.2 Signal faces shall be plumb and adjusted to proper direction. Faces and frameworks shall be plumb and level, symmetrically arranged, and secure after alignment. Mounting shall conform to details in the plans.

427.4.3 Overhead mast arm mounted traffic signal

assemblies will normally be mounted horizontally. When the plans call for an overhead signal assembly to be mounted vertically to a mast arm or span wire, the mounting bracket shall be as detailed in the plans.

427.4.4 Backplates and directional louvers shall be installed on signal assemblies according to the recommendation of the manufacturer.

427.5 MEASUREMENT AND PAYMENT.

427.5.1 Traffic signal assemblies, optically programmed traffic signal assemblies, backplates, and directional louvers will be measured by the unit complete in place.

427.5.2 The accepted quantities of traffic signal assemblies, optically programmed traffic signal assemblies, backplates, and directional louvers will be paid for at the contract unit price per unit of measurement for each of the pay items listed as shown on the bid proposal.

SECTION 428

VEHICLE, PEDESTRIAN, AND EMERGENCY VEHICLE DETECTORS

428.1 GENERAL: This work shall consist of furnishing and installing vehicle detectors in roadways, pedestrian push buttons on signal standards, and emergency vehicle optical detectors (EVOD) systems at signalized intersections in compliance with the specifications, details shown on the plans, and Standard Drawings, at the locations shown on the plans, or as established by the ENGINEER.

428.2 REFERENCES.

428.2.1 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition

D49 Chemical Analysis of Red Lead
D113 Ductility of Bituminous Materials
D150 AC Loss Characteristics
D412 Rubber Properties in Tension
D903 Peel or Striping Strength of Adhesive Bonds
D1190 Concrete Joint Sealer-Hot Poured Elastic Type
D2240 Rubber Property-Durometer Hardness

428.2.2 International Municipal Signal Association (IMSA) Standards, Latest Edition

Official Wire and Cable Specifications

428.2.3 Manual On Uniform Traffic Control Devices (MUTCD), Latest Edition

428.2.4 National Electrical Code (NEC)

428.2.5 National Electrical Manufacturers Association (NEMA) Standards, Latest Edition

428.3 MATERIALS.

428.3.1 LOOP VEHICLE DETECTOR MODULE

428.3.1.1 GENERAL.

428.3.1.1.1 A loop vehicle detector module shall be a self contained, electronic sensing device which registers the presence of a vehicle by recognizing inductance change in a loop of wire embedded in a roadway. The detector module shall be rack mounted in a traffic signal controller cabinet, connected to the cabinet wiring through 44 terminal cinch jones connector (50-44-30m) and wire harnesses. All detector modules shall be the two channel type with independent channel controls. When called for on the plans, each channel shall include a delay/extension time

function.

428.3.1.1.2 All loop vehicle detector modules shall in combination with this specification conform to NEMA Standards Publication TS-1-1989 or latest edition for Traffic Control Systems.

428.3.1.2 DESIGN

428.3.1.2.1 All loop detector modules shall utilize digital design throughout (for threshold, time and cycle calculations). Period measurement, the time elapsed per cycle, or frequency measurement, the cycles counted in a set time interval, may be used as a means to determine a change in inductance.

428.3.1.2.2 The two channel construction shall insure isolation of the channels, to allow elimination of "cross talk" between adjacent loops by frequency selection. Period measurement detectors shall use alternate scanning to accomplish this isolation. Isolation may also be accomplished by sequential excitation and measurement.

428.3.1.2.3 The detector module shall include a fail safe to call feature on each channel to provide a detect output in the event of open circuit loops.

428.3.1.2.4 The minimum composite loop inductive operating range shall be 50-1000 micro-henries and shall allow up to 1000 feet of loop lead-in.

428.3.1.2.5 Detector modules may be self-tuning with automatic tracking or require initial tuning with a minimum automatic drift compensation range of ± 5 percent after initial adjustment

428.3.1.2.6 Detector module outputs should be optically coupled. The output shall be fail safe (closed) in the event of power loss.

428.3.1.3 OPERATION

428.3.1.3.1 Operational selections or adjustments shall be made by digital or thumb wheel switches on the front panel. A minimum selection of three frequency ranges and three sensitivity (change in inductance) ranges shall be provided along with a presence or pulse output mode and a reset selector. Controls shall be separate and repeated for each channel.

428.3.1.3.2 An output indication (LED) shall be provided for each channel and located on the front panel.

428.3.1.4 DELAY / EXTEND OPERATION

428.3.1.4.1 When specified on the plans, each channel shall include a digital timer to permit delaying or extending detection outputs.

428.3.1.4.2 Loop vehicle detectors shall include switches to select delay, extend/delay time, extension or timer off operation. Minimum range and steps shall be 0-30 seconds in 1-second increments for delay time and 0-7.5 seconds in 0.5-second increments for extend time.

428.3.1.4.3 Output indicators shall display difference in normal detection and delay/extend interval by flashing during this period or by two indicators per channel, separating "Call" and "detect."

428.3.1.4.4 An external input for each channel shall be provided for the state of the green indication of the associated phase. When this "green" input is true, it shall disable delay timing, and when false, extension timing shall be disabled. (When detector logic inhibits times only on application of external signal (115 VAC), connect external input to same phase red when plans call for extend operation.)

428.3.1.5 TWO CHANNEL DETECTOR: On a two (2) channel detector, both channels shall have active power inputs so as to permit either channel to be operated independently without the remaining channel connected. All connector terminal assignments shall comply with NEMA Standards Part 15.

428.3.1.6 LIGHTNING AND TRANSIENT PROTECTION: All detectors shall meet the NEMA requirements for transient testing. This shall be accomplished through the use of MOV(s) for protection from voltage induced in loop lead, installed in cabinet at loop field terminals; flash over protection from internal circuit to ground.

428.3.1.7 TESTING

428.3.1.7.1 The CONTRACTOR shall have the loop vehicle detectors transported to the Traffic Engineering Operations Division at Pino Yard in Albuquerque, New Mexico for testing prior to the ENGINEER's acceptance of compliance with these specifications. Said testing will be effected concurrently with the controller testing under Section 429 - Traffic Actuated Controllers.

428.3.1.7.2 The loop vehicle detectors will be inspected and tested as follows:

428.3.1.7.2.1 Visual inspection for compliance with the specifications and requirements on the plans.

428.3.1.7.2.2 Sample testing for compliance to NEMA standards.

428.3.1.7.2.3 Testing at Traffic Engineering Operations Division and at the completed loop detector installations in accordance to the following. A small vehicle will be simulated by two empty standard steel five-gallon pails each, approximately 12 inches diameter by 19 inches deep and weighing 3.5 pounds held 12 inches over the pavement (SVS--small vehicle simulation).

428.3.1.7.2.3.1 SENSITIVITY TEST: Using four 6-foot by 6-foot, 3-turn loops in series, 100 feet of lead-in cable, hold one pail over center of a loop, then two pails. The detector shall detect at a maximum height of 12 inches and 30 inches, respectively, over the pavement. Repeat using 500 feet of lead-in cable. Using 6-foot by 30-foot, 2-turn (2-4-2) quadruple loop with 100 feet of lead-in cable, carry two pails (SVS) transversely across loop. The detector shall detect and hold the entire distance across the loop at a maximum height of 12 inches. Repeat with 500 feet of lead-in cable. (Actual installation sensitivity tests may be made with the lead-in cable required on the plans, up to 1000 feet and total loop areas not exceeding the special test loops.)

428.3.1.7.2.3.2 HOLD TIME TEST: Under the sensitivity test procedure, an SVS held over the center of each type loop shall provide a continuous detection output for at least 3 ½ minutes.

428.3.1.7.2.3.3 LONG DETECTION AND RECOVERY TEST

428.3.1.7.2.3.3.1 Using a single 6 foot by 6 foot loop or a 6 foot by 30 foot quadruple loop, with sensitivity set for a small vehicle park automobile over loop. The detector shall be capable of holding call for 10 minutes.

428.3.1.7.2.3.3.2 After the automobile is tuned out, remove the automobile and immediately repeat hold time test. The detection shall be dropped and then immediately picked up and held by an SVS.

428.3.1.7.2.3.4 ADJACENT LANE REDUCTION TEST: Using the lowest sensitivity setting that produces detection under the sensitivity test, park an automobile 3 feet from nearest edge of loop(s) and repeat sensitivity test.

428.3.1.7.2.3.5 PULSE MODE REPHASE TEST: Using the detector in pulse mode, park an automobile transversely across the loop(s). Two seconds after the automobile is parked the remainder of the loop shall detect an SVS (generate additional output pulse). Remove the automobile and verify that within one second an SVS is detected.

428.3.1.7.2.3.6 Loop detectors shall perform satisfactorily for the 30-day test period in accordance with the requirements on the plans.

428.3.2 LOOP DETECTOR WIRE (Field)

428.3.2.1 LOOP DETECTOR WIRE: Loop detector wire shall be used for installation in pavement saw cuts. All loop detector wire shall be No. 14 AWG stranded copper wire cross-linked polyethylene (XHHW) insulation conforming to requirements of IMSA Official Wire and Cable Specification 51-3.

428.3.2.2 DUCTED LOOP DETECTOR WIRE: Ducted loop detector wire shall be used for installation in pavement saw cuts or by directly overlaying with paving material. Ducted loop detector wire shall be loop detector wire loosely encased in a polyvinyl chloride or a polyethylene, 0.250 inch O.D. tube. All ducted loop detector wire shall conform to the requirements of IMSA Official Wire and Cable Specification 51-5, except the interior No. 14 AWG stranded conductor may either be insulated with polyvinyl chloride with a nylon jacket (THHN) or polyethylene (XHHW).

428.3.3 LOOP LEAD-IN CABLE: Loop lead-in cable shall be used to connect the loop (installed in the pavement) to the loop detector unit (installed in controller cabinet). Loop lead-in cable shall be No. 16 AWG copper, polyethylene insulated twisted pairs, shielded and enclosed with a polyethylene jacket. All loop lead-in cable shall conform to IMSA Official Wire and Cable Specification 50-2.

428.3.4 LOOP DETECTOR SEALANT

428.3.4.1 Loop detector sealant shall be used as a filler for loop saw cuts, and to secure and protect the loop detector wire. The sealant shall have sufficient strength and hardness to withstand the stress and abrasion subjected by vehicular traffic yet remain flexible enough to provide stress relief under thermal movement. The sealant shall have the ability to bond to both concrete and asphalt, a rapid rate of curing (open to traffic in ½ hour after installation), initial fluidity to permit installation in a narrow saw cut to at least 40°F, moisture insensitivity (apply to damp pavement), and resistance to vehicular fluids and road salt.

428.3.4.1.1 HOT-TYPE APPLICATION: Sealant shall be a hot-melt, rubberized asphalt compound furnished in "bricks" which is formulated specifically to be stiff, non-tracking, flexible at low pavement temperatures, and suited for use as a sealant for traffic loop cuts. At application temperatures, sealant shall be a thin, free flowing fluid which pours easily, penetrates fine cuts, self-levels, and permits easy application. Sealant shall be melted and applied to pavements in accordance with manufacturer's recommendations using either pressure feed melter applicator units or pour pots. After curing, the sealant shall have the following minimum physical and electrical properties:

TEST	ASTM METHOD	MIN.
Penetration, 77°F, (100 g, 5 sec)	D 1190	35 max.
Softening Point		180 ° F min.
Ductility, 77 ° F	D 113	15 cm min.
Mandrel Bend, °F, 180 deg., 5s, ½" dia.	Pass	
Pour Temperature	380 ° F	
Safe Heating Temperature	As specified	

428.3.4.1.2 COLD-TYPE APPLICATION.

428.3.4.1.2.1 Sealant shall be furnished in quart cartridges or 5-gallon pails, and may be applied by conventional cartridge gun or bulk handling pump equipment. The uncured (wet) material shall have a viscosity of 20,000 cps (approximately) at 77°F using a Brook-field Viscometer, #6 spindle at 20 RPM, and have a nonvolatile content (solids) of 75-85% by weight. The material shall cure at a rate to allow, being driven over almost immediately after installation and be dry to the touch within 24 hours. The sealant shall be nonshrinking and remain flexible at temperatures down to -40°F. Sealants shall have the following minimum physical and electrical properties after curing:

TEST	ASTM METHOD	MIN.
Hardness	D 2240	65-85
Tensile Strength	D 412	500 psi
Elongation	D 412	400%
Adhesion (Peel Strength) (canvas to conc.)	D 903	15 lb.
Arc Resistance	D 49	71 secs
Dielectric Strength	D 150	6.35 @ 50 Hz

428.3.4.1.2.2 The CONTRACTOR shall include, with material submittal lists, manufacturer's test data for listed physical properties, and installation recommendations.

When requested by the ENGINEER, the CONTRACTOR shall also furnish a sample for evaluation by the Traffic Engineer. Sealant formulas judged to have failed within one year (either test or permanent installation) shall not be acceptable. Failure shall be considered excessive shrinkage, cracking, peeling and/or bond failures to pavement.

428.3.5 PUSH-BUTTON STATION

428.3.5.1 The housing of the push-button station shall be of substantial tamper proof construction and made of cast aluminum. The assembly shall be weatherproof and so constructed that it will be impossible to receive any electrical shock under any weather conditions. The housing shall be shaped to fit the curvature of the pole to which it is attached and shall provide a rigid installation. The housing body shall contain a direct push-type actuator button, micro-switch-type or approved equal. The housing cover shall be of the same size and shall contain the push-button sign.

428.3.5.2 Pedestrian push-button signs shall be porcelain enameled sheet steel of 0.036-inch minimum thickness or sheet aluminum of 0.063-inch minimum thickness; 9 inches by 12 inches in size. Each hole shall be provided with a brass grommet if porcelain enameled steel signs are used. Sign corners shall be finished round. Instructions and arrows on the signs shall be black enamel on white enamel background, and the instructions shall be as shown on the plans.

428.3.5.3 Push button housings shall be finished with two coats of best quality infrared oven-baked paint as follows:

428.3.5.3.1 FIRST COAT: Baked epon primer, zinc chromate or equal.

428.3.5.3.2 SECOND COAT: Flat black baked enamel.

428.3.5.4 A single piece cast aluminum pedestrian push-button assembly composed of a push-button assembly, pedestrian sign, sign frame and mounting saddle shall be used when shown on the plans. The push-button shall have silver contacts rated at 35 amps at 12 volts and shall be constructed in such a fashion to prevent vandalism and freezing in inclement weather. The casting shall include a raised legend suitable for visually impaired pedestrians. The single piece pedestrian push-button assembly shall be capable of being attached either by drilling and tapping the mounting surface or by using banding brackets as shown on the plans.

428.3.6 PREFORMED DETECTOR LOOPS.

428.3.6.1 Preformed detector loops shall be factory assembled and shall be asphalt-rubber filled pre-dimensioned loop detectors. The loop shall consist of two or more turns of No. 14 wire with type TFFN insulation. The loop detector wire shall be encased in 3/8 inch polypropylene conduit in the head of the loop. The conduit shall be injected with hot rubber-asphalt sealant to prevent the entrance of water and the movement of wires within the conduit. Inter-loop splicing will not be permitted, but fold points may be provided to facilitate shipping, handling, and installation. Fold points shall occur at not less than six (6) feet nor more than every twenty (20) feet.

428.3.6.2 Conduit used for the loop assembly shall be polypropylene 3/8 inch Copolymer PP SDR-9 molded to the shape required. Typical corner radius on quadruple, diamond, and square shaped loops shall be three (3) inches. The corners shall be hot molded 90 degree bends which are all integral to the loop conduit.

428.3.6.3 Joints shall be located for convenience in shipping and installation. A nominal five (5) inch space shall be provided in the 3/8 inch polypropylene. A sleeve that slides over the space in the 3/8 inch polypropylene shall be a ten (10) inch length of 3/4 inch polypropylene schedule 80.

428.3.6.4 Expansion-contraction joints shall be used at all fold points as specified herein.

428.3.6.5 A Tee shall be used at the center connection on quadrupole shape loops. All Tees shall be CPVC heavy wall injection molded.

428.3.6.6 A flexible 1/2 inch schedule 80 PVC section shall be used to connect the pull Tees to the body of the loop assembly and to the home-run or interconnect. The length of the flexible section shall be as required for proper assembly and to maximize the physical strength of the loop. The flexible Tee section shall have a non-metallic cover made with CPVC and extended skirts with ribbed reinforcing. It shall be made with heavy wall CPVC and have the strength required to withstand construction equipment loading.

428.3.6.7 The side outlets of the Tee body shall be one (1) inch deep and joint with 1/2 inch trade size PVC or CPVC conduit. The center outlet of the Tee shall accept a 3/4 inch trade size conduit. The cover shall be glued onto the Tee body upon completion of the assembly.

428.3.6.8 The completely assembled Tee shall be able to withstand the weight of fully loaded dump and concrete trucks, the tracks of paving machines, and similar

construction vehicles and equipment. It shall not break, crack, or crush when subjected to compressive loading of heavy construction equipment.

428.3.6.9 The field installation of the preformed detector loops shall consist of the routing and placement in existing asphalt pavement during applications of hot asphalt, or prior to concrete paving.

428.3.6.10 All material for assembling and installing the interconnects and home-runs shall be provided directly by the manufacturer. Field assembly of the home-runs and interconnects may result in the conduits being partially sealed when approved by the ENGINEER.

428.3.6.11 The use of factory-sealed home-runs and interconnects shall be used wherever possible.

428.3.6.12 Loop detector, home-runs, and interconnections layouts shall be as recommended by the manufacturer, but shall achieve the traffic lane or movement detection as indicated on the plans and as specified herein.

428.3.6.13 The pull boxes and terminal hand holes shall be installed when called for on the plans, but can be field adjusted for the installation of the home-runs and interconnections for the performed detector loops. However, the field adjustments will require the pull boxes and terminal hand holes to be installed in preformed detector loops. The manufacturer's field positions of the pull boxes and terminal hand holes shall be approved by the ENGINEER.

428.3.7 Microloops

428.3.7.1 Microloops shall be a small, cylindrical unit designed to be installed beneath the road surface which shall be capable of being connected to an inductive loop vehicle detector to provide pulse mode vehicle detection. Microloops shall conform to the following requirements:

428.3.7.1.1 The microloop probe shall be sealed for moisture protection.

428.3.7.1.2 The microloop shall be capable of operating from -35F to +165F.

428.3.7.1.3 The microloop shall have a sensitivity of approximately 3.5 to 8 microhenries/oerstad at 40 KHZ and 0.2 to 0.6 oerstad ambient magnetic field.

428.3.8 EMERGENCY VEHICLE OPTICAL DETECTOR SYSTEMS

428.3.8.1 This work shall consist of furnishing and installing an Emergency Vehicle Optical Detector (EVOD) systems at signalized intersections on signal standards and in control cabinets in compliance with the specifications and the details shown in the plans.

428.3.8.2 The system shall employ optical communication to identify the presence of designated priority vehicles and cause the traffic signal controller to advance or hold a desired traffic signal display selected from phases normally available. The optical signal shall be encoded for vehicle identification and classification. The optical signal shall interface with software for record-keeping, logging, and intersection set-up.

428.3.8.3 The matched set of components which make up the Emergency Vehicle Optical Detector (EVOD) system shall cause the existing traffic controller to be manipulated upon recognition of the signal from the vehicle.

428.3.8.4 This communication shall be effective to the optical detectors at or near the intersection over a line-of-sight path of at least 2500 feet.

428.3.8.5 The EVOD system shall operate on a first come, first-served basis, or on a dual priority basis. The EVOD system shall be designed to yield to other priority demands such as railroad crossings.

428.3.8.6 The EVOD system shall interface with existing traffic signal controllers without compromising normal operation or existing safety provisions. The EVOD system shall consist of an optical emitter, optical detectors, optical detector cable, and encoded phase selectors.

428.3.8.7 To ensure desired performance, the EVOD system shall provide matched system components, proven through integrated testing and extensive functional experience. The matched system components shall offer compatibility with all types of traffic signal controllers, i.e., electromechanical, or solid-state. Matched components shall provide future system compatibility of all priority control elements.

428.3.8.8 EVOD OPTICAL EMITTER ASSEMBLY

428.3.8.8.1 EVOD optical emitters shall be a lightweight, weather resistant, light emitting device with internal regulated power supply.

428.3.8.8.2 The optical emitter assembly shall produce precisely times, crystal controlled optical energy pulses of high intensity light from a single source, at a rate of 14.035Hz or 9.639Hz depending on the emitter control

switch employed. The optical emitter shall send an encoded signal to classify and identify the emergency vehicle.

428.3.8.9 EVOD OPTICAL DETECTOR

428.3.8.9.1 EVOD optical detectors shall be light weight, weatherproof, adjustable, single or dual directional optical detector assemblies.

428.3.8.9.2 Internal circuitry shall transform optical energy from the optical emitter assembly into electrical signals for delivery (up to 1000 feet) via optical detector cable to the phase selection equipment.

428.3.8.9.3 The unit shall be of high impact polycarbonate construction with non-corrosive hardware and shall be designed for simple mounting at or near an intersection on mast arm, pedestal, pipe, or span wire and shall operate over an ambient temperature range of minus thirty degrees (-30°C) to plus sixty (+60°C).

428.3.8.9.4 The unit shall be responsive to the optical emitter at a distance of at least 2500 feet and shall be capable of providing the necessary electrical signal to the phase selector through up to 1000 feet (305m) of optical detector cable.

428.3.8.10 EVOD OPTICAL DETECTOR CABLE

428.3.8.10.1 EVOD optical detector cable shall be durable, and shall have the necessary electrical characteristics to carry power to the optical detector from the phase selector and to carry the optical detector signal to the phase selector.

428.3.8.10.2 The cable shall have three (3) conductors AWG 20 (7 x 28) stranded and an individually tinned drain wire to provide signal integrity and transient protection. Cable conductors shall be copper and shall be shielded with aluminized polyester. The shield wrapping shall have a twenty percent (20%) overlap to ensure shield integrity following conduit and mast arm pulls.

428.3.8.10.3 The cable shall deliver the necessary quality signal from the optical detector to the phase selector over a non-spliced distance of 1000 feet (305m).

428.3.8.10.4 The cable shall deliver sufficient power to the optical detector over a non-spliced distance of 1000 feet (305m).

428.3.8.10.5 The cable insulation rating shall be 600 volts, minimum.

428.3.8.10.6 The cable temperature rating shall be eighty degrees (80°C) minimum.

428.3.8.10.7 The cable shall be color coded as follows:

1. Orange for delivery of optical detector power (+);
2. Blue for optical detector power return (-) or optical detector signal;
3. Yellow for optical detector signal;
4. Bare for optical detector power return (-).

428.3.8.11 PHASE SELECTOR ASSEMBLY

428.3.8.11.1 The EVOD phase selection assembly shall interface between the optical detectors and the controller unit, shall not compromise the existing controller unit's fail-safe provision and shall provide sufficient power for up to three (3) optical detectors per channel.

428.3.8.11.2 The assembly shall provide suitable sensitivity to the optical detector signal, computer software, or encoded emitter on a maintenance vehicle.

428.3.8.11.3 The assembly shall be a plug-in, two (2) channel, dual priority device intended to be installed directly into the input file of control cabinets equipped with priority phase selection software.

428.3.8.11.4 The assembly shall be powered from AC mains and contain an internal, regulated power supply to power optical detectors.

428.3.8.11.5 The assembly shall be capable of recognizing the following pulse rates as delivered by the optical detectors:

1. 9639 ± 0.119 Hz as Frequency I;
2. 14.035 ± 0.255 Hz as Frequency II.

428.3.8.11.6 The assembly shall deliver signals to the controller to cause selection of the desired phase green display for the approaching vehicle.

428.3.8.11.7 The assembly shall have a test switch for each channel to deliver Frequency I or Frequency II signal pulse rates to verify proper function at both optical emitter flash rates, first-come, first-served operation, and Frequency II override capability.

428.3.8.11.8 The assembly shall have a selectable call dropout time of five (5) or ten (10) seconds $\pm 2.5\%$.

428.3.8.11.9 The phase selector shall be a modular, microprocessor controlled, two (2) channel, four (4) phase,

high priority device, expandable to a four (4) channel, eight (8) phase, dual ring controller. The phase selector module shall have memory and shall be programmable via a personal computer. The phase selector module shall have a communication port on the front panel.

428.3.8.11.10 The phase selector shall continuously monitor all GREEN, WALK, and pedestrian clearance displays for a smooth transition from controller to phase selector interval timing.

428.3.8.12 EVOD RELIABILITY

428.3.8.12.1 All equipment supplied as part of the optical priority remote traffic control system intended for use in the controller cabinet shall meet the electrical and environmental specifications spelled out in the NEMA standards publication TSI-1983 part 2.

428.3.8.12.2 All equipment supplied as part of the priority control system intended for use in on emergency vehicles shall operate properly over an ambient temperature range of minus thirty degrees (-30°C) to sixty degrees (60°C) and in air with relative humidity from five percent (5%) to ninety five percent (95%) and a vehicle battery voltage of from ten (10) volts to fifteen (15) volts.

428.4 CONSTRUCTION REQUIREMENTS.

428.4.1 LOOP DETECTOR

428.4.1.1 The installation of a loop detector consists of two distinct elements. The first element is the installation of the loop (inductive coil) in the pavement, at the location and geometry shown on the plans, including a low inductance lead-in cable back to the control cabinet. The second element is the installation of the loop vehicle detector module (sensing unit in the control cabinet, including all wiring to output the presence of a vehicle. Loop detector (total system) installations will not be accepted by the ENGINEER until it is demonstrated that the installation will accurately detect the presence of vehicles as required on the plans and in the specifications.

428.4.1.2 Loop detectors shall be installed in accordance to details on the plans and the following requirements and procedures:

428.4.1.2.1.1 Saw cuts shall be made in pavement of the dimensions and shape detailed in the plans, using an abrasive cutting wheel concrete saw. Saw cut shall be 2¼ inches to 2½ inches deep and approximately 1/4 inch wide. (A 3/8 inch wide slot shall be used to install ducted loop

detector wire).

428.4.1.2.1.2 When a contract includes new pavement or additional paving material overlay, the saw cut and wire installation shall be made at least below the last paving lift of 5/8 inch or greater thickness. No saw cuts will be permitted in final lift of surfacing. In the case of pavement overlay, the saw cut shall be a minimum of 2¼ inches below the final surfacing elevation. When the contract calls for heater scarification pavement treatment, the saw cuts shall be made after this operation has been completed.

428.4.1.2.1.3 Saw cuts intersecting at 40° or more shall be core drilled at intersection point to accommodate wire slack. One-inch to two-inch diameter holes are to be drilled at angle points to the same depth of the saw cuts. Cuts across concrete pavement expansion joints shall also be drilled at this point to allow wire slack. Saw cuts shall overlap by a sufficient length to provide a smooth bottom, even depth wire channel.

428.4.1.2.1.4 When there is more than one loop terminating at a pull box, each loop shall have a separate saw cut back to the box and these saw cuts shall be no closer than 6 inches.

428.4.1.2.2 A separate 1-inch rigid electrical conduit entrance shall be provided at the pull box for each loop. This conduit shall begin at the end of the pavement saw cut and run under any curb and gutter and sidewalk in conformance to the details in the plans. The ends of the conduit shall have all sharp edges removed and shall be "bushed". A 1" - 2" wide hole shall be broken out on the pavement end of the conduit. Wire through this hole shall be left slack and the end of the conduit shall be backfilled and sealed with a soft-setting butyl rubber or asphaltic joint sealer. The remaining portion of the hole shall be filled with the approved saw cut sealant.

428.4.1.2.3 A continuous run of loop detector wire shall be placed in the saw cut, wound around the coil section the number of turns shown on the plans or as directed by the ENGINEER. No more than four wires or turns shall be placed in a single saw cut. Loop detector wire pairs shall be twisted (four to six twists per foot) between the loop (thru the lead-in saw cut and conduit) to the shielded lead-in splice.

428.4.1.2.4.1 Before placement of the sealant and wire, the saw cut shall be cleaned of all debris and standing water by blowing out with compressed air. (The pavement surface may be damp to the touch). The inside of the saw cut shall be free from any sharp protrusions such as from

loose aggregate or uneven saw cuts.

428.4.1.2.4.2 Wire run through drilled corners and joint crossings shall be left slack. This slack portion of wire shall be encapsulated with a soft-setting butyl rubber or asphaltic joint sealer.

428.4.1.2.4.3 The following types of wire installation methods shall be used. (When the plans call for a specific method, only that method will be permitted).

428.4.1.2.4.4 All sealant shall be placed in a saw cut by means of a special nozzle. The saw cut shall be filled to approximately 1/8 inch of the top. No spill over onto the pavement surface will be permitted (any excess shall immediately be struck off). Sealant shall not be placed when the ambient temperature is below 40° F. or manufacturer's requirements, or when precipitation is occurring or impending. The sealant will be considered part of the saw cut operation and no separate payment shall be made therefor.

428.4.1.2.4.5 Ducted loop detector wire may be installed during a paving operation by securely attaching the loop in the proper shape to the pavement surface and overlaying with the next paving lift(s) of 2 inches or greater total thickness. Means of securing the loop, before overlaying, may be by placing the ducted wire in slot cut in the pavement or by securing the corners by a method approved by the ENGINEER, then covering the wire by hand with a small amount of asphaltic paving material. Ducted loop detector wire shall not be bent less than a 1-inch radius.

428.4.1.2.4.6 Preformed loops and microloops shall be placed in accordance with the manufacturer's specifications.

428.4.1.2.5 When a multiple loop system (same channel) is used, adjacent loops shall be wound with opposite rotations. Rotation reversal may be accomplished by reversing leads at the pull box. The CONTRACTOR shall mark the beginning of the loop detector wire and the pull box before beginning the winding installation process to allow determining the direction of rotation. All multiple loops shall be connected in series to the lead-in cable at the pull box or splice point.

428.4.1.2.6.1 Loop lead-in cable shall be run continuously from the loop detector wire splice to the terminal in the control cabinet. No splices in the lead-in cable will be permitted. The drain (ground) wire in the lead-in cable shall be connected to earth ground at the cabinet end only. The ground wire at the curb side pull box

shall be neatly clipped off adjacent to the end of the outer jacket.

428.4.1.2.6.2 Connections between the loop detector wire and the lead-in cable shall be soldered. No open-flame torches shall be used for soldering. The splices shall be made waterproof by encapsulating the bared wire with a two-part sealant, 3-M #3570 connector sealant, or equal. The splices shall then be wrapped with a high quality, all-weather electrical tape or approved self-bonding tape, overlapping the wire insulation approximately 1 inch and of sufficient layers to equal 1½ times the thickness of the original insulation. The outer jacket of the cable shall be sealed in a similar manner except the tape shall overlap the outer jacket by four inches. When ducted loop detector wire is used, sealant shall be applied at the end of the tube portion then wrapped with tape to prevent water entry.

428.4.1.2.6.3 The "V" splices formed shall be suspended high in the pull box to prevent immersion in water.

428.4.1.2.7 After the loop installation in the roadway has been completed, each loop shall be checked with a megger to insure the integrity of the installation. The resistance of each loop shall be greater than 10 megohms at 500 volts. When called for by the ENGINEER, a check will be made of the completed loop detector system in accordance with this Section 428.

428.4.2 PUSH-BUTTON STATIONS: shall be mounted on the side of traffic signal poles as shown in the plans.

428.4.3 EVOD OPTICAL DETECTOR SYSTEM

428.4.3.1 EVOD optical detector systems shall be installed in accordance with the manufacturer's recommendations. The equipment manufacturer shall not modify the existing traffic controller unit beyond adding the necessary hardware to the traffic controller cabinet.

428.4.3.2 The manufacturer or its authorized representative shall be responsible for system check-out prior to purchaser's acceptance by verifying proper installation per recommended interfaces, verifying that optical ranges are properly set, and verifying that phase selector timings or controller software timings are properly set.

428.4.3.3 The CONTRACTOR shall provide appropriate training for the Traffic Engineer's personnel and emergency vehicle operators, and assist in trouble shooting, maintenance, and system operation.

428.5 MEASUREMENT AND PAYMENT.

428.5.1 Loop vehicle detector modules, preformed loops including lead, microloops, and push-button stations will be measured by the unit complete in place.

428.5.2 Loop detector wire, ducted loop detector wire, loop lead-in cable, and loop detector saw cut will be measured by the linear foot complete in place.

428.5.3 Emergency vehicle optical detector system components including phase selector racks, phase selector modules, "D" panels (including cables and harnesses), optical detectors, and optical emitters will be measured by the unit complete in place. Optical detector cable will be measured by the linear foot complete in place.

428.5.4 The accepted quantities of loop vehicle detector modules, preformed loops, microloops, push-button stations, loop detector wire, ducted loop detector wire, loop lead-in cable, loop detector saw cut, and emergency vehicle optical detector system components including phase selector racks, phase selector modules, "D" Panels (including cables and harnesses), optical detectors, optical emitters, and optical detector cable will be paid for at the contract unit price per unit of measurement for each of the pay items listed as shown on the bid proposal.

TRAFFIC SIGNAL CONTROLLERS

429.1 GENERAL: This work shall consist of furnishing and installing traffic actuated controllers, special auxiliary control equipment, and cabinets in compliance with the specifications, details shown on the plans, and Standard Drawings at the locations shown on the plans, or as established by the ENGINEER.

429.2 REFERENCES.

- 429.2.1 Manual on Uniform Traffic Control Devices (MUTCD), Latest Edition
- 429.2.2 National Electrical Code (NEC), Latest Edition
- 429.2.3 National Electrical Manufacturers Association (NEMA) Standards, Latest Edition

429.3 MATERIALS.

429.3.1 TRAFFIC-ACTUATED CONTROLLER

429.3.1.1 General.

429.3.1.1.1 These specifications together with the NEMA Standards Publication TS-1-1989 or latest edition for Traffic Control Systems describe required features, functions, and test procedures for traffic actuated controllers. These specifications shall be considered in addition to the minimum requirements for a NEMA controller. All controllers furnished shall be of a modular design microprocessor type, unless otherwise called for on the plans or special provisions.

429.3.1.1.2 All input/output electrical connections for all standard and special functions shall be multi-terminal, MS type plugs on the front of the controller, conforming to the latest NEMA interface standards. (RS-232-C ports may be used for communications and special functions).

429.3.1.1.3 All controllers shall meet all requirements for a solid state NEMA traffic actuated controller and shall utilize the latest state-of-the-art design employing microprocessor and CMOS logic circuitry.

429.3.1.1.4 All controllers shall use a keyboard for entry of all operator timing and functional data into nonvolatile memory. The keyboard shall be of a type providing tactile feedback when depressed. The procedure required to enter, revise and display operator data shall be menu driven and

designed to minimize the number of key strokes; all key functions shall be marked on the front of the controller, clearly and easily readable by the operator. The display shall be LCD with adjustable contrast and back lighting. The operator data shall be retained in memory for a minimum of 30 days after removal of primary power.

429.3.1.1.5 All controllers shall be capable of being programmed in different patterns of phase sequences: quad-left (NEMA), sequential, or combination of concurrent and sequential. All controllers shall permit programming of phases as inactive. The signal plan shall be pre-programmed by the manufacturer as called for on the plans. This signal plan (sequence, inactive phases, any overlaps, and/or preempt sequences) shall be nonvolatile (not held exclusively in RAM). All programmed data shall be retained in non-volatile EEPROM. In addition, battery backup shall be provided in the same module for the purpose of power down clock operation and battery backed RAM for non-programmed data, such as message logs.

429.3.1.1.6 All controllers shall be of modular design consisting of a main processor board (MPU) input/output interface, and the power regulation. The power transformer and capacitors may be rigidly fixed to the frame. Modules may be directly removable from the front of the controller. The keyboard and LCD displays shall be on the front of the controller. Provisions shall be made in the design to allow time base coordination and preemption programming through the controller keyboard.

429.3.1.1.7 All controllers shall be furnished with a front panel mounted RS 232-C industry standard input/output port. This port shall be capable of printing out program data to a stand alone printer; direct interface with a personal computer for uploading and downloading program data; and direct interface with a dial-up modem for remote communications with a personal computer over telephone lines. These connections shall be done such that there is no interruption to the signal operation.

429.3.1.1.8 All controllers shall have LCD alphanumeric displays for timing, status and programming information. Each ring shall be provided with a separate display (simultaneous dual ring display). The display shall have two modes of operation (run and program). In the run mode, current phase, interval and interval time remaining shall be displayed. In the programming mode, the phase, interval or programmable function, and the time or value

shall be displayed. The controller shall permit the display of an operator-entered time or value before entering into memory, and shall provide for the automatic sequencing through the programming to minimize the required key strokes. It shall be possible to enter a four digit numeric security code to prevent unauthorized changes under the programming mode. Access to stored information shall be available at all times.

429.3.1.1.9 Internal preemption shall be furnished for all controllers, providing railroad and/or emergency vehicle preemption sequences. Preemption shall provide as a minimum, six independent preemption programs. It shall be possible to prioritize preemption, delay before preemption, cycle during preemption by hold phase assignments, and provide for pedestrian clearance through initial clearance yellow. All intervals to preemption shall be timed and all operator data shall be programmed through the controller keyboard. All operator-entered preempt data shall be made available on the printer hard copy. The furnished preempt sequencing and operation shall be as called for on the plans. All railroad preemption shall be in conformance with MUTCD requirements and include a track clearance phase. Return to normal controller operation shall be in accordance with the plan phasing diagram and a detector call shall be placed on phases as noted.

429.3.1.1.10 Internal time base coordination shall be furnished for all controllers providing the synchronization and control functions for coordinating actuated signalized intersections without the use of interconnecting cables. Coordination shall be made on a time of day, day of week and week of year basis. The coordinator shall function as a standard signal system coordinator using Force Offs, Holds and Phase/Ped Omits outputs and phase green inputs, capable of supervising the controller. The coordinator shall keep to the accuracy of the AC line frequency, and without line voltage to accuracy of at least +.005% (+50 ppm). The battery backup shall maintain real time and memory for at least 720 hours. The time clock shall keep track of time of day in seconds, day of week and week of year. It shall be possible to program for automatic Daylight Saving Time changes. In the event of a power disruption, the coordinator shall automatically upload itself upon return to line voltage. The coordinator shall have the minimum availability of 160 program changes, selectable on the minimum basis of 10 daily program groups, two weekly programs, and 10 exception day (holiday) programs. The program change (on or off of any single function) shall be selectable at least to a minute of any hour of a day. The coordinator shall have minimum selectable system options of 4 cycles, 4 splits per cycle, 3 offsets per cycle, 3 permissive periods per split, one pedestrian permissive period per split, and 3 force offs per split. Cycle settings shall be selectable from 0 to 255

seconds in one-second increments, or as a percentage of the cycle length. Offsets, permissive periods, and force off points may be programmable from 0 to 255 seconds in one-second increments or as a percentage of the cycle length. Offset seeking shall be selectable for dwell or shortway offset transitions. It shall be possible to manually select any program. The coordinated phase(s) shall be selectable and shall be programmed as called for on the plans. Display(s) shall be provided to allow the user (with keyboard control) to display the current time of day, week of year, cycle countdown, current plan in effect, hold, force off, sync outputs, and all programmed data as they occur.

429.3.1.2 GENERAL DESIGN REQUIREMENTS

429.3.1.2.1 COMPONENTS

429.3.1.2.1.1 All timing circuits shall consist entirely of solid state electronic circuitry consistent with the state-of-the-art large scale integration circuit (LSI) techniques. The CONTRACTOR shall furnish cross reference and data sheets showing the parameters of all solid state devices used.

429.3.1.2.1.2 All switching functions shall be accomplished through the use of solid state electronic circuitry. No electromechanical devices, such as rotary, stepping, or line-switches, or time/break relays, shall be used for switching functions.

429.3.1.2.1.3 All printed circuit boards (assemblies) shall be of glass epoxy, two-ounce copper circuit traces, conforming to NEMA requirements for traffic signal controllers. Current carrying traces shall be covered with a solder mask material, and those boards containing a major number of CMOS components shall be coated with a humidity sealant. In addition, circuit reference designation for all components shall be clearly marked immediately adjacent to the component.

429.3.1.2.1.4 All components shall be amply derated with regard to heat dissipating capacity and rated voltage so that with maximum ambient temperature and maximum applied voltage, material shortening of life or shift in values shall not occur.

429.3.1.2.1.5 The design life of all components under 24 hour-a-day operating conditions in their circuit applications shall not be less than five years.

429.3.1.2.2 CONSTANCY OF INTERVALS: Constancy of Intervals. The controller shall be of such design that the length of any interval, portion, period, or unit extension may be set to two significant digits and will

be and remain within ± 100 milliseconds of that setting if the line voltage is at any value from 95 volts to 135 volts, the ambient temperature is between -30 degrees F and +165 degrees F, and the line frequency is 60 hertz plus or minus 0.3 hertz. This performance shall include cold and hot starts and shall be obtained without the use of power-consuming heating or cooling apparatus of any kind.

429.3.1.2.3 POWER: The controller and all associated equipment shall be designed for use on 115-volt, 60-cycle, single phase AC.

429.3.1.2.4 MECHANICAL CONSTRUCTION.

429.3.1.2.4.1 The controller shall be housed in either a sheet aluminum, steel, or approved housing with a durable finish.

429.3.1.2.4.2 The controller shall be modular by design, conforming to microprocessor type specification.

429.3.1.2.4.3 Printed circuit boards shall be designed to plug into receptacles within the controller.

429.3.1.2.4.4 Printed circuit boards shall be provided with secure fastening devices to prevent falling out during transportation or handling.

429.3.1.2.4.5 All assemblies shall be interchangeable between controllers of the same manufacturer and series.

429.3.1.2.5 ENVIRONMENTAL: All controllers shall conform to NEMA Standards for Environmental, Interface, and Functional Requirements.

429.3.1.3 CONTROL REQUIREMENTS.

429.3.1.3.1 GENERAL: Operator timing and functional programming shall be accomplished on the front panel of the controller. Programmed NEMA overlap boards may be inserted in a slot provided on the front panel or internally within the controller. Operator programming shall be by digital switches or keyboard entry, consistent with these specifications.

429.3.1.3.2 PHASE TIMING: The following timing intervals shall be provided for each traffic phase. The interval and minimum range of adjustment of the timing intervals shall be:

INTERVAL	TIMING RANGE (SECONDS)	MAX RESOLUTION (INCREMENTS)
Minimum	0-99	1
Extension (Gap)	0-9.9	0.1
Yellow Change	0-9.9	0.1
Red Clearance	0-9.9	0.1
Maximum (MAX 1)	0-99	1
Maximum (MAX 2)	0-99	1
Walk*	0-99	1
Ped. Clearance*	0-99	1
Red revert**	2-7	1

* Need be furnished with each through traffic movement phase only.

**Per controller or ring; may be internal setting.

429.3.1.3.3 PHASE CONTROL FUNCTIONS: Each phase shall be capable of being set to the following functions:

429.3.1.3.3.1 MAX RECALL (NON ACT): automatically returns phase and extends green timing to that of MAX GREEN. In absence of opposing phase demand, the controller shall rest in GREEN.

429.3.1.3.3.2 PED RECALL (NON ACT): automatically returns phase to WALK-PED CLEARANCE and vehicle right of way without vehicle and Pedestrian demand.

429.3.1.3.3.3 VEH. RECALL (EXT.): automatically places a recurring demand for vehicle service without actual vehicle demand when not in its green interval.

429.3.1.3.3.4 NON LOCKING (MEMORY OFF): phase operates in fully actuated mode; memory of vehicle demand is retained only when a vehicle is in the detection zone (detector outputting).

429.3.1.3.3.5 LOCKING (MEMORY ON): phase operates in fully actuated mode; memory of vehicle demand (detector output) is retained in the phase until that phase is served.

429.3.1.4 OPERATIONAL REQUIREMENTS

429.3.1.4.1 TIMING REQUIREMENTS

429.3.1.4.1.1 The clearance period shall consist of time intervals of preset duration, namely:

- (1) Yellow Change Interval.
- (2) Red Clearance Interval.

429.3.1.4.1.2 Each phase shall be provided with an initial interval control determining the guaranteed minimum green period for that phase. With a pedestrian actuation or a pedestrian and vehicle actuation, the minimum green shall consist of the sum of the walk interval and pedestrian clearance interval or minimum green interval, whichever is greater.

429.3.1.4.1.3 Each phase shall be provided with an extension interval control which shall provide vehicles added green time beyond the minimum green time by vehicle actuation(s). Successive actuations shall cancel the remainder of the previous extension interval and shall initiate a complete new extension interval for the vehicle which provided the actuation. Should transfer of right of way occur while an extension interval is unexpired, the right of way shall be returned at the next opportunity in the cycle.

429.3.1.4.1.4 Each phase shall contain two maximum green timing interval controls which shall set a limit on the length of time that continuous traffic on the right of way phase can extend the right of way for that phase after an actuation is registered for any conflicting phase. Normal operation shall be in the (MAX 1) maximum interval. The second (MAX 2) maximum interval shall be effected by both an external and internal input.

429.3.1.4.1.5 Actuation of a pedestrian push button during a pedestrian clearance interval or at any other time while the pedestrian "Don't Walk" signal is being displayed shall register the presence of said pedestrian. This actuation shall be remembered so that the pedestrian walk indication will be accorded at the next assignment of right of way to the phase.

429.3.1.4.1.5.1 In the event of a registered pedestrian actuation on a phase with no demand for pedestrian or vehicular right of way on a conflicting phase, the phase shall be capable of recycling and providing pedestrian and pedestrian clearance intervals.

429.3.1.4.1.5.2 The minimum and guaranteed pedestrian protection shall consist of the pedestrian clearance interval. During the balance of the right of way and clearance intervals the "Don't Walk" shall be steady.

429.3.1.4.2 PHASING REQUIREMENTS

429.3.1.4.2.1 Right of way shall not be given to any street without an actuation (call) and, in complete absence of traffic (or recall option), right of way shall remain on the street where it was last assigned unless RED REST option has been exercised; then the controller shall cycle to all red and remain until a phase call.

429.3.1.4.2.2 All controllers shall operate as a concurrent phase timing (dual ring) controller, or sequential (single ring) configuration. All phases shall be identified (numbered) and operate in accordance with a NEMA dual ring (quad-left) configuration or sequential configuration. All controllers furnished shall be capable of operating eight field phases. Controllers shall be capable of assigning the right of way to a single phase or any combination of non-conflicting phases, and shall normally operate in the mode specified on the plans. Phases skipped on each ring for no demand and recall functions for each phase shall be as specified for sequential controllers. Controllers shall have the capability of providing four overlap phases in any phase combination, programmable on both a standard NEMA plug-in overlap program board and operator keyboard entry.

429.3.1.4.3 All controllers shall have all input/output features per phase, ring and unit as required under NEMA Standards. Any unused inputs/outputs shall be wired to and identified on the controller back panel.

429.3.1.4.4 All controllers shall have an initialization control to start at the beginning of the programmed GREEN, YELLOW, or RED interval of the selected phase(s), as called for on the plans, application of power or the EXTERNAL START input. Vehicle and pedestrian calls shall then be placed on phases.

429.3.2 SYSTEM MASTER

429.3.2.1 A system master shall be a traffic adjusted system master (arterial or multi system as specified) of a microprocessor or computer design. When specified on the plans, peripheral equipment, communication equipment and/or a cabinet shall be part of this item. The exact location shall be as called for on the plans. All system masters shall conform to the design, operational, and communication requirements called for on the plans and/or special provisions.

429.3.2.2 All units shall be shelf mounted in the controller cabinet with MS or RS-232 type connectors, and shall be housed in a metal cabinet; conforming to this Section 429.

429.3.3 CABINETS, SUPPORT EQUIPMENT, AND WIRING

429.3.3.1 GENERAL

429.3.3.1.1 Unless otherwise specified on the plans the components of the controller shall be provided in a sturdy, weatherproof metallic housing hereinafter referred to as a

controller cabinet

429.3.3.1.2 Unless otherwise specified on the plans, all cabinets shall be wired for the full application of all phases, pedestrian signals on all through movements, and all normal overlaps for either four phase-single ring operation, or eight phase-dual ring operation. All vehicle detection shall be wired. The cabinet shall be furnished so that to implement any initially unused phases or functions, it shall only be necessary to add load switches, vehicle detectors, disconnect any jumpers and rearrange field conductors.

429.3.3.1.3 All ground mounted cabinets shall be #14 gauge sheet steel or 0.125 inch minimum thickness type 5052-H32 aluminum. Pedestal cabinets shall be aluminum of 0.125-inch minimum thickness cabinets shall be designed and manufactured for rigid mounting whether intended for pole or pedestal mounting. The cabinets shall not flex on their mounts. The specific types of controller cabinets and their internal components and wiring arrangements for a particular installation shall be as necessary to provide a complete operating traffic control system as called for on the plans or in the special provisions, and as follows:

429.3.3.1.3.1 The cabinet shall have a main door which shall be equipped with a Corbin tumbler lock number 1548-1 and an auxiliary door equipped with a treasury type lock Corbin Number R357SG5 for a police key. The main door handle shall have provisions for padlocking in the closed position. A rain channel shall be incorporated into the design of the main door opening to prevent liquids from entering the enclosure. The cabinet door must be a minimum of 80% of the front surface of the cabinet. A stiffener plate shall be welded across the inside of the main door to prevent flexing. The top of the cabinet shall incorporate a slope toward the rear to prevent rain accumulation. All seams shall be sealed with RTV sealant or equivalent material on the interior of the cabinet. The main door and police door-in-door shall close against a weatherproof and dust proof closed cell neoprene gasket seal. The lower section of the cabinet door shall be equipped with a louvered air entrance. The air inlet shall be at least 16 inches by 20 inches in size. Louvers must satisfy the NEMA rod entry test for 3R ventilated enclosures. A non-corrosive, vermin and insect proof, removable air filter shall be secured to the air entrance. The filter shall fit snugly against the cabinet door wall. The main door hinge shall be a one piece, continuous piano hinge with a stainless steel pin running the entire length of the door mounted on the right side when facing the cabinet. The hinge shall be attached in such a manner that no rivets or bolts are used.

429.3.3.1.3.2 Substantial metallic shelves or brackets to support the controller and auxiliary equipment shall be

furnished and installed. A minimum of two (2) shelves shall be provided, unless approved otherwise. The shelves shall be adequately supported at both ends by angle-type braces. The shelves shall be of sufficient strength to prevent the shelf from sagging with the full weight of the control equipment.

429.3.3.1.3.3 Control cabinets shall be of sufficient size to allow the controller assembly and all associated equipment to stand in an upright position on the shelving. No equipment shall be placed on the floor of ground mounted cabinets. The control cabinet shall be of sufficient size to allow the removal of the controller assembly by pulling this assembly straight out. It shall not be necessary to turn the assembly sideways to remove it from the cabinet. The cabinet shall be of sufficient size to allow the door to be closed with no interference to the wire harness running to the door. All equipment and wall mounted devices shall be capable of being removed without relocating or unjacking one device to another device. Cabinet wiring shall be such that the front panels of control equipment are not obscured.

429.3.3.1.3.4 The minimum acceptable cabinet size shall be as follows or as specified on the plans or in the special provisions, provided that the above mentioned space requirements are met:

TYPE OF CAB.	OUTSIDE DIMENSIONS HxWxD	USE
G	33" X 20" X 14"	When called for on plans
M	48" X 30" X 16"	When called for on plans
MSX	57" X 30" X 17"	When called for on plans
P	54" X 38" X 24"	4-Phase single ring operation
P	54" X 38" X 24"	8-phase dual ring operation
R	72" X 38" X 24"	When called for on plans

429.3.3.1.3.5 All cabinets for controllers shall be of the ground mount type with internal bolts, unless otherwise called for on the plans. Anchor bolts and templates for their installation shall be shipped as soon as possible to the CONTRACTOR so that the necessary concrete base may be installed in advance of receiving the controller.

429.3.3.1.3.6 All cabinets shall be finished as follows:

- a. Steel Cabinets, Inside and Outside.
First Coat. Flow Stage Iron Phosphate coating
Second Coat. TGIC Polyester Power
Coat paint matching Federal Standard 595A
Color Chip 27886, with a minimum dry film

thickness of 2 mm.

- b. Aluminum cabinets: No paint required.
- c. Special projects: Finish either steel or aluminum cabinets as designated on plans.

429.3.3.2 CABINET WIRING, TERMINALS AND FACILITIES: These specifications together with NEMA Standards, describe the requirements for wiring, terminals and facilities within the cabinet.

429.3.3.2.1 CABINET WIRING

429.3.3.2.1.1 All cabinet wiring shall be neat and firm and all harness and cabinet wiring shall be laced or bound together with Ty wrap or equivalent.

429.3.3.2.1.2 All back panel wiring shall conform to the following gauge and color:

Grn/walk loadswitch out - brown wire	- 14 gauge
Yellow loadswitch out - yellow wire	- 14 gauge
Red/don't walk loadswitch out - red wire	- 14 gauge
CMU (other than AC pwr) - violet wire	- 22 gauge
Controller I/O - blue wire	- 22 gauge
AC+(pwr panel to main panel) - blk wire	- 8 gauge
AC+(main panel) - blk wire	- 10 gauge
AC-(pwr panel to main panel)- white wire	- 8 gauge
AC-(main panel) - white wire	- 10 gauge
Chassis ground (pwr panel) - green wire	- 8 gauge
DC ground - grey wire	- 22 gauge
Flash programming- orange wire	- 14 gauge

429.3.3.2.1.3 All wiring, 14 AWG and under, shall conform to MIL-W-16878/I, type B/N, 00V, 19 strand tinned copper. The wire shall have a minimum of 0.010 inch thick PVC insulation with clear nylon jacket and rated to 105 degrees Celsius. All 12 AWG and larger wire shall be UL listed THHN/THWN 90 degrees celsius, 600 V, 0.020 inch, thick PVC insulation and clear nylon jacketed.

429.3.3.2.1.4 All connecting cables and wire runs shall be secured by mechanical clamps. Stick-on type clamps are not acceptable.

429.3.3.2.1.5 Logic ground and chassis ground shall be isolated from each other within the cabinet. In addition, chassis ground and AC- shall not be tied together within the cabinet.

429.3.3.2.1.6 All wire at solder joints shall be hooked or looped around the eyelet or terminal block post prior to

soldering to insure circuit integrity. Lap joint soldering is not acceptable.

429.3.3.2.1.7 All back panel, D interface panel, and detector panel terminal blocks should be permanently numbered and labeled as to their function.

429.3.3.2.2 BACK PANEL

429.3.3.2.2.1 A back panel shall be provided for termination of all DC logic wiring. This panel shall be located on the back of the cabinet below the equipment shelves and shall include the load bay and the flasher/flasher relays. All terminals and plug-in units shall be readily accessible without moving any equipment.

429.3.3.2.2.2 The back panel shall be a pre-wired type with the controller harness, conflict harness, and detector inputs permanently wired to the back of the panel. Connections for DC wiring shall be ¼-inch quick connect tab type, 300 Volt and 20 amp. rated, the wire being mechanically stripped ¼-inch and the tab firmly crimped covering wire and insulation, or soldered. All AC connections on the panel back and all connections to the load switch/flasher receptacles shall be soldered. All NEMA functions shall be brought out to the front of the panel with screw type connector. It shall be possible to program on the front, using jumpers (clips or wires), the signal outputs for all the types of phasing operations possible for the specified controller and to access all NEMA functions on the front for future auxiliary equipment. The terminal functions shall be clearly marked with the appropriate NEMA designation. When auxiliary equipment logic is called for on the plans, these connections shall be made on the front of the panel.

429.3.3.2.2.3 The panel shall be mounted to the cabinet so as to allow sufficient clearance between the cabinet wall and the panel's back connections. It shall be possible to drop the panel in the field (access back wiring) using simple hand tools. The load bay, including flasher, shall be a rack-mounted type. The load switches and flasher shall be adequately supported after insertion to prevent falling out due to vibrations.

429.3.3.2.2.4 The following minimum positions for plug-in units shall be provided:

TYPE OF CAB.	LOAD	RELAY	
	SWITCH POSITION	FLASH POSITION	NEMA FLASHER
4 phase single ring	8	2	1
8 phase dual ring	16	4	1

429.3.3.2.3 POWER DISTRIBUTION PANEL: The power distribution panel shall be provided on the lower

right-hand side of the cabinet and shall be fully enclosed with a removable cover to prevent accidental shock. The power panel shall include the main power feed terminal (barrier type), the required AC protection from lightning (EDCO SHP-300 surge arrestor or approved equal), filter (RFI), MOV to ground, and any NEC requirements.

429.3.3.2.4 DETECTOR PANEL

429.3.3.2.4.1 A detector panel shall be provided on the left-hand side of the cabinet.

429.3.3.2.4.2 Terminal blocks (barrier type), with removable buss bars shall be provided for all detectors and pedestrian push-button field conductors as required on the plans. The detector rack shall include the "J" pin conductor appropriately terminated for extend/delay operation.

TYPE OF CABINET	DETECTOR RACK POSITION	DETECTOR TERMINAL BLOCKS
4 phase single ring	16	20
8 phase dual ring	16	32

8 PHASE DUAL RING OPERATION
16 POSITION DETECTOR RACK
(MINIMUM FOR EACH CABINET)
U=Unit

U 1	U 2	U 3	U 4	U 5	U 6	U 7	U 8
PH1	PH2	PH6	PH2EC	PH3	H4	PH8	PH4EC
PH5	PH2	PH6	PH6EC	PH7	PH4	PH8	PH8EC
U=UNIT							

SYSTEM DETECTORS & PREEMPTION

U 9	U 10	U 11	U 12	U 13	U 14	U 15	U 16
SD1	SD3	SD5	SD7	SD9	PED	EVP1	EV3
SD2	SD4	SD6	SD8	SD10	ISO	EVP2	EV4
U=UNIT							

4 PHASE SINGLE RING OPERATION
8 CHANNEL DETECTOR RACK
(MINIMUM FOR EACH CABINET)

U 1	U 2	U 3	U 4	U 5	U 6	U 7	U 8
PH1	PH2	PH4	PH2EC	SD1	SD3	PED	EV1
PH3	PH2	PH4	PH4EC	SD2	SD4	ISO	EV2
U=UNIT							

429.3.3.2.4.3 Connector/Pin assignments (2x22 pin edge card connector with 0.156 inch contact centers, key slots located between B & C and M & N) shall be as follows:

A = DC (-) Common
1 = Call Delay Inhibit (Channel 1)
B = DC (+) Power
2 = Call Delay Inhibit (Channel 2)
C = Reset
4 & D = Loop #1
5 & E = Loop #1
F = Output #1A Optocoupler (Collector)
H = Output #1A Optocoupler (Emitter)
8 & J = Loop #2
9 & K = Loop #2
L = Chassis Ground
S = Output 1B AccuCount FET (Drain)
W = Output #2A Optocoupler (Collector)
X = Output #2A Optocoupler (Emitter)
Y = Output #2B AccuCount FET (Drain)
Z = Output #1C Fail FET (Drain)
19 = Output #2C Fail FET (Drain)

All pins not listed are spares.

429.3.3.2.5 "D" CONNECTOR PANEL: A "D" connector panel with harness shall be provided with each cabinet assembly on the left hand side of the cabinet, fully wired to provide all functions. All terminal blocks shall be barrier type. The panel shall contain provisions for mounting two (2) 120 volts AC relays for preempt inputs 1 and 2, and 1/4 AMP fuses for each relay.

429.3.3.2.6 TERMINALS: All terminals shall be numbered and identified with nomenclature that corresponds to the nomenclature on the controller assembly wiring diagram.

429.3.3.2.7 TELEMETRY INTERFACE

429.3.3.2.7.1 A telemetry interface harness and printed circuit board interface panel shall be supplied with each cabinet assembly. All terminal blocks shall be barrier type. As a minimum, the following input/output shall be accessible from the telemetry interface panel.

Local Controller Command Lines 1 & 2.
Local Controller Read Back Lines 1 & 2.
Master Controller Command Lines 1 & 2.
Master Controller Read Back Lines 1 & 2.
Chassis Grounds.
Four Special Function Outputs.
Eight System Detector Inputs.
Flash Input.
CMU Flash Input.

429.3.3.2.7.2 A socket mounted communication line transient protection device shall be supplied with the

telemetry interface panel. The transient protection device shall be wired in series with the telemetry communications circuit.

429.3.3.2.7.3 Communication line impedance shall be matched to the transmitter output impedance to minimize noise on the line.

429.3.3.2.8 SYSTEM MOV RATING: When a system master is called for, MOV rating shall be provided on the DC outputs (controller inputs) when not provided internal to the unit.

429.3.3.2.9 WIRING DIAGRAMS

429.3.3.2.9.1 Four sets of wiring diagrams (one shall be mylar type) shall be furnished for each cabinet. The cabinet shall be equipped with a plastic envelope to house one or more cabinet wiring diagrams. These wiring diagrams shall be furnished with the equipment submitted to the ENGINEER before testing will begin.

429.3.3.2.9.2 The cabinet wiring diagrams shall show and identify the connectors for all equipment and switches, relays, flashers, etc.

429.3.3.2.9.3 The diagrams shall also have a complete intersection sketch, with street names and north arrow including labeling of signal heads and detectors and a signal sequence chart identified and related to the intersection sketch.

429.3.3.2.10 ADDITIONAL ITEMS: The following additional terminals, protection devices, and switches shall be furnished for all cabinets:

429.3.3.2.10.1 A UL listed circuit breaker for filtered AC power serving all solid state devices including load switches, sized as follows:

- (1) 40 AMP protection for four phase single ring assemblies.
- (2) 50 AMP protection for eight phase dual ring assemblies.

429.3.3.2.10.2 A separate 20 AMP breaker for AC circuit serving the G.F.I. outlets, fan and light.

429.3.3.2.10.3 Terminal blocks (barrier type) for all AC+ connections.

429.3.3.2.10.4 Copper ground strip, mounted and ground to cabinet wall, for connection of all common conductors.

429.3.3.2.10.5 All field signal output circuits shall be terminated on an unfused barrier type terminal block with a minimum rating of 15 amps. AC field terminals shall have a number 10-32x7/16 inch screw as a minimum. All field input/output terminals shall be identified by permanent numerical marking strips. All field flash sequence programming shall be accomplished at the field terminals with the use of screwdriver only. Field terminal blocks shall be wired to use four positions per vehicle or overlap phase (green, yellow, red, flash). It shall not be necessary to debuss field terminal blocks for flash programming.

429.3.3.2.10.6 Terminal blocks (barrier type) shall be provided to terminate a special equipment harness. These terminals shall be located on the right-hand side of the cabinet, above the power distribution panel.

429.3.3.2.10.7 Terminals for connecting interconnect cable tie points and intercabinet termination when required. Transient protection (MOV with rating or as called for on the plans) shall be provided on all external lines.

429.3.3.2.10.8 One duplex G.F.I. convenience outlet shall be furnished for energization of test equipment, tools, and lighting. A second duplex G.F.I. convenience outlet, wired to filtered AC power, shall be furnished for telemetry equipment. The G.F.I. convenience outlets shall be NEMA type 5-15R.

429.3.3.2.10.9 Switches behind police auxiliary door.

429.3.3.2.10.9.1 Main switch, identified "On-Off," wired to turn off signal light power when switched to off position and to de-energize the controller and auxiliary equipment. This switch and connecting wiring, shall be rated at 50 AMP minimum.

429.3.3.2.10.9.2 Auto flash switch, identified "Auto Flash," wired to keep controller energized and to place signals on flash when switched to flash position. The controller shall have stop timing applied when in the flash position.

429.3.3.2.10.10 Interior Cabinet Switches.

429.3.3.2.10.10.1 The interior switches below and convenience outlet specified above shall be combined on a single panel and mounted on the back side of the cabinet door unless otherwise noted. All switches except main switch shall be heavy duty and rated 15 AMPS minimum. Momentary push buttons shall be rated at 1 AMP minimum for all vehicle and pedestrian inputs to the controller. Any exposed terminals or switch solder points shall be covered with a non-flexible shield to prevent accidental contact. All

switch functions must be permanently and clearly labeled. All wire routed to the police door and test push button panel shall be adequately protected against damage from repetitive opening and closing of the main door.

429.3.3.2.10.10.2 Test Switch. Two-position switch, identified "Auto Flash," wired to de-energize the signal light power when switched to flash position and to permit the controller to cycle through its normal sequences while displaying flash indications on signals.

429.3.3.2.10.10.3 Controller On/Off Switch. Two-position switch, identified "Controller On/Off," wired to de-energize the controller and auxiliary equipment when switched to the off position.

429.3.3.2.10.10.4 Vehicle and Pedestrian Detector Switches. Two position momentary switches labeled "ON TEST" wired to each vehicle and pedestrian detector input for permitting the substitution of manual call into each controller detector input. Identify switches as to phase/function.

429.3.3.2.10.10.5 Preemption Test Switches. Test switches shall be provided to permit a manual preempt input. Each preemption phase shall have a separate switch with each phase appropriately identified.

429.3.3.2.10.10.6 Conflict Monitor Door Switch. The cabinet shall include a switch that prevents a signal from full operation without the conflict monitor property connected to the cabinet harness.

429.3.3.2.10.10.7 Door Open Switch. The cabinet shall include a door switch to log an event to the system master that the door is open.

429.3.3.2.10.10.8 Fluorescent Light Door Switch. The cabinet shall include a door switch that turns the cabinet fluorescent light on when the cabinet door is open.

429.3.3.2.10.11 Radio line filter (RFI) for filtering AC+ lights and control power for solid state light control and controller operation.

429.3.3.2.10.12 Pedestrian push-button isolation (field circuit) shall be rack mounted to protect solid state devices from transient voltages, i.e., prevent transients from being induced in the open pedestrian push-button circuits by isolation transformer(s), or by optoisolation.

429.3.3.3 ADDITIONAL CABINET FEATURES

429.3.3.3.1 Cabinet Fan. A fan shall be mounted in the controller cabinet and shall be thermostatically controlled

and shall turn on at a cabinet temperature manually adjustable through a range of 70 degrees F to 160 degrees F. The fan and cabinet vent holes shall be located with respect to each other so as to direct the bulk of the air flow over the controller unit. The inside opening shall be covered with ¼-inch maximum mesh screening to prevent the operator from accidentally coming in contact with moving fan blades. The cabinet intake fan vent here shall be filtered.

429.3.3.3.2 Fluorescent Light. A fluorescent fixture and lamp shall be mounted in the cabinet over the door, positioned so as to minimize damage when sliding equipment off shelves. The fluorescent fixture shall be for an F20T12 lamp in all ground mounted cabinets and for an F15T12 lamp in pedestal cabinets. The lamp shall be packaged separately when transported to avoid breakage. The fluorescent light shall be turned on by use of a door switch.

429.3.3.3.3 Door Stops. Each controller cabinet door which is 22 inches or more in width or 6 square feet or larger in area shall be provided with a stop to limit door opening to both 90 degrees and 180 degrees, plus or minus 10 degrees. The stop shall be provided with a catch which can be operated when the door reaches the extreme open position and which will hold the door open securely until released.

429.3.3.4 SOLID STATE SIGNAL AND PEDESTRIAN LOAD SWITCHES

429.3.3.4.1.1 All signal load switches shall be external to the controller and shall be carried in the back panel load bay.

429.3.3.4.1.2 In addition to this specification, all signal control load switches shall conform to NEMA Standards.

429.3.3.4.2 The signal control assembly shall consist of a separate plug-in unit containing control circuitry for the operation of three separate signal lamp circuits. Vehicle and pedestrian control assemblies shall be interchangeable. Any unused output of each control assembly shall not be used for any other function or phase.

429.3.3.4.3.1 Circuitry shall consist of solid state electronic components. No mechanical relays shall be used for the opening and closing of signal light circuits or for any other purpose.

429.3.3.4.3.2 The design life of all components under 24 hours per day operating conditions in their circuit application shall not be less than five years.

429.3.3.4.4 All load switches shall be rated at 20 AMPS.

429.3.3.4.5 Each load switch shall include three LED indicators on the face of the switch, visible through the door opening of the cabinet, and connected to the input functions.

429.3.3.5 SOLID STATE FLASHER

429.3.3.5.1 A solid state flasher, NEMA type 3, 20 amps per circuit, dual-circuit, shall be furnished with each controller cabinet. The flasher shall be rack-mounted in the back panel adjacent to the load bay. All solid state flashers shall conform to NEMA Standards.

429.3.3.5.2 The flasher transfer relays shall be the normally open, multi-contact plug type. A sufficient number of relays shall be provided to permit any combination of flashing red or yellow indications. One RC network shall be wired in parallel with each group of three flash transfer relays and any other relay coils. All flash transfer relay sockets shall be Cinch-Jones #2408SB or approved equal.

429.3.3.6 CONFLICT MONITOR (NEMA Plus).

429.3.3.6.1 A conflict monitor unit shall be furnished with each controller. All signal monitors shall be the self-contained, shelf mounted type with the appropriate NEMA MS connector(s). In addition to this specification, all conflict monitors shall conform to NEMA Standards.

429.3.3.6.2 Minimum monitor functions shall be as follows:

429.3.3.6.2.1 Conflicting GREEN, YELLOW or WALK signal indications at the controller assembly field terminals.

429.3.3.6.2.2 Detect the absence of a required RED signal indication at the field terminal when the GREEN or YELLOW inputs of that channel are not active. The red monitor point shall be made on the field side of the field output terminal.

429.3.3.6.2.3 Monitor the operating voltage in the controller unit and the + 24 volt DC inputs.

429.3.3.6.2.4 Simultaneous sensing of active GREEN and YELLOW or GREEN and RED signal indications on a channel. If either of these conditions exist for 700 milliseconds, the conflict monitor shall not trigger. If either of these conditions exist for 1000 milliseconds, the conflict monitor shall trigger.

429.3.3.6.2.5 Absence of an active YELLOW input for a preset period (2.0 to 2.8 second range) following the termination of an active GREEN input on a channel.

429.3.3.6.2.6 In the event of any of the above faults, the monitor shall apply stop timing to the controller unit and transfer the signals to a flashing operation.

429.3.3.6.2.7 Green or Walk vs. Yellow. When enabled, all channels will monitor for Green or Walk indications on at the same time as the Yellow for that same channel.

429.3.3.6.2.8 Green, Walk or Yellow vs. Red. When enabled, the corresponding channel will monitor for Green, Walk or Yellow indications on with the Red indication of the channel.

429.3.3.6.3 Manual reset shall be required following a conflict or sequence failure, or absence of red; to place signals in normal operation. Return to normal operation shall be automatic after a power supply fault or power outage, following a preset period of flashing operation. Flashing operation shall not be returned to normal operation if a conflict has been detected prior to a power interruption.

429.3.3.6.4 A cabinet interlock shall be provided indicating the presence of the monitor and causing a transfer to flashing operation if the monitor is disconnected.

429.3.3.6.5 Monitor shall include a LCD readout display with the minimum indicators required as follows:

- a. Triggering of the conflict monitoring.
- b. Triggering of the RED monitoring.
- c. Triggering of the sequence monitoring.
- d. Triggering of the +24V monitor portion #1.
- e. Triggering of the +24V monitor portion #2.
- f. Triggering of the controller voltage monitor.
- g. One indicator per channel which displays an active GREEN, YELLOW or WALK input. This channel indicator shall latch with the triggering of the conflict monitor.
- h. A RED failure. The channel indicator(s) in fault shall illuminate.
- i. A sequence failure. The channel indicator(s)

in fault shall illuminate.

j. Green or Walk vs. Yellow.

k. Green, Walk or Yellow vs. Red.

429.3.3.6.6 Monitor shall be capable of recording fault history and generating reports.

429.3.3.6.7 Type of monitor to be furnished:

<u>CABINET TYPE</u>	<u>MONITOR TYPE</u>
4 phase single ring	NEMA Plus 6 Channel
8 phase dual ring	NEMA Plus 12 Channel

429.3.4 If new traffic actuated controllers and controller cabinets are called for on plans, the CONTRACTOR shall provide controllers and cabinets made by the same manufacturer.

429.4 CONSTRUCTION REQUIREMENTS.

429.4.1 Traffic signal controller cabinets shall normally be installed on concrete bases in the location shown on the plans or as directed by the ENGINEER. The cabinet door shall face away from the street unless otherwise specified on the plans. Upon installation of a ground mounted controller cabinet, the necessary grout or caulking shall be placed between cabinet and concrete base to provide a weather-resistant, dust-tight installation.

429.4.2 Should the CONTRACTOR find it necessary at a certain traffic signal system installation to provide a controller cabinet which is too large to be mounted on the type mounting arrangement as shown on the plans, he shall immediately notify the ENGINEER that a mounting change is necessary. This notification shall be prior to the pouring of the base as shown on the plans. The CONTRACTOR shall provide the proper mounting hardware and mount the controller cabinet as directed by the ENGINEER.

429.4.3 No conduit entry shall be made into the side of the cabinet unless otherwise called for on the plans or approved by the ENGINEER.

429.4.4 TESTING

429.4.4.1 The CONTRACTOR shall have the controllers and cabinets, and any specified auxiliary equipment transported to Traffic Engineering Operations Division, Pino Yard, City of Albuquerque with appropriate written documentation including project identification, signal plan sheets, operator manuals, and transmittal letter. These items will be delivered no less than 60 days prior to the

ENGINEER's acceptance of compliance and the equipment will be tested for a minimum of 30 days of the 60 day period. The controller and cabinet furnished at this time shall be capable of operation with all load outputs and shall be complete in accordance with the plans, including any auxiliary equipment.

429.4.4.2 The controller may be subjected to inspection and testing as follows:

429.4.4.2.1 Visual inspection for compliance with contract requirements, arrangement of equipment, specified markings, and workmanship.

429.4.4.2.2 Operational Testing.

1. Specified phasing.
2. Various timings.
3. Indicators.
4. Pedestrian phasing.
5. Auxiliary functions and interconnects.
6. Flash mode.
7. All possible conflicts for fail safe.
8. Preemption interruption with every function and phase, when applicable.
9. Load switches at 1800 watts.
10. Interrupted power test.
11. Timings and operation at input voltage of 105 and 130 VAC.
12. Ambient temperature of 160 degrees F + 5 degrees F for a maximum period of 14 days.

429.4.4.2.3 The controller will be deemed to have failed to comply with these specifications if, as a result of the above mentioned tests, its operation or component parts are affected in any manner.

429.4.4.2.4 In the event of a component failure all testing will be stopped, and the CONTRACTOR will be so notified. It will then be the CONTRACTOR's responsibility to provide for the disposition or repair of the controller. The CONTRACTOR may submit new or repaired equipment for testing, and the ENGINEER will determine

the length of this new test period up to 30 days.

429.4.4.2.5 Upon notification of completion of the lab test and acceptance, the CONTRACTOR shall transport the controller and cabinet from the Pino Yard to the project site.

429.4.4.2.6 In addition to the lab tests, final acceptance of all controllers and cabinets shall occur as specified in Section 420 - General Clauses for Traffic Signal and Street Lighting Systems.

429.4.5 TURN ON

429.4.5.1 The turn on of all controllers and auxiliary equipment after installation shall be made only after the entire signal system has been inspected and approved by the ENGINEER and the Traffic Engineer. The CONTRACTOR shall give the ENGINEER, and the Traffic Engineer at least five (5) working days advanced written notice of the anticipated turn-on time. Personnel of Traffic Engineering Operations Division shall be present during turn on. The CONTRACTOR shall remove any conflicting traffic control signing as directed by the ENGINEER.

429.4.5.2 When called for on the plans, the CONTRACTOR shall arrange for a qualified manufacturer's representative to be present at the turn-on and/or to conduct a prepared school for new or special control equipment. The time and location shall be as specified on the plans.

429.4.6 MODIFICATIONS: Modifications and/or added equipment to an existing cabinet shall be made by a qualified signal manufacturer's representative. Cabinet wiring diagrams will be available at Traffic Engineering Operations Division, Pino Yard, City of Albuquerque or as noted on the plans. The proposed modifications to these wiring diagrams shall be returned and approved by the ENGINEER before any cabinet modification work is started. All work shall be inspected by the Traffic Engineer or his delegated representative(s) before the system is re-energized.

429.4.7 REMOVE AND RESET SIGNAL CONTROLLER: Remove and Reset Signal Controller. The CONTRACTOR shall disconnect existing signal controller from the existing controller cabinet, relocate the controller to the location shown on the plans, and reinstall the controller in a new or used controller cabinet.

429.4.8 REMOVE AND RESET SIGNAL CONTROLLER CABINET: The CONTRACTOR shall construct new foundations for the signal controller cabinet. The CONTRACTOR shall then remove existing signal

controller cabinet and relocate the signal controller cabinet to the new foundations. All field wiring including loop lead-in cables, power, pedestrian pushbuttons, and signals shall be reconnected to provide a complete and operational signal.

429.5 MEASUREMENT AND PAYMENT.

429.5.1 Traffic actuated controllers, system masters, four phase single ring controller cabinets, eight phase dual ring controller cabinets, including all associated auxiliary equipment, will be measured by the unit of each type specified, complete in place.

429.5.2 Removing and resetting signal controllers and cabinets will be measured by the unit of each type specified, complete in place.

429.5.3 The accepted quantities of traffic actuated controllers system masters, four phase single ring controller cabinets, eight phase dual ring controller cabinets and removing and resetting signal controllers and cabinets will be paid for at the contract unit price per unit of measurement for each of the pay items listed as shown on the bid proposal.

SECTION 430

REMOVAL OF TRAFFIC SIGNAL PRESSURE DETECTOR

430.1 GENERAL

The work covered by this section consists of furnishing all labor, equipment, materials, and incidentals necessary for the removal and disposal of existing traffic signal pressure detectors and removal and replacement of pavement, as specified herein.

430.2 REFERENCES

430.2.1 ASTM
D 1557

430.2.2 This publication:
SECTION 336
SECTION 343

430.3 MATERIALS

Replacement of pavement shall be with asphalt concrete as described in Section 336.

430.4 REMOVAL METHODS

430.4.1 Prior to removal CONTRACTOR shall verify with Traffic engineering that detector is inactive. Traffic signal pressure detectors shall be removed by means and methods such that no adjacent pavement to remain in place is damaged. At any intersection, only one detector on any leg shall be worked on at any one time.

430.4.2 Prior to removing the detector, the pavement shall be marked with smooth, horizontal lines a distance of six inches (6") around the perimeter of the concrete foundation. Then, the pavement shall be saw cut with a power saw along these lines to a depth sufficient to permit removal without damaging adjacent pavement. Any unnecessary irregular breaking caused by the CONTRACTOR shall be replaced at no additional expense to the City. Any irregular breakage regardless of the cause shall be trimmed back as required by the ENGINEER. After the cut is made, the pavement shall be removed around the perimeter of the detector according to Section 343.

430.4.3 Existing conduit shall then be disconnected and the detector removed by whatever means necessary so that adjacent pavement remains undamaged.

430.5 PAVEMENT REPLACEMENT

430.5.1 All loose and foreign material shall be removed and the base smoothed and compacted. Subbase material shall be placed and compacted to 95 percent of maximum density, as determined by ASTM D 1557. The top of the subbase material shall be 8 inches below the surface of the adjoining pavement.

430.5.2 If the adjacent pavement is asphaltic concrete, then the following procedure for pavement replacement shall apply. Asphalt tack coat shall then be applied. An asphalt concrete base course, 1500-lb. stability, shall be placed in maximum 4-inch lifts to within one and one-half inches of the surface of the adjacent pavement. A one and one-half inch asphalt concrete surface course, 1800-lb. stability, shall be placed over the base course to match the grade of the existing surface.

430.5.3 If the adjacent pavement is Portland cement concrete, pavement replacement shall meet the Standard Specifications for Portland Cement Concrete Pavement.

430.6 MEASUREMENT AND PAYMENT

The removal of pavement and pressure detector, disconnection of conduit, and placement of pavement materials, as specified shall be considered a complete construction item. Pay shall be made at the unit price per each detector, as specified in the Bid Proposal.

SECTION 431

BEACONS AND SPECIAL SIGNAL EQUIPMENT

431.1 GENERAL. This work shall consist of furnishing and installing intersection control and hazard identification beacons and other specialized signal equipment in compliance with the specifications, details shown on the plans, and Standard Drawings at the location shown on the plans, or as established by the ENGINEER.

431.2 REFERENCES.

431.2.1 American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications, Latest Edition

M133 Preservative and Pressure Treatment Process for Timber

431.2.2 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition

A123 Zinc Coating on Product Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Stripes

431.2.3 Manual on Uniform Traffic Control Devices (MUTCD), Latest Edition

431.2.4 National Electrical Code (NEC), Latest Edition

431.2.5 National Electric Manufacturers Association (NEMA) Standards, Latest Edition

431.2.6 This Publication, Latest Edition

SECTION 101 PORTLAND CEMENT CONCRETE

SECTION 102 STEEL REINFORCEMENT

SECTION 501 EXCAVATION AND BACKFILL FOR STRUCTURES

SECTION 701 TRENCHING, EXCAVATION, AND BACKFILL

431.3 MATERIALS.

431.3.1 BEACON ASSEMBLY: Beacon assemblies shall be single section, 12" lens, traffic signal assemblies in accordance to the requirements of Section 427 Signal Assemblies. Beacon assemblies shall normally display a flashing red or yellow indication as called for on the plans. Beacons shall be mounted on the specified support (Type I standard, sign support or span wire) as detailed on the plans. The mounting of beacons may be singly or in groups as required.

431.3.2 SPAN WIRE INSTALLATION: Span wire installments shall be a set of poles and guy wire support system over a roadway normally used for flashing beacons and temporary signals. Span wire installations shall include poles, guy wire, clamps, shackles, turnbuckles and all additional material listed on the plans.

431.3.2.1 POLES

431.3.2.1.1 Poles shall be free standing, steel strain poles, or timber poles capable of supporting the span and specified without noticeable bending.

431.3.2.1.1.1 STEEL STRAIN POLES: Strain poles shall be fabricated from round or octagonal, tapered steel tube of a length detailed on the plans and a wall thickness of 3 gauge (approx. 1/4 inch.) or thicker as required by the design span shown on the plans and an AASHTO 80 wind loading. The steel shall have a yield strength of 48,000 psi or greater. All strain poles shall be galvanized inside and out in accordance with ASTM A 123. The length and minimum top and bottom pole outer diameters shall be as called for on the plans.

431.3.2.1.1.2 TIMBER POLES: Timber poles shall be treated in accordance with the "equipments of AASHTO M-133. Poles shall be of the size called for on the plans and as a minimum shall be butt treated.

431.3.2.2 ANCHORS: The anchor base shall be designed to develop the maximum strength of the shaft. Anchor bolts shall be 1 1/2" diameter by 5'0" long with minimum tensile strength of 85,000 psi, or as called for on the plans. All anchor bolts shall be provided with two nuts and two washers each.

431.3.2.3 GUY STRAND WIRE: Guy strand wire (7-wire) shall be provided with an approximate weight of 273 lbs. per 1,000 feet and a minimum braking strength of 10,000 lbs.

431.3.3 FLASHER CONTROLLER.

431.3.3.1 FLASHER

431.3.3.1.1 The flasher unit shall be an alternating two-circuit (115 VAC), solid state plug-in type with a 20 amp or greater rating per circuit. The unit shall be designed to plug into a NEMA type.

431.3.3.1.2 All flasher units shall be fully solid state

with no moving parts. The unit shall utilize zero voltage switching with 50 percent on-time and a flash rate of 50 to 60 per minute. All flasher units shall be designed to operate at full capability from -30F to +160F ambient temperature.

431.3.3.2 CABINET.

431.3.3.2.1 The cabinet shall be a sturdy, cast or sheet aluminum housing with a hinged main door equipped with a lock for a police key. Two police keys shall be furnished with each cabinet. The cabinet shall be at least 12 inches by 10 inches by 6 inches deep or as required to house the specified equipment. All switches and controls shall be accessible through the front door.

431.3.3.2.2 The cabinets shall be designed for side-of-pole mounting unless otherwise shown on the plans. Access to the cabinet shall be through a hole located in the bottom and top, drilled and threaded to accept a 1 ½ inch GRC conduit, or as detailed on the plans. All cabinets shall be finished in accordance with Section 429 - Traffic Signal Controllers.

431.3.3.2.3 All cabinet wiring shall be neat and firm. All wiring and harnesses shall be laced or bound together with Ty wrap or equivalent. All terminals shall be numbered and identified in accordance with a cabinet wiring diagram which shall be furnished by the supplier. The flasher cabinet shall include the following terminals, protection devices and switches:

- a. Terminal (barrier type) for 115 VAC power feed.
- b. Main power supply circuit breaker,, 15 amp. min. rating.
- c. Terminals (barrier type) for field conductor to beacons, one for each circuit.
- d. Signal shutdown switch, not affecting clock power.
- e. Copper ground strip, grounded to cabinet, for connection of all common conductors.
- f. Terminal (barrier type) for time switch opening and closing as required.
- g. Radio line filter for filtering AC + power.
- h. Lighting arrester for filtering lighting or high voltages to ground for protection of equipment.

431.3.3.2.4 When specified, the flasher controller shall

include a time switch. The time switch shall be a weekly time clock, programmable for the on/off function at up to eight times a day and 40 times a week. The time clock shall have an available automatic daylight saving time correction. It shall be possible to vary or omit a day program. Programming shall be by keyboard and/or digital switches. Time of day and keyboard entered data shall be shown on an LED display. The clock shall have battery backup so that in the event of loss of AC power, time will be held a minimum of 48 hours at an accuracy of ± 0.005% or better. The time switch shall make it possible to turn the flashing field indications on or off on either a time of day basis or manually. The time clock unit shall be mounted on the back side of door.

431.4 CONSTRUCTION REQUIREMENTS.

431.4.1 Beacons and flasher controllers shall be mounted on the specified support as called for and detailed in the plans.

431.4.2 Installation of span wire poles including anchor bolts shall include the erection of poles as shown on the plans, installation of anchor bolts in a foundation, and leveling the pole. The foundation shall cure for a minimum of 7 days before the pole placement. Grout (4 inches minimum) shall be placed between anchor base and the top of the foundation after raking. The complete span wire shall be tensioned with the sag shown on the plans or as directed by the ENGINEER.

431.4.3 Required electrical cable shall be run inside the pole and extended through the top with standard weatherhead fittings if steel poles are used. Electrical cable shall be run inside galvanized rigid conduit along the outside of the pole if wooden poles are used.

431.4.4 When "temporary signal spans" for use during construction are called and there is not a signal controller available, the CONTRACTOR shall supply a signal controller.

431.4.5 When the plans call for temporary signal spans the CONTRACTOR shall remove the material on completion of the work. Temporary signal spans shall remain the property of the CONTRACTOR after removal unless otherwise specified on the plans.

431.5 MEASUREMENT AND PAYMENT.

431.5.1 Beacons and flasher controllers will be measured by the unit, complete in place.

431.5.2 Span wire installation will be measured by the lump sum including all items listed on the plans or as shown in the Standard Drawings complete in place.

431.5.3 Temporary Signal Spans will be measured by the lump sum including all items listed on the plans or as shown in the Standard Drawings, all adjustment work required during construction phases, and all electrical energy and maintenance costs, complete in place.

431.5.4 The accepted quantities of beacons, flasher controllers, signal spans, and temporary signal spans will be paid for at the contract unit price per unit of measurement for each of the pay items listed as shown on the bid proposal

SECTION 432

LUMINAIRES

432.1 GENERAL. This work shall consist of furnishing and installing luminaires on standards, bridge structures, or sign supports in compliance with the specifications, details shown on the plans, and Standard Drawings, at the locations shown on the plans, or as established by the ENGINEER.

432.2 REFERENCES.

431.2.1 American National Standards Institute (ANSI)
Standards, Latest Edition

RP8 Roadway Lighting (IES)

432.3 MATERIALS.

432.3.1 STREET LIGHT LUMINAIRE.

432.3.1.1 Street light luminaires shall be horizontal-burning cobra type with a 2-inch slipfitter on the house side for mounting on a Type V standard. The lamp type (metal halide, or high pressure sodium), lamp wattage, and line voltage shall be as specified on the plans or in the special provisions. The required ballasts shall be an integral part of the luminaire and shall be pre-wired to the lamp socket (may use quick disconnect plugs), requiring only connection to the power supply terminal (screw type).

432.3.1.2 Unless otherwise specified in the plans, all fixtures shall have full cutoff optics and shall have an ANSI/IES M-C-II distribution. Photometric data shall be submitted to the ENGINEER for approval.

432.3.1.3 Glassware shall be of the refractor type (unless otherwise specified in plans as a cutoff type) with inner and outer prisms for horizontal light control. Refractors shall be Borosilicate glass.

432.3.1.4 The refractor shall be mounted in a door-frame assembly which shall be hinged to the luminaire at the house side and fastened at the street side by means of an automatic latch.

432.3.1.5 The reflector shall be anodized aluminum, ALZAK, ALGLAS or approved equal treatment. The socket shall be of a high grade porcelain with both axial and vertical adjustment.

431.3.1.6 The reflector and lamp socket shall be secured to the upper housing. The refractor and doorframe assembly shall be forced upward at the street side by spring

pressure against a gasket seat when in the closed and latched position.

432.3.1.7 The ballast shall be an easily removable power pack connected by a quick disconnect plug. The ballast shall be accessed through a separate rear door not disturbing the sealed optical system, or through a single door, also accessing the optical system, when the ballast is mounted to a tray that is removable without the use of tools.

431.3.1.8 The slipfitter shall provide positive clamping on 1-1/4 or 2" pipe bracket. It shall also permit leveling of the luminaire on the horizontal ± 3 degrees.

431.3.1.9 Luminaires with full cutoff distributions shall utilize a shielded optical system that incorporates a specially designed reflector and a heat and impact resistant flatglass lens. The luminaire shall allow no light above 90° .

431.3.1.10 An individual photocell controller on the top of the housing, mounted inside or outside, shall be provided when specified on the plans or special provisions.

431.3.1.11 All gaskets shall be composed of a material capable of withstanding the temperature involved and shall be securely held in place. The housing and refractor ring shall be of die-cast aluminum. The latch and exposed hinge parts shall be manufactured from noncorrosive material.

431.3.1.12 When mounted on Bridge Deck, the pole shall be mounted on a vibration dampening pad and the fixture shall have a lamp stabilizer to reduce the potential for damage to the fixtures from vibration. The fixture shall be certified to withstand a 3G vibration test.

432.3.2 AREA LUMINAIRE: Area luminaires shall be decorative type luminaires mounted on Type IV standards. The general appearance, color, and electrical requirements shall be as detailed in the special provisions and/or plans. Unless otherwise specified, the luminaire shall provide a symmetrical light distribution.

432.3.3 UNDERPASS LUMINAIRE

432.3.3.1 Underpass luminaires shall be designed to mount directly on a wall with surface wiring or over a recessed outlet box, in conformance with details on the plans. The luminaire may be mounted by a flush outlet box stud or by three mounting bolts. Underpass luminaires shall be weatherproof, self-contained units with an integral

ballast. The luminaire shall consist of a die cast aluminum base housing, Borosilicate Prismatic Glass Refractor, hinged lens assembly and have a quality gasket between the door and housing.

432.3.3.2 The reflector shall be of anodized aluminum, ALZAK, ALGLAS, or approved equal. The aluminum reflector and socket shall be mounted rigidly to the housing.

432.3.3.3 Lamps shall be 150-watt high pressure sodium, ANSI Code S55 unless otherwise specified on the plans or in the special provisions.

432.3.3.4 Vandal protection shall be provided by either a cast aluminum grid guard or a Lexan shield over the refractor. The latches shall be tamper resistant.

432.3.3.5 The luminaire shall light an area one mounting height on either side of the fixture and two mounting heights in front.

432.3.4 BALLASTS.

432.3.4.1 GENERAL: Ballasts for high intensity discharge lamps shall be for the primary current and types of lamps specified on the plans and/or in the special provisions. Unless otherwise specified, the ballast shall be an integral part of the luminaire. All ballasts shall be designed to meet ANSI Specifications.

432.3.4.2.1 HIGH PRESSURE SODIUM BALLASTS

432.3.4.2.1.1 Ballasts for 250W and 400W high pressure sodium lamps shall have isolated primary and secondary lamp circuit windings. They shall have a Transient Impulse Level of 10 KV, voltage input range of + 10% and ballast loss of no more than 20%.

432.3.4.2.1.2 If the drawings specify a integrated circuit design ballast, it shall have isolated primary and secondary lamp circuit windings and transient impulse level of 10 KV. The voltage input range shall be + 13% and the lamp wattage regulation shall be 2%.

432.3.5 LAMPS

432.3.5.1 H.I.D. (high intensity discharge) lamps for luminaires shall conform to the following requirements:

HPS/ Wattage	Description (ANSI)	Min Initial Lumens	Min Rated Life (hrs)	Use
150	Clear (S55)	16,000	24,000	Underpass
250	Clear (S50)	27,500	24,000	Roadway
400	Clear (S51)	50,000	24,000	Roadway

432.3.5.2 Based on 10 hours per start. When less than 24,000 hrs., it is median value of life expectancy. When 24,000 +, 67% of lamps shall be expected to be burning at 24,000 hrs.

432.4 CONSTRUCTION REQUIREMENTS.

432.4.1 The CONTRACTOR shall properly align and level all luminaires in accordance with the manufacturer's and design requirements.

432.4.2 The installation of luminaires shall include two single conductors, #10 or as specified on the plans, to the standard pole base or nearest splice point into main distribution feed.

432.4.2.1 The installation of underpass luminaires shall include all conduit and wiring to the nearest pull box (splice point into the main distribution feed) and all necessary mounting devices.

432.4.2.2 The above specified wiring, conduit, mounting hardware and switches shall be considered part of the luminaire installation and no separate payment will be made therefor.

432.4 MEASUREMENT AND PAYMENT.

432.4.1 Luminaires will be measured by the unit, complete in place.

432.4.2 The accepted quantities of luminaires will be paid for at the contract unit price per unit of measurement for each of the pay items as shown on the bid proposal

SECTION 440

REFLECTORIZED PAINTED PAVEMENT MARKINGS

440.1 GENERAL: This work shall consist of furnishing and installing permanent and temporary reflectORIZED painted pavement markings in substantial compliance with the specifications and details shown on the plans, at the locations shown on the plans, or as established by the ENGINEER.

440.2 REFERENCES.

440.2.1 Manual on Uniform Traffic Control Devices (MUTCD), Latest Edition

440.3 MATERIALS.

440.3.1 TRAFFIC PAINT: Traffic paint shall conform to the requirements of the City of Albuquerque for White and Yellow Traffic Line Paints Used on Construction Projects (Combination Alkyd and Hypalon - Fast Dry Type).

440.3.2 GLASS BEADS: Glass reflectorizing beads shall conform to the requirements of the City of Albuquerque for Glass Beads.

440.3.3 TEMPORARY MARKING TAPE

440.3.3.1 Temporary adhesive marking tape shall consist of weather and traffic resistant yellow or white reflective marking material and shall conform to the following requirements:

440.3.3.1.1 DESCRIPTION: The adhesive pavement striping material shall consist of white or yellow reflective marking material on a conformable non-metallic backing coated with a pressure sensitive adhesive and designed for marking of bituminous or portland cement concrete surfaces.

440.3.3.1.2 COLOR: The color of the visible surface shall be either white or yellow in accordance with the MUTCD and shall closely match the color of the paint specified in this Section 440.

440.3.3.1.3 REFLECTANCE: The white and yellow markings shall have the following initial minimum reflectance values at 0.2 degree and 0.5 degree observation angles and 86 degrees entrance angle as measured in accordance with the testing procedure of Federal Test Method Standard 370 unless a higher value is specified on the plans.

TEMPORARY MARKING TAPE			
Minimum Retroreflectivity (Millicandelas Per Footcandle Per Square Foot)			
OA	EA	White	Yellow
0.2	86	1770	1310
0.5	86	1270	820

Where: OA = Observation Angle in Degrees

EA = Entrance Angle in Degrees

440.3.3.1.4 ADHESION: The material shall have a precoated pressure sensitive adhesive which does not require a liner for protection from contamination, pre-adhesion, or blocking within the roll. Said material shall show no appreciable loss of adhesion after application.

440.3.3.1.5 CONFORMABILITY: The material shall be flexible and formable, shall show no cracking, flaking, or loss of reflective elements and, following application, shall remain conformed to the texture of the pavement surface.

440.3.3.6.1 PHYSICAL PROPERTIES.

440.3.3.1.6.1 DIMENSIONS: The thickness of the adhesive marking tape for normal use, shall not be less than 10 mils and shall be provided in 4-inch or 6-inch width (plus or minus 1/16 inch) unless otherwise specified.

440.3.3.1.6.2 WEAR RESISTANCE: Wear resistance samples of the adhesive pavement striping material applied to standard specimen plates and tested in accordance with Federal Test Methods No. 141, Method 6192, using a CS-17 wheel and 1000 gram load shall not exhibit a significant change in color after 5000 cycles.

440.3.3.1.7 REMOVABILITY

440.3.3.1.7.1 Temporary adhesive pavement striping material shall be readily removable from the pavement by following the manufacturer's recommendations, unless otherwise specified.

440.3.3.1.7.2 Removal shall not require sandblasting, solvent or grinding methods and shall not result in objectionable staining of the pavement surface.

440.3.3.1.8 DURABILITY: The material shall be

weather resistant and show no appreciable fading, lifting, or shrinkage.

440.3.3.1.9 GENERAL

440.3.3.1.9.1 The materials as supplied shall be of good appearance and free from cracks, and the edge shall be true, straight, and unbroken.

440.3.3.1.9.2 The adhesive pavement striping material shall be packaged in accordance with accepted commercial standards, shall be stored at temperatures not to exceed 100 degrees Fahrenheit under normal conditions, and shall be suitable for use for a period of at least one (1) year after purchase.

440.3.4 ACCEPTANCE: Acceptance of traffic paint and temporary marking tape will be based upon receipt of certificates of compliance and documentation that the batch of paint and/or marking tape to be used has been tested by an independent laboratory and conforms with specifications.

440.4 CONSTRUCTION REQUIREMENTS.

440.4.1 GENERAL

440.4.1.1 The traffic paint, and beads shall be placed on the pavement by a spray type, self-propelled pavement marking machine, except that temporary striping during construction may be placed with other equipment designed for application of paint, or beads.

440.4.1.1.1 The machine shall be capable of applying a clear-cut 4-inch line or lines.

440.4.1.1.2 The machine shall be equipped with a mechanical device capable of placing a broken reflectorized centerline with a 10-foot painted segment and a 30-foot gap.

440.4.1.1.3.1 The machine shall be equipped with an air-operated glass bead drop-in dispenser controlled by the spray gun mechanism.

440.4.1.1.3.2 The dispenser shall be capable of placing the glass spheres into the paint line as the paint is applied to the pavement in such a manner as to provide satisfactory marking and delineation.

440.4.1.1.4.1 The volume of paint and glass beads in place shall be measured by the quantity per mile method. The CONTRACTOR shall provide certification of the volume of the paint and bead tanks. The CONTRACTOR shall strap the tanks prior to beginning striping operation and again after a mile has been striped. As an alternative,

the CONTRACTOR may externally mark the tanks indicating a volume equivalent to the tolerances shown in this Section 440 or have a calibrated rod marked with the equivalent volumes. The volumes shall be measured after a mile has been striped. At the option of the ENGINEER, if the striping machine is equipped with air atomized spray units, (not airless), and paint and bead gauges, the volume may be determined by utilizing said gauges.

440.4.1.1.4.2 The CONTRACTOR shall be required to restripe the roadway if 50% of the paint or beads is not placed on the roadway or if the ENGINEER determines that the striping is not adhering to the pavement or the glass beads are not adhering to the paint.

440.4.1.1.5 When paint has settled excessively, the CONTRACTOR shall redisperse the settled pigments at the bottom of the paint drums, with a mixing device, prior to pumping or loading paint into the striping unit so excess pigments are not left on the bottom of the paint drum. Thinner shall not be allowed to be pumped into the paint tanks. If the CONTRACTOR uses thinner to clean his equipment, the CONTRACTOR shall be responsible for disposing of all debris including, but not limited to, thinner at disposal sites approved by government agencies regulating the disposal of such materials.

440.4.2 PLACEMENT OF BEADS AND TRAFFIC PAINT.

440.4.2.1 Reflectorized painted markings for temporary use on final surfacing is prohibited. Pavement markings shall be applied during daylight hours when the pavement surface is dry and the weather is not foggy, rainy, excessively windy, or otherwise adverse to the application of markings. The surface shall be free from excess asphalt or other deleterious substances before traffic paint or beads are applied. The CONTRACTOR shall remove dirt, debris, grease, motor oils, rocks, or chips from the pavement surface before applying markings.

440.4.2.2 The CONTRACTOR shall provide the necessary personnel and equipment to divert traffic from the installation area where the work is in progress and during drying time. The CONTRACTOR shall submit a traffic control plan to the City's Construction Coordination Division for approval prior to the commencement of work. All damage to the pavement marking due to the CONTRACTOR's negligence or failure to maintain traffic control shall be repaired at the CONTRACTOR's expense.

440.4.2.3 Permanent reflectorized painted markings shall consist of two applications of markings. For painted markings on new pavement the second application of

markings shall be placed no sooner than twenty-one days after placement of the first application of markings as directed by the ENGINEER.

440.4.2.4 If paint is not adhering to the pavement or if the glass beads are not adhering to the paint, or if the second application of pavement markings are not placed over the first application of markings in accordance with this Section 440, the CONTRACTOR will be required to remove the striping, and to restripe the roadway.

440.4.3 TOLERANCE FOR PLACING PAINT AND BEADS

440.4.3.1 The finished line shall be smooth, aesthetically acceptable and free from undue waviness.

440.4.3.2 Painted lines shall be 4, 8, or 12 inches wide as shown on the plans with a tolerance of plus or minus 1/8 inch and shall be placed at a minimum rate of 19.75 gallons of paint per mile for a solid 4-inch line and 4.94 gallons per mile for a broken 4-inch line, based on a 10-foot stripe and a 30-foot gap (40-foot cycle). Other widths of striping shall be applied at the minimum rate that is the equivalent multiple of the above.

440.4.3.3 The length of painted segment and gap shall not vary more than six (6) inches in a 40-foot cycle.

440.4.3.4 The following transverse gap dimension between centerline stripes for two (2) and three (3) stripe combinations reflect a three (3) paint gun set up on the striping unit. The broken line shall be placed on the centerline of the roadway with the respective left and right no passing zones placed so a two (2) inch gap exists between the broken and no passing zone stripe. There shall be an eight (8) inch gap between the double yellow markings for no passing zones.

440.4.3.5 Glass reflectorizing beads shall be applied on the wet paint at a minimum rate of six (6) pounds to each gallon of paint. This translates into a minimum weight of beads of 29.6 lbs. per mile of broken line and 118.5 lbs. per mile of solid line.

440.4.4 PLACING TEMPORARY ADHESIVE MARKING TAPE.

440.4.4.1 Adhesive tape marking materials shall be applied as follows:

440.4.4.1.1 The CONTRACTOR shall provide the necessary Personnel and equipment to warn and divert traffic during installation and removal from the area where

the work is in progress as approved by the ENGINEER. The surface to which the tape is applied shall be dry and free of oils, grease, dust, dirt and other deleterious substances and shall be primed with a primer material which is recommended by the manufacturer of the tape.

440.4.4.1.2 The tape shall be rolled or tamped down immediately after application until it adheres properly and conforms to the surface of the pavement in accordance with the manufactures recommendation.

440.4.4.1.3 Where striping is continuous, there will be no more than 3 splices per 120 feet of length.

440.4.5 REMOVAL OF TEMPORARY PAVEMENT MARKINGS

440.4.5.1 TEMPORARY ADHESIVE MARKING TAPE: All temporary pavement markings placed on the final pavement surface shall be removed by the CONTRACTOR when such temporary pavement markings are no longer required for traffic control as determined by the ENGINEER. Where temporary pavement markings, which are to be removed, consist of adhesive marking tape, the removal shall be complete with no segments or pieces of tape remaining on the pavement. The use of non-reflective black adhesive marking tape to obliterate temporary pavement markings will not be permitted. Overpainting is not an acceptable method.

440.4.5.2 REFLECTORIZED PAINTED MARKINGS: ReflectORIZED painted markings for temporary use on final surfacing is prohibited. ReflectORIZED painted markings when used for temporary pavement markings shall be removed where required by traffic control plan in accordance with the provisions of Section 443 - Pavement Marking Removal.

440.4.6 COMPLIANCE WITH MUTCD: All reflectORIZED painted markings and temporary adhesive marking tape shall conform to the Manual on Uniform Traffic Control Devices (MUTCD).

440.5 MEASUREMENT AND PAYMENT.

440.5.1 ReflectORIZED painted markings will be measured by the linear foot of 4-inch width, complete in place.

440.5.2 Temporary adhesive marking tape will be measured by the linear foot of 4-inch width, complete in place.

440.5.3 Removal of adhesive marking tape will not be measured.

440.5.4 Removal of reflectorized painted markings will be measured by the linear foot of 4-inch width, complete in place, in accordance with the provisions of Section 443 - Pavement Marking Removal.

440.5.5 The accepted quantities of reflectorized painted markings and temporary adhesive marking tape will be paid for at the contract unit price per unit of measurement for each of the pay items as shown on the bid proposal. The removal of reflectorized painted markings will be paid in accordance with the provisions of Section 443 - Pavement Marking Removal.

SECTION 441

RETROREFLECTIVE PREFORMED PLASTIC PAVEMENT MARKINGS

441.1 GENERAL: This work shall consist of furnishing and installing retroreflective preformed plastic pavement symbols, legends, stripes and markings in compliance with the specifications and the details shown on the plans at the locations shown on the plans, or as established by the ENGINEER.

441.2 REFERENCES

441.2.1 American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications, Latest Edition

441.2.2 American Society for Testing and Materials (ASTM), Latest Edition

441.2.3 Manual on Uniform Traffic Control Devices (MUTCD), Latest Edition

441.3 MATERIALS.

441.3.1 RETROREFLECTIVE PREFORMED PLASTIC PAVEMENT MARKING MATERIAL

441.3.1.1 Retroreflective preformed plastic pavement marking material shall consist of white or yellow weather-resistant reflective film conforming to the requirements set forth herein. The material shall be manufactured and packaged in such a manner as to permit storage at normal shelf temperature for a period of not less than two years from date of purchase. Prefabricated legends and symbols shall conform to the applicable shapes, sizes, and color as outlined in the Manual on Uniform Traffic Control Devices.

441.3.1.1.1 COMPOSITION: The retroreflective preformed plastic markings shall consist of high-quality plastic materials, pigments, and 1.5 index glass beads uniformly distributed throughout their cross-sectional area, with a reflective layer of beads embedded in the top surface. Materials will be furnished with the appropriate adhesive system recommended by the manufacturer for successful installation.

441.3.1.1.2 SKID RESISTANCE: The surface of the retroreflective preformed plastic marking material shall provide a minimum skid resistance value of 50 BPN when tested according to ASTM E 303-667.

441.3.1.1.3 COLOR: The retroreflective preformed

plastic marking material shall be white or yellow in accordance with MUTCD unless otherwise specified.

441.3.1.1.4 THICKNESS: The thickness of the retroreflective preformed plastic marking material without adhesive shall be 60 mils (0.06").

441.3.1.1.5 DURABILITY AND WEAR RESISTANCE: The retroreflective preformed plastic pavement marking material, when properly applied, shall provide a neat, durable marking. The preformed plastic marking material shall provide a cushioned resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting, or shrinkage within three years after installation, and shall show no significant tearing, rollback, or other signs of poor adhesion.

441.3.1.1.6 CONFORMABILITY AND RESEALING: The retroreflective preformed plastic marking material shall be capable of conforming to pavement contours, breaks, faults, etc., through the action of traffic at normal pavement temperatures. The film shall have resealing characteristics such that it is capable of fusing with itself and previously applied marking film of the same composition under normal conditions of use.

441.3.1.1.7 TENSILE STRENGTH: Retroreflective preformed plastic marking material shall have a minimum tensile strength of 40 pounds per square inch of cross section when tested according to ASTM D 638. A test specimen six (6) inches by one (1) inch by 0.06 inch minimum thickness shall be tested at a temperature range of 70 to 80 degrees F using a jaw speed of 0.25 inch per minute.

441.3.1.1.8 ELONGATION: Retroreflective preformed plastic marking material shall have a minimum elongation of 50% when tested in accordance with ASTM D 638.

441.3.1.1.9 PLASTIC PULL TEST: Retroreflective preformed plastic marking material shall support a dead weight of four pounds for not less than five minutes at a temperature range of 70 to 80 degrees F. Test specimen size shall be six (6) inches by one (1) inch by 0.06 inch minimum thickness.

441.3.1.1.10 PIGMENTATION: The pigment for retroreflective preformed plastic marking material shall be selected and blended to provide a plastic which is white or

yellow conforming to the Manual on Uniform Traffic Control Devices through the expected life of the pavement marking plastic.

441.3.1.1.11 GLASS BEADS

441.3.1.1.11.1 The glass beads for retroreflective preformed plastic marking material shall be colorless and have a minimum index of refraction of 1.50 when tested using the liquid oil immersion method. The size and quality of the beads will be such that performance requirements shall be met.

441.3.1.1.11.2 The retroreflective preformed plastic marking material shall have glass retention qualities such that when a two (2) inch by six (6) inch specimen is bent over a ½ inch diameter mandrel with the two (2) inch dimension perpendicular to the mandrel axis, a microscopic examination of the area on the mandrel shall show no more than 10% of the beads with entrapment by the binder of less than 40%.

441.3.1.1.11.3 Bead adhesion shall be such that beads are not easily removed when the film surface is scratched firmly with a thumbnail.

441.3.1.1.11.4 Applied as per manufacturer's recommendations, retroreflective preformed plastic marking material shall have an effective performance life of up to three years.

441.3.2 ACCEPTANCE: Acceptance of retroreflective preformed plastic pavement marking material will be based upon receipt of certificates of compliance and documentation that the material has been tested by an independent laboratory and conforms with specifications.

441.4 CONSTRUCTION REQUIREMENTS.

441.4.1 The retroreflective preformed plastic pavement symbols, legends, stripes and marking shall be applied to the asphaltic and/or portland cement concrete pavement at the locations shown on the plans or as designated by the ENGINEER.

441.4.2 The asphaltic and/or portland cement concrete pavement surface shall be clean and free of moisture, soil or other deleterious substances. A brooming or compressed air method shall be utilized to clean the pavement surface.

441.4.3 If inlayed material is required in the plans, the reflectorized plastic marker material shall be applied to the roadway surface following the placement of bituminous pavement and before final rolling is completed at the

locations shown on the plans or as designated by the ENGINEER.

441.4.4 Hot plastic retroreflective pavement marking will be considered by Traffic Engineering Operations Division as a substitute for cold plastic provided that installation is carried out per the manufacturer's specifications. Hot plastic shall be a minimum of 90 mil thickness for lane lines and 125 mil for transverse lines. Ten pound drop-on glass beads per 100 sq. ft. is required. All markings shall be alkylid thermoplastic.

441.4.5 CONTRACTOR shall remove all conflicting existing pavement markings.

441.4.6 When designated on the plans, the CONTRACTOR shall provide temporary lane delineation by placing a twelve (12) inch long strip of four (4) inch wide plastic temporary lane marking, forty (40) feet on center, on each new lift of asphalt surfacing including temporary asphalt connections, asphalt treated base course, asphaltic concrete base course, and asphaltic concrete surface course to cover a lapse in time before the final surfacing course and final striping is placed. After final striping is placed, any temporary lane lines remaining on the final surface course shall be removed.

441.4.7 COMPLIANCE WITH MUTCD: All retroreflective preformed plastic pavement markings shall conform to the Manual on Uniform Traffic Control Devices.

441.5 MEASUREMENT AND PAYMENT.

441.5.1 The retroreflective preformed plastic pavement stripes will be measured by the linear foot of either 4-inch, 8-inch, 12-inch, or 24-inch width, complete in place.

441.5.2 The retroreflective preformed plastic pavement cross walks will be measured by the linear foot of 8-inch width, complete in place.

441.5.3 The retroreflective preformed plastic pavement stop bars will be measured by the linear foot of 12-inch width, complete in place.

441.5.4 The retroreflective preformed plastic pavement symbols, legends and markings will be measured per unit, complete in place.

441.5.5 The retroreflective preformed plastic pavement temporary lane lines will be measured by the linear foot of 4-inch width, complete in place.

441.5.6 The accepted quantities of retroreflective

preformed plastic pavement stripes, stop bars, symbols, legends and temporary lane lines will be paid for at the contract unit price per unit of measurement for each of the pay items listed as shown on the bid proposal

SECTION 443

PAVEMENT MARKING REMOVAL

443.1 GENERAL. This work consists of the removal of pavement stripes and other pavement markings composed of paint, thermoplastics, scotch tape, vinyl pads, calcined flint, or spray plastic by water blasting or surface planning, or as approved by the ENGINEER.

443.2 EQUIPMENT: The CONTRACTOR shall furnish all equipment required to complete the removal of existing pavement markings identified in the plans per this section.

443.3 CONSTRUCTION REQUIREMENTS.

443.3.1 MARKING REMOVAL: Existing markings may be removed by either water blasting or surface planning, or as approved by the ENGINEER.

443.3.2 ERADICATION: Existing markings identified to be removed shall be completely obliterated to a maximum depth of .25 inches and for a width equal to two times the width of the stripe or marking to be removed.

443.3.3 CONFLICTING MARKINGS: Should the pavement marking removal operation result in a scaring of the roadway surface greater than .25 inches or a condition in which the removed marking could be interpreted to be, due to the scaring of the roadway surface, a active pavement marking, the CONTRACTOR shall patch the roadway surface so that area effected by the marking removal is similar to the surrounding pavement. Areas considered to be conflicting with roadway markings shall be determined by the ENGINEER. The CONTRACTOR shall submit a plan identifying the method of patching to the ENGINEER for approval.

443.3.4 The CONTRACTOR shall submit a traffic control plan to the City's Construction Coordination Division for approval prior to the commencement of work.

443.3.5 The CONTRACTOR shall remove and dispose of all debris arising from the stripe or pavement marking removal operation as directed by the ENGINEER.

443.4 MEASUREMENT AND PAYMENT.

443.4.1.1 Removal of pavement stripe will be measured

by the linear foot, complete.

443.4.1.2 Removal of pavement marking composed of thermoplastics, vinyl pads, calcined flint to spray plastic will be measured by the square foot, complete.

443.4.2 Patching of pavement to eliminate conflicts between the scared pavement and permanent striping shall be considered incidental to the cost associated with marking removal. CONTRACTOR shall conduct pavement marking removal operation as to minimize the need for pavement patching.

SECTION 450

TRAFFIC SIGNS AND SIGN STRUCTURES

450.1 GENERAL: This work shall consist of furnishing and installing traffic signs and sign structures in compliance with the specifications and details shown on the plans at the locations shown on the plans, or as established by the ENGINEER.

450.2 REFERENCES

450.2.1 Aluminum Association Standards, Latest Edition

450.2.2 American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications, Latest Edition

M120 Zinc (ASTM B6)

450.2.3 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition

A123 Zinc (Hot Galvanized) on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips

A525 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

B209 Aluminum and Aluminum-Alloy Sheet & Plate

B545 Electrodeposited Coatings of Tin

E97 Directional Reflectance of Opaque Specimens by Fiber Photometry

450.2.4 Federal Highway Administration (FHWA) Standards, Latest Edition

Highway Signs Color Specifications

450.2.5 Government Services Administration (GSA) Standards, Latest Edition

450.2.6 Manual on Uniform Traffic Control Devices (MUTCD), Latest Edition

450.2.7 This Publication, Latest Edition

450.2.8 United States Standards, Latest Edition

Product Standard for Construction and Industrial Plywood

450.3 MATERIALS.

450.3.1 GENERAL: Materials shall be manufactured in conformity with the requirement of GSA L-S-300C and ASTM Standards.

450.3.2 RETROREFLECTIVE SHEETING.

450.3.2.1 The CONTRACTOR shall provide certification that retroreflective sheeting complies with the requirements of GSA L-S-300C. Retroreflective sheeting shall consist of a smooth, flat exterior film with retroreflective elements having a uniform homogeneous appearance. The sheeting shall be weather resistant and shall have a protected pre-coated adhesive backing.

450.3.2.2 COLORS

450.3.2.2.1 The diffuse day color of the retroreflective sheeting shall conform to the requirements of Table I of GSA L-S-300C and shall be determined in accordance with ASTM E 97 Standard Method of Test for 45-Deg., 0-Deg. Directional Reflectance of Opaque Specimens by Filter Photometry. (Geometric characteristics must be confined to illumination incident with 10° of, and centered about, a direction of 45° from the perpendicular to the test surface; viewing is within 15° of and centered about the perpendicular to the test surface. Conditions of illumination and observation must not be interchanged.) The standards to be used for reference shall be the Musnell Papers designated in Table 1. Papers shall have been recently calibrated on a spectrophotometer.

450.3.2.2.2 The test instrument shall be one of the following:

1. Advanced retrotechnology Model G920.
2. Gardner Multipurpose Reflectometer or Model XL20 and XL23 color and color difference meter

450.3.2.2.3 Colors shall be matched visually and shall be within the limits shown on the Color Tolerance Charts issued by the Federal Highway Administration, Office of Traffic Operations. The CONTRACTOR shall provide certification that the diffuse day color of the reflective sheeting will conform to the requirements of GSA L-S-300C, Table I, determined in accordance with the requirements of ASTM E 97.

450.3.2.2.4 If a dispute arises about the results of instrumental testing using diffuse lighting and unidirectional

viewing, acceptance of the material will be based on the results of the visual test using the appropriate color tolerance chart. Daytime color and nighttime color shall conform to the Standard Highway Signs Color Specification issued by FHWA.

450.3.2.3 SPECIFIC INTENSITY

450.3.2.3.1 The sign faces shall have the minimum specific intensity per unit area (SIA) values at 0.2° and 0.5° observation (divergence) angles expressed as average candlepower per footcandle per square foot (candles per lux per square meter) of material as shown in Tables 1, 2, 3, 4, 5, and 6. Measurements shall be conducted in accordance with photoelectric testing procedures for reflective sheeting as provided in paragraph 4.4.7 of GSA L-S-300C and paragraph 441.02(a) of FHWA Specification FP-85.

450.3.2.3.2 Measurements shall be made with the entrance (incidence) and observation angles positioned in the same place.

TABLE 1
Type II Sheeting (Enclosed Lens)

MINIMUM REFLECTIVITY
(Average Candlepower Per Footcandle Per Square Foot)

OA	EA	Wht	Or	Yel	Red	Grn	Blu	Bm
0.2	-4	70. 0	25. 0	50. 0	14. 5	9.0	4.0	1.0
0.2	30	30. 0	7.0	22. 0	6.0	3.5	1.7	0.3
0.5	-4	30. 0	13. 5	25. 0	7.5	4.5	2.0	0.3
0.5	30	15. 0	4.0	13. 0	3.0	2.2	0.8	0.2

Where OA = Observation Angle in Degrees

EA = Entrance Angle in Degrees

Wht = White Or = Orange Yel = Yellow

Grn = Green Blu = Blue Bm = Brown

TABLE 2
Type II-A Sheeting (Enclosed Lens)

MINIMUM REFLECTIVITY
(Average Candlepower Per Footcandle Per Square Foot)

OA	EA	Wht	Or	Yel	Red	Grn	Blu	Bm
0.2	-4	140 .	60. 0	100 .	30. 0	30. 0	10. 0	5.0
0.2	30	60. 0	22. 0	36. 0	12. 0	10. 0	4.0	2.0
0.5	-4	50. 0	20. 0	33. 0	10. 0	9.0	3.0	2.0
0.5	30	28. 0	12. 0	20. 0	6.0	6.0	2.0	1.0

Where OA = Observation Angle in Degrees

EA = Entrance Angle in Degrees

Wht = White Or = Orange Yel = Yellow

Grn = Green Blu = Blue Bm = Brown

TABLE 3
Type III Sheeting (Encapsulated Lens)

MINIMUM REFLECTIVITY
(Average Candlepower Per Footcandle Per Square Foot)

OA	EA	Wht	Or	Yel	Red	Grn	Blu	Bm
0.2	-4	250	100	170	45	45	20	12
0.2	30	150	60	100	25	25	11	8.5
0.5	-4	95	30	62	15	15	7.5	5
0.5	30	65	25	45	10	10	5	3.5

Where OA = Observation Angle in Degrees

EA = Entrance Angle in Degrees

Wht = White Or = Orange Yel = Yellow

Grn = Green Blu = Blue Bm = Brown

450.3.2.4 RETROREFLECTIVE SHEETING
ADHESIVE: Retroreflective sheeting shall include a pre-coated pressure sensitive adhesive (GSA L-S-300C, Class I) or a tack free, heat activated adhesive (GSA L-S-300C, Class II), either of which can be applied without necessity of additional adhesive coats on the sheeting or application surface. The protective liner attached to the adhesive backing shall be removable by peeling without soaking in water or other solvent and shall be easily removed after accelerated storage for four (4) hours at 150 degrees F under weight of 2.5 pounds per square inch. During removal, the liner shall not break, tear, nor adhesive be removed.

450.3.2.5 RETROREFLECTIVE SHEETING DURABILITY AND WORKMANSHIP

450.3.2.5.1 Retroreflective sheeting shall have sufficient strength and flexibility to be handled, processed, and applied according to the recommendations of the sheeting manufacturer without appreciable stretching. When processed and applied in accordance with recommended procedures, retroreflective material shall be weather resistant and following cleaning shall show no appreciable discoloration, cracking, crazing, blistering, or dimensional change. Retroreflective material, when exposed to normal traffic and weather, shall not support fungus growth or accumulate dirt to the extent that the retroreflective brightness before cleaning is less than 75 percent of the retroreflective brightness after cleaning, when measured at 0.2° divergence and -4° incidence. The sheeting surface shall be readily refurbished by cleaning and clear overcoating in accordance with the manufacturer's recommendations.

450.3.2.5.2 Retroreflective sheeting shall be applied to properly treated substrate as recommended by the sheeting manufacturer. Paints and sealers shall be dry before succeeding coats are applied and before packaging. Finished signs shall show careful workmanship and have a smooth and uniform surface. All letters and numbers shall be clean-cut and sharp.

450.3.2.5.3 The sheeting surface of Type II and Type II-A sheeting shall be solvent resistant to gasoline, VM&P naphtha, mineral spirits, turpentine and methanol.

450.3.2.5.4 The sheeting surface of Type III A, B, C and Type IV, sheeting shall be solvent resistant such that it can be cleaned with a soft, clean cloth dampened with VM&P naphtha or mineral spirits.

450.3.2.6 RETROREFLECTIVE SHEETING DELIVERY AND HANDLING: Retroreflective sheeting shall be delivered in good condition and shall have a good appearance, free from ragged edges, cracks, and extraneous materials. When retroreflective sheeting is furnished in continuous rolls, splices shall be smooth with no discernible line of demarcation, and the sheeting shall be suitable for continuous application. Retroreflective sheeting shall be packaged so that no damage or defacement can occur during shipment or storage. Sheeting shall be used within the time frame recommended by the manufacturer.

450.3.2.7 MULTIPLE PIECES OF SIGN SHEETING: Sign faces comprising two (2) or more pieces or panels of retroreflective sheeting shall match in color and provide uniform appearance and brilliance by day and night. The

entire face of each sign panel shall be covered with one (1) unspliced sheet of retroreflective sheeting, except that splicing is permissible where the substrate panel exceeds 48 inches in vertical dimension. No vertical splicing of sheeting shall be used. Materials shall be color-matched and the top piece shall overlap the bottom by a minimum of ½ inch in order to eliminate water penetration.

450.3.2.8 SCREENING INKS AND PROCESS PASTE

450.3.2.8.1 Unless otherwise prohibited, screening inks, process pastes or film overlays can be used, in lieu of manufactured colors at the option of the sign manufacturer, to produce both the legend and background. Only the film overlays or screened colors of green, blue, red, brown and black may be used. Only those screening inks, process pastes or film overlays recommended by the retroreflective sheeting manufacturer shall be used. Said recommendations shall be obtained in writing and a copy filed in accordance with the requirements of this Section 450.

450.3.2.8.1.1 OUTDOOR WEATHERABILITY: The outdoor weatherability of the applied screening inks, process paste or film overlay shall be comparable to the outdoor durability of the retroreflective sheeting.

450.3.2.8.1.2 ADHERENCE: No screening inks, process pastes or film overlay shall be removed when tested by applying cellophane tape over a properly cured, color processed area and removing the tape with one quick motion. The tape shall be 3/4 inch wide 3M Company Scotch Brand Cellophane Tape No. 600, or approved equal.

450.3.2.8.1.3 SOLVENT RESISTANCE: After proper curing, screened sign faces shall be solvent resistant to cleaning solvents recommended by the manufacturer of the retroreflective sheeting and the screening inks, process pastes, and film overlay.

450.3.2.8.1.4 VANDAL RESISTANCE: Screened sign faces shall be resistant to aromatic type solvents. The process and materials used shall be as recommended by the manufacturers of the retroreflective sheeting, screening inks, process pastes, and film overlay in order to facilitate the removal of paints or other oil based matter sprayed or painted on signs.

450.3.2.8.1.5 COLOR: The color of the screened sign faces surface as specified shall meet all applicable requirements and shall conform to the Standard Highway Signs Color Specification issued by the FHWA.

450.3.2.8.1.6 RETROREFLECTIVE INTENSITY (Transparent Colors)

450.3.2.8.1.6.1 Transparent colored inks or transparent colored film overlays shall be processed and applied in accordance with the recommendations of the sheeting manufacturer.

450.3.2.8.1.6.2 The minimum retroreflective intensity value of the transparent color area processed on white sheeting shall be not less than those specified below in Table 7, 8, 9, 10, 11 and 12 for each color at 0.2 degrees observation and -4 degrees entrance angles, expressed in candelas per footcandle per square foot of processed area.

450.3.2.8.1.7 PROCESS COLORS ON SHEETING.

TABLE 4
Type II Retroreflective Intensity

Process Color on Type II Enclosed Lens Sheeting
(White Reflective Sheeting Per Retroreflective Intensity Value)

(Candelas Per Footcandle Per Square Foot)

RED	BLUE	GREEN
10	3	6

TABLE 5
Type II Retroreflective Intensity

Process Color on Type II-A Enclosed Lens Sheeting
(White Reflective Sheeting Per Retroreflective Intensity Value)

(Candelas Per Footcandle Per Square Foot)

RED	BLUE	GREEN
21	7	21

TABLE 6
Type III-A Retroreflective Intensity

Process Color on Type III-A Enclosed Lens Sheeting
(White Reflective Sheeting Per Retroreflective Intensity Value)

(Candelas Per Footcandle Per Square Foot)

RED	BLUE	GREEN
31.5	14	31.5

TABLE 7
Type III-B Retroreflective Intensity

Process Color on Type III-B Enclosed Lens Sheeting
(White Reflective Sheeting Per Retroreflective Intensity Value)

(Candelas Per Footcandle Per Square Foot)

RED	BLUE	GREEN
31.5	14	31.5

TABLE 8
Type III-C Retroreflective Intensity

Process Color on Type III-C Enclosed Lens Sheeting
(White Reflective Sheeting Per Retroreflective Intensity Value)

(Candelas Per Footcandle Per Square Foot)

RED	BLUE	GREEN
24.5	14	24.5

TABLE 9
Type IV Retroreflective Intensity

Process Color on Type IV Enclosed Lens Sheeting
(White Reflective Sheeting Per Retroreflective Intensity Value)

(Candelas Per Footcandle Per Square Foot)

RED	BLUE	GREEN
24.5	14	24.5

TABLE 10

Min. Color Contrast Ratios of Fully Reflectorized Sign
(For Information Only)

Sheeting Type	White/ Red	White/ Green	White/ Blue	White/ Brown
II	5:1	8:1	17:1	70:1
IIA	5:1	5:1	14:1	25:1
III	6:1	6:1	13:1	18:1

450.3.3 SIGN LEGENDS AND SHEETING.

450.3.3.1 The word "legend" used herein and on the plans indicates all letters, numerals, symbols, arrows,

borders, or other accessories that contain and convey the sign message and shall be either a sign sheeting with integral, semi-rigid, 0.005 inch minimum thickness aluminum backing, or sign sheeting applied to a demountable 0.030 inch minimum thickness 6061-T6 or 5052-H38 aluminum alloy; or approved self-adhering machine cut sheeting. Retroreflective sheeting for legends including letters, numerals, symbols, borders and route markers, shall be white as specified in Table 3 of this Section 450. Legends shall conform with the details shown on the plans and the provisions of MUTCD. Color, reflectorization, and configuration of legends shall be as shown on the plans and herein provided:

450.3.3.1.1 PLYWOOD AND ALUMINUM SIGNS: The legend may be a sign sheeting with integral, semi-rigid 0.005 inch and minimum thickness aluminum backing; or sign sheeting applied to demountable 0.030 inch minimum thickness 6061-T6 or 5052-H38 aluminum alloy; or approved self adhering; machine cut sheeting as specified in Table 3 of this Section 450; or reverse screened using a weatherproof screen process enamel that is compatible with the background and that will provide the designated colors and reflectorization of the sign; or reverse film overlaid with an approved film overlay. These legends shall be applied edge sealed, reverse screened, clear coated, and finished as applicable, as recommended by the manufacturer of the retroreflective sheeting.

450.2.4 SIGN BACKGROUNDS

450.3.4.1 Color and configuration of sign backgrounds shall be as shown on the plans. The sign face shall provide a plane surface free from warps, dents, burrs, mars, or other defects resulting from fabrication, shipment, storage, or installation. The entire sign face may be rejected because of any of these defects or because of dirty, marred, or defective background or legend. Completed sign faces mounted in place will be inspected at night.

450.3.4.1.1 Plywood and aluminum signs shall be surfaced with Type II sheeting as specified in Table 1 of this Section 450.

450.2.5 PLYWOOD PANEL SIGNS

450.3.5.1 Plywood shall be classed as group 1, 5/8 inch thick, 5 ply, grade B-B or better, high density overlay on both sides, exterior type plywood conforming to the requirements of the current U.S. Product Standard for Construction and Industrial Plywood marked with a trademark by an approved testing agency, or Canadian Standards Association, bearing legible grade marking of the American Plywood Association or the Canadian Council of

Forest Industries.

450.3.5.1.1 Edges shall be finished to produce a smooth surface without holes. All edges and corners of the sign panels shall be rounded to eliminate edge sharpness and chipping. All edges shall receive two thick coats of exterior type, polysilicone alkyd resin base enamel paint or one thick coat of ready-mixed polysilicone alkyd resin primer followed by one thick coat of polysilicone alkyd resin base enamel. The paint must be thick enough so the individual plys are not visible. The first coat of paint or primer shall be either white or yellow and the second coat shall be either brown or black.

450.3.5.1.2 All painting shall be completed before the retroreflective sheeting is placed.

450.3.5.1.3 The plywood sign blank shall be prepared for retroreflective sheeting as specified by the facing material manufacturer. Retroreflective sheeting, legend and clear coat, shall be applied in accordance with manufacturer's recommendations, this Section 450. Hardware for mounting plywood panel signs shall comply with the requirements of this Section 450.

450.2.6 ALUMINUM PANEL SIGNS.

450.2.6.1 Aluminum panel signs under 24 inches in width shall be 0.080-inch minimum thickness 6061-T6 or 6062-H38 aluminum alloy. Aluminum panel signs 24 inches and over in width shall be 0.125-inch minimum thickness 6061-T6 or 5052-H38 aluminum alloy. All aluminum alloys shall conform to the requirements of ASTM B 209 and shall be supplied as flat stock material. All aluminum panel signs shall have smooth edges and corners.

450.3.6.2 The aluminum sign blank shall be prepared for retroreflective sheeting as specified by the facing material manufacturer. Retroreflective sheeting, legend, and clear coat, shall be applied in accordance with manufacturer's recommendations, this Section 450 Retroreflective Sheeting and this Section 450 Sign Legends and Sheeting. A copy of the manufacturers recommendations shall be kept on file as specified in this Section 450 for review by the ENGINEER during the periodic inspections of the manufacture's sign shop. The aluminum sign panel shall have a square punched hole to receive a carriage bolt or a lock washer for use with a carriage bolt and tamper proof nut. Hardware for mounting aluminum panel signs shall comply with the requirements of this Section 450, Sign Structures and Hardware.

450.3.7 SIGN STRUCTURES AND HARDWARE

450.3.7.1 Steel posts and base posts for plywood or aluminum panel signs shall be of the dimensions and cross section shown on the plans. Steel posts and base posts shall either be finished by one of the following methods:

450.3.7.1.1 Hot dipped galvanized in accordance with the requirements of ASTM A 525 or ASTM A 123;

450.3.7.1.2 Hot dip galvanized zinc coating in accordance with the requirements of AASHTO M 120, followed by a chromate conversion coating and a cross-linked polyurethane acrylic exterior coating;

450.3.7.1.3 Painted with a green paint meeting the requirements of GSA 595-A, (Color No. 14109). Said green paint shall be a minimum of one (1) mil in thickness.

450.3.7.2 Hardware for post assembly shall be hot dipped galvanized or cadmium plated in accordance with ASTM A 165, stainless steel, or mechanically galvanized in accordance with ASTM B 545 (Class Fe/Sn 20). Post assembly hardware shall be of the dimensions shown on the plans.

450.3.8 BOLTS: Size 5/16 inch-18 UNC for sign attachment shall be a tamper proof carriage bolt, either hot dipped galvanized, cadmium plated in accordance with ASTM A 165, stainless steel, or mechanically galvanized in accordance with ASTM B 545 (Class Fe/Sn 20). Tamper resistant nuts, size 5/16 inch-18 UNC shall be used and fabricated from C1008 hot rolled steel, case hardened to R55-60, and plated with zinc yellow dichromate, 0.002 inch and 0.005 inch thick.

450.4 CONSTRUCTION REQUIREMENTS.

450.4.1 CERTIFICATION OF MANUFACTURER: The CONTRACTOR shall submit, in writing, the name of the proposed sign manufacturer, project number, and certification that all sign materials comply with the specifications.

450.4.2 SIGN IDENTIFICATION

450.4.2.1 The following identification labels shall be affixed to all signs and shall include the information as listed:

450.4.2.1.1 MANUFACTURING IDENTIFICATION LABELS: These labels shall include the wording: "Manufactured By", the initials of the sign fabricator, the month and year of fabrication, the initials of the reflective sheeting manufacturer and the wording "Theft is a Crime";

450.4.2.1.2 CONTRACTORS IDENTIFICATION LABEL: This label shall include the CONTRACTOR's Name, Date Installed, Month and Year.

450.4.2.2 The above labels may be either die stamped in 3/8 inch letters and numerals, or made with high-tack adhesive sign sheeting (reflective or non-reflective) prepared with screened ink in 1/2 inch letters and numerals.

450.4.2.3 The labels shall be placed on the lower back side of the sign, and located so as not to fall behind any post or frame member. Die stamping shall be performed in a manner that will not damage the finished sign. The label shall have similar weather resistance characteristics as the sheeting and shall last for at least the expected service life of the sign. The labels shall be affixed at the time the sign is manufactured.

450.4.3 APPROVAL OF SHOP DRAWINGS.

450.4.3.1 Standard signs shall be constructed in accordance with the detail drawing furnished to the CONTRACTOR by the City of Albuquerque. The CONTRACTOR shall submit detailed shop drawings of all special code signs (those other than the standard MUTCD coded signs) to the ENGINEER and the Traffic Engineer for approval. The CONTRACTOR shall not begin fabrication of special coded signs until the shop drawings are approved by the ENGINEER and the Traffic Engineer. These drawings shall show the complete legend, arrangement of letters and numerals, letter and numeral height, letter series, symbols, borders and dimensions.

450.4.3.2 The CONTRACTOR shall not erect the signs until the shop drawings are approved.

450.4.3.3 The CONTRACTOR must verify the post lengths with the ENGINEER and the Traffic Engineer before installation operations are started.

450.4.4 INSPECTION

450.4.4.1 All material and finished signs shall be subject to inspection and release or installation by the ENGINEER and the Traffic Engineer at the Project site prior to installation, and shall be subject to final inspection at the project after installation. The entire sign may be rejected if there are mars, damages, stains, discolorations, or defacements resulting from fabrication, storage, shipment or installation.

450.4.4.2 The ENGINEER and the Traffic Engineer shall at all times during work hours, have free entry to the parts of the sign manufacturing plant that are involved in the

manufacture and production of signs. Adequate facilities required for inspection shall be furnished without charge to the ENGINEER and the Traffic Engineer for inspection of signs and to verify the manufacturer's Q.C. Program.

450.4.4.3 Test panels, twelve (12) inches by twelve (12) inches representative of each state of production, shall be furnished on request, to the ENGINEER and the Traffic Engineer. These panels shall be processed along with regular production run and witnessed by the ENGINEER and the Traffic Engineer. Should there be any question as to validity of a test panel, a completed sign shall be furnished upon request. Signs not conforming in all respects to the requirements of these specifications may be rejected and the manufacturer's Q.C. Program may be withdrawn. The ENGINEER may select a sign at random for submittal to Traffic Engineering Operations Division for further inspection. The ENGINEER will return the sign to the CONTRACTOR in time for the sign to be installed in accordance with the CONTRACTOR's schedule.

450.4.5 PACKAGING AND SHIPPING: All signs shall be suitably packaged and protected for proper shipment and storage. Signs shall be delivered undamaged to the project site.

450.4.6 FABRICATION

450.4.6.1 Material ½ inch thick or less may be sheared, blanked, sawed, or milled. Material over ½ inch thick shall be sawed or milled. Cut edges shall be true and smooth and free from excessive burrs or ragged breaks. Re-entrant cuts shall be filleted by drilling prior to cutting. Unless the plans show otherwise, flame cutting will not be permitted.

450.4.6.2 Bolt holes shall be drilled to finish sizes.

450.4.6.3 Steel surfaces to be in contact with aluminum shall be galvanized or of stainless steel.

450.4.6.4 Aluminum surfaces to be in contact with concrete or earth shall be given a heavy coat of an alkali-resistant bituminous paint.

450.4.7 INSTALLATION AND REMOVAL OF SIGNS: The CONTRACTOR shall erect traffic sign structures at locations shown on the plans. Existing traffic control signs removed by the CONTRACTOR shall be delivered to locations designated by the ENGINEER. The CONTRACTOR shall verify the sign locations with the ENGINEER prior to their installations.

450.4.8 USE OF CERTIFIED SIGNS ONLY: The CONTRACTOR's sign manufacturer must supply signs with

an identification on the back of the sign as specified in this Section 450 which matches the approved sign manufacturer identified on the documentation letter. The CONTRACTOR shall not install permanent signs until the ENGINEER has verified that the shipment of signs delivered has a manufacturer's check list and has given the CONTRACTOR authorization to begin sign installations. The CONTRACTOR must use the manufacturer for which certification was requested.

450.4.9 SIGN STORAGE: The CONTRACTOR shall store material, including posts, under a roof or otherwise covered for protection against the elements. Materials shall be stored so as not to be on the ground or come in contact with surface runoff water.

450.4.10 REMOVING AND RESETTING PLYWOOD OR ALUMINUM PANEL SIGNS: The CONTRACTOR shall remove existing designated plywood or aluminum panel signs, sign posts, and base posts and stockpile sign posts and base posts at locations designated by the ENGINEER, or as shown in the plans. Removed plywood or aluminum panel signs shall be reset on new steel sign posts and base posts in compliance with this Section 450 and details shown on the plans.

450.4.11 SCHEDULE: A written schedule for the removal and resetting of existing traffic signs shall be submitted to the ENGINEER for approval prior to commencement of sign removal.

450.5 MEASUREMENT AND PAYMENT.

450.5.1 Steel posts and base or anchor posts for plywood or aluminum panel signs will be measured per each post, complete in place.

450.5.2 Plywood or aluminum panel signs will be measured by the square foot of sign face area mounted on drive-down posts, complete in place.

450.5.3 Removing and resetting of plywood or aluminum panel signs and signs will be measured by the unit, complete in place.

450.5.4 The accepted quantities of traffic signs and sign structures will be paid for at the contract price per unit of measurement for each of the pay items listed as shown on the bid proposal.

SECTION 500

STRUCTURES

500.1 GENERAL

This section defines the various construction items that are associated with the completion of a concrete, steel, timber, or masonry unit structures, or a combination thereof.

500.2 CONTENTS

<u>Section No.</u>	<u>Title</u>
501	Excavation and Backfill for Structures
502	Driving Piles
503	Subdrainage
510	Concrete Structures
511	Pneumatically Applied Concrete
512	Precast Prestressed Members
520	Steel Structures
530	Timber Structures and Timber Construction
540	Concrete Block Masonry Structures
541	Brick Masonry Structures
550	Metal Railings

SECTION 501
EXCAVATION AND BACKFILL FOR STRUCTURES

501.1 GENERAL

The work performed under this specification shall include, but not be limited to providing the equipment, labor and materials for the excavation and backfill of areas related to structures, such as bridges, foundations, walls, storm drain inlets, as specified on the plans and therein or as authorized by the ENGINEER.

501.2 REFERENCES

501.2.1 American Society for Testing Materials (Latest Edition)(ASTM)

- C136 Test for Sieve or Screen Analysis of Fine and Coarse Aggregate
- D422 Particle-Size Analysis of Soils
- D423 Test for Liquid Limit of Soils
- D424 Test for Plastic Limit and Plasticity Index of Soils
- D698 Moisture-Density Relations of Soils Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in.(305mm) Drop
- D1140 Amount of Materials In Soils Finer Than No.200(75um)Sieve
- D1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb(4.54-kg)Rammer and 18-in. (457mm) Drop
- D2922 Density of Soil and Soil Aggregate In-Place by Nuclear Methods
- D3017 Moisture Content of Soil and Soil Aggregate In-Place by Nuclear Methods
- D4253 Maximum Density of Soils using a Vibratory Table
- D4254 Minimum Index Density of Soils and Calculation of Relative Density

501.2.2 This Publication:
Section 207 Lean Fill Construction
Section 301 Subgrade Preparation

501.3 EXCAVATION

501.3.1 All excavation for structures shall be made in accordance with applicable regulations such as the Department of Labor's Occupational Safety and Health Administration Standards 29CFR Part 1926, Subpart P or any applicable amendments.

501.3.2 When slope limit for structural excavation is shown on the plans, those limits are to establish the pay quantities for structural excavation and backfill only and in no way shall relieve the CONTRACTOR from meeting the requirements of 501.3.1 above.

501.3.3 The bottom width of the excavation shall be a minimum of the bottom width of the structure foundation plus one foot (1') on each side to provide space for erection and removal of forms. Additional bottom area may be required due to the type and size of compaction equipment the CONTRACTOR chooses to use.

501.3.4 CONTRACTOR shall be responsible for obtaining and maintaining a temporary storage site for usable excavated material during the period of construction. CONTRACTOR may request through the ENGINEER, approval of the OWNER to store excavated material within the street right-of-way or on City property.

501.4 COMPACTED BACKFILL

501.4.1 Backfill material shall be either Class I, II, III, or Class IV soils as defined in TABLE 501.4.A, or Lean Fill complying with the requirements of Section 207. The CONTRACTOR shall not place backfill against a portland cement concrete structure until the concrete has attained 80% of the design strength as determined by the average strength of two field cured cylinders. The field cured cylinders shall be cured in the field under the same condition as the concrete in the structure, represented by the cylinders.

501.4.2 The CONTRACTOR shall remove unsuitable material which either will not compact readily or serve the intended purpose and replace it with suitable material as authorized by the ENGINEER.

501.4.3 All forms, braces, and debris shall be removed before start of backfilling.

501.4.4 Backfill material shall be placed in level lifts and each compacted lift shall not exceed 6 inches.

501.4.5 Soil used for the backfill around structures shall be compacted to a dry density of not less than 90% of maximum dry density in a moisture range of optimum moisture +/-2% as determined in accordance with ASTM D1557 (modified), unless the soil contains 35% or more finer than the No. 200 sieve. If the soil used has 35% or more finer than the No. 200 sieve, it shall be compacted to a dry density of 90% of maximum dry density in a moisture content range of at least optimum moisture to +4% above optimum as determined in accordance with ASTM D698 (Standard).

501.4.6 When structural backfill is within the roadway area, this area shall be compacted to 90% dry density as specified in 501.4.5 and rework and compacted to 95% dry density at the same time as the surrounding subgrade area is compacted as specified in Section 301.

501.5 GRAVEL DRAINS

501.5.1 The construction plans may require the installation of weep holes in the concrete walls to relieve the surcharge pressure of ground water. Gravel drains are intended to provide a drainage course to the weep holes. The size, shape, and

TABLE 501.4.A

EMBEDMENT SOILS CLASSIFICATIONS

SOILS CLASS	SOIL TYPE	DESCRIPTION
CLASS I SOILS*		Manufactured angular, granular material, 1/4 to 1-1/2 inches (6 to 40 mm) size, including materials having regional significance such as crushed stone or rock, broken coral, crushed slag, cinders, or crushed shells, complying to the requirements of Class II soils.
CLASS II SOILS**	GW	Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more of coarse fraction retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
CLASS II SOILS**	GP	Poorly graded gravels and gravel-sand mixtures, little or no fines. 50% or more of coarse fraction retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
CLASS II SOILS **	SW	Well-graded sands and gravelly sands, little or no fines. More than 50% of coarse fraction passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
CLASS II SOILS**	SP	Poorly graded sands and gravelly sands, little or no fines. More than 50% of coarse fraction passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
CLASS III SOILS***	GM	Silty gravels, gravel-sand-silt mixtures. 50% or more of coarse fraction retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
CLASS III SOILS***	GC	Clayey gravels, gravel-sand-clay mixtures. 50% or more of coarse fraction retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
CLASS III SOILS***	SM	Silty sands, sand-silt mixtures. More than 50% of coarse fraction passes No. 4 sieve. More than 50% retained on No. 200 sieve.
CLASS III SOILS***	SC	Clayey sands, sand-clay mixtures. More than 50% of coarse fraction passes No. 4 sieve. More than 50% retained on No. 200 sieve.
CLASS IV SOILS	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
CLASS IV SOILS	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
CLASS IV SOILS	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
CLASS IV SOILS	CH	Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
CLASS V SOILS	OL	Organic silts and organic silty clays or low plasticity. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
CLASS V SOILS	OH	Organic clays of medium to high plasticity. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
CLASS V SOILS	PT	Peat, muck and other highly organic soils.

* Soils are as defined in ASTM D2487, except for Class I Soil which is defined in ASTM D2321.

** In accordance with ASTM D2487, less than 5% passes No. 200 sieve.

***in accordance with ASTM D2487, soils with 5% to 12% passing No. 200 sieve fall in a borderline classification that is more characteristic of Class II than of Class III.

Location of the gravel drain will be shown on the construction plans.

501.5.2 Gravel drain material shall consist of a material complying with the following gradation, and having the same or similar gradation curve as defined by the specification limits when graphically plotted on a standard aggregate gradation chart.

SIEVE SIZE	% PASSING
3 inch	100
1/2 inch	70 - 100
no. 4	50 - 80
no. 16	25 - 50
no. 50	5 - 15
no.200	0 - 5

Liquid Limit	NV (no value)
Plasticity Index	NP (non plastic)

**The drain material shall comply with the following material size ratios:

$$12 < / = R50 < / = 58$$
$$R50 = \frac{50\text{-percent size GDM}}{50\text{-percent size BM}}$$

$$12 < / = R15 < / = 40$$
$$R15 = \frac{15\text{-percent size GDM}}{15\text{-percent size BM}}$$

where

GDM - represents the Gravel Drain Material
BM - represents the Base Material (surrounding soil)

501.5.3 A separator (membrane type) geotextile fabric shall be used to encase the Gravel Drain Material in areas where the surrounding soil has 30% or greater of its material passing the no. 200 sieve.

501.6 MEASUREMENT AND PAYMENT

501.6.1 Measurement:

501.6.1.1 Unless specified on the plans, in the Supplemental Technical Specification and/or in the Bid Proposal no separate measurement will be made for excavation and backfill for structures. This work shall be considered incidental to and part of the cost of the structure.

501.6.1.2 When specified on the plans, in the Supplemental Technical Specifications and/or in the Bid Proposal excavation and backfill for structures shall be measured by the cubic yard of excavation.

501.6.1.3 Gravel drains will be measured by the cubic foot based on the neat line volume shown on the plans or as authorized by the ENGINEER.

501.6.2 Payment:

501.6.2.1 Payment for excavation and

backfill for structures shall be made at the contract unit price per structure or per cubic yard of excavated quantity, complete in place, which price shall include all equipment, labor and materials required to excavate, stock pile, backfill, compact, and the removal and disposal of excess material.

501.6.2.2 Payment for gravel drains shall be made at the contract unit price per cubic foot, complete in place, which price shall include all equipment, labor and materials required in furnishing the gravel and geotextile fabric, the installation of both and the compaction required.

SECTION 502

DRIVING PILES

502.1 GENERAL

The driving of piles will comply with the specifications contained in this section. The type and location of piles to be installed shall be shown on the construction plans. The specifications for the various types of piles are included in Sections 150, 151, and 152.

502.2 REFERENCES

This Publication:
SECTION 150
SECTION 151
SECTION 152

502.3 INSTALLATION

502.3.1 Piles driven under this specification shall be accurately spaced and driven either vertically or to the prescribed batter, as indicated on the plans; no greater variation from the vertical or specified batter line than 1/4 of an inch per foot of length being permitted. Piles otherwise driven and those seriously damaged in driving shall be removed or cut off and replaced with new piles. Should any pile be raised by the subsequent driving of others, it shall be redriven.

502.3.2 The pile top elevations shown on the plans are approximate and are to be used as a basis for establishing quantities for piling, including exploratory piles, for bidding purpose only.

502.3.3 When required in the Supplementary Specifications, one pile of the type selected or designated for the work shall be driven in each pier and abutment area as an exploratory pile. The location of these piles shall be determined by the ENGINEER.

502.3.4 The conditions under which the exploratory piles will be driven shall be as ordered by the ENGINEER. These exploratory piles shall be furnished and driven by the CONTRACTOR and under normal circumstances shall be left in place and utilized as one of the specified piles.

502.3.5 Exploratory piles shall be driven with the same size and type hammer operating with the same effective energy and efficiency as that to be used in driving the remainder of the piles.

502.3.6 The purpose of driving the exploratory piles is to determine the length and penetration that will be

required in the balance of the piles. Therefore, no piles other than the exploratory piles shall be driven at each pier or abutment area until such determination has been made by the ENGINEER and has been reported to the CONTRACTOR.

502.3.7 The ENGINEER shall order the top elevation to which the piling shall be driven for the particular pier or abutment. All piles shall be driven to the top elevation as established by the ENGINEER or deeper if necessary to develop the prescribed bearing value as determined by the formula hereinafter prescribed.

502.3.8 Required excavations in the areas through which the piles are to be driven shall be made before any pile is driven therein. NO excavation may be made below the bottom of the pile footing elevation, unless approved by the ENGINEER.

502.3.9 When piles are to be driven through bridge approach embankment and the depth of the embankment at the pile location is in excess of 5 feet, the pile shall be driven in a hole drilled through embankment. The hole shall have a diameter of not less than the butt diameter of the pile plus 6 inches. After driving the pile, the annular space around the pile shall be filled to ground surface with dry sand or pea gravel.

502.3.10 No piles shall be driven within 25 feet of any concrete that has not attained a minimum compressive strength of 2000 psi.

502.4 PILE DRIVING EQUIPMENT AND OPERATIONS

502.4.1 No piles shall be driven, no piles shall be jetted, and no pile holes shall be drilled unless the ENGINEER is present during the operation.

502.4.2 All piles shall be protected during driving with an approved driving head. The tops of timber piling shall be trimmed to fit the driving head, and the piles shall be protected against brooming and splitting. Timber piles shall be pointed (4 inches square point) or shod with metal shoes when required. A cushion block approved by the ENGINEER shall be used. In case the metal pile top folds, corrugates, or is otherwise damaged due to impact of the hammer blow,

the CONTRACTOR may be required to reinforce the top of the pile.

502.4.3 Unless otherwise provided, bearing piles shall be driven with a pile hammer delivering not less than 15,000 foot pounds of energy per blow, except timber piling may be driven with drop hammers or pile hammers having an energy rating not less than 6,800 foot pounds. Pile hammers shall be operated at speeds recommended by the manufacturer.

502.4.4 Gravity hammers for timber piles shall weigh approximately 3,000 pounds, except that the hammer shall not weigh more than 3,500 pounds. The maximum drop shall not exceed 10 feet. When the hammer fails to produce the required bearing, the ENGINEER may permit 5 blows at not to exceed 36,000 foot pounds of energy per blow as a final check of bearing obtained. The CONTRACTOR shall furnish the ENGINEER with a certified scale weight of the hammer to be used. Steam, air, or diesel hammers for driving timber piling shall develop an energy of not less than 6,800 foot pounds of the manufacturer's rated energy.

502.4.5 Pile driver leads shall be constructed so as to afford freedom of movement to the hammer and shall be held firmly in position by guys, stiff braces, or other effective method to prevent swinging and to support the pile in driving and insure the hammer blow being delivered squarely on the end of the pile. When driving batter piles, the lead shall be inclined and effectively braced so as to remain in line with the desired position of the pile. The driving of piles by the use of followers will not be permitted without written permission of the ENGINEER.

502.4.6 When approved by the ENGINEER, the CONTRACTOR may supplement driving equipment with a water jetting plant without extra compensation. The number of jets and the volume and pressure of water at the jet nozzle shall be sufficient to freely erode the material adjacent to the pile. The plant shall have a sufficient capacity to deliver at all times at least 325 g.p.m. at 100 pounds pressure per square inch at two 3/4 inch nozzles. Before the desired penetration is reached, the jets shall be withdrawn and the pile shall be driven by the manner to obtain the final penetration and bearing.

502.4.7 Piles shall be driven to not less than the minimum penetration elevation shown on the plans, unless otherwise permitted by the ENGINEER. Piling shall be driven to at least the

design bearing shown on the plans, unless otherwise directed by the ENGINEER. Timber piling shall not be driven to a computed bearing in excess of 50 tons.

502.4.8 When approved by the ENGINEER, water jets or drilling may be used in conjunction with the hammer to obtain the specified penetration. If possible, the last 3 feet of penetration shall be obtained by driving without the use of water jets.

502.4.9 Test blows, to determine average penetration, shall be applied after the jets have been removed. The use of water jets will not modify any of the requirements of this section.

502.4.10 Unless drilled holes are shown on the plans, holes other than starting holes shall not be drilled until the ENGINEER has determined that piling cannot be driven, except where piling is to be placed in compacted fill at abutments.

502.4.11 When permitted by the ENGINEER, pilot holes may be drilled to an elevation sufficient to allow driving the pile to at least minimum penetration elevation, but not more than full specified length, providing that such may be accomplished without injury to the pile and full bearing is achieved. Where piling is to be placed in compacted fill at abutments, when permitted by the ENGINEER, pilot holes may be drilled to the natural ground elevation prior to attempting to drive the piling. All drilled pilot holes will be considered incidental to the completion of the work and no measurement or payment will be made therefor.

502.4.12 The drilling of holes shall be done by approved methods and in such manner that the piles will be accurately positioned as shown on the plans.

502.4.13 Unless larger hole is permitted by the ENGINEER to obtain minimum penetration, the diameter of the drilled holes shall not exceed the following:

502.4.13.1 Timber Piles--One inch larger than the average between the tip and butt diameters.

502.4.13.2 Pipe Piles--The outside pile diameter.

502.4.13.3 "H" Piles--Two inches smaller than the diagonal measurement of the pile.

502.4.14 When a pile is set in a hole larger than the diameter of the pile, the portion of the hole in solid material

shall be filled with Class A concrete and the portion of the hole above solid material may be filled with sand or other suitable material. These materials will be considered incidental to the completion of the work and no direct payment will be made therefor.

502.4.15 The ENGINEER shall make an inspection to determine if shooting with explosives or redesign is necessary when piles cannot be driven or holes drilled. Shooting of holes with explosives will not be allowed without written permission.

502.4.16 Driven pilot holes may be used to loosen and break up the compacted strata to such an extent that the piles may be driven to the required depth through the driven pilot holes.

502.4.17 Abutment bearing piles shall not be driven until the approach embankment material, underneath and adjacent to the abutment, has been placed and compacted to the required density. The surface of such approach embankment, after compaction, shall be not less than the elevation of the bottom of the abutment.

502.4.18 When steel pipe piling are included in the work, the CONTRACTOR shall have available at all times a suitable device, of a type approved by the ENGINEER, for thoroughly illuminating the interior of the pipe piles for their entire length after they have been driven. Any pipe pile that shows breaks, deformations, or other defects that would impair the strength or efficiency of the completed pile shall be pulled or abandoned if approved by the ENGINEER and replaced at the CONTRACTOR's expense.

502.4.19 After steel pipe piles have been driven to final penetration, such piles will be given a final inspection. Any water or other foreign substance inside the piles shall be removed. Upon approval of the driven piles by the ENGINEER, such piles shall be filled with concrete. The initial deposit in the pipe shall be 2 or 3 cubic feet of Portland cement mortar, which shall be followed by deposits of concrete in layers not more than 3 feet in depth and each layer shall be compacted by rodding or by other approved methods before a succeeding layer is placed. The work of placing and compacting the concrete shall be carried on continuously in successive layers until the entire pipe pile is completely filled. The schedule for driving piles shall be such as to avoid vibrations and pressure reaching piles or other structural components in which

concrete has been placed and taken initial set but has not attained sufficient strength to resist damage.

502.5 COMPUTATIONS FOR BEARING VALUES

502.5.1 In the absence of loading tests, the bearing value of a pile will be determined as herein provided. When required by the ENGINEER, a pile shall be left to set for a period not to exceed 24 hours and again driven to determine the safe bearing value.

502.5.2 Each structural steel pile, steel pipe pile, or timber pile driven without a core or mandrel shall have a bearing value determined as follows:

502.5.2.1 Gravity hammers:

$$P = \frac{2 WH}{S + 1.0}$$

502.5.2.2 Single-acting steam, air, or diesel hammers having open ends:

$$P = \frac{2 WH}{S + 1.0}$$

502.5.2.3 Double-acting steam, air, or diesel hammers having enclosed ends:

$$P = \frac{2E}{S + 1.0}$$

502.5.2.4 Where:

P = Allowable safe bearing value in pounds.

W = Weight in pounds of striking parts of the hammer.

H = Height of fall or stroke of the ram in feet.

E = Manufacturer's rated energy in foot pounds per blow at the rated speed for double acting steam or air hammers.

502.5.2.5 E = Ninety percent of the average equivalent energy in foot pounds as determined by a gauge attached to the hammer and recorded during the period when the average penetration per blow is recorded, for diesel hammers having enclosed rams. Hammers of this type shall be equipped with a gauge and applicable charts supplied, which will evaluate the equivalent energy being produced under any driving condition, otherwise the formula for diesel hammers with open end will apply.

502.5.2.6 S = Average penetration in inches per blow during the last 10 to 20 blows.

502.5.3 Steel pile shells driven with a core or mandrel, the bearing value of a single pile will be determined by one of the formulas herein provided:

502.5.3.1 Single-acting steam, air, or diesel hammers having open ends:

$$P = \frac{2WH}{S + \frac{0.1(w)}{W}}$$

502.5.3.2 Double-acting steam, air, or diesel hammers having enclosed ends:

$$P = \frac{2E}{S + \frac{0.1(w)}{W}}$$

502.5.3.3 Where:

(w) = Weight of the pile including the weight of the core or mandrel in pounds.

502.5.4 The formulas in Subsections 502.5.2 and 502.5.3 are applicable only when:

502.5.4.1 The gravity hammer has a free fall.

502.5.4.2 The penetration is at a reasonably quick and uniform rate.

502.5.4.3 The lifting line on the hammer is slack so that the whole weight of the hammer is on the pile.

502.5.4.4 There is no appreciable bounce after the blow. Twice the height of the bounce shall be deducted from "H" to determine its true value in the formulas.

502.5.4.5 The head of a wood pile is free from broomed or crushed wood fiber.

502.5.4.6 A follower is not used.

502.6 TOLERANCES AND REJECTION

502.6.1 Piles, preparatory to driving, shall be located accurately in the correct position. During the driving, the pile shall be held in its correct position by adequately braced leads, a heavy template, struts, cables, toggles, or other approved methods.

502.6.2 Foundation piling shall be driven with a maximum variation of not to exceed 1/4 inch per foot from the vertical or from the batter shown, with the head of the pile varying not to exceed 6 inches from the plan position. These tolerances may be waived by the ENGINEER if, in his opinion, the

conditions made such tolerances impractical and the capability of the structure is not impaired by exceeding the tolerances given. Foundation piling shall not be driven until after the excavation is approximately complete.

502.6.3 Trestle piling shall be driven with a maximum variation of not to exceed 1/4 inch per foot from the vertical or batter shown, with the pile varying not to exceed 3 inches from the plan position. These tolerances may be waived by the ENGINEER if, in his opinion, the conditions make such tolerances impractical and the capability of the structure is not impaired by exceeding the tolerances given.

502.6.4 Piles broken by reason of internal defects or by improper driving or driven out of the tolerances allowed will be rejected. When permitted by the ENGINEER, a second pile may be driven adjacent to the rejected pile, provided such second pile is driven without detriment to the structure; otherwise the rejected pile shall be removed and replaced. The removing and replacing of a rejected pile or the furnishing and driving of a second pile adjacent to a rejected pile will be considered incidental to the completion of the work and no measurement or payment will be made therefor.

502.6.5 The tops of all piles shall be cut off normal to the pile or to the bevel shown on the plans and to the elevations established by the ENGINEER.

502.6.6 Structural steel piles and steel pipe piles shall be accurately cut off at the required elevation. Steel pipe piles shall be cut off before being filled with concrete.

502.7 TIMBER PILES WITH TIMBER CAPS

Timber piles which support timber caps shall conform to the plane of the bottom of the superimposed cap. Wedging or shimming between the pile and cap will not be permitted. The heads of all treated and untreated timber piles for trestles, after driving and cutting off, shall be treated by either method herein provided. Heads of piling encased in concrete do not require either of the following treatments:

502.7.1 A coat of hot creosote oil shall first be applied to the head of the pile and a protective cap then built up by applying alternate layers of loosely woven fabric and hot asphalt or tar, using 3 applications of asphalt or tar

and 2 layers of fabric. The fabric shall measure 6 inches more in each direction than the pile diameter and shall be turned down over the pile neatly trimmed, and the edges secured by binding with 2 turns of No. 10 galvanized wire. The fabric shall be wired in advance of the final coat of asphalt or tar which shall extend down over the wiring.

502.7.2 Three coats of hot creosote oil shall first be applied to the head of the pile followed by 1 coat of hot roofing pitch. Each coat shall be allowed to become practically dry before applying the succeeding coat. A covering of 20 gauge galvanized sheet metal shall be placed over the pitch coating. The cap material shall measure not less than 6 inches more in each direction than the diameter of the piling and shall be turned or bent down over the pile. The edges shall be neatly trimmed and secured to the pile with large-head galvanized nails.

502.8 STEEL PILE COLUMNS

Steel pile columns shall be placed in dug or drilled holes at locations, batters, and elevations shown on the plans. After placement, steel pipe pile columns shall be filled with concrete and painted as herein provided:

502.8.1 Steel pile columns shall be set plumb or to the batter shown on the plans. Variation greater than 1/8 inch per foot from the vertical or batter line indicated will not be permitted. The top of the pile shall not be out of the position shown on the plans by more than 1 inch.

502.8.2 Closed-end pipe pile columns shall be placed to bear directly on the solid rock or shale at the bottom of the excavation. When required, a layer of Portland cement mortar shall be deposited on the bottom of the excavation on the cleaned surface of rock or shale to provide a full bearing for the closed end of the pipe. Mortar deposited under water shall be placed by means of a suitable tremie. In case the excavation is dry or is dewatered, open-end pipe pile columns may be used when approved by the ENGINEER. When open-end pipe pile columns are used, the top of the rock or shale at the bottom of the excavation shall be thoroughly cleaned before placing the columns.

502.8.2.3 After steel pipe pile columns have been placed in final position, they shall be given a final inspection. Any water or other foreign substance inside

the pipe shall be removed. Upon approval by the ENGINEER, the pipes shall be filled with concrete. The initial deposit in the pipe shall be 2 or 3 cubic feet of Portland cement mortar, which shall be followed by deposits of concrete in layers not more than 3 feet in depth and each layer compacted by rodding or by other method satisfactory to the ENGINEER before a succeeding layer is placed. The work of placing and compacting the concrete shall proceed continuously in successive layers until the entire pipe is completely filled.

502.9 BEARING PILE LOAD TEST

502.9.1 General

When required, this work shall consist of a test load on a driven pile to determine the bearing capacity and settlement behavior of the pile. The pile load test shall be conducted under the supervision of the ENGINEER.

502.9.2 Test Methods

502.9.2.1 The CONTRACTOR shall apply the test load concentrically by such method that the test load acting on the pile may be accurately determined and controlled at any time. The CONTRACTOR shall submit the method of anchorage and loading to the ENGINEER, for approval prior to beginning any test.

502.9.2.2 The CONTRACTOR shall furnish accurate gauges and devices for determining the load applied and shall furnish the ENGINEER with a certificate of calibration of the gauges or devices from an approved laboratory prior to use.

502.9.2.3 The CONTRACTOR shall furnish the ENGINEER with adequate facilities for making load and settlement readings 24 hours per day, except such engineering instruments and apparatus normally used by the ENGINEER.

502.9.2.4 The load shall be applied to the pile as near the ground surface as practicable or as designated by the ENGINEER. If the load is applied on a pile projecting appreciably above ground, care shall be taken to prevent failure by column action. Test piles shall be vertical within the tolerances provided. Test loading results will not be accepted when pile fails structurally during test loading due to faulty installation or procedure by the CONTRACTOR.

502.9.2.5 After load testing is completed, test piles and anchor piles shall be used as bearing piles, unless rejected

by the ENGINEER. Rejected test piles and anchor piles shall be removed by the CONTRACTOR at his expense.

502.9.2.6 Test load shall be applied not less than 24 hours after test pile and anchor piles have been driven. When test loading pipe piles, the test piles and anchor piles shall not be loaded until the concrete has attained a compressive strength of not less than 2,400 psi. The ENGINEER may require all piles to be driven within the test area before the test pile is test loaded. The load shall be applied in increments as herein provided. The first load application shall be approximately 4/5 of the design bearing capacity in tons as shown on the plans. Additional load increments of 10 tons each shall be applied not less than 1 hour after all measurable settlement due to previous loading has been determined. Such load increments shall be applied, as herein provided, until the load test has been completed. Measurable settlement is defined as settlement of 1/8 inch or more subsequent to an intermediate reading.

502.9.2.7 Readings of the amount of settlement will be made by the ENGINEER immediately before and after the application of each load increment and at intermediate intervals 20 minutes apart. Such readings and corresponding load increments and total load will be recorded.

502.9.2.8 The application of load will be considered complete when the gross settlement of the loaded pile reaches the yield point, except when the yield point is reached before the total load equals 1.6 times the design load of the pile as shown on the plans. Yield point is defined as when the additional amount of settlement exceeds 0.02 inch per ton for the increment applied. When this amount of settlement per increment occurs before the total load equals 1.6 times the design bearing capacity, an additional similar increment of load shall be applied to determine if this amount of settlement per increment is repeated or exceeded. If this amount of settlement per increment is repeated or exceeded, the application of load will be considered complete; but if not, the application of increments will be continued until yield point occurs or until the maximum amount of load required is applied.

502.9.2.9 The CONTRACTOR will not be required to apply a total load greater than 3 times the design bearing capacity in tons, unless otherwise shown on the plans or in the Supplementary Specifications.

502.9.2.10 When the yield point in the settlement has not been reached after the last increment of load required has been applied, the application of the total load shall be continued for not less than 12 hours after all measurable settlement has ceased.

502.9.2.11 Immediately after the total load is removed from the pile, the net settlement will be recorded by the ENGINEER. Not less than 3 hours after the total load is removed from the pile, the settlement will again be recorded by the ENGINEER.

502.9.2.12 When it becomes necessary, due to unforeseen conditions, to remove and reapply any of the test load, such application shall be made gradually in increments approved by the ENGINEER.

502.10 MEASUREMENT AND PAYMENT

Measurement and payment of the various items will be as follows:

502.10.1 Splices for structural steel piles, structural steel pile columns, steel pipe piles, and steel pipe pile columns will be considered incidental to the completion of the work and no measurement or payment will be made therefor.

502.10.2 Pile load tests will be measured as follows:

502.10.2.1 First pile load test.

502.10.2.2 Each subsequent pile load test.

502.10.3 All pile cut-offs will be considered incidental to the completion of the work and no measurement or payment will be made therefor.

502.10.4 Piles that have been driven or partially driven and subsequently ordered removed by the ENGINEER will be considered incidental to the completion of the work and no measurement or payment will be made therefor.

502.10.5 When drilled holes for bearing piles are called for on the plans, such drilled holes will be measured to the nearest vertical foot.

502.10.6 Metal shoes for timber piling, authorized by the ENGINEER and furnished by the CONTRACTOR, will be measured by the unit per each.

502.10.7 All jetting and all pilot holes will be considered incidental to the completion of the work and no measurement or payment will be made therefor.

502.10.8 Test piles driven and not included in the permanent structure will be measured to the nearest vertical foot. Payment will be made at the unit price per vertical foot per type of pile as indicated in the Bid Proposal.

502.10.9 Piles of approved length, furnished and not driven, will be measured to the nearest linear foot. Payment will be made at the unit price per foot per type of pile as indicated in the Bid Proposal.

502.10.10 All piles of the various types and lengths permanently incorporated in the structure will be measured to the nearest vertical foot after cut-off.

502.10.11 Concrete placed in steel pipe piles or steel pipe columns will be measured to the nearest 1/10 cubic yard. Payment will be made at the unit price per cubic yard as shown in the Bid Proposal.

502.10.12 Steel reinforcement placed in steel pipe piles or steel pipe columns will be measured by the pound. Payment shall be made at the unit price per pound as stated in the Bid Proposal.

SECTION 503 SUBDRAINAGE

503.1 GENERAL

The work performed under this specification shall include, but not limited to providing the equipment, labor and materials for the excavation, installation and backfilling of subdrainage improvements as specified on the plans and herein or as authorized by the ENGINEER.

SIEVE SIZE	% PASSING
3 inch	100
1/2 inch	70 - 100
no. 4	50 - 80
no. 16	25 - 50
no. 50	5 - 15
no. 100	0 - 15
Liquid Limit	NV (no value)
Plasticity Index	NP (non-plastic)

503.2 REFERENCES

503.2.1 American Society for Testing Materials (Latest Edition)(ASTM)

F758 Smooth Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain System for Highways, Airports, and Similar Drainage

503.2.2 This Publication:

Section 101 Portland Cement Concrete
Section 121 Plastic Pipe
Section 920 Sanitary and Storm Sewer Manholes
Section 1502 Submittals

**The drain material shall comply with the following material size ratios:

$$12 < / = R50 < / = 58$$

$$R50 = \frac{50\text{-percent size GDM}}{50\text{-percent size BM}}$$

$$12 < / = R15 < / = 40$$

$$R15 = \frac{15\text{-percent size GDM}}{15\text{-percent size BM}}$$

where

GDM-represents the Gravel Drain Material
BM -represents the Base Material (surrounding soil)

503.4 SUBDRAINAGE PIPE

Subdrain pipe unless specified on the plans or in the Supplemental Technical Specifications as solid wall pipe shall be perforated pipe as specified in ASTM F 758. Solid wall pipe shall be in accordance with Section 121.

503.5 PIPE JOINTS AND FITTINGS

503.5.1 All pipe and fitting joints shall be the rubber gasket type in accordance with Section 121. No "open joints" will be permitted on the subdrain pipe.

503.5.2 All fittings used on subdrain piping shall be the rubber gasket type, having the same or better strength as the pipe required and be approved by the pipe manufacturer for use on the pipe.

503.6 SUBDRAINAGE MANHOLES

Subdrain manholes shall be as detailed on the plans and shall be in accordance with Section 920.

503.7 FILTER AND DRAIN MATERIALS

503.7.1 A separator (membrane type) geotextile fabric as specified on the plans or in the Supplemental Technical Specification shall be used to encase the gravel drain material.

503.7.2 Gravel drain material shall consist of a material complying with the following gradation, and having the same or similar gradation curve as defined by the specification limits when graphically plotted on a standard aggregate gradation chart.

503.8 PLACEMENT

503.8.1 The area in which the subdrain is to be installed shall be backfilled, compacted and re-excavated or excavated to the line and grade shown on the plans for the drain material.

503.8.2 The geotextile fabric shall be placed in the trench so as to form a continuous cover on all four (4) sides of the gravel drain material after it is placed, with a minimum of a one-foot (1') overlap on the top of the gravel. If the length of the subdrain is longer than the geotextile fabric, the fabric may be installed with a two-foot (2') overlap with the upstream end laid under the downstream end.

503.8.3 The gravel drain material shall be placed in the bottom, on top of the fabric, up to or a few inches above the grade of the pipe. The pipe shall be installed to the line and grade shown on the plans or as authorized by the ENGINEER. Gravel drain material shall be placed around and on top of the pipe as shown on the plans. The geotextile fabric shall be placed over the top of the gravel with a minimum of a one-foot (1') overlap.

503.8.4 The upstream end of the subdrain pipe shall be left open until the placement steps outlined above have been completed. Water shall be introduced into the upstream end of the pipe to flush out any debris in the pipe. The amount of water needed will

depend on the condition of the pipe. After flushing the end of the pipe shall be capped and the gravel drain material and fabric placed around the end of the pipe.

503.8.5 Upon completion of the above steps, one foot (1') of fill shall be placed over the subdrain area and additional fill placed and compacted as specified for fill, or subgrade, etc. The first foot of fill over the subdrain will not be tested for compaction.

503.9 SUBMITTALS

The CONTRACTOR shall submit the information specified in Section 1502 on the pipe, fittings, gravel, and fabric.

503.10 MEASUREMENT AND PAYMENT

503.10.1 Subdrain shall be measured by the linear foot along the centerline of the pipe and through all fittings.

503.10.2 Payment for subdrain shall be made at the contract unit price per linear foot complete in place which price shall include all equipment, labor and materials required to excavate and install the pipe, fittings, gravel drain material, and geotextile fabric.

CONCRETE STRUCTURES

510.1 GENERAL

Concrete structures, such as: bridges, culverts, storm inlets, retaining walls, abutments, piers, footings, foundations and similar structures, shall be constructed in conformity with these specifications and the construction plans.

510.2 REFERENCES

510.2.1 This Publication:

Section 101 Portland Cement Concrete
 Section 102 Steel Reinforcement
 Section 103 Epoxy-Coated Steel Reinforcement
 Section 105 Concrete Curing Compound
 Section 107 Joint Filler and Sealant Material
 Section 337 Portland Cement Concrete Pavement
 Section 349 Concrete Curing
 Section 501 Excavation and Backfill for Structures
 Section 502 Driving Piles

510.2.2 Others

PS-1-66 Specifications for Plywood, U.S. Products Standard, U.S. Department of Commerce.

Standard Specifications for Welding for Highway and Railroad Bridges, American Welding Society.

510.3 MATERIALS

510.3.1 CONCRETE

Concrete for use in work constructed under this section shall conform to the requirements of Section 101 and as shown on the plans or as specified in the Supplementary Technical Specifications and approved by the ENGINEER.

510.3.2 STEEL REINFORCEMENT

Reinforcement bars shall conform to the requirements specified in Section 102 and 103.

510.4 SUBGRADE FOR CONCRETE STRUCTURES

Earth subgrade upon which concrete is placed shall be firm and free from water and/or frost. All subgrade on which Structural concrete is to be placed shall be compacted to the minimum density specified in Section 501 or on the plans. Ground water shall be kept twelve (12") inches below the subgrade until the concrete has set. When the subgrade is in dry earth, it shall be moistened with water from a spray nozzle immediately before concrete is placed. When the design details for the project provide for the construction of filter or drain material consisting of gravel or combination of gravel and sand, which material becomes

subgrade for concrete, the placing of steel reinforcement and pouring of concrete shall follow the placing of the filter or drain material as closely as practical. The filter or drain material shall be kept dewatered to the extent necessary to prevent any portion of concrete materials being carried away before the concrete has attained its final set. When concrete is to rest on rock, the rock shall be fully uncovered. The surface of the rock shall be removed to a depth sufficient to expose sound rock. Bedrock shall be roughly leveled off or cut to approximately horizontal and vertical steps. Seams in the rock shall be grouted as directed by the ENGINEER and the base for structures shall be slush grouted or otherwise treated as the ENGINEER may direct.

510.5. FORMS

510.5.1 Forms shall be of suitable material and of type, size, shape, quality, and strength to enable construction as designed. The forms shall be true to line and grade, mortar tight, and sufficiently rigid to resist any appreciable amount of springing out of shape during placing of the concrete. The responsibility for their adequacy shall rest with CONTRACTOR. All dirt, chips, sawdust, nails, and other foreign matter shall be completely removed from forms before any concrete is deposited therein. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes that would appreciably deface the finished surface. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused, and the reuse of forms shall be subject to approval of the ENGINEER. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly treated with an approved releasing agent that will leave no objectionable film on the surface of the forms that can be absorbed by the concrete. Care shall be exercised that no releasing agent is deposited on previously placed concrete. Forms for all surfaces that will not be completely enclosed or hidden below the permanent surface of the ground shall be made of surfaced lumber or material which will provide a surface at least equally satisfactory. Any lumber or material which becomes badly checked or warped prior to placing concrete may be rejected. Forms for all exposed surfaces of bridges, viaducts, over crossings, and similar structures shall be constructed of plywood or an approved equal. Plywood for forms shall conform to the specifications of the U.S. Department of Commerce, U.S. Product Standard PS 1-66 Class I or II. All form panels shall be placed in a neat, symmetrical pattern with the horizontal joints level and continuous. Unless otherwise shown on the plans, all exposed edges shall have a 3/4 inch chamfer. Forms for curved surfaces shall be so constructed

and placed that the finished surface will not deviate appreciably from the arc of the curve. Forms shall be so constructed that portions, where finishing is required, may be removed without disturbing portions of form to remain. Form clamps or bolts approved by the ENGINEER shall be used to fasten forms. The use of twisted wire loop ties to hold forms in position will not be permitted, nor shall wooden spreaders be used unless authorized by the ENGINEER. Clamps or bolts shall be of sufficient strength and number to prevent spreading of the forms. They shall be of such type that they can be entirely removed or cut back 1 inch below the finished surface of the concrete. Forms for outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales. The CONTRACTOR may, at his own option, place such portions of the concrete directly against the sides of the excavation or sheathing without the use of outside forms, provided that the following conditions are met:

510.5.1.2 If concrete is placed against sheathing, such sheathing shall be closely fitted and shall be outside of the concrete lines shown on the plans. Those surfaces against which the concrete is placed shall be faced with building paper. Except as otherwise specified hereinafter, all sheathing shall be removed but not until either at least 7 days after placing concrete or until the concrete has attained sufficient strength to support itself and any load that may be placed on it.

510.5.2 Care should be used in pulling sheathing so as to avoid damaging the concrete. Voids left by the removal of sheathing, piles, and/or similar sheathing supports shall be backfilled with material having a sand equivalent of not less than 30 and consolidated. When, in the opinion of the ENGINEER, field conditions or the type of sheathing or methods of construction used by the CONTRACTOR are such as to make the removal of sheathing impracticable, that portion of the sheathing against which concrete has been placed shall be left in place.

510.5.3 Regardless of the method used in placing concrete without outside forms, the following stipulations shall hold:

510.5.3.1 The reinforcing steel shall be accurately set and held firmly in place, to the satisfaction of the ENGINEER.

510.5.3.2 The CONTRACTOR shall assume all risks of damage to the work or to existing improvements due to any reason whatsoever that may be attributable to the method of construction outlined above.

510.5.3.3 Should the method of construction of placing directly against the sides of the excavation or sheathing without use of outside forms not prove satisfactory in the opinion of the

ENGINEER, the CONTRACTOR shall discontinue said method of construction and construct the structure by using outside forms.

510.6 FALSEWORK

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be superimposed were the entire superstructure placed at one time. All falsework, staging, walkways, forms, ladders, cofferdams, and similar accessories shall equal or exceed the minimum applicable requirements of the Federal and State statutes and local ordinances. Compliance with such requirements shall not relieve the CONTRACTOR from full responsibility for the adequacy and safety of said items. Falsework shall be founded upon a solid footing safe against undermining and protected from softening. When the falsework is supported on timber piles, the piles shall be driven to a bearing value as determined by the formula specified in Section 502, equal to the total calculated pile loading. Falsework and forms shall be so constructed as to produce in the finished structure the lines and grades indicated on the plans. Suitable jacks or wedges shall be used in connection with the falsework to set the forms to grade or camber shown on the plans or to take up any settlement in the formwork either before or during the placing of the concrete. However, single wedges for this purpose will not be permitted, it being required that all such wedges be in pairs to insure uniform bearing. Dead load deflection in stringers and joists will be compensated for by varying the depth of the joists or by using varying depth nailing strips. Arch centering shall be removed uniformly and gradually beginning at the crown and working toward the springline to permit the arch to take its load slowly and evenly. Centering for adjacent arch spans shall be struck simultaneously. Falsework under any continuous unit or rigid frame shall be struck simultaneously, the supporting edges being released gradually and uniformly starting at the center and working both ways toward the supports.

510.7 REMOVAL OF FORMS

510.7.1 The falsework supporting any span of a continuous or rigid frame structure subject to bending stress shall not be released until after the last concrete placed in the span and in the adjoining spans (excluding concrete above the deck slab) has attained a compressive strength of not less than 80 percent of its design strength or 21 days after the concrete is placed, whichever occurs first. Stairway riser forms shall be removed and the finish of the steps completed on the day the concrete is poured. Metal stairway treads, if required by the plans, shall be installed immediately after the steps have

been poured. Forms and falsework supporting the bottom slab of the superstructure of box girder structures shall remain in place until the curing period of the deck of the superstructure has expired. Forms for the webs of box girders shall be removed before the deck slab is poured. Forms for the upper deck slab which are to remain in place shall be supported by bolts through the girder webs or some equally satisfactory method that will prevent the transfer of any load to the lower deck slab. Forms supporting the concrete deck slab of box girders may be left in place. All interior forms in box girders, except those permitted to remain in place, shall be completely removed and the inside of the box girder. Side forms for beams, girders, columns, railings, or other members wherein the forms do not resist dead load bending may be removed after a period of 36 hours, unless otherwise directed by the ENGINEER, provided that satisfactory arrangements are made to cure and protect the concrete thus exposed in accordance with Section 349. Side forms for arch rings, columns, and piers shall be removed before the members of the structure which they support are placed so that the quality of the concrete may be inspected. Such forms shall be so constructed that they may be removed without disturbing other forms which resist direct load or bending stress.

510.7.2 The periods of time at which the CONTRACTOR may remove forms, as set forth in this Section, are permissive only and subject to the CONTRACTOR assuming all risks that may be involved in such removals. At his option, the CONTRACTOR may leave the forms in place for such longer periods as are, in his opinion, required.

510.8 PLACING REINFORCEMENT

Reinforcing bars shall be accurately placed as shown on the plans and shall be firmly and securely held in position by wiring at intersections and elsewhere as necessary to prevent shifting of bars, with wire not smaller than No. 16, and by using concrete or metal chairs, spacers, metal hangers, supporting wires, and other approved devices of sufficient strength to resist crushing under full load. The use of wooden supports will not be permitted. Placing bars on layers of fresh concrete as the work progresses and adjusting bars during the placing of concrete will not be permitted. Before placing reinforcing steel in the forms, the reinforcing steel shall be thoroughly cleaned of mortar, oil, dirt, loose mill scale, loose or thick rust, and coatings of any character that would destroy or reduce the bonds. No concrete shall be deposited until the placing of the reinforcing steel has been inspected and approved.

510.9 SPLICING

Splices of bars shall be made only where shown on the plans or as approved by the

ENGINEER. Where bars are spliced, they shall be lapped at least 20 diameters for deformed bars, unless otherwise shown on the plans. Welding of reinforcing steel will be permitted when authorized by the ENGINEER in writing and shall be in accordance with the American Welding Society (Standard Specifications for Welding for Highway and Railroad Bridges).

510.10 BENDING REINFORCEMENT

Bends and hooks in bars shall be made in the manner prescribed by the American Concrete Institute. Bars shall not be bent nor straightened in a manner that will injure the material. Bars with kinks or unspecified bends shall not be used.

510.11 WELDED WIRE FABRIC

Welded wire fabric shall be held firmly in place. Welded wire fabric shall be spliced not less than two meshes.

510.12 PLACING CONCRETE

510.12.1 Where a schedule for placing concrete is shown on the plans, no deviation will be permitted therefrom unless approved in writing by the ENGINEER. The placing of concrete for a given area shall start at the low point and shall proceed up grade, unless otherwise permitted by the ENGINEER. With the exception of concrete placed in slope paving and aprons and concrete placed under water, all concrete shall be compacted by means of high frequency internal vibrators of a type, size, and number approved by the ENGINEER. The number of vibrators employed shall be ample to consolidate the incoming concrete to a proper degree within 15 minutes after it is deposited in the forms. In all cases, at least 2 vibrators shall be available at the site of the structure in which more than 25 cubic yards of concrete is to be placed. The vibrators shall not be attached to or held against the forms or the reinforcing steel. The locations, manner, and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate and without causing water or cement paste to flush to the surface. Fresh concrete shall be spread in horizontal layers insofar as practicable, and the thickness of the layers shall not be greater than can be satisfactorily consolidated with the vibrators. If additional concrete is to be placed, care shall be taken to remove all laitance and to roughen the surfaces of the concrete to insure that fresh concrete is deposited upon sound concrete surfaces. Layers of concrete shall not be tapered off in wedge-shaped slopes but shall be built with square ends and level tops.

510.12.2 Mixed concrete, after being deposited, shall be consolidated until all voids are filled and free mortar appears on the surface. The concrete shall be placed as nearly as possible in its final position.

The use of vibrators for extensive shifting of the mass of fresh concrete will not be permitted. Fresh concrete shall not be permitted to fall from a height greater than 6 feet without the use of adjustable length pipes or "elephant trunks" or "Trimmies." The use of approved external vibrators for compacting concrete will be permitted when the concrete is inaccessible for adequate compaction, provided the forms are constructed sufficiently rigid to resist displacement or damage from external vibration. During the placing of concrete, care shall be taken that methods of consolidation used will result in a surface of even texture free from voids, water, or air pockets and that the coarse aggregate is forced away from the forms in order to leave a mortar surface. Spades or broad-tined forks shall be provided and used to produce the desired results if required by the ENGINEER. The use of chutes in conveying or depositing concrete will be allowed only at the discretion of the ENGINEER; and wherever they are used, they shall be laid at such inclination as will permit the flow of concrete of such consistency as is required. The use of additional water in mixing the concrete to promote free flow in chutes of low inclination will not be allowed. Where necessary in order to prevent segregation, chutes shall be provided with baffle boards or a reversed section at the outlet. Columns shall be poured preferably through pipes of adjustable length and not less than 6 inches in diameter. Horizontal members or sections shall not be placed until the concrete in the supporting vertical members or sections has been consolidated and settlement has occurred.

510.13 JOINTS

The work shall be so prosecuted that construction joints will occur at designated places shown on plans unless specifically permitted otherwise by the ENGINEER. The CONTRACTOR shall complete, by continuous depositing of concrete sections of the work comprised between such joints. The joints shall be kept moist until adjacent concrete is placed. All construction joints at the bottom of walls or arches, at the top of walls, and all longitudinal construction joints having a keyed, stepped, or roughened surface shall be cleaned by sandblasting prior to pouring the adjacent concrete. Any quality of sand may be used which will accomplish the desired results. Other methods of cleaning joints may be used provided the method and result is approved by the ENGINEER. Joint cleaning operations shall be continued until all unsatisfactory concrete and all laitance, coatings, stains, debris, and other foreign materials are removed. The surface of the concrete shall be washed thoroughly to remove all loose material. The method used in disposing of waste water employed in washing the concrete surfaces shall be such that the waste water will not stain, discolor, or affect exposed surfaces of the structure. The method of disposal

will be subject to the approval of the ENGINEER. All horizontal construction joints or those on slight slopes shall be covered with mortar. Expansion and contraction joints in the concrete structures shall be formed where shown on the drawings and as directed by the ENGINEER. In general, such joints shall have smooth abutting surfaces, painted, or separated and sealed in accordance with Section 107 or as detailed on the plans. No reinforcement shall be extended through the joints, except where specifically noted or detailed on the plans.

510.14 PLACING CONCRETE UNDER ADVERSE WEATHER CONDITIONS

Concrete for structures shall not be placed on frozen ground nor shall it be mixed or placed while the ambient temperature is below 40°F. Concrete shall not be placed during rainfall unless adequate protection is provided. Upon written notice from the ENGINEER, all concrete which may have become damaged due to adverse weather conditions, shall be replaced by the CONTRACTOR at no expense to the OWNER.

510.15 SURFACE FINISHES

The classes of surface finish described hereafter shall be applied to various parts of concrete structures as specified. Bridge decks shall be finished in conformity with Section 337. When required by the ENGINEER, the CONTRACTOR, prior to placing of concrete, shall provide a test section for evaluation of the surface finish to be employed. There will be no separate payment made for the test sections.

510.15.1 ORDINARY SURFACE FINISH

510.15.1.1 Immediately after the forms have been removed, all exterior form bolts shall be removed to a depth of at least 1 inch below the surface of the concrete and the resulting holes or depressions cleaned and filled with mortar, except on the interior surfaces of box girders the bolts shall be removed flush with the surface of the concrete. Mortar shall consist of 1 part by volume of cement to 2 parts of sand. Mortar shall be mixed approximately 45 minutes in advance of use. Care shall be exercised to obtain a perfect bond with the concrete. After the mortar has thoroughly hardened, the surface shall be rubbed with a carborundum stone in order to obtain the same color in the mortar as in the surrounding concrete. All fins caused by form joints and other projections shall be removed and all pockets cleaned and filled. Mortar for filling pockets shall be treated as specified for bolt holes.

510.15.1.2 In the judgment of the ENGINEER, if rock pockets or other defects are of such extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of the structure affected.

510.15.1.3 Ordinary Surface Finish shall be applied to all concrete surfaces either as a final finish or preparatory to a higher class finish. Ordinary Surface Finish, unless otherwise specified, shall be considered as a final finish on the following surfaces:

510.15.1.3.1 The undersurfaces of slab spans, box girders, filled spandrel arch spans, and floor slabs between T girders or superstructures not for grade separation structures.

510.15.1.3.2 The inside vertical surface of T girders or superstructure not for grade separation structures and the exposed surfaces of channel walls.

510.15.1.3.3 Surfaces which are to be buried underground or covered with embankment and surfaces above finished ground of culverts where not visible from the traveled way.

510.15.1.4 On surfaces which are to be buried underground or surfaces which are completely enclosed, such as the cells of box girders, the removal of fins and form marks and the rubbing of mortared surfaces to a uniform color will not be required.

510.15.2 CLASS 1 SURFACE FINISH

510.15.2.1 After completion of the Ordinary Surface Finish, the entire surface specified shall be sanded with a power sander or other approved abrasive means as required to obtain a uniform color and texture. The use of power carborundum stones or discs will be required to remove unsightly bulges or irregularities. The Class 1 Surface Finish shall be applied after the removal of forms. The object of these operations is to obtain a smooth, even surface of uniform appearance and to remove unsightly bulges or depressions due to form marks and other imperfections. The degree of care in building forms and the character of materials used in formwork will be a contributing factor in the amount of such sanding and grinding requirement, and the ENGINEER shall be the sole judge in this respect.

510.15.2.2 Class 1 Surface Finish as hereinafter specified shall be applied to the following surfaces unless otherwise specified in the Supplementary Technical Specifications.

510.15.2.2.1 All surfaces of superstructures for grade separation structures.

510.15.2.2.2 All exposed surfaces of bridge piers, columns and abutments, and retaining walls and to at least 1 foot below finished grade.

510.15.2.2.3 The outside vertical surfaces and bottom surface of outside girders and the under surfaces of cantilever sidewalks, safety curbs, and floor slabs overhanging

outside girders only of superstructures not for grade separation structures.

510.15.2.2.4 All surfaces of open spandrel arch rings, spandrel columns, and abutment towers.

510.15.2.2.5 Exposed surfaces of culvert headwalls and retaining walls, where visible from a traveled way.

510.15.2.2.6 Surfaces inside of culvert barrels having a height of 4 feet or more for a distance inside the barrel at least equal to the height of the culvert.

510.15.2.2.7 All interior surfaces of pump house motor and control rooms and engine generator rooms.

510.15.3 CLASS 2 SURFACE FINISH

Class 2 Surface Finish as hereinafter specified shall be applied to the following surfaces unless otherwise specified in the Supplementary Specifications: all surfaces of concrete railing, including barrier railing, rail posts, rail end posts, and rail base. When Class 2 Surface Finish is specified, the Ordinary Surface Finish and Class 1 Surface Finish shall be completed in succession. The process specified under Class 2 Surface Finish shall then be deferred until all other work, which would in any way affect or mar the final finish, is complete. The CONTRACTOR shall then apply a brush coat or surface film of thin cement mortar composed of 1 part Portland cement and 1 part of fine sand of such size that it will pass a No. 16 sieve or, at the option of the ENGINEER, a neat cement wash. In either case, an amount of calcium chloride equal to 5 percent by volume of the cement shall be used in the brush coat. When the cement film has set sufficiently so that the sand particles or cement will not drag out of surface pin but before the final set has taken place, the entire surface shall be thoroughly rubbed either by hand or by mechanical means with fine carborundum stone until a smooth surface of even texture, color, and appearance is obtained. No greater amount of mortar shall be applied in advance of rubbing than can be completely rubbed before final setting takes place. Immediately following the rubbing process, the finished surface shall be thoroughly washed with water.

510.16 CURING

Immediately after the completion of the finishing operations as the condition of the concrete will permit without danger of consequent damage thereto, the CONTRACTOR shall initiate the curing of the concrete as specified in Section 349 and/or as approved by the ENGINEER.

510.17 TESTS

Testing procedures shall be as provided for in Section 101. The number of test

specimens to be taken for compression tests shall be as specified in Section 101 or as otherwise required by the ENGINEER.

510.18 MEASUREMENT: Structural Concrete for Concrete Structures shall be measured by the cubic yard or as part of a lump sum item as indicated in the Bid Proposal.

510.18.2 PAYMENT: The payment for Structural Concrete shall be at the contract unit price per cubic yard or lump sum, complete in place. Payment shall include all material, equipment and labor required in forming, supporting, placing, finishing, curing, form and support removal, and cleanup.

SECTION 511

PNEUMATICALLY APPLIED CONCRETE

511.1 GENERAL

Pneumatically applied mortar or concrete, designated herein as gunite or approved equal, shall consist of premixed sand and portland cement pneumatically transported in a dry state to a nozzle where hydration takes place immediately prior to expulsion.

511.2 REFERENCES

- 511.2.1 ASTM
C 39
C 42

- 511.2.2 This publication
SECTION 105

511.3 EQUIPMENT

511.3.1 The cement gun should be operated at a minimum air pressure of 45 pounds per square inch on the gun tank when 100 feet or less of material hose is used, and the pressure should be increased 5 pounds for each additional 50 feet of hose required. Nozzles used for applying the material shall have a maximum size of 1 5/8 inches unless otherwise permitted by the ENGINEER.

511.3.2 Water used for hydration shall be maintained at a uniform pressure, which shall be at least 15 pounds per square inch above air pressure at the gun.

511.4 PROPORTIONS AND MIXING

Unless otherwise specified, the material shall consist of a mixture of cement and sand in the proportions, by volume, of 1 part of cement to 4 1/2 parts sand. The sand and cement shall be thoroughly mixed in a power mixer for at least 1 1/2 minutes before placement in the chamber of the gun. The dry mixed material shall be used promptly after mixing, and any material that has been mixed for more than 45 minutes shall be wasted.

511.5 TESTS

511.5.1 During the application of the material, the CONTRACTOR shall cooperate with the ENGINEER in making compressive tests required to determine the quality of the material being placed in the work. The tests shall be conducted in conformity with the requirements of ASTM C 39. Test specimens shall be made so as to represent the quality of material being placed in the work by each nozzleman and shall consist of 6 inches x 12 inches cylinders made by shooting the material vertically into cylindrical cages of 1/2 inch mesh hardware cloth mounted on a board. The

material outside the mold should be removed immediately after shooting the specimen so that the wire mesh can be detached before testing. The number of test specimens to be taken shall be as provided in the Supplementary Specifications or as determined by the ENGINEER. Separate test specimens made at the same place and time shall be tested at the age of 7 and 28 days. The specimens at the age of 7 days shall develop a minimum compressive strength of 2,400 pounds per square inch, and at the age of 28 days the specimens shall develop a minimum compressive strength of 3,500 pounds per square inch unless otherwise specified herein. In lieu of the above tests, the ENGINEER may elect to perform core tests. A minimum of 3 cores shall be taken for each 250 cubic yards or fraction thereof of material deposited.

511.5.2 Cores shall be obtained and tested in accordance with ASTM C 42. One core shall be removed and tested at an age of 14 days, the other 2 cores at an age of 28 days. Fourteen day cores shall develop a minimum strength of 2,200 psi. Twenty-eight day cores shall develop a minimum strength of 3,000 psi unless otherwise specified herein.

511.5.3 If the cores show deficient strength, additional cores shall be taken at the CONTRACTOR's expense from adjacent areas. Two cores shall be required for each deficient core. Should such deficiency be evident in 14 day cores, on approval of the ENGINEER, the CONTRACTOR may proceed with the work on his own responsibility until the 28 day cores are tested.

511.5.4 Where conditions preclude the possibility of obtaining cores from the material in place, the ENGINEER may approve cores taken from a representative test panel made at the same time and under the same conditions as the material being placed in the work.

511.6 PLACEMENT

511.6.1 Earth surfaces to which the material is to be applied shall be neatly trimmed to line and grade and shall be free of all loose material. The surface need not be compacted by slope rolling or other measures unless required by the plans or Supplementary Specifications.

511.6.2 No high subgrade will be permitted and excavation made below subgrade shall be backfilled with compacted fill or, at the CONTRACTOR's option, with

the material. However, no additional compensation will be allowed for such compacted fill nor for increased thickness of material placed on account of low subgrade.

511.6.3 Asphaltic concrete surfaces shall be thoroughly cleaned of any growth, silt and clay, or any other material detrimental to the material and then washed with water under pressure.

511.6.4 Masonry, rock, and concrete surfaces shall be examined and all loose material removed therefrom. The surface shall be thoroughly cleaned with steel scrapers or brushes to remove all dust, dirt, mortar, grease, or other deleterious substances and then washed with water.

511.6.5 Whenever brushing and scraping do not secure suitable results, sandblasting may be required.

511.6.6 All surfaces shall be wetted with water before application of the material, and no material shall be applied to surfaces on which free water exists.

511.6.7 The velocity of the material as it leaves the nozzle shall be maintained uniformly at a rate determined for given job conditions. Material which rebounds and does not fall clear of the work or which collects on the surfaces shall be blown off or otherwise removed. Rebound shall not be used in any portion of the work, and no pavement will be incorporated for rebound or other losses.

511.6.8 The nozzle shall be held at such distance and position that the stream of flowing material will impinge at approximately right angles to the surface being covered. Any portions of the placed material which tend to sag or which show soft or sandy pockets or are otherwise unsatisfactory shall be cut out and replaced. Reinforcement thus damaged or destroyed shall be replaced by trimming back and properly lapping and tying, to the satisfaction of the ENGINEER.

511.6.9 Reinforcement shall be firmly supported in the position shown on the plans. Mortar blocks, metal chairs, clips, or spacers with wire ties or other acceptable means shall be used to properly anchor and place the reinforcement.

511.6.10 Where material is placed on overhead surfaces, the amount of water used shall be so adjusted that approximately 3/4 inch of the placed material shall adhere without support. The limit of thickness has been exceeded when the material begins to sag or slough.

511.7 FORMS AND GROUND WIRES

511.7.1 The forms shall be built in accordance with applicable provisions of the specifications, except all forms shall be built so as to permit the escape of air and rebound.

511.7.2 Ground wires shall be installed in such manner that they accurately outline the finished surface as indicated on the plans. They shall be located at intervals sufficient to insure proper thickness throughout. Wires shall be stretched tight and shall not be removed prior to application of the finished coat.

511.7.3 Headers will be required where the plans indicate a formed edge and at plan joints.

511.8 JOINTS

511.8.1 Construction joints shall be sloped off at an angle of approximately 45° to the surface being shot. Before shooting the adjacent sections, the sloped portion shall be thoroughly cleaned and wetted by means of air and water blast.

511.8.2 The plan joint shall be formed in accordance with and placed in the locations as designated on the plans.

511.9 FINISH

511.9.1 Upon reaching the thickness and shape outlined by forms and ground wire, the surface shall be rodded off to true lines.

511.9.2 Any low spots or depressions shall be brought up to proper grade by placing additional material. Ground wires shall then be removed; and unless otherwise specified, the surface shall then be broom finished to secure a uniform surface texture. Rodding and working with a wood float shall be held to a minimum.

511.9.3 Rebound or accumulated loose sand shall be thoroughly cleaned up and disposed of to the satisfaction of the ENGINEER. In no case shall it be floated into the surface of the work.

511.9.4 When a nozzle finish is specified on the plans, ground wires shall not be used and the surface shall be left as uniform as possible without rodding. Nozzle finishes will not be permitted where the underlay has been floated.

511.10 CURING

511.10.1 The pneumatically placed material shall be cured as prescribed for concrete curing, Section 105.

511.10.2 The CONTRACTOR shall at all times protect the finished work from being scarred or damaged in any way.

511.11 MEASUREMENT AND PAYMENT

Measurement for pneumatically placed concrete will be made in conformity with the terms of the Contract and will be based on units and/or quantities as set forth in the Bid Proposal. Such payment shall be full compensation for furnishing all labor, materials, tools, and equipment and doing all work required to complete the Work in conformity with the plans and specifications.

SECTION 512

PRECAST PRESTRESSED CONCRETE MEMBERS

512.1 GENERAL

This work shall consist of furnishing and placing precast prestressed concrete members in accordance with the details shown on the plans and as specified in these specifications and the Supplementary Specifications. This work shall include the manufacture, transportation, and storage of girders, slabs, and other structural members of precast prestressed concrete and shall also include the placing of all precast prestressed concrete members. The members shall be furnished complete including all concrete, prestressing steel, bar reinforcing steel, and incidental materials in connection therewith. Prestressing shall be performed by either pretensioning or post-tensioning methods. The method of prestressing to be used shall be optional with the CONTRACTOR, subject to the requirements specified in these specifications. Prior to casting any members to be prestressed, the CONTRACTOR shall submit to the ENGINEER for review complete details of the method, materials, and equipment he proposes to use in the prestressing operations, including any additions or rearrangement of reinforcing steel from that shown on the plans. Such details shall outline the method and sequence of stressing and shall include complete specifications and details of the prestressing steel and anchoring devices, anchoring stresses, type of enclosures, and all other data pertaining to the prestressing operation, including the proposed arrangement of the prestressing steel in the members, pressure grouting, materials, and equipment. For any rearrangement of stress force pattern, the stress calculations shall be submitted for approval by the ENGINEER.

512.2 REFERENCES

512.2.1 ASTM

A 416
A 421

512.2.2 This Publication: SECTION 101 SECTION 510

512.3 CONCRETE

Concrete construction shall conform to the provisions in Section 510 of these specifications or as provided in the Supplementary Specifications. The design of the precast prestressed concrete

members is based on the use of concrete having a minimum compressive strength or strengths at 28 days of not less than the values shown on the plans. The CONTRACTOR shall be responsible for furnishing concrete for prestressed members which contains not less than 6 sacks of cement per cubic yard of concrete, which is workable and which conforms to the strength requirements specified. Batch proportions shall be determined by the CONTRACTOR. The compressive strength of the concrete will be determined from concrete test cylinders cured under conditions similar to those affecting the member. The use of admixtures for the purpose of producing high strength at an early date shall be subject to the approval of the ENGINEER. In no case shall the admixture contain calcium chloride. Aggregate for use in the manufacture of concrete for prestressed members may be 1 inch maximum or 3/4 inch maximum, in lieu of 1 1/2 inch maximum, at the option of the CONTRACTOR. Concrete shall not be deposited in the forms until the ENGINEER has inspected the placing of the reinforcement, enclosures, anchorages, and prestressing steel. The concrete shall be vibrated internally or externally, or both, as required to consolidate the concrete. The vibrating shall be done with care and in such manner that displacement of reinforcement, enclosures, and prestressing steel will be avoided. Holes for anchor bars and for diaphragm dowels which pass through the member, openings for connection rods, recesses for grout, and holes for railing bolts shall be provided in the members in accordance with the details shown on the plans. Where diaphragm dowels do not pass through the member, the dowels may be anchored in the member by embedment in the concrete or by means of an approved threaded insert. Forms for interior cells or holes in the members shall be constructed of a material that will resist breakage or deformation during the placing of concrete and will not materially increase the weight of the member. Lifting anchors may be installed in members to be placed in bridge decks provided that all portions of the anchor above the concrete are removed after the members are placed. Side forms for prestressed members may be removed after a period of 24 hours, provided arrangements satisfactory to the ENGINEER are made for curing and protecting the concrete. However, side forms may be removed as soon as the transfer strength has been attained. The steam-curing method or other approved methods

may be used for curing precast prestressed concrete members in lieu of water curing. Steam curing, if elected by the CONTRACTOR, shall conform to the following provisions:

512.3.1 After placement of the concrete, members shall be held for a minimum 2-hour presteaming period. If the ambient air temperature is below 50°F, steam shall be applied during the presteaming period to hold the air surrounding the member at a temperature between 50°F and 90°F.

512.3.2 All exposed surfaces of the members shall be kept wet continuously during the holding and curing period.

512.3.3 The steam shall be saturated low pressure and shall be distributed uniformly over all exposed surfaces of the member but shall not directly impinge on the exposed concrete surfaces.

512.3.4 The steam hood shall be equipped with temperature recording devices that will furnish an accurate continuous permanent record of the temperatures under the hood during the curing period. The position of the temperature devices shall be approved by the ENGINEER.

512.3.5 During application of the steam, the temperature gradient within the enclosure shall not exceed 40°F per hour. The curing temperature shall not exceed 150°F and shall be maintained at a constant level for sufficient time necessary to develop the required compressive strength.

512.3.6 The members shall be protected from sudden temperature and moisture changes for at least 48 hours after completion of steam curing.

512.4 PRESTRESSING STEEL

512.4.1 Prestressing steel shall be high-tensile wire conforming to ASTM A 421, high-tensile wire strand conforming to the following requirements: the cross sectional steel area of wire strand shall be within 0.003 square inch of the nominal steel areas shown in Table I of ASTM A 416. In the event the CONTRACTOR elects to use a wire strand manufactured to a higher breaking strength than is specified in ASTM A 416, such higher strength strand shall, in addition, conform to the requirements of Table 512.4.1.

512.4.2 High-tensile strength alloy bars shall be thermal stress relieved to produce a suitable metallurgical structure

and shall be individually proof tested during the process of manufacturing to a minimum of 90 percent of the manufacturer's minimum guaranteed ultimate strength. The mechanical properties of the completed bars shall be as per Table 512.4.2.

512.4.3 Bars of different ultimate strengths shall not be used interchangeably in the same member, unless otherwise permitted by the ENGINEER. In handling and shipping bars, every care shall be taken to avoid bending, injury from deflection, scraping, or over-stressing of the bars. All damaged bars will be rejected. When bars are to be extended by the use of couplers, the assembled units shall have a tensile strength of not less than the specified minimum ultimate tensile strength. Failure of any one sample to meet this requirement will be cause for rejection of the heat of bars and lot of couplers. The location of couplers in the member shall be subject to approval by the ENGINEER. All wire or strand to be post-tensioned shall be:

512.4.3.1 Protected from corrosion during shipping by a factory treatment or processing.

512.4.3.2 Protected against abrasion during shipment and handling.

512.4.3.3 Installed in members after steam curing, when steam curing is used.

512.4.3.4 Grouted in the enclosures within 48 hours after the wire or strand has been tensioned.

512.4.4 Wires shall be straightened if necessary to produce equal stress in all wires of wire groups or parallel lay cables that are to be stressed simultaneously or when necessary to insure proper positioning in the enclosures. Where wires are to button-headed, the buttons shall be cold formed symmetrically about the axis of the wires and shall develop the full strength of the wire. No cold-forming process shall be used that causes indentations in the wire. When the button-headed wire assembly is tested as a unit in tension, at least 90 percent of the failures at or above the minimum guaranteed ultimate strength of the wire shall occur in the wire and not in the buttons. All prestressing steel shall be protected against rust and other corrosion and damage and shall be free of all dirt, scale, and pits due to rust, oil, grease,

TABLE 512.4.1

STRENGTH REQUIREMENTS

BREAKING STRENGTH REQUIREMENTS

Nominal Diameter (inches)	3/8	7/16	1/2
Breaking Strength (lbs.), min.	23,000	31,000	41,000
Nominal Steel Area (sq. in.)	0.058	0.116	.1531
Nominal Weight, 1000 ft., (lbs.)	292	400	525

YIELD STRENGTH REQUIREMENTS

Nominal Diameter (inches)	3/8	7/16	1/2
Initial Load (lbs.)	2,300	3,100	4,130
Maximum Load 1% Extension (lbs.)	19,600	26,400	35,100

TABLE 512.4.2

MECHANICAL PROPERTIES

	Regular Grade	Special Grade
Ultimate tensile strength psi, min.	145,000	160,000
Yield strength, measured by the 0-7 percent extension under load method, psi, min	130,000	140,000
Elongation in 20-bar diameters after rupture, percent, min.	4.0	4.0
Reduction of area, percent, min.		
Modulus of elasticity at 70 percent of the manufacturer's minimum guaranteed ultimate strength psi, min.	25 x 10 ⁶	25 x 10 ⁶
Diameter tolerances shall conform to ASTM A 29.		

and other deleterious substances when finally encased in concrete or grouted in the member.

512.5 ANCHORAGES AND DISTRIBUTION

512.5.1 All post-tensioned prestressing steel shall be secured at the ends by means of approved anchoring devices. The anchors shall be of such nature that they will not kink, neckdown, or otherwise damage the prestressing steel. The load from the anchoring device shall be distributed to the concrete by means of approved devices that will effectively distribute the load to the concrete. Anchoring devices for all post-tensioned prestressing steel shall be of the permanent type. Where the end of a post-tensioned assembly will not be covered by concrete, the anchoring devices shall be recessed so that the ends of the prestressing steel and all parts of the anchoring devices will be at least 2 inches inside of the end surface of the members, unless a greater embedment is shown on the plans. Following post-tensioning, the recesses shall be filled with grout and finished flush. When headed wires are used, the outside edge of any hole for prestressing wire through a stressing washer or through an unthreaded bearing ring or plate shall not be less than 1/4 inch from the root of the thread of the washer or from the edge of the ring or plate.

512.5.2 Distribution plates or assemblies shall conform to the following requirements:

512.5.2.1 The final unit compressive stress on the concrete directly underneath the plate or assembly shall not exceed 3,000 pounds per square inch, and suitable grillage of reinforcing steel shall be used in the stressed area.

512.5.2.2 Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed the yield point of the material or cause visible distortion, as determined by the ENGINEER, in the anchorage plate when 100 percent of the ultimate load is applied.

512.5.3 Should the CONTRACTOR elect to furnish anchoring devices of a type which are sufficiently large and which are used in conjunction with a steel grillage embedded in the concrete that effectively distributes the compressive stresses to the concrete, the steel distribution plates or assemblies may be omitted.

512.6 ENCLOSURES

Enclosures for prestressing steel shall be metallic and mortar-tight and shall be accurately placed at the locations shown on the plans or approved by the ENGINEER. In lieu of metallic enclosures, openings for prestressing steel may be formed by means of cores or ducts composed of rubber or other suitable material that can be removed prior to installing prestressing steel. All enclosures or openings or anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing.

512.7 PRESTRESSING

512.7.1 All prestressing steel shall be tensioned by means of hydraulic jacks. Each jack shall be equipped with a pressure gauge having an accurately reading dial at least 6 inches in diameter and each jack and its gauge shall be accompanied by a certified calibration chart showing the relationship between gauge readings and stress in the ram for both ascending and descending movements of the ram.

512.7.2 The tensioning of prestressing steel in any post-tensioned member and the cutting or releasing of prestressing steel in any pretensioned member shall not be performed until tests on concrete cylinders indicate that the concrete in the member has attained a compressive strength of not less than the value shown on the plans.

512.7.3 Subject to prior approval by the ENGINEER, a portion of the total prestressing force may be applied to a member when the strength of the concrete in the member is less than the value shown on the plans and the member may then be moved. Approval by the ENGINEER of such partial prestressing and moving shall in no way relieve the CONTRACTOR of full responsibility for successfully constructing the members.

512.7.4 The cutting and releasing of prestressing steel in pretensioned members shall be performed in such an order that lateral eccentricity of prestress will be a minimum. The prestressing steel shall be cut off flush with the end of the member and the exposed ends of the prestressing steel shall be heavily coated with roofing asphalt or coal tar.

512.7.5 Post-tensioning will not be permitted until it is demonstrated to the satisfaction of the ENGINEER that the prestressing steel is free and unbonded in the enclosure.

512.7.6 The tensioning process as applied to post-tensioned members shall be so conducted that tension being applied and the elongation of the prestressing steel may be measured at all times. A record shall be kept of gauge pressures and elongations at all times and shall be submitted to the ENGINEER for approval.

512.7.7 Prestressing steel in post-tensioned members shall be tensioned by simultaneous jacking at each end of the assembly, except as provided by the following:

512.7.8 Jacking from one end of the assembly will be permitted on simple span members under 65 feet in length, provided the calculations show that the maximum temporary tensile stress at the center of the span will not be more than 70 percent of the ultimate tensile strength of the prestressing steel.

512.7.9 For simple span members 65 feet and over in length, jacking from one end will be permitted, provided the calculations and also field tests demonstrate that the maximum stresses at the center of the span will not be more than 70 percent of the ultimate tensile strength of the prestressing steel.

512.7.10 Unless otherwise permitted by the ENGINEER, half of the prestressing steel in each member shall be stressed from one end of the span and the other half from the opposite end. Determination of the jacking stresses shall be supported by calculations or both calculations and field tests when specified, prepared by the CONTRACTOR. The CONTRACTOR shall submit his calculations to the ENGINEER for approval and prior to making field tests, shall submit details of his proposed gauges and load devices for determining the jacking load at each end of the test prestressing unit to the ENGINEER for approval. The stress at the center will be calculated from the average of the end test loads. Jacking stresses within 2 percent of the specified values will be considered satisfactory.

512.7.11 The friction coefficients on Table 512.7.11 shall be used in calculating friction losses. K represents the wobble of the ducts, and U represents the curvature in draped cables.

512.7.12 The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed 75 percent of the ultimate tensile strength of the prestressing steel. The prestressing steel shall be anchored at stresses (initial stress) that will result in the ultimate retention of working forces of not less than those shown on the plans but in no case shall the initial stress exceed 70 percent of the ultimate tensile strength of the prestressing steel.

512.8 BONDING AND GROUTING

Post-tensioned prestressing steel shall be bonded to the concrete by pressure grouting and enclosures or openings. All prestressing steel to be bonded to the concrete shall be free of scale and pits due to rust, dirt, oil, grease, and other deleterious substances. Grouting equipment shall be capable of grouting to a pressure of at least 100 pounds per square inch. The grouting shall consist of neat cement and water conforming to the provisions in Section 101, Portland Cement Concrete. The grout shall completely fill the enclosure or opening. All enclosures or openings shall be clean and free of all foreign materials that would impair bonding of the grout. Each enclosure or opening shall be thoroughly flushed out with water and blown out with air or cleaned by other approved methods immediately prior to grouting. After post-tensioned prestressing steel has been pressure grouted, the member shall not be moved or otherwise disturbed until at least 24 hours have elapsed.

512.9 SAMPLES FOR TESTING

512.9.1 Sampling and testing shall conform to the specifications of ASTM A 416 and ASTM A 421 and as specified in this section. Samples from each size and each lot of prestressing steel wires and bars, from each manufactured reel of prestressing steel strand, and from each lot of anchorage assemblies and bar couplers to be used shall be furnished for testing. All materials for testing shall be furnished by the CONTRACTOR at his expense. The CONTRACTOR shall have no claim for additional compensation in the event his work is delayed awaiting approval of the materials furnished for testing. All wire or bars of each size from each mill lot and all strand from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each such lot can be accurately identified at the job site. Each lot of anchorage assemblies and bar couplers to be installed in the site shall be like-

TABLE 512.7.11

FRICTION COEFFICIENTS

Type of Steel	Type of Duct	K	U
Bright metal wire or strand	Bright metal	0.002	0.30
	Galvanized	0.0015	0.25
Bright metal bars	Bright metal	0.0003	0.20
	Galvanized	0.0002	0.15

wise identified. All unidentified prestressing steel, anchorage assemblies, or bar couplers received at the site will be rejected. The following samples of material and tendons, selected by the ENGINEER from the prestressing steel at the plant or job site, shall be furnished by the CONTRACTOR to the ENGINEER well in advance of anticipated use:

512.9.1.1 For wire or strand, one 7 foot long sample shall be furnished for each heat or reel; and for bars, one 6 foot long sample shall be furnished for each heat.

512.9.1.2 If the prestressing tendon is to be prefabricated, one completely fabricated prestressing tendon 5 feet in length for each size of tendon shall be furnished, including anchorage assemblies. If the prestressing tendon is to be assembled at the job site, sufficient wire or strand and end fittings to make up one complete prestressing tendon 5 feet in length for each size of tendon shall be furnished, including anchorage assemblies.

512.9.1.3 If the prestressing tendon is a bar, one 6 foot length complete with one end anchorage shall be furnished; and in addition, if couplers are to be used with the bars, two 3 foot lengths of bar equipped with one coupler and fabricated to fit the coupler shall be furnished.

512.9.2 Prestressing systems previously tested and approved need not be furnished as complete tendon samples, provided there is no change whatsoever in the material, design, or details previously approved. Shop drawings shall contain an identification of the project on which approval was obtained, otherwise sampling will be necessary. For prefabricated tendons, the CONTRACTOR shall give the ENGINEER at least 10 days notice before commencing the installation of end fittings or the heading of wires. The ENGINEER may inspect all end fitting installations and wire headings while such fabrication is in progress at the plant and will arrange for all required testing of the material to be shipped to the site. No prefabrication tendon shall be shipped to the site without first having been released by the ENGINEER, and each tendon shall be tagged before shipment for identification purposes at the site. All unidentified tendons received at the site will be rejected. Job site or site as referred to herein shall be considered to mean the location where the members are to be manufactured, whether at the project site or a removed casting yard.

The release of any material by the ENGINEER shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

512.10 HANDLING

Extreme care shall be exercised in handling, storing, moving, and erecting precast prestressed concrete members to avoid twisting, racking, or other distortion that would result in cracking or damage to the members. Precast prestressed members shall be handled, transported, and erected in an upright position; and the points of support and directions of the reactions with respect to the member shall be approximately the same during transportation and storage as when the member is in its final position. Precast prestressed concrete members shall be placed in the structure in conformity with the plans and Supplementary Specifications. Precast prestressed concrete piling shall be placed in accordance with the provisions for concrete piling.

512.11 MEASUREMENT AND PAYMENT

Precast prestressed concrete members will be measured using the unit quantities for furnishing precast prestressed concrete members of the various types and lengths as outlined in the Bid Proposal or quantities for erecting the members as shown in the Bid Proposal. When various lengths or types of members are grouped together for measurement, the basis of grouping will be shown on the Bid Proposal. This measurement shall include furnishing all labor, materials, tools, equipment, and incidentals for completing all work involved and ready for erection, as shown on the plans and as provided in these specifications, the Supplementary Specifications, or as directed by the ENGINEER. Measurement also includes furnishing and placing transverse connections, anchor rods, lifting eyes, expansion joint material, as well as grouting spaces and recesses between the members.

SECTION 520

STEEL STRUCTURES

520.1 GENERAL

This work shall consist of furnishing, erecting, and painting structural steel members and elements of structural steel, steel forgings, steel castings, gray iron castings, malleable castings, wrought iron, bronze castings, rolled copper alloy, and other ferrous or nonferrous materials in substantial compliance with the specifications, dimensions, shapes, and design shown on the plans for steel structures and for concrete structures where structural steel is indicated, according to latest AISC specifications.

520.2. REFERENCES

520.2.1 ASTM

A 36
A 47
E 350

520.2.2 AASHTO

M 102	M 108
M 103	M 183
M 105	M 228
M 107	

520.2.3 This Publication:
SECTION 139
SECTION 157

520.2.4 Others:
Specifications for Welded
Highway and Railroad Bridges,
American Welding Society

520.3 MATERIALS

Applicable materials specifications are as follows:

520.3.1 Structural steel shall conform with the requirements of AASHTO M 183 (ASTM A 36), unless otherwise specified.

520.3.2 Rivet steel shall conform with the requirements of AASHTO M 228.

520.3.3 Steel forgings shall conform with the requirements of AASHTO M 102, Class C 1.

520.3.4 Steel castings shall conform with the requirements of AASHTO M 103, Grade 65-35.

520.3.5 Gray iron castings shall conform with the requirements of AASHTO M 105, Class 30.

520.3.6 Malleable castings shall conform with the requirements of ASTM A 47. Malleable castings shall be boldly filleted at angles and the arises shall be sharp and perfect.

520.3.7 Wrought iron plates, bars, and shapes shall conform with the requirements of ASTM E 350.

520.3.8 Cast bronze plates shall conform with the requirements of AASHTO M 107, Alloy B.

520.3.9 Rolled copper alloy plates shall conform with the requirements of AASHTO M 108, Alloy No. 1.

520.3.10 Sheet lead shall be of good commercial quality.

520.3.11 Aluminum and aluminum alloy materials shall conform with the ASTM or Aluminum Alloy Designation shown on the plans.

520.3.12 Paint shall conform with applicable requirements of Section 157, Paint. All steel members shall be painted with one coat of red lead and two coats of aluminum paint, unless otherwise specified.

520.4 CONSTRUCTION REQUIREMENTS

520.4.1 Structural material, either plain or fabricated, shall be stored at the bridge shop above the ground on platforms, skids, or other supports. It shall be kept free from dirt, grease, and other foreign matter and shall be protected from corrosion. These requirements shall apply to fabricated material stored prior to shipment, as well as to the unfabricated material stored at the shop.

520.4.2 Rolled material, before being laid off or worked, shall be straight. When straightening is required, it shall be done by methods that will not produce fractures or otherwise injure the metal. The metal shall not be heated unless permitted by the ENGINEER. The heating shall not be a higher temperature than that producing a dark cherry red color. After heating, the metal shall be cooled slowly. Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture. Sharp kinks and bends shall

be cause for rejection of the material. Finished members shall be true to line and free from twists, bends, and other deformities.

520.4.3 Workmanship and finish shall conform with current standard shop practices. Shearing, flame cutting, and chipping shall be done carefully and accurately. Sheared edges of plates more than 5/8 inch in thickness and carrying calculated stress shall be planed for a depth of 1/4 inch. Re-entrant cuts shall be filleted before cutting.

520.4.4 Steel or wrought iron may be flame cut, provided a smooth surface is obtained. Flame cutting by hand shall be done only when approved by the ENGINEER, and the surface of such cuts shall be made smooth by planing, chipping, or grinding.

520.4.5 Shop inspection of structural steel does not relieve the CONTRACTOR of responsibility for fabrication errors. Errors discovered in the field shall be corrected by the CONTRACTOR without expense to the OWNER.

520.4.6 The inspector shall furnish 8 copies of a shop inspection report covering fabrication and inspection of all structural steel items, including a report on the interpretation of the radiographs when applicable.

520.5 WELDING

520.5.1 General Welding of steel shall be confined to such details as shown on the plans or authorized by the ENGINEER and shall conform to the specifications for Welded Highway and Railway Bridges of the American Welding Society. Shop shall remove all slag from shop welds before shipment.

520.5.2 Welded Steel Girders: Where welding is called for on the plans, welds may be made by an automatic or semi-automatic submerged arc in a deposit of granular or powdered flux using direct current or may be manually welded with shielded metal arc electrodes conforming to American Welding Society Specifications except that E6012, E6013, E6020, E7014, and E7024 electrodes shall not be used.

520.5.3 The fabricator will be required to demonstrate the capability of the electrodes, flux, and procedures he proposes to use for submerged arc welding.

520.5.4 All tension flange butt welds shall be radiographed for the entire

length of the joints. The tension area of all web plate butt welds shall be radiographed. If defects found in the above welds indicate the desirability, enough of the compression flange butt welds shall be radiographed to satisfy the ENGINEER of their acceptability.

520.5.5 At the option of the ENGINEER, fillet welds shall be examined by magnetic particle or penetrant dye techniques. One foot in each 10 feet of such welds may be examined; and if defects found indicate the desirability, additional examinations shall be made.

520.5.6 The radiographs, penetrant dye, or magnetic particle inspections shall be made by a qualified operator approved by the ENGINEER using approved equipment in accordance with Appendix E of A.W.S. Specifications for Welded Highway and Railway Bridges. The quality of the welds shall be acceptable under Paragraph 409 and Appendix F of these A.W.S. Specifications.

520.5.7 Defects in welds as shown by the inspections shall be removed by chipping or grinding to sound metal and the resulting cavities shall be rewelded. Welds that have been repaired shall be re-examined by methods initially used to reveal the defects.

520.5.8 All butt welds in flange plates shall be ground smooth with adjacent plates. The entire transition adjacent to butt welds between plates of different width or different thickness shall be ground smooth with adjacent plates, with grinding being done in direction of the stress. This grinding to produce a smooth transition without any trace of undercut or overlap of the weld. Care must be exercised to prevent grinding a depression in the thinner plate for the narrower plate at the junction. If this occurs, the depression must be filled with weld metal and the transition ground smooth.

520.5.9 The CONTRACTOR shall provide all equipment apparatus, supplies, and labor required for making the radiographic tests and magnetic particle or penetrant dye examinations and the cost thereof shall be included in the contract unit price per pound for structural steel. The CONTRACTOR shall turn over the radiograph films to the ENGINEER for interpretation.

520.5.10 The CONTRACTOR shall furnish a certified copy of test reports of all pertinent required tests under the

American Welding Society Specifications made on electrodes of the same class, size, and brand and which were manufactured by the same process and with the same materials as the electrodes furnished. The tests may have been for process qualifications or quality control and shall have been made within one year prior to manufacture of the electrodes furnished. The CONTRACTOR shall furnish 8 copies of the manufacturer's certification that the process and material requirements were the same for manufacturing the tested electrodes and the furnished electrodes.

520.6 JOINTS AND CONNECTIONS

520.6.1 When plans require abutting joints to be milled, the ends of the abutting members shall be accurately faced to provide a full and even bearing when assembled in the structure. When the plans require close joints, the opening between ends of abutting tension members shall not exceed 1/8 inch and the opening between abutting ends of rolled girders at splices shall not exceed 1/4 inch.

520.6.2 End connection angles of floor beams and stringers shall be flush with each other and accurately set to position and length of member. End connection angles shall not be finished unless shown on plans and the finished thickness shall not be less than the thickness shown on the plans. When finishing is authorized by the ENGINEER to remedy faulty assembling and riveting, the thickness shall not be reduced more than 1/16 inch nor shall the rivet bearing value be reduced below design requirements.

520.7 RIVETED PLATE GIRDERS

520.7.1 Plate girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than 1/8 inch below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates in girders having cover plates may be 1/2 inch less in width than the distance back to back of flange angles. Splices in webs of girders without cover plates shall be sealed on the top edge with red lead paste prior to painting. At web splices, the clearance between the ends of the web plates shall not exceed 3/8 inch. The clearance at the top and bottom ends of web splice plates shall not exceed 1/4 inch.

520.7.2 End stiffeners of plate girders or rolled beams and intermediate stiffeners for concentrated loads shall be milled or ground to obtain an even bearing against the flange angles or rolled flange. Intermediate stiffeners shall fit sufficiently tight against bottom flanges to exclude water after being painted. Fillers under stiffeners shall fit within 1/4 inch at each end. Flanges of rolled beams, against which stiffeners are to be made to bear, and at splices shall be straightened perpendicular to the web at the location of the stiffener before stiffeners are fitted and at the spliced end before shipment.

520.8 HOLES FOR RIVETS AND BOLTS

520.8.1 All holes shall be either punched or drilled. Shop connections for forming parts of a member composed of not more than 5 thicknesses of metal may be punched 1/16 inch larger than the nominal diameter of the connector whenever the thickness of the metal is not greater than 3/4 inch for structural steel or 5/8 inch for alloy steel. When there are more than 5 thicknesses or when any of the main material is thicker than 3/4 inch in carbon steel, or 5/8 inch in alloy steel, or when required for field connections, all the holes shall be subpunched or subdrilled 3/16 inch smaller and, after assembling, reamed 1/16 inch larger or drilled from the solid to 1/16 inch larger than the nominal diameter of the connector. All holes in material which is thicker than the nominal diameter of the connectors shall be subdrilled and reamed or drilled from the solid after assembling. The diameter of the die shall not exceed the diameter of the punch by more than 1/16 inch. When holes are enlarged to admit the connectors, they shall be reamed. Holes must be clean cut, without torn or ragged edges. Poor matching of holes will be cause for rejection.

520.8.2 Reamed holes shall be cylindrical, perpendicular to the member, and not more than 1/16 inch larger than the nominal diameter of the connector. Drilled holes shall be 1/16 inch larger than the nominal diameter of the connector. Burrs on the outside surfaces shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist drills. Assembled parts shall be taken apart for removal of burrs caused by drilling or reaming. Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being

reamed or drilled and shall be match-marked before disassembling. The use of tack welding in the shop of riveted beam and girder cover plates or bolted field splice materials for the purpose of drilling or reaming the holes will not be permitted.

520.8.3 Unless otherwise provided, holes in all field connections and field splices of main truss or arch members, continuous beams, plate girders, and rigid frames shall be subpunched or subdrilled and reamed either assembled or through a steel template not less than 1 inch thick or drilled full size either assembled or through a steel template not less than 1 inch thick. Other satisfactory methods approved by the ENGINEER may be used. The assembly, including alignment, camber, accuracy of holes, and milled joints shall be carefully checked before reaming is begun. Unless otherwise authorized by the ENGINEER, each individual truss, arch, continuous beam, plate girder, or rigid frame shall be assembled in the shop before reaming is commenced.

520.8.4 All holes for floor beams and stringer field connections and other connections shown on the plans shall be subpunched or subdrilled and reamed or drilled full size to a steel template not less than 1 inch thick or reamed or drilled full size while assembled. Other satisfactory methods approved by the ENGINEER may be used.

520.8.5 All holes punched or drilled full size shall be so accurately punched or drilled that when assembled and before any reaming is done a cylindrical pin 1/8 inch smaller in diameter than the nominal size of the hole may be entered perpendicular to the face of the member without drifting in not less than 75 percent of the contiguous holes in the same plane. The remaining holes may be reamed not to exceed 1/32 inch to pass the cylindrical pin. Connections not meeting the requirements herein provided may be rejected. The accuracy of subdrilled holes shall be the same as required for punched holes. When holes are reamed, drilled, or assembled, 85 percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32 inch between adjacent thickness of metal.

520.9 FABRICATION

520.9.1 Surface of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together

with bolts before reaming, riveting, or bolting is begun. Tack welding will not be permitted. Assembled pieces shall be taken apart when required for the removal of burrs and shavings produced by the reaming or drilling operation. The member shall be free from twists, bends, and other deformation.

520.9.2 End connection angles, stiffener angles, beam and girder cover plates, and similar parts shall be carefully adjusted to correct positions and bolted, clamped, or otherwise firmly held in place until connected. Tack welding will not be permitted, except on welded cover plates.

520.9.3 Parts not completely connected in the shop shall be secured by bolts to prevent damage in shipment and handling.

520.9.4 Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be matchmarked, and a diagram showing such marks shall be shown on the shop drawings.

520.9.5 The size of rivets shown on the plans shall be the size before heating. Rivet heads shall be of standard shape, unless otherwise provided, and of uniform size for the same diameter of rivet. Rivet heads shall be full, concentric with the shank and in full contact with the surface of the member.

520.9.6 Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot, completely filling the holes. Rivet points that are heated more than the remainder of the rivet shall not be driven. When a rivet is ready for driving, it shall be free from slag, scale, or other adhering matter. Any rivet which is scaled excessively will be rejected. Rivets which throw off sparks when taken from the forge shall not be driven. All rivets that are burned, loose, badly formed, or otherwise defective shall be removed and replaced. Any rivet head that is deficient in size or is driven off center shall be removed. Stitch rivets that are loosened by the driving of adjacent rivets shall be removed and replaced. In cutting out defective rivets, care shall be taken not to injure the adjacent metal; and when required, the rivet shanks shall be removed by drilling, the use of a cutting torch will not be permitted. Caulking or recupping of rivet heads will not be permitted. Approved beveled rivet sets shall be used for forming rivet heads on sloping surfaces. Counter-sinking shall be neatly done, and counter-sinking rivets shall completely fill the holes.

520.9.7 Bolted connections shall be used when shown on the plans or authorized by the ENGINEER for connections where it is impracticable to drive rivets. Where bolted connections are required, the bolts used shall be of the type shown on the plans or designated by the ENGINEER. High tensile strength bolts shall conform to the provisions of Section 139.

520.9.8 Turned bolts shall conform to details shown on the plans. The bolt shank shall be 1/16 inch larger than the nominal bolt size, shall be turned to a driving fit, and finished with a finishing cut. The threaded end shall be the nominal bolt size and shall terminate against the shank with a square shoulder entirely outside the hole. The bolts shall be of such length that threads will be entirely outside the hole and will extend entirely through the nuts not more than 1/4 inch. Heads and nuts shall be hexagonal. One-fourth inch nut locks shall be used on all turned bolts.

520.9.9 Ribbed bolts shall have a drive fit. The ribbed shank shall be slightly larger than the nominal bolt diameter with triangular longitudinal ribs. The ribbed shank shall extend entirely outside of the hole. The threaded end shall be the nominal bolt size and shall terminate against the shank with a square shoulder. Heads may be button heads, and nuts shall be hexagonal and recessed on the inside face to receive the shank and permit tightening securely against the connected parts. Ribbed bolts shall be of such length that threads will extend through the nuts not more than 1/4 inch. Self-locking nuts or 1/4 inch nut locks will be required on all bolts.

520.9.10 Unfinished bolts shall be standard bolts with square or hexagonal heads and hexagonal nuts. Bolts shall be threaded to such a length that not more than one thread will be within the grip of the connected parts and bolts shall be of the length that threads will extend through the nut not more than 1/4 inch. One-fourth inch nut locks shall be used on all bolts.

520.9.11 Turned and ribbed bolts shall be driven accurately into the holes without damaging the threads. The heads and nuts shall be drawn tight against the connected parts with a suitable wrench. Heads of drive fit bolts shall be tapped with a hammer while the nut is being tightened. Where bolts are used in beveled surfaces, beveled washers shall be provided to give full bearing to the head or nut.

520.10 BASE AND CAP PLATES--PINS AND ROLLERS

520.10.1 Ends of columns taking bearing upon base and cap plates shall be milled to true surfaces and correct bevels after the main section of these members and the end connection angles have been fully connected.

520.10.2 Cap and base plates of columns and the sole plates of girders and trusses shall have full contact when assembled. The plates, if warped or deformed, shall be hot-straightened, planed, or otherwise treated to secure an accurate, uniform contact. After being riveted in place, the excess material of countersunk rivet heads shall be chipped smooth and flush with the surrounding metal and the surfaces which are to come in contact with other metal surfaces shall be planed or milled, when required, to secure proper contact. The surfaces of base and sole plates that are to come in contact with masonry shall be rough-finished or not-straightened when not free from warps or other deficiencies.

520.10.3 When planing the surfaces of expansion plates, the cut of the tool shall be in the direction of expansion. Surfaces of cast bronze bearing plates for sliding contact shall be carefully milled and polish finished. Finishing of rolled copper alloy plates will not be required provided they have a plane with a smooth surface. Surfaces of pedestals and shoes which come in contact with metal surfaces shall be planed and those which are to take bearing upon the masonry shall be rough-finished.

520.10.4 Pins and rollers shall be accurately turned to dimensions and shall be smooth, straight, and free from flaws. Pins and rollers more than 9 inches in diameter shall be forged and annealed. Pins larger than 9 inches in diameter shall have a hole not less than 2 inches in diameter bored longitudinally through the centers. Pins showing defects will be rejected.

520.10.5 Pin holes shall be bored to dimensions, smooth and straight, at right angles with the axis of the member and parallel, unless otherwise required. The diameter of the pin hole shall not exceed that of the pin by more than 1/16 inch for pins 5 inches or less in diameter or 1/32 inch for larger pins. Boring of holes in built up members shall be done after the assembly is completed.

520.10.6 Threads for pins shall conform to the American National Coarse Thread Series, Class 2, free fit, except that the pin ends having a diameter of 1 3/8 inches or more shall be threaded 6 threads to the inch.

520.11 PRE-ERECTION REQUIREMENTS

520.11.1 Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon. The CONTRACTOR shall furnish as many copies of material orders, shipping statements, and erection diagrams as the ENGINEER may direct. The weights of the individual members shall be shown on the statements. Members weighing more than 3 tons shall have the weights marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged. Bolts and rivets of one length and diameter and loose nuts and washers of each size shall be packed separately. Pins, small parts, and packages of rivets, bolts, washers, and nuts shall be snipped in boxes, crates, kegs, or barrels. The gross weight of any package shall not exceed 300 pounds. A list and description of the material shall be plainly marked on the outside of each shipping container. When steel is painted in the shop, field rivet heads, field bolt heads and nuts, and abrasions in the original shop coat, due to handling during shipping and erecting, shall be covered with shop paint after the steel is erected.

520.11.2 The CONTRACTOR shall give ample notice to the ENGINEER of the beginning of work, at shop, so that inspection may be provided. No material shall be fabricated before the ENGINEER has been notified. Shop inspection may be waived by the ENGINEER.

520.11.3 The CONTRACTOR shall submit to the ENGINEER five complete sets of blueprints of shop and erection drawings for preliminary approval. One approved set will be returned to the CONTRACTOR with notations. The CONTRACTOR shall then furnish the ENGINEER with 10 sets of the final shop drawings for approval and no fabrication shall be done before approval has been given. No changes shall be made on any drawing without the approval of the ENGINEER. The CONTRACTOR shall furnish the ENGINEER with eight copies of mill test reports covering all structural steel items, including railing.

520.11.4 Structural material, either plain or fabricated, shall be stored above the ground on platforms, skids, or other supports. Such material shall be kept free from dirt, grease, and other foreign matter and properly drained and protected as far as practicable from corrosion. Girders and beams shall be placed upright and shored. Long members shall be supported on skids placed near enough together to prevent injury from deflection.

520.12 ERECTION REQUIREMENTS

520.12.1 Falsework shall be properly designed and substantially constructed and maintained for the required loads. When required, the CONTRACTOR shall prepare and submit to the ENGINEER for approval plans for falsework. Approval of the CONTRACTOR's falsework plans shall not relieve the CONTRACTOR of his responsibility. Falsework which cannot be founded on a footing shall be supported on falsework piling.

520.12.2 All work of erection shall be subject to the inspection of the ENGINEER, who shall be given all facilities required for a thorough inspection of workmanship. Before starting the work of erection, the CONTRACTOR shall inform the ENGINEER as to the method of erection he proposes to follow and the amount and character of equipment he proposes to use, which shall be subject to the approval of the ENGINEER. The approval of the ENGINEER shall not relieve the CONTRACTOR of his responsibility for the safety of his method or equipment or from carrying out the work as herein provided.

520.12.3 Column bases, truss and girder pedestals and shoes, and other masonry bearings shall have a full and uniform bearing upon the substructure masonry. Such bearings shall not be placed on the bridge seat areas of piers or abutments that are improperly finished or irregular.

520.12.4 The shoes and pedestals of truss and girder spans, the bases of columns, and other masonry bearings shall be located to correct alignments and elevations. Unless otherwise provided, shoes and pedestals of truss and girder spans shall be placed on lead sheets of the thickness shown on the plans.

520.12.5 Anchor bolt holes shall be installed at locations and in manner shown on the plans, perpendicular to the plane of the bridge seat. Unless otherwise shown on the plans or authorized by the ENGINEER, anchor bolts placed in

drilled holes shall be set in Portland cement mortar. The mortar shall consist of 1 part cement to 1 part clean, fine grained sand mixed with a minimum of water necessary to set the anchor bolts. Anchor bolts shall be placed in the dry holes to assure satisfactory fit after setting. The bolts shall be set as herein provided. The holes shall be partially filled with mortar so that by uniform even pressure or light blows with a hammer the bolts will be forced into the holes and the mortar will rise to the top of the holes. All excess mortar shall be removed after the bolts have been set. The anchor bolt nut shall rest firmly against the metal shoe or pedestal. Anchor bolts at the expansion ends of spans shall permit the free movement of the span.

520.12.6 Field assembling of the component parts of a structure shall be consistent with standard construction practices to prevent injury to the metal. Members bent or twisted shall be corrected or removed and replaced without expense to the OWNER.

520.12.7 Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension cord splices are fully connected and all other truss connections pinned or bolted. Rivets or bolts, in splices of butt joints of compression members and in railings, shall not be placed until the span has been swung.

520.12.8 Riveted or bolted field splices and joints for assembling steel members shall be made up with erection bolts and cylindrical erection pins. A sufficient number of erection pins shall be used to align the holes and a sufficient number of bolts shall be used to bring and hold the component parts of the splice or joint in full contact. In assembling and making up splices and connections for main truss and arch members at least 1/2 of the holes shall be filled with pins and bolts. All splices and connections carrying traffic during erection shall be made up with pins and bolts in at least 3/4 of the holes.

520.12.9 Erection bolts shall be of the same nominal diameter as the rivets or field bolts. Cylindrical erection pins shall be 1/32 inch larger than the nominal diameter of the rivets or bolts. High tensile strength steel bolts may be used as erection bolts, provided they are not loosened and retightened.

520.12.10 The straightening of bent edges of plates, angles, and other shapes shall be done by methods not likely to produce fracture or other injury. The metal shall not be heated unless permitted by the ENGINEER, in which case the heating shall not be to a higher temperature than that producing a dark cherry red color. After heating, the metal shall be cooled as slowly as possible. Following the completion of the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of incipient or other fractures.

520.12.11 The results obtained in the field assembling and riveting of the members of a structure shall conform to the requirements for shop assembling and riveting. Field-driven rivets shall be inspected and accepted before being painted. Field riveting or bolting shall be done before the falsework is removed, except for compression chords of trusses, unless special permission to the contrary is given by the ENGINEER. Railings shall not be fastened until the falsework has been removed and all dead load is in place on the span and shall be adjusted to bring the railing to exact line and grade.

520.12.12 Pneumatic hammers shall be used for field riveting. Cup faced dollies, fitting the head closely to insure good bearing, shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal. Unfair holes shall be reamed or drilled if permitted by the ENGINEER. Rivets shall be heated uniformly to a light cherry red color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shank, and shall have full bearing all around. They shall not be smaller than the heads on the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets, the surrounding metal shall not be injured; if necessary, they shall be drilled out. No rivets shall be removed by flame cutting.

520.12.13 Unless otherwise required, bolted splices and field connections shall be fitted up as required for riveted connections with drift pins and fitting-up bolts.

520.12.14 Pilot and driving nuts shall be used in driving pins, details shall be shown on the shop plans. One pilot and one driving nut for each size pin shall be furnished by the CONTRACTOR without charge. Pins shall be driven so that the members will take full bearing on them.

520.12.15 The correction of minor misfits involving unarmful amounts of reaming, cutting, and chipping will be considered a legitimate part of the erection. However, any error in the shop fabrication or deformations resulting from handling and transportation which prevent the proper assembling and fitting up of parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the ENGINEER and his approval of the method of correction obtained. The correction shall be made in his presence.

520.12.16 Before concrete floor are placed on steel truss or arch spans, the centering under the bridge shall be released and the span swung free on its supports. The operation of placing the concrete in any floor slab shall be continuous between expansion joints, unless otherwise provided on the drawings.

520.13 MEASUREMENT AND PAYMENT

520.13.1 Structural steel and other metal material will be measured by the computed weight, in pounds, based on the details shown on the fabricator's approved shop drawings or from detailed plans prepared by the ENGINEER when shop drawings are not required. Payment will be made at the unit price per pound in accordance with the Bid Proposal. When provided in the the Bid Proposal, structural steel and other metals may be measured and paid for on a lump sum basis.

520.13.2 The CONTRACTOR will be paid only for the material actually installed in the completed structure.

520.13.3 Should the CONTRACTOR, upon his request in writing, be allowed to substitute heavier sections than are called for on the design drawings, the additional weight of such heavier sections will not be paid for.

520.13.4 The ENGINEER may require the CONTRACTOR to furnish scale weights of the metal members. If the scale weight of any member is less than 97.5 percent of the computed weight, it shall be cause for rejection.

520.13.5 The computed weight will be determined as follows:

520.13.5.1 The weight of steel shall be assumed at .2833 pounds per cubic inch. The weight of cast iron shall be assumed at .2575 pounds per cubic inch. The weight of bronze shall be assumed at .3102 pounds per cubic inch. The weight of lead shall be assumed at .4091 pounds per cubic inch.

520.13.5.2 The weight of rolled shapes and plates shall be computed on the basis of their nominal weights and dimensions, as shown on the approved shop drawings, deducting for copes, cuts, and open holes, except that open holes for rivets shall not be deducted.

520.13.5.3 The weight of heads of rivets and bolt elements outside the grip, in place in the finished structure, shall be included in the computed weight.

520.13.5.4 The weight of castings shall be computed according to the net volume of the finished casting as shown on the approved shop drawings, with an addition of 10 percent for fillets and overrun.

520.13.5.5 The weight of weld metal shall not be included in the computed steel weight.

SECTION 530

TIMBER STRUCTURES AND TIMBER CONSTRUCTION

530.1 GENERAL

Timber structures erected under these specifications shall conform to the dimensions and details shown on the plans and shall be constructed in accordance with these requirements unless otherwise provided.

530.2 REFERENCES

- 530.2.1 This Publication:
SECTION 146
SECTION 157

530.3 MATERIALS

Timber and lumber that is stored prior to its use shall be neatly piled on skids in a manner that will prevent warping and shall be protected from the sun when so required. Materials shall be stored or piled to permit ready access for inspection. The use of cant hooks, peavies, or other pointed tools and hooks will not be permitted in the handling of structural timber, lumber or piles. Care and precaution shall be exercised in handling treated material in order not to damage or abrade the surface thereof to the extent of exposing untreated wood, and any piece so damaged or abraded will be rejected. Treated timber or piling cut after treatment shall be treated in accordance with Section 146. This same requirement shall apply to any surface that has become damaged or abraded to the extent of exposing untreated wood. All borings and holes shall be similarly treated, and those that are not to be used for rods, bolts, pins, screws, spikes, and the like or that will not subsequently be otherwise closed shall be tightly filled with treated plugs. Timber for floors and decks and that which is to be used in construction of split ring or shear plate connected trusses shall be well seasoned and thoroughly air dried before being incorporated in the work. This requirement shall apply to all material treated or untreated.

530.4 WORKMANSHIP

All lumber and timber shall be cut and framed to a close fit and shall have even bearing over the entire contact surfaces. No shimming will be permitted in making joints. Holes for drift pins in untreated lumber shall be bored with a bit 1/16 inch less in diameter than the pin or dowel. Holes for drift pins and

dowels in treated lumber shall be bored with a bit of the same diameter as the pin or dowel. Holes for truss rods or bolts shall be bored with a bit 1/16 inch larger than the rod or bolt. Holes for lag screws shall be bored with a bit not larger than the base of the thread. In small timbers where the prevention of splitting is necessary, holes shall be bored for spikes with a bit having a diameter not larger than that of the spike. In the installation of metal timber connectors, care shall be exercised to insure that the connector is installed concentric with its corresponding bolt; and if more than one connector bolt is installed in any individual joint, all bolts in such joint shall be drawn up to an even and uniform tension. The grooves for split-ring and shear-plate connectors shall be drawn up to an even and uniform tension. The grooves for split-ring and shear-plate connectors shall be carefully cut to a uniform width and depth for full perimeter thereof. The dimensions of these grooves and the manner and means of cutting shall be as recommended by the manufacturer of the particular connector to be installed; and any special tool or equipment used in cutting the grooves shall be operated in the manner and at the speed similarly recommended. Toothed-ring and spiked-grind connectors shall be installed by means of pressure equipment of a type intended for the purpose. However, split-ring connectors shall not be forced on but shall be expanded to such extent as to readily slip over the core formed by the groove without damaging the wood. All bolts, unless otherwise indicated on the plans, shall be 3/4 inch in diameter or larger and shall be of sufficient length to project beyond the nut when the nut is drawn tight. Bolts shall be fitted at each end with either a malleable iron (ogee) washer or a steel plate at least 3 inches square and not less than 3/8 inch thick or as otherwise shown on the plans.

530.5 FRAMING

530.5.1 Mudsills shall be firmly and evenly bedded on solid material.

530.5.2 Sills and caps shall have a full even bearing on the pedestals, mudsills, posts, or piles. Caps and sills shall be securely drifted to the posts by drift bolts not less than 3/4 inch in diameter,

extending into the post by at least 9 inches, and set approximately in the center of the posts.

530.5.3 Bents shall be accurately aligned before the bracing is placed. Bracing shall be fastened at the ends and at each intersection by 3/4 inch bolts. Bracing shall be of such length as will provide a minimum distance of 8 inches between the outside bolt and the end of the brace.

530.5.4 In placing joints, the better edge shall be placed down. The elevation of the tops of adjacent joists shall not vary more than 1/8 inch. Outside joists shall have butt joints. Interior joists shall be lapped and shall extend the full width of the cap to obtain full bearing. Bridging between joists shall be solid and fastened to the joists near the top of the block and on each side of the bottom of the block. Bridging shall be accurately cut to fit closely between the joists.

530.5.5 Trusses when completed shall show no irregularity of line. Chords shall be straight and true from end to end in horizontal projection, and in vertical projection shall show a smooth curve through panel points conforming to the correct camber. Uneven and rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.

530.5.6 Laminated bridge floors shall be constructed with planks, as shown on the plans. The planks shall be laid with the better edge down.

530.6 PAINTING

The railing of timber bridges, including the posts, the entire outer edge of bridge decks except treated surfaces, and any other surfaces indicated on the plans to be painted, shall be painted as prescribed in Section 157. The surface of wooden guard rails above the ground shall be painted as prescribed in Section 157. The lumber shall be cut to fit and then the entire surface shall be given the specified prime coat. The remaining coats shall be applied after the structure has been erected.

530.7 MEASUREMENT AND PAYMENT

Timber structures will be measured as provided in the Bid Proposal. Where board measure is used, the quantity will be determined from nominal widths and thicknesses and the actual lengths of the pieces in the finished structure, except

that in laminated timber flooring the number of laminations shall be the required number of the size specified after dressing and the length of each lamination shall be considered as the full width of length of the floor.

SECTION 540

CONCRETE BLOCK MASONRY STRUCTURES

540.1 GENERAL

Work to be done under this section shall consist of the construction of concrete block masonry walls incorporated into and being part of a building or structure, and free standing and retaining walls, constructed of concrete block masonry units. Wall heights, thickness, pilaster locations, reinforcing length, and other data shall be as shown on the plans, specified herein, and as specified in the Supplementary Specifications.

540.2 REFERENCES

540.2.1 This Publication:
SECTION 106

540.3 MASONRY UNITS

Unless otherwise specified and except for manhole construction, concrete block masonry shall be constructed of Grade N-I or N-II hollow masonry units.

540.4 MORTAR AND GROUT

Except as otherwise herein specified, all mortar and grout shall conform to Section 106. Mortar and grout for use in sewer manholes shall be prepared from Type II cement or approved equal. All work shall be executed in the best workmanlike manner and in full compliance with the applicable building ordinances. Masonry walls shall be laid true, level, and plumb in accordance with the plans. Surfaces on masonry units shall be clean, dry, and free from dirt when laid in the walls.

540.5 CONSTRUCTION

All concrete block units shall be dry when laid. During construction all partially laid walls, as well as units in storage, shall be protected from moisture. All concrete block units and any partially laid walls which become wet during the construction shall be permitted to dry for at least one week or longer if required by weather conditions before recommencing work. Proper masonry units shall be used to provide for all openings in walls, bond beams, lintels, pilasters, etc., with a minimum of unit cutting. Where masonry unit cutting is necessary, all cuts shall be neat and regular and edges exposed in the finished work shall be cut with a power-driven abrasive saw. Where no bond pattern is shown, the wall shall be laid up in

straight uniform course with regular running bond. Intersecting masonry walls and partitions shall be bonded by staggering the joints to form a masonry bond and the use of 1/4 inch minimum diameter steel ties at 24 inches o.c. maximum. Where stack bond is indicated on the plans, approved metal ties shall be furnished and installed as directed by the ENGINEER. Mortar joints shall be straight, clean, and uniform in thickness. Unless otherwise specified or detailed on the plans, horizontal joints shall be approximately 3/8 inch thick with full mortar coverage on the face shells, shall have vertical joints buttered well for a thickness equal to the face shell of the block, and these joints shall be shoved tightly so that the mortar bonds to both blocks. Masonry to be plastered shall have all mortar joints trowel cut flush. Exposed walls shall have joints tooled with a round bar (or V shaped bar) to produce a dense, slightly concave surface well bonded to the block at the edges. Tooling shall be done when the mortar is partially set but still sufficiently plastic to bond. All tooling shall be done with a tool which compacts the mortar, pressing the excess mortar out of the joint rather than dragging it out. If it is necessary to move a block so as to open a joint, the block shall be removed from the wall, cleaned, and set in fresh mortar.

540.6 PLACING REINFORCING STEEL

Reinforcing steel and wire mesh type of reinforcing shall be placed as indicated on the plans. Splices shall be lapped a minimum of 40 diameters, except that dowels other than column dowels need be lapped only 30 diameters. Column dowels shall lap 50 diameters. Outside horizontal steel shall lap around corners 40 diameters and be carried through columns unless otherwise shown on the plans. Inside horizontal steel shall extend as far as possible and bend into corner core. A dowel shall be provided in the foundation for each vertical bar. Where horizontal courses are to be filled, metal stops shall be used. Use of paper stops will not be permitted. All horizontal reinforcing steels shall be laid in a course of bond beam blocks filled with grout. Vertical cores containing steel shall be filled solid with grout and thoroughly rodded. Where knockout blocks are not used, steel shall be erected and wired in place before 3 courses have been laid. Vertical cores

at steel locations shall be filled as construction progresses. Where knockout blocks are used, vertical cores at steel locations shall be filled in lifts of not more than 4 feet. The maximum height of pour shall be 8 feet. Cores shall be cleaned of debris and mortar and shall have reinforcing steel held straight in place. If ordered by the ENGINEER, inspection and cleanout holes shall be provided at the bottom of each core to be filled. Reinforcing shall be inspected prior to placing grout.

540.7 CURING

Newly constructed masonry shall be kept damp for at least five days with a nozzle regulated fog spray sufficient only to moisten faces of the masonry but not of such quantity as to cause water to flow down over the masonry or by the use of approved curing compounds or as specified in the Supplementary Specifications.

540.8 MEASUREMENT AND PAYMENT

540.8.1 Concrete block masonry walls shall be measured by the wall area in square feet, as determined by the mathematical product of the length, including pilasters, and the height from the top of the footing to the top of the wall. Payment shall be made on the Bid Proposal's unit price per square foot, as per specified wall or block width and design (hollow, concrete filled blocks or reinforced).

540.8.2 The footing shall be measured separately by the cubic yard of plain or reinforced concrete as specified on the drawings and appropriate bid items.

SECTION 541

BRICK MASONRY STRUCTURES

541.1 GENERAL

Work to be done under this section shall consist of the construction of brick masonry walls incorporated into and being part of a building or structure, and free standing and retaining walls, constructed of brick masonry units. Wall heights, thickness, pilaster locations, reinforcing, length, and other data shall be as shown on the plans.

541.2 REFERENCES

541.2.1 This Publication:
SECTION 106
SECTION 108

541.3 MATERIALS

Unless otherwise specified, brick masonry shall be constructed of Grade MW brick as described in Section 108 and cement mortar as described in Section 106.

541.4 BRICKLAYING

541.4.1 The amount of wetting will depend on the rate of absorption of the brick at the time of laying. When being laid, the brick shall have suction sufficient to hold the mortar and to delete the excess water from grout and shall be sufficiently damp so that the mortar will remain plastic enough to permit the brick to be leveled and plumbed after being laid without breaking the mortar bond.

541.4.2 Brick work shall be plumb, level, straight, and true to dimensions shown on the plans. Such work shall start, where feasible, at the least important corner of wall and the CONTRACTOR shall request an early inspection of the work by the ENGINEER. All pattern work, bonds, or special details indicated on the drawings shall be accurately and uniformly executed. Face bonding shall be as shown on the drawings but, if not shown, shall be running bond for standard size brick and approximately 1/3 bond for oversize brick and approximately 1/4 bond for modular brick. All bed and head joints shall be solidly filled with mortar at the time of laying.

541.4.3 Unless otherwise shown or detailed on the plans, the thickness of mortar joints shall be uniformly 1/2 inch.

541.4.4 Face brick shown to be laid in stack bond shall have the center lines of vertical joints plumb and the brick laid

equidistant from the center line with not more than 1/8 inch variation in the width of these joints. The brick in each separate "stack" shall not vary more than 1/8 inch in length, but the separate "stack" may vary in width of stacks.

541.4.5 When mortar has slightly stiffened, solidly fill with mortar all interstices between bricks and between bricks and other materials and also fill all line pin holes. Jointing and tooling shall be done before mortar has stiffened.

541.4.6 Masonry to be plastered shall have all mortar joints trowel cut flush.

541.4.7 Masonry to be painted and not shown to be tooled or raked shall have all joints carefully and evenly struck with a trowel.

541.4.8 Masonry to be left exposed without paint or plaster shall have all mortar joints carefully and evenly tooled with a metal jointing tool of a type as approved by the ENGINEER. Masonry shown or indicated to have raked joints shall have the joints raked out 3/8 inch deep, then tooled with a flat jointing tool, then brushed with a stiff nonmetallic brush. Sack-rubbing or wiping finished masonry with rags will not be permitted.

541.5 PROTECTION

Protect all sills, ledges, offsets, other materials, etc. from droppings of mortar during construction. Protect the tops of all unfinished masonry from rain by using water-repellent covering, such as roofing felt or tar paper. Protect the surfaces of wall, piers, etc. from mortar droppings or splashes at scaffold heights.

541.6 CURING

Finished masonry shall not be wetted except when exposed to extreme hot weather or hot wind, and then only by using a nozzle-regulated fog spray sufficient only to dampen the face but not of such quantity to cause water to flow down over the masonry.

541.7 REINFORCED GROUTED BRICK MASONRY

541.7.1 Mortar in all bed joints shall be held back 1/4 inch from edges of brick adjacent to grout space or shall be beveled back and upward from grout space. The thickness of head and bed joints shall be as hereinbefore specified

or shown. Head joints specified or shown to be less than 5/8 inch thick shall be solidly filled with mortar as bricks are laid. Head joints 5/8 inch or more in thickness may have mortar sufficient only to form dams to retain the grout. Bed joints shall not be deeply furrowed with the trowel. All brick shall be shoved at least 1/2 inch into place. One outer tier may be carried up not more than 12 inches before grouting, but the other tier shall be not more than 4 inches high before placing the grout.

541.7.2 Grout shall be thoroughly agitated and mixed to eliminate segregation before being placed. All interior grout spaces shall be filled with grout and immediately puddled or swished with a stick or rod (not a trowel) sufficiently to cause the grout to flow into all interstices between the bricks and to fully encase the reinforcing steel. Wherever possible, grouting shall be done from the inside face of exterior masonry. If any grout contacts the finished masonry, it shall be immediately removed and the surface cleaned.

541.7.3 In masonry which is more than 2 tiers in thickness, including pilasters and columns, the interior shall be of whole or half bricks placed into grout with not less than 3/4 inch of grout surrounding each brick or half brick. Except at the finish course, all grout shall be stopped 1 1/2 inches below the top of both outer tiers.

541.7.4 Where necessary to stop off a longitudinal run of masonry, it shall be done only by racking back 1/2 brick length in each course and stopping grout 2 inches back of the rack. Tothing will not be permitted unless special approval is given by the ENGINEER.

541.7.5 Reinforcing steel shall be accurately placed in strict accordance with the drawings and notes thereon. Vertical steel shall be held firmly in proper position. Where necessary, this shall be done by means of frames or other suitable devices. Horizontal steel may be placed as the work progresses.

541.8 MEASUREMENT AND PAYMENT

When the Bid Proposal contains items for construction of free standing brick masonry walls and brick masonry retaining walls, the unit of measurement shall be the linear foot for the various designated wall heights and wall thickness. Otherwise the work will have been incorporated as part of a lump sum bid item for a building or structure.

SECTION 550

METAL RAILING

550.1 GENERAL

This work shall consist of furnishing and erecting metal railing in substantial compliance with the specifications and the dimensions, lines, and grades shown on the plans or established by the ENGINEER.

550.2 REFERENCES

550.2.1 ASTM

A 36

A 120

550.2.2 AASHTO

M 183

550.2.3 This Publication:

SECTION 157

SECTION 520

550.3 MATERIALS

The materials shall be in conformity with the following requirements:

550.3.1 Railing shall be fabricated from the material designated on the plans. If not so designated, railing may be fabricated from either steel or aluminum alloy.

550.3.2 The design of railings shall conform to the particular type or types designated on the plans. The CONTRACTOR will be required to submit complete shop details and erection plans for all railings.

550.3.3 Steel Railings--Unless otherwise shown on the plans, structural steel for steel railings, including bolts, shall conform to the requirements of AASHTO M 183 (ASTM A 36).

550.3.4 Pipe Railings--Steel pipe for pipe railing members shall be black seamless steel pipe of the size, dimensions and details shown on the plans, and conforming to the requirements of ASTM A 120. The hydrostatic test will not be required.

550.3.5 Aluminum Railings--Aluminum alloys for all castings, tubing, structural shapes, plates, bolts and washers shall conform to the requirements of ASTM specifications for alloys for the various items required as designated on the plans.

550.4 CONSTRUCTION REQUIREMENTS

550.4.1 STEEL RAILINGS:

550.4.1.1 Steel railings shall be fabricated and erected in accordance with the pertinent requirements for the fabrication and erection of structural steel under Section 520. Steel railings shall be erected in accordance with the details shown on the plans. Care shall be taken to obtain accurate vertical and horizontal alignment.

550.4.1.2 Unless otherwise provided on the plans, all steel railing members shall be painted with one prime coat of red lead and linseed oil and two coat of aluminum paint. The paint shall conform to the requirements for paint under Section 157. The preparation of surfaces and the application, protection, and drying of paint coatings shall conform to the requirements for painting under Section 157. Surface adjacent to field welds shall not be painted until after the welds are completed. Surfaces that are inaccessible after erection shall be painted and allowed to dry before the member is erected. After erection, all abrasions and omissions shall be recoated.

550.4.2 PIPE RAILINGS:

Construction methods for pipe railings shall conform to construction methods for steel railings as outlined above.

550.4.3 ALUMINUM RAILINGS:

550.4.3.1 Aluminum railings shall be fabricated and erected in accordance with the requirements for fabrication and erection of structural steel under Section 520 with the following modifications:

550.4.3.1.1 Cutting--Material 1/2 inch thick or less may be sheared, sawed, or milled. Material over 1/2 inch thick shall be sawed or milled. Cut edges shall be true, smooth, and free from excessive burrs or ragged breaks. Reentrant cuts shall be filleted by drilling prior to cutting. Flame cutting will not be permitted.

550.4.3.1.2 Bending--To facilitate bending, material may be heated to a temperature not exceeding 400 degrees F. for a period not to exceed 30 minutes.

550.4.3.1.3 Rivet and Bolt Holes--Rivet and bolt holes may be drilled to finished size or may be subpunched smaller than the nominal diameter of the fastener and reamed to size. The amount by which the diameter of the subpunched hole is

smaller than that of the finished hole shall be at least one-quarter of the thickness of the piece. The finished diameter of holes shall be not more than 7 percent greater than the nominal diameter of the fastener except:

550.4.3.1.3.1 Slotted holes shall be as called for on the drawings.

550.4.3.1.3.2 Anchor bolt holes may be up to 50 percent greater than the nominal bolt diameter with a maximum of 1/2 inch greater than the nominal bolt diameter.

550.4.3.2 Driven heads of rivets shall be flat head or cone head. Flat heads shall have a diameter not less than 1.4 and a height not less than 0.4 times the nominal rivet diameter. Cone heads shall have a diameter not less than 1.4 and an overall height not less than 0.65 times the nominal rivet diameter. The included angle at the apex of the cone head shall be approximately 127 degrees.

550.4.3.3 Rivets shall be driven with squeeze riveters when practical or otherwise by pneumatic hammers of approved size. Rivets 1/2 inch or less in diameter shall be driven cold. Rivets over 1/2 inch diameter may be driven hot. Rivets shall be heated in a hot air type furnace providing uniform temperatures throughout the rivet chamber and equipped with automatic temperature controls. The rivet temperature shall be held between 990 degrees F. and 1,050 degrees F. for not less than fifteen minutes and not more than one hour before driving. Hot rivets shall be transferred from the furnace to the work and driven with a minimum loss of time.

550.4.3.4 Welding shall be done by an arc welding process in which no welding flux is used. The type of electrodes shall be as noted on the railing drawings. Welding shall be done only as called for on such drawings.

550.4.3.5 Tubular vertical balusters may be fastened to horizontal rails by expanding the tubes where they pass through the rails. The holes shall be drilled to a size not more than 1/32 inch greater than the nominal diameter of the baluster tube. A standard self-feeding tapered roll expander shall be used. Balusters shall be expanded to a tight fit in all rails.

550.4.3.6 The portion of the aluminum alloy anchor bolts which is intended to be exposed outside the finished concrete surface shall be given a protective coating of grease or heavy oil before the concrete is placed.

550.4.3.7 Contact with Other Materials--Where aluminum alloys come in contact with other metals or with concrete, the contacting surfaces shall be thoroughly coated as required on the railing drawings.

550.4.3.8 Except as required above for contact with other materials, aluminum railings shall not be painted.

550.4.3.9 Aluminum railings shall be erected in accordance with details shown on the plans. Care shall be taken to obtain accurate horizontal and vertical alignment.

550.5 MEASUREMENT AND PAYMENT

550.5.1 Measurement of metal railing will be made by one of the following methods:

550.5.1.1 By lineal measured foot from end to end of the metal railing in place.

550.5.1.2 By computed weight, in pounds, based on details shown on the fabricator's approved shop drawings or from detailed plans prepared by the ENGINEER when shop drawings are not required.

550.5.1.3 By the unit of the completed metal railing.

550.5.2 Metal railing will be paid for at the Bid Proposal's unit price per lineal foot or pound, or per lump sum.

SECTION 600

OPEN CHANNELS, DIKES OR DAMS

600.1 GENERAL

600.1.1 This section shall provide the specifications for storm drainage facilities, such as: open channels, dikes, and dams. For the purposes of this section these facilities are defined as follows:

600.1.2 Open channel shall mean open rectangular concrete channels and lined or unlined trapezoidal channels.

600.1.3 Dikes are for diversion of storm drainage flows and shall be constructed of compacted earth, riprap, soil-cement stabilization, or concrete surface.

600.1.4 Earth dams for detention of storm run-off may require one of the surface treatments as indicated for dikes.

600.2 CONTENTS

<u>Section No.</u>	<u>Title</u>
601	Earthwork for Open Channels, Dikes or Dams
602	Portland Cement Concrete for Channel Lining and Dike or Dam Surfacing
603	Riprap Surface Treatment
604	Flexible Soil Mattings
610	Gabions

SECTION 601

EARTHWORK FOR OPEN CHANNELS, DIKES, OR DAMS

601.1 GENERAL

Earthwork specifications for channels, dikes, and dams shall consist of excavation, grading, side sloping, and compaction. Structural earthwork requirements are contained in Section 500.

601.2 REFERENCES

ASTM D 1557

This publication:
SECTION 201
SECTION 204

601.3 CLEARING AND GRUBBING

The area for clearing and grubbing shall be defined on the construction plans and this area shall be cleared and grubbed in compliance with Section 201.

601.4 UNSUITABLE MATERIALS

601.4.1 Unsuitable materials include all material that contains debris, roots, organic matter, stones or boulders too large to be used in the intended construction, or other materials that are determined by the ENGINEER to be suitable. Otherwise suitable materials which are unsuitable due to excess moisture content will not be classified as unsuitable material unless it cannot be dried by manipulation, aeration or blending with other materials satisfactorily as determined by the ENGINEER.

601.4.2 On-site unsuitable materials will not be used for channel, dike, or dam construction. The CONTRACTOR shall remove and dispose of all unsuitable materials.

601.5 ROCK EXCAVATION

601.5.1 Rock excavation shall consist of igneous, metamorphic and sedimentary rock, naturally in place, which cannot be excavated without blasting or the use of rippers, and all boulders or other detached stones having a volume of one (1) cubic yard or more, as determined by physical measurements or visually by the ENGINEER. Where any portion of the excavation contains strata classified as Rock Excavation and the various strata are parted with strips or strata not classified as Rock Excavation which constitute twenty-five (25) percent or less of the total thickness of the rock plus non-rock layers, the entire volume

of the combined layers shall be paid as Rock Excavation. Removal of surface boulders in excess of 1 cubic yard in volume shall be paid for under Clearing and Grubbing, unless specifically identified as Rock Excavation.

601.6 CHANNELS

Open channels for the purpose of this section shall mean lined or unlined trapezoidal channels.

601.6.1 EXCAVATION:

601.6.1.1 Excavation for channels shall be made to provide a uniform unlined channel surface for natural or earth channels or a surface suitable for placement of a specified lining material. Surfaces of the excavation shall be firm and unyielding and shall be such as will stand or can be made to stand without sloughing.

601.6.1.2 Excavation to provide a subgrade for lined channels or subdrainage material shall be to the lines indicated on the drawings; and excavation made below subgrade shall be backfilled and compacted to a density of not less than 90 percent, as determined by ASTM D 1557, or if approved by the ENGINEER with the concrete or other materials being placed. However, no payment will be made for such overexcavation or for the backfill thereof, regardless as to the approved material used for such backfill.

601.6.1.3 Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, the voids remaining after the removal of such boulders or interfering objects shall be backfilled as follows:

601.6.1.4 When the void is below the subgrade for a lined channel, it shall be filled with suitable material, as approved by the ENGINEER, compacted to a density of not less than 90 percent, as determined by ASTM D 1557, or with the approval of the ENGINEER, concrete of the same mix as used in the concrete channel.

601.6.1.5 When the void is in the side of the excavation, suitable material, as approved by the ENGINEER, shall be placed in the manner and to the same relative density as the backfill in the vicinity of the void or, with the approval of the ENGINEER, concrete of the same mix as

used in a concrete lined channel. If concrete is placed prior to lining, a lower grade concrete may be used only if approved by the ENGINEER.

601.6.1.6 If during the progress of excavation material is encountered which, in the opinion of the ENGINEER, is unsuitable for subgrade for the structure to be constructed thereon, the ENGINEER may direct the CONTRACTOR to excavate beyond the pay lines shown on the drawings. However, suitability of subgrade shall be determined by the ENGINEER on the basis of its ability to withstand the load of the proposed channel and not upon the capacity to withstand the loads which may be placed thereon by the CONTRACTOR's equipment. Should the CONTRACTOR be directed to excavate beyond the pay lines shown on the drawings, said pay lines will be extended to include such ordered excavation and the pay lines for sub-drainage material, if used, will be adjusted accordingly.

601.6.1.7 Materials used for work performed by the CONTRACTOR to stabilize subgrade so it will withstand loads which may be placed thereon by his equipment shall be at the CONTRACTOR's expense.

601.6.2 FILL AND COMPACTED BACKFILL:

601.6.2.1 Suitable material obtained from the project excavations will be used as fill or backfill provided all organic material, rubbish, debris, and other objectionable material contained therein are first removed. However, stone and broken Portland cement concrete pavement obtained from the project excavations will be permitted in the backfill or fill with the following limitations:

601.6.2.1.1 The maximum dimension of any piece used shall be 12 inches.

601.6.2.1.2 Pieces larger than 4 inches shall not be placed within 12 inches of any structure.

601.6.2.2 Unless otherwise specified on the plans, the density, placement, and compaction of fills and backfills shall be as specified in Section 204.

601.6.2.3 There shall be no extra payment made for moving and using excavated materials within the limits of the projects.

601.6.3 GRADING

601.6.3.1 Grading of unlined channels and berms shall conform to the following tolerances:

601.6.3.1.1 A vertical tolerance of none above and 3 inches below the specified grade will be allowed on channel bottom, channel side slopes in both cut and fill, and berms and access road side slopes in cut.

601.6.3.1.2 A vertical tolerance of none below and 3 inches above the specified grade will be allowed on top surfaces of berms and access road in both cut and fill, and berm and access road side slopes in fill.

601.6.3.1.3 Regardless of the construction tolerances specified, excavation and grading shall be performed so that finished surfaces are in uniform planes with no abrupt breaks in the surface.

601.6.3.1.4 Construction tolerances specified hereinabove for grading are solely for purposes of field control.

601.6.3.2 Grading tolerances for channels which will be lined with concrete, riprap, or flexible matting shall be specified on the construction plans.

601.7 DIKES AND DAMS

601.7.1 The construction plans shall specify the zones for key or core excavation, type of earth materials in each zone, maximum compaction required in each zone, and surface grading tolerances.

601.7.2 The CONTRACTOR will submit samples of the proposed fill materials for compliance with the specifications.

601.8 MEASUREMENT AND PAYMENT

601.8.1 Earthwork for open channels shall be measured by the cubic yard in place at the time of excavation. Payment will be made at unit price per cubic yard for the particular operation, as specified in the Bid Proposal.

601.8.2 Clearing and grubbing may be included in the unit price of the excavation, or may be at a lump sum price, or may be at a unit price per cubic yard. Bid Proposal shall specify the unit of payment.

601.8.3 Compacted fill will be measured by the cubic yard of the material compacted in place. Payment will be made at the unit price per cubic yard per specified material as defined in the Bid Proposal.

601.8.4 Rock excavation will be paid by the cubic yard in place, prior to start of construction and measured to the

limits of excavation specified on plans.
No compensation will be made to the
CONTRACTOR for excess rock excavation due
to overshooting, nor for the cost of
backfilling voids or depressions
resulting from overshooting.

SECTION 602

PORTLAND CEMENT CONCRETE FOR CHANNEL LINING AND DIKE OR DAM SURFACING

602.1 GENERAL

This section governs the construction of Portland Cement Concrete for channel lining, or surfaces of dikes or dams on a prepared subgrade in substantial compliance with the lines, grades, thickness, and typical cross-sections shown on the plans or established by the ENGINEER.

602.2 REFERENCES

602.2.1 American Society for Testing and Materials (Latest Editions)(ASTM)

C-33 Specification for Concrete Aggregates

602.2.2 This Publication:

Section 101 Portland Cement Concrete
Section 102 Steel reinforcement
Section 105 Concrete curing Compound
Section 107 Joint Filler and Sealant Material
Section 349 Concrete Curing

602.3 MATERIALS

602.3.1 The cement, water, fly ash, and admixtures used in the concrete work constructed under this section shall conform to the requirements of Section 101 or as modified by the plans and/or the Supplemental Technical Specifications and the approved concrete mix design(s).

602.3.2 Aggregates shall meet the requirements of ASTM C-33 and shall conform to the grading for Size Number 467, as per Table 2 of ASTM C-33.

602.3.3 Steel reinforcement used in the concrete constructed under this section shall conform to the requirements of Section 102 or as modified by the plans and/or the Supplemental Technical Specifications and the approved shop drawings of the steel reinforcement.

602.3.4 Expansion joint material, fillers and sealants used in the concrete constructed under this section shall conform to the requirements of Section 107 or as modified by the plans and/or the Supplemental Technical Specifications and the approved shop drawings, if required.

602.3.5 Liquid membrane-forming compounds for curing concrete if used on the concrete constructed under this section shall conform to the requirements of Section 105 or as modified by the plans and/or Supplemental Technical Specifications.

602.4 STEEL REINFORCEMENT

The steel reinforcement size and spacing shall be as shown on the construction plans. Concrete blocks or steel chairs shall be used to provide the requirement

minimum clearance of 3" between the subgrade and the steel.

602.5 CONCRETE JOINTS

602.5.1 Expansion, contraction, and/or construction joint spacing and details shall be as shown on the construction plans.

602.5.2 Where joints are formed, preformed polyethylene zip-strip forms shall be used. The joint shall be completed while the concrete is plastic where the construction joints are allowed with preformed metal forms to remain in place, no bonding agent will be used, and the edging tool shall have a 1/4 inch radius. This type of joint will be allowed above nuisance flow elevations only.

602.5.3 Where saw cutting is allowed or required, it shall be done with a wheel mounted saw, except where hand held saw is required to complete the saw cuts at plane intersections.

602.5.4 Where saw cutting is required to re-size or straighten sealant nosing, it shall be done with a wheel mounted double bladed saw so that the nosing faces are uniformly spaced, vertical and true, or with a track mounted adjustable arbor saw so that the two nosing cuts will achieve the same results as a double bladed saw. Hand held saws will be allowed for joining the cuts at plane intersections where the mounted saws cannot reach.

602.5.5 All joints to be sawed shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints shall be sawed in sequence. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, the contraction joint groove shall be formed prior to initial set of concrete. Contraction joints shall be formed or sawed to one-fourth the depth of the concrete lining.

602.5.6 At end of concrete placement construction joints shall have a 12 inch thickened edge or as shown on plans. Said joints shall be formed with continuous steel through the forms, and the forms shall be removed before the concrete placement is continued. When the forms are removed, the previously placed concrete shall be sandblasted to remove oil and wax and a fresh concrete epoxy bonder applied immediately before fresh concrete is placed against it. This joints shall be edged with

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a 1/8 inch maximum radius tool.

602.6 PLACEMENT, CONSOLIDATION, AND FINISHING OF CONCRETE

602.6.1 The thickness of the concrete lining shall be as specified on the construction plans.

602.6.2 The ENGINEER shall approve the CONTRACTOR'S proposed method of placing and consolidating the fresh concrete. The use of a canal or slope paving machine is encouraged. Such machine must meet the following conditions:

602.6.2.1 It shall be of the type having rollers and augers and shall also have vibrating pans, or spud-type vibrators capable of vibrating at 3500 impulses per minute.

602.6.2.2 The machine shall be in good repair and properly maintained. Fuel tanks must be full before placing concrete, and should be of sufficient capacity to preclude refueling during concrete placement.

602.6.2.3 Rails must be strong enough and sufficiently anchored to prevent flexing or bending when the machine is operated. Rails must be kept clean during paving operations.

602.6.3 Slope paving machine operation shall include the following procedures:

602.6.3.1 Follow manufacturer's guidance regarding set-up and operation.

602.6.3.2 A dry run shall be made before concrete is placed to check grades and lines and proper operation.

602.6.3.3 Only authorized operator(s) will be allowed on the machine while in operation.

602.6.3.4 Augers shall be adjusted up or down to maintain a roll of concrete one inch high on the front or leading end of the finishing rollers.

602.6.3.5 The rear of the machine should be raised slightly (about 1/8 inch) to allow grout on the side of the finishing rollers to feather itself out and leave a smooth finish.

602.6.3.6 The machine shall be advanced such that all concrete receives at least three passes of the rollers.

602.6.4 Concrete placement shall include the following techniques:

602.6.4.1 A concrete pump or other ENGINEER approved method shall be used to place the concrete. Provision shall be made for a backup unit. Concrete samples for slump tests shall be taken at the pump outlet.

602.6.4.2 Concrete shall be placed close to the final position, and to its full thickness.

602.6.4.3 Do not place concrete more than 12 feet in front of the machine.

602.6.4.4 The height of the concrete roll in front of the augers shall be at least one-half the diameter of the auger.

602.6.5 Finishing of the concrete shall be accomplished with a magnesium or aluminum float followed by a medium broom. The surface shall be finished to a plane having no variation in excess of 1/4 of an inch when measured with a 10 foot straightedge, including joints to existing, adjacent concrete surfaces, unless a curved surface is specified.

602.7 CURING

602.7.1 Immediately after the finishing operations have been completed the CONTRACTOR shall initiate the curing of the concrete as specified in Section 349 and/or as approved by the ENGINEER.

602.8 PROTECTION FROM DRAINAGE FLOWS

602.8.1 The CONTRACTOR shall take all necessary precautions to assure that no damage to new work or the existing channels in work areas is caused either by flood waters, well wash water or other drainage. Suggested precautions include scheduling work in conjunction with favorable weather forecasts and by coordinating work with the Public Works Dept., Water Systems Division, 5501 Pino N.E..

602.8.2 Adequate control of water channeling and pumping shall be done to prevent damage to existing or new channel lining. Concrete lining damaged by water action shall be removed and replaced by the CONTRACTOR at the CONTRACTOR'S expense. The CONTRACTOR will hold the OWNER harmless for any damage to materials, equipment or manpower caused by flooding.

602.9 REPAIR AND REPLACEMENT OF CONCRETE LINING

602.9.1 Work that is found to be defective or damaged prior to acceptance, or existing lining damaged by the CONTRACTOR'S operations shall be replaced by the CONTRACTOR at no expense to the OWNER.

602.9.2 The Portland cement concrete to be used for repair shall conform to Section 101.

602.10 TOLERANCE IN PAVEMENT THICKNESS

602.10.1 Acceptance of the finished channel lining with respect to thickness shall be on the basis of random core sampling, as designated by the ENGINEER. A minimum of two core samples will be taken from longitudinal lengths of channel not to exceed 500 linear feet, or from a one day's

placement of concrete not to exceed 500 linear feet. If deficiencies are noted, the ENGINEER may require additional core samples to be taken. All coring required by the ENGINEER shall be at the OWNER'S expense.

602.10.2 Should the CONTRACTOR desire to have additional core samples taken these samples would be taken at the CONTRACTOR'S expense.

602.10.3 Deduction for a deficiency in thickness shall be made according to Table 602.10.3. Thickness deficiency shall be based on the average thickness of the number of samples taken within the specified length of channel.

602.10.4 It shall be the responsibility of the person requesting the core sampling to have the core holes immediately filled with fresh concrete. This concrete shall be of the same concrete mix and of equal compressive strength as the original concrete.

602.10.5 Any concrete lining that is noted to be deficient in thickness at or more than the reject level on Table 602.10.3 shall be removed and replaced at the CONTRACTOR'S expense.

602.10.6 For information purposes only, the ENGINEER may have the core samples tested for compressive strength.

602.11 STRENGTH TEST REQUIREMENTS

602.11.1 Concrete for channel lining shall be designed for a minimum compressive

strength as specified in Section 101 or as modified in the Supplemental Technical Specifications and the approved concrete mix design(s).

602.11.2 The CONTRACTOR shall furnish the concrete for casting cylinders. Unless otherwise specified, four (4) cylinders shall be made for each 100 cubic yards of concrete placed. The ENGINEER or an independent testing laboratory designated by the ENGINEER shall fabricate and test specimens. Sampling and testing of smaller quantities of concrete used in minor channel work will be done as required by the ENGINEER. Results of all tests shall be reported to the ENGINEER, CONTRACTOR, SUPPLIER, AND OWNER.

602.11.3 Casting, curing, and testing of concrete cylinders shall comply with the requirements in Section 101.

602.12 MEASUREMENT AND PAYMENT

602.12.1 MEASUREMENT: Concrete lining or surfacing shall be measured by the square foot, as measured along the finished surface for the type and thickness stated on the construction plans.

602.12.2 PAYMENT: The payment for concrete lining or surfacing shall be at the contract unit price per square foot per type and thickness complete in place, which price shall include all material, equipment and labor required in the subgrade finishing, placement of the reinforcement steel, forming, placement of the concrete, finishing, curing, form removal, backfilling, and cleanup.

TABLE 602.10.3

DEDUCTIONS FOR DEFICIENCY IN THICKNESS
(Average thickness per core measured in accordance with ASTM C 174)

Thickness Deficiency	Percentage of Contract Price Allowed 6"*	7"*	8"*
0 to 1/4"	100	100	100
Greater than 1/4" to 1/2"	90	92	94
Greater than 1/2" to 3/4"	Reject	84	88
Greater than 3/4" to 1"		Reject	82
Greater than 1"			Reject

*Design Thickness

SECTION 603

RIPRAP SURFACE TREATMENT

603.1 GENERAL

The construction of riprap surface treatment shall consist of furnishing and placing stone, with or without grout, with or without wire mesh, or sacked concrete riprap. The depth and type of riprap shall be as shown on the construction plans.

603.2 REFERENCES

603.2.1 ASTM
C 143

603.2.2 This publication:
SECTION 101
SECTION 109

603.3 MATERIAL

603.3.1 Riprap stone shall be as specified in Section 109 of these specifications.

603.3.2 Other materials necessary for completion of various types of Riprap Surface Treatments shall be as specified in the following subsections.

603.4 PREPARATION OF GROUND SURFACES

603.4.1 The bed for the riprap shall be shaped and trimmed to provide even surfaces. A footing trench shall be excavated along the toe of the slope as shown on the plans.

603.4.2 Specified filter cloth shall be placed on earth bed prior to placement of stone.

603.4.3 Earth surface shall be shaped and trimmed to conform to the construction plans prior to the placement and compaction of the gravel type of filter material.

603.5 PLACING RIPRAP STONE

603.5.1 When the required riprap is less than 20 inches in depth, stone shall be placed by hand unless otherwise authorized by the ENGINEER. Stone shall be placed to provide a minimum of voids. The larger stone shall be placed in the toe return, foundation course, and on the outer surface of the riprap. Stones shall be placed with their longitudinal axis normal to the face of the embankment and so arranged that each rock above the foundation course has at least a 3 point bearing on the underlying stones. Bearing on smaller stones used to chink voids

will not be acceptable. Interstices between stones shall be chinked with small stones and spalls. The finished surface shall be even and tight and shall not vary from the planned surface by more than 3 inches per foot of depth. When the required riprap is 20 inches or more in depth, the stone may be placed by dumping and spread in layers by bulldozers or other suitable equipment.

603.5.2 Riprap shall be placed to its full design thickness (depth) in one operation.

603.6 GROUTED RIPRAP

603.6.1 Riprap shall be placed as specified and grouted with Portland cement mortar. The grout shall consist of one part cement and 3 parts by volume of aggregate. The Portland cement shall be Type I or Type II as specified in Section 101 and the aggregate shall be 2 parts sand and 1 part gravel passing a 3/8 inch square mesh screen. The amount of water shall be such as to permit gravity flow into the interstices with limited spading and brooming. The consistency of the grout shall be as approved by the ENGINEER.

603.6.2 Except when hand mixing is permitted by the ENGINEER, grout shall be mixed in an approved machine mixer for not less than 1 1/2 minutes. Should hand mixing be permitted, the cement and aggregate shall be thoroughly mixed in a clean, tight mortar box until the mixture is of uniform color after which clean water shall be added in such quantity as to provide a grout of the specified consistency.

603.7 SACKED CONCRETE RIPRAP

603.7.1 The Portland cement, aggregates, and mixing shall be as specified in Section 101 and as herein specified. The aggregate may be pit-run material, at least 80 percent of which shall pass a 1 1/2 inch square mesh screen. Separating aggregates by primary sizes will not be required. Los Angeles abrasion tests and soundness tests will not be required.

603.7.2 The mixed concrete shall contain 376 pounds (4 sacks) of Portland cement per cubic yard.

603.7.3 The amount of water shall be such as to produce a mixture with a slump

of 3 to 5 inches when tested in accordance with ASTM C 143.

603.7.4 Sacks shall be made of at least 10 ounce burlap and shall be approximately 19 1/2 inches by 36 inches measured inside the seams when the sack is laid flat.

603.7.5 Slopes on which the sacked concrete riprap is to be placed shall be finished within 0.2 foot of the designated grades. The first course shall be a double row of stretchers laid in a neatly trimmed trench. The second course shall be a single row of headers. The third and remaining courses shall be stretchers or headers as shown on the plans and shall be placed so that joints between courses are staggered. Dirt and debris shall be removed from the tops of sacks before the next course is laid thereon. Headers shall be placed with the folds upward. Not more than 4 vertical courses shall be placed in any tier until the initial set has taken place in the first course of any such tier.

603.7.6 When, in the opinion of the ENGINEER, there will not be proper bearing or bond due to delays in placing succeeding layers or the hampering of work by storm, mud, or for any cause, a small trench shall be excavated back of the row of sacks already in place and this trench filled with fresh concrete before more sacks are placed. Payment for the concrete in the trenches shall be at the price per cubic yard for sacked concrete riprap. Payment for excavating the trenches shall be considered as included in the payment for the concrete in the trench.

603.7.7 Sacked concrete riprap shall be cured by sprinkling with a fine spray of water every 2 hours during daylight for not less than 3 days.

603.8 WIRE ENCLOSED RIPRAP

603.8.1 Wire enclosed riprap shall consist of a layer of rock of the required thickness enclosed on all sides in wire fabric in conformity with the details shown on the plans. The wire fabric shall be drawn tightly against the rock on all sides and tied with galvanized wire of the required gauge. The ties shall be spaced approximately 2 feet on centers and shall be anchored to the bottom layer of wire fabric, extended through the rock layer, and tied securely to the top layer of wire fabric. When indicated on the plans, wire enclosed riprap shall be anchored to the slopes by steel stakes driven through the riprap

into the embankment. Stakes shall be spaced as shown on the plans. Wire fabric used for riprap shall conform to the mesh, gauge, and weight shown on the plans. Tie wire shall be galvanized and of the gauge shown on the plans. Wire fabric shall be furnished in such lengths and widths as to reduce the number of splices to a minimum.

603.8.2 Steel stakes shall be cut to the required length from steel railroad rails, galvanized steel pipe, or steel angles of the dimension and weight shown on the construction plans.

603.9 FILTER CLOTH

603.9.1 MATERIAL: The filter cloth shall be a non-woven polyester geotextile, such as: Mirafi No. 140N drainage Fabric, Mirafi Inc., Charlotte, North Carolina, or approved equal.

603.9.2 INSTALLATION: The surface to receive the cloth shall be prepared to a relatively smooth condition free of obstructions, depressions, and debris. The cloth shall not be laid in a stretched condition but shall be laid loosely with a long dimension perpendicular to the channel centerline. The cloth shall be placed so the upstream edge overlaps the downstream edge a minimum of 12 inches, with securing pins inserted through both layers at no greater than two-foot intervals. Cloth damaged or displaced before or during installation or placement of the overlaying riprap shall be replaced or repaired to the satisfaction of the ENGINEER at the CONTRACTOR'S expense.

603.10 GRAVEL TYPE OF FILTER MATERIAL

603.10.1 MATERIAL: Filter material shall be comprised of sand, gravel, and cobble in mixes as specified on the plans. Alternate materials such as milled Portland cement concrete, concrete wash, or reclaimed material may be substituted with the ENGINEER'S approval.

603.10.2 INSTALLATION: Filter material shall be used as a subbase for riprap as shown on the plans. The minimum depth of filter material shall be one foot unless the plans provide an alternate detail for filter blanket construction.

603.11 MEASUREMENT AND PAYMENT

603.11.1 Riprap, such as: plain stone, grouted, wire enclosed, or sacked concrete, shall be measured by the cubic yards placed to the lines and grades shown on the construction plans. Payment for riprap will be made at the unit price

per cubic yard for the type of riprap as specified in the Bid Proposal and shall include materials, labor, and equipment necessary to complete the work.

603.11.2 Filter cloth shall be measured by the square foot and overlaps shall be measured as a single layer of cloth. Payment shall be made at the unit price per square foot as per Bid Proposal, and shall include shipping, handling, storage, seams, special fabrication, securing pins, and/or installation.

603.11.3 Gravel type filter material shall be measured by the cubic yard of material in place, in accordance with the construction plans. Payment will be made at the unit price per cubic yard as per Bid Proposal and shall include all materials, labor, and equipment necessary for the installation of the material.

SECTION 604

FLEXIBLE SOIL MATTINGS

604.1 GENERAL

Flexible soil mattings provide reinforcement to the soil slopes and/or bottoms of low velocity channels, dikes, and small dams. In addition to the soil reinforcement, certain of these materials will permit growth of native vegetation or park type of grass cover. Because of the various applications which may be encountered the construction plans will indicate the types of materials to be installed, the location of the material in relation to the soil surface, seeding if required, and securing material.

604.2 REFERENCES

604.3 MATERIALS

604.3.1 Prior to placement of materials other than those approved in this section, the CONTRACTOR shall furnish samples and manufacturer's literature of other similar products, which he intends to use, to the ENGINEER for review and approval.

604.3.2 The following products are approved:

604.3.2.1 Filter fabric--"Stabilenka", Types T-80, T-100, or T-140N, manufactured by American Enka Company, Enka, North Carolina.

604.3.2.2 Germination blanket--"Curlex", either standard or high velocity, manufactured by American Excelsior Company, Arlington, Texas.

604.3.2.3 Interwoven flexible monofilament matting, "Enkammat", Types 7010 or 7020, manufactured by American Enka company, Enka, North Carolina.

604.3.2.4 Erosion control and revegetation mat, "Miramat, ECRM," manufactured by Mirafi, Charlotte, North Carolina.

604.3.2.5 Staples for securing the matting to the soil surface will conform to the material, shape, and dimensions, as shown on the construction plans.

604.4 INSTALLATION

604.4.1 The placement of one or more of the matting materials shall conform to the details on the construction plans.

604.4.2 Unless otherwise specified on the plans, filter material will have a

minimum overlap of 1 inch and the interwoven flexible monofilament material will have a 3 inch overlap. The germination blanket will only require butting of the edges.

604.4.3 Stapling or pinning spacing shall be as shown on the plans.

604.4 The location of the various matting materials in relation to the soil surface will be shown as a placement section on the construction plans.

604.4.1 When required, select soils, suitable for seeding, may be specified on the construction plans.

604.5 MEASUREMENT AND PAYMENT

604.5.1 Matting material shall be measured by the square foot, as measured along the finished surface for the type of material installed. Payment shall be made at the unit price per square foot for the specific material, as defined in the Bid Proposal, and shall include material, placement, and staples. If overlapping is required, the matting material shall be considered as a single layer; no extra payment for overlapped material.

604.5.2 Seeding shall be a separate item, as measured and paid for per the Bid Proposal.

604.5.3 Select backfill or cover soil materials will be measured by the square yard per specified thickness. Payment will be made at the unit price per square yard per specified thickness and material, as defined in the bid Proposal.

SECTION 610

GABIONS

610.1 GENERAL

This work shall consist of furnishing, transporting, and constructing wire mesh gabions in compliance with the construction plans and these specifications. Installation of the gabions shall be at the locations shown on the plans.

610.2 REFERENCES

610.2.1 ASTM

A 116	C 88
A 239	C 131
B 117	D 1557

610.2.2 This publication SECTION 109

610.2.2.1 This specification covers the use of galvanized steel wire mesh baskets filled with stone used as retaining walls, slope paving, river bank protection, outfall structures, weirs and drop structures, etc.

610.3 DEFINITIONS

610.3.1 Gabions are defined as galvanized steel wire mesh box-shaped baskets, of various sizes. The baskets are filled on site with clean-hard stones.

610.3.2 The selvages of the gabions are the thicker perimeter and edge wires to which the wire mesh is securely tied to withstand sudden or gradual stress from any direction.

610.3.3 Reinforcing wires are the thicker wires incorporated into the netting during fabrication.

610.3.4 The diagrams are internal wire mesh partitions which divide the gabion into equal-sized cells.

610.3.5 Lacing or binding wire is the wire used to assemble and join the gabion units.

610.3.6 Connecting wires are the internal wires used to prevent the gabions from bulging.

610.4 MATERIALS FOR WIRE MESH BASKETS

610.4.1 FABRICATION:

610.4.1.1 Gabions shall be fabricated so that the sides, ends, lid, and partitions

can be assembled at the construction site into rectangular baskets of the specified sizes. Gabions shall be of single unit construction. The base, ends, and sides shall be woven into a single unit, or one edge of these members shall be connected to the base section of the gabion so that strength and flexibility at the point of connection is at least equal to that of the mesh.

610.4.1.2 Where the length of the gabion exceeds one and one-half its horizontal width, the gabion shall be equally divided by partitions, of the same mesh and wire diameter as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary partitions secured in proper position on the base section so that no additional tying at this juncture will be necessary.

610.4.1.3 Perimeter edges shall be securely selvaged or bound so that the joints formed by tying the selvages have approximately the same strength as the body of the mesh. Ties used for this purpose shall be spaced at not more than 6-inch centers.

610.4.2 DIMENSIONS: Gabions shall be supplied as specified in various lengths and heights shown on the plans. See Table 610 for standard sizes.

610.4.3. TOLERANCES: Gabion dimensions are subject to a tolerance limit of + 3 percent of manufacturer's published sizes.

610.4.4 WIRE:

610.4.4.1 Wire used in the body of the mesh shall be approximately 0.12 inch in diameter, (after galvanization). Wire used in the mesh shall equal or exceed ASTM A 116, finish 5, medium hardness, Class 3 coating. Samples for testing shall include at least one sample of each component of the mesh. Uniformity of coating shall equal or exceed 10 one-minute dips by the Preece Test, ASTM A 239. A certification of resistance to corrosion may be substituted in lieu of requirements for Class 3 coating as follows: A section of mesh, including twists or fastenings forming the mesh, shall be exposed to a salt spray fog

TABLE 610

STANDARD GABIONS

<u>Size Code</u>	<u>Dimensions L x W x H</u>	<u>No. of Cells</u>	<u>Capacity Cu. Yds.</u>	<u>Filler Rock</u>
A	6'x3'x3'	2	2	Type L
B	9'x3'x3'	3	3	Type L
C	12'x3'x3'	4	4	Type L
D	6'x3'x1'x6"	2	1	Type L
E	9'x3'x1'x6"	3	1.5	Type L
F	12'x3'x1'x6"	4	2	Type L
G	6'x3'x1'	2	0.666	Type VL
H	9'x3'x1'	3	1	Type VL
I	12'x3'x1'	4	1.33	Type VL

test, ASTM B 117, for at least 200 hours before failure to any part of the mesh.

610.4.4.2 Tie and connection wire shall be supplied in sufficient quantity for securely fastening all edges of the gabion and diaphragms and to provide for four cross-connecting wires in each cell 1/2 unit high and 8 connecting wires in each cell 1 unit high. Selvage or perimeter basket frame wire shall be of a heavier gauge than the mesh wire with a minimum diameter of 0.150 inches (US gauge 9) after galvanization. Lacing and connecting wire shall meet the same specifications as the wire used in the gabion body except that its diameter shall be of 0.0866 inches (US gauge 13 1/2) after galvanization.

610.4.4.3 All of the above wire diameters are subject to tolerance limit of $\pm 2 \frac{1}{2}\%$.

610.4.5 MESH OPENINGS: Opening of the mesh shall not exceed 4 inches in the longest dimension.

610.4.6 NON-RAVELING CONSTRUCTION: The wire mesh shall be fabricated so as to be non-raveling. This is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single wire strand in a section of mesh is cut and the section of mesh is then subjected to the load test described in Load Test Number 1.

610.4.7 MESH ELASTICITY: The wire mesh shall have elasticity sufficient to permit elongation of the mesh equivalent to a minimum of 10 percent of the length of the section of mesh under test without reducing the diameter or tensile strength of individual wire strands to values less than those for similar wire 0.01 inch smaller in diameter.

610.4.8 METHOD OF SAMPLING, INSPECTION, AND TEST:

610.4.8.1 Mesh: A section of mesh 6 feet in length and not less than 3 feet in width, after first being subjected to the elongation test described in Subsection 610.3.7, shall withstand a load test of 6,000 pounds applied to a 1-square foot area approximately in the center of the section. This test is more specifically described in Load Test Number 1.

610.4.8.2 Load Test No. 1: A uncut section of mesh, 6 feet in length, not less than 3 feet in width, and including all

selvage bindings, shall be the ends securely clamped for 3 feet along the width of the sample. When the width of the section under test exceeds 3 feet the clamps shall be placed at the center of the width, and the excess width shall be allowed to fall free on each side of the clamped section. The sample shall then be subjected to tension sufficient to cause 10 percent elongation of the sample section between the clamps. After elongation and while clamped, as described above (and otherwise unsupported), the section shall be subjected to a load applied to a 1-square foot area in the approximate center of the sample section between the clamps and in a direction perpendicular to the direction of the tension force. The sample shall withstand, without rupture of any strand or opening of any mesh fastening, an actual load, so applied, equaling or exceeding, 6,000 pounds.

610.4.8.3 The fan head used in the test shall be circular and have its edges beveled or rounded to prevent cutting of the wire strands.

610.4.8.4 Inspection and Certification: The CONTRACTOR shall furnish a certified report of tests made by a approved testing laboratory showing that the product to be supplied equals or exceeds these specifications.

610.4.9 MARKING: Each gabion shall be clearly marked by color code or some other readily identifiable means to indicate size.

610.5 ROCK FILLER MATERIAL

610.5.1 Rock used in filling gabions shall be as shown in Table 610. Rock shall meet the requirements of Section 109 Riprap Stone.

610.6 CONSTRUCTION REQUIREMENTS

610.6.1 Gabions shall be constructed and erected in accordance with the manufacturer's published procedures or, as a minimum, as specified herein.

610.6.2 The foundation under the gabions shall be prepared as shown on the drawings, but as a minimum, the top six inches of the gabion soil foundation shall be compacted to no less than 95 percent of maximum density, as determined by ASTM D 1557.

610.6.3 The aggregate shall be placed within the baskets in such a manner as to

eliminate as many open pockets as possible. Gabions may be filled by hand or by mechanical means. Every effort shall be made to keep voids and bulges in the gabions to a minimum in order to ensure proper alignment and a neat, compact, square appearance. Exposed surfaces shall be hand placed to provide an aesthetic appearance.

610.6.4 ASSEMBLING AND PLACING

610.6.4.1 Each gabion shall be assembled by tying all untied edges with binding wire. The binding wire shall be tightly looped around every other mesh opening along the seams in such a manner that single and double loops are alternated.

610.6.4.2 A line of empty gabions shall be placed into position according to the contract drawings and binding wire shall be used to securely tie each unit to the adjoining one along the vertical reinforced edges and the top selvages. The base of the empty gabions placed on top of a filled line of gabions shall be tightly wired to the latter at front and back.

610.6.4.3 To achieve better alignment and finish in retaining walls, gabion stretching is recommended.

610.6.4.4 Connecting wires shall be inserted during the filling operation in the following manner:

610.6.4.4.1 36" Gabions

- I. Gabions shall be filled to a depth of twelve (12) inches.
- II. One connecting wire in each direction shall be tightly tied to opposite faces of each gabion cell at a height of twelve (12) inches above the base.
- III. Gabions shall be filled with a further depth of twelve (12) inches, and two connecting wires shall similarly be tied at this level.
- IV. Gabions shall be filled to the top.

610.6.4.4.2 18" and 12" Gabions

610.6.4.4.3 Connecting wires are not necessary unless the 18" size is used to build vertical structures; in this case, two wires, one in each direction, at 9" from the base, must be placed as above.

610.6.4.5 The gabions in any row shall be filled in stages so that local deformations may be avoided. That is, at no time shall any gabion be filled to a depth exceeding one foot more than the adjoining gabion.

610.6.4.6 When a gabion has been filled the lid shall be bent over by hand until it meets the front and ends. Then the lid shall be tightly bound to the rest of the basket with the lacing wire along all edges and internal cell diaphragms in the same manner described above for assembly.

610.7 MEASUREMENT AND PAYMENT

610.7.1 Gabions shall be measured by the cubic yard in place, based on basket dimensions shown on the plans, and shall include excavation, baskets, rock filler, and removal of waste materials. Payment will be made at the unit price per cubic yard as specified in the Bid Proposal.

610.7.2 No direct payment will be made for excavation and disposal of material required for placement of gabions or for backfill and compaction behind the gabion walls, and the cost thereof will be considered incidental to the completion of the work.

SECTION 700

TRENCHING AND BORING FOR UTILITIES

700.1 GENERAL

This section pertains to the trenching, backfilling and compaction for all utilities. Also included in this section are the requirements for boring, drilling and jacking of casings for utility carrier pipes.

700.2 CONTENTS

<u>Section No.</u>	<u>Title</u>
701	Trenching, Excavation and Backfill
710	Boring, Drilling and Jacking

SECTION 701

TRENCHING, EXCAVATION AND BACKFILL

701.1 GENERAL

Trench excavation and backfill for underground utilities, sanitary sewer, storm sewer, water lines, and appurtenances shall conform to these specifications or as specified in the Supplemental Technical Specifications or as authorized, in writing, by the ENGINEER.

701.2 REFERENCES

701.2.1 American Society for Testing Materials (Latest Edition)(ASTM)

- D-422 Method for Particle-Size Analysis of Soils
- D-698 Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb.(2.49-kg) Rammer and 12-in(304.8-mm) Drop.
- D-1557 Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 10-lb.(4.54 kg) Rammer and 18-in(457-mm) Drop.
- D-2321 Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
- D-2487 Classification of Soils for Engineering Purposes
- D-2922 Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- D-3017 Test Method for Moisture Content of Soil and soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- D-4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

701.2.2 This Publication:

- Section 207 Lean Fill Construction
- Section 301 Subgrade Preparation
- Section 302 Aggregate Base Course
- Section 336 Asphalt Concrete Pavement
- Section 337 Portland Cement Concrete Pavement
- Section 340 Portland Cement Concrete Curbs, Gutters, Walks, Driveways, Alley Intersections, and Median Paving

701.3 TERMINOLOGY

701.3.1 For the purpose of these specifications in this Section, the descriptive terms "flexible," "plastic" and "non-rigid" are similarly interchangeable as utilized in these specifications and appurtenant reference material.

701.3.2 Rigid pipe shall be reinforced concrete, concrete cylinder, and vitrified clay pipes.

701.3.3 Flexible pipe shall be polyvinyl chloride, polyethylene, ductile iron, and corrugated metal pipes.

701.3.4 Standard Detail Drawings show the trench cross-sections which identify the meaning and limits of terminology used in these specifications for the terms

"foundation, bedding, haunching, initial backfill, final backfill, embedment, pipe zone, cover, springline, and pipe width."

701.3.5 The Unified Soil Classification System in ASTM D 2487 shall be utilized for the purpose of material classifications. See Table 701.3.A for a listing of referenced soil classes.

701.4 NOTIFICATION OF FORTHCOMING WORK

701.4.1 To assure that the construction work progresses in a timely manner and that good public relations are maintained with the property owners, the following actions are considered essential:

701.4.1.1 Prior to the start of construction the CONTRACTOR shall assist the ENGINEER in notifying the adjacent property owners as to when construction will start, the estimated completion date, who to contact if a problem arises, and any anticipated access blockages.

701.4.1.2 Prior to the start of trenching operations, including pavement cutting and removal, the CONTRACTOR should coordinate with the ENGINEER any problem areas involving traffic control, access to private properties, stockpiling of excavated materials, and other utility conflicts.

701.4.1.3 The CONTRACTOR shall provide the ENGINEER with the name and telephone number of at least two contact persons during non-working hours.

701.5 TRENCH SAFETY

The CONTRACTOR shall be responsible for maintaining all trenches in a safe condition; thereby protecting the workers and the general public. Trench slopes and other protection shall be in accordance with applicable regulations such as the Department of Labor's Occupational Safety and Health Administration Standards 29CFR Part 1926, subpart P or any applicable amendments.

701.6 BRACING EXCAVATIONS

701.6.1 Excavation for pipe shall normally be by open unsupported trenches unless local conditions warrant trench bracing.

701.6.2 Excavations shall be braced and sheeted to provide complete safety to persons working therein and bracing shall comply with applicable Federal (OSHA), State and local laws and ordinances. Support systems for trenches in excess of 20 feet deep and adjacent to existing improvement or subject to vibrations or ground water shall be in accordance with OSHA regulations. The CONTRACTOR shall be fully responsible for sufficiency and adequacy of bracing excavations with

TABLE 701.3.A

EMBEDMENT SOILS CLASSIFICATIONS

SOILS CLASS	SOIL TYPE	DESCRIPTION
CLASS I SOILS*		Manufactured angular, granular material, 1/4 to 1-1/2 inches (6 to 40 mm) size, including materials having regional significance such as crushed stone or rock, broken coral, crushed slag, cinders, or crushed shells, complying to the requirements of Class II soils.
CLASS II SOILS**	GW	Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more of coarse fraction retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
CLASS II SOILS**	GP	Poorly graded gravels and gravel-sand mixtures, little or no fines. 50% or more of coarse fraction retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
CLASS II SOILS **	SW	Well-graded sands and gravelly sands, little or no fines. More than 50% of coarse fraction passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
CLASS II SOILS**	SP	Poorly graded sands and gravelly sands, little or no fines. More than 50% of coarse fraction passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
CLASS III SOILS***	GM	Silty gravels, gravel-sand-silt mixtures. 50% or more of coarse fraction retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
CLASS III SOILS***	GC	Clayey gravels, gravel-sand-clay mixtures. 50% or more of coarse fraction retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
CLASS III SOILS***	SM	Silty sands, sand-silt mixtures. More than 50% of coarse fraction passes No. 4 sieve. More than 50% retained on No. 200 sieve.
CLASS III SOILS***	SC	Clayey sands, sand-clay mixtures. More than 50% of coarse fraction passes No. 4 sieve. More than 50% retained on No. 200 sieve.
CLASS IV SOILS	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
CLASS IV SOILS	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
CLASS IV SOILS	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
CLASS IV SOILS	CH	Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
CLASS V SOILS	OL	Organic silts and organic silty clays or low plasticity. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
CLASS V SOILS	OH	Organic clays of medium to high plasticity. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
CLASS V SOILS	PT	Peat, muck and other highly organic soils.

* Soils are as defined in ASTM D2487, except for Class I Soil which is defined in ASTM D2321.

** In accordance with ASTM D2487, less than 5% passes No. 200 sieve.

***In accordance with ASTM D2487, soils with 5% to 12% passing No. 200 sieve fall in a borderline classification that is more characteristic of Class II than of Class III.

respect to work under construction and to adjacent utility lines and private property.

701.6.3 If the soil conditions within the trench area require support, the CONTRACTOR may elect to use tight sheeting, skeleton sheeting, stay bracing, trench jacks, or a movable trench shield to support the trench during pipe laying operations, such as: bedding preparation, pipe laying, and backfilling of haunches and initial zone.

701.6.4 No sheeting shall be permitted to remain in the trench except when, in the opinion of the ENGINEER, field conditions or type of sheeting or methods of construction used by the CONTRACTOR, warrant the supports must remain. The ENGINEER may opt to have the lower portion (within the pipe zone) of the sheeting to remain. If the CONTRACTOR plans on removing the sheeting, he shall submit a method to the ENGINEER for approval to treat the void created by the removal of the sheeting within the pipe zone and below.

701.6.5 When a movable trench shield is used, the trailing half of the shield should be notched to the height of the top of the pipe. This will allow the haunch area of the pipe to be compacted properly to the wall of the trench. If the trench shield is not notched, a sub trench shall be excavated for pipe installation such that the bottom of the trench shield does not enter the pipe zone.

701.7 DEWATERING

701.7.1 Trenching and pipe laying operations may encounter standing water or ground water which would preclude the proper placing of bedding, backfilling, and laying pipe. The water shall be removed by pumps and associated equipment, such as well points, to lower the water level. Dewatering shall continue for a minimum of 24 hours after placement of any concrete.

701.7.2 Dewatering operations shall remove the water to achieve a stable foundation for pipe embedment and backfilling. The ENGINEER shall determine if adequate foundation has been attained. The ground water shall be lowered to a minimum depth of 6 inches below pipe grades. Should over excavation be necessary due to unsuitable foundation conditions, the ground water shall be additionally lowered as necessary.

701.7.3 The CONTRACTOR shall submit a plan for approval by the ENGINEER as to how and where the waste water will be disposed. Waste water will not be discharged into traffic and pedestrian lanes or onto private properties.

701.7.4 The CONTRACTOR shall obtain a permit from the New Mexico State Engineer prior to commencing dewatering operations.

701.7.5 The CONTRACTOR shall also be responsible for any adverse effect his dewatering operation has to private

property, including providing temporary water to residences and/or businesses necessitated by the effect on private wells.

701.7.6 The CONTRACTOR shall arrange his dewatering operation in a neat and orderly manner such that access to adjacent properties is maintained, the discharge system does not leak and that any power generation complies with applicable noise limit regulations.

701.8 REMOVAL OF EXISTING PAVEMENT, SIDEWALK, AND DRIVEWAY

701.8.1 Existing concrete pavement, sidewalk, or driveway removed in connection with construction shall be replaced to neatly sawed edges. Cuts shall be neat and to true straight lines with no shatter outside the removal area. If a saw cut would fall within 30 inches of a construction joint, cold joint, expansion joint, or edge, the concrete shall be removed and replaced to the joint or edge. Concrete sidewalk and/or driveway may be removed so that a minimum of 30-inch square is replaced. If the saw cut would fall within 12 inches of a score mark, the concrete shall be removed and replaced to the score mark.

701.8.2 Existing bituminous pavement removed in connection with construction shall be cut with a saw, pavement breaker, cutting wheel, or other suitable tool approved by the ENGINEER. Care shall be taken to assure that the edge of the removed pavement does not vary from a straight line more than 2 inches from the mean.

701.8.3 Saw cutting shall be 1-1/2 inches in depth or 1/4 the thickness of the pavement, sidewalk, or driveway, whichever is greater. All saw cuts or other scoring shall be made perpendicular to the surface of the material to be cut.

701.8.4 Any unnecessarily irregular breakage or cracking caused by the CONTRACTOR shall be removed and replaced by the CONTRACTOR without added expense to the OWNER.

701.8.5 The CONTRACTOR shall be responsible for the disposal of removed materials.

701.8.6 Saw cutting is required on all concrete or asphalt paving on State maintained streets or roads.

701.8.7 Paving cuts for manholes and valve boxes and other utility appurtenances shall be square and at dimensions specified on the Standard Detail Drawings or on the construction plans.

701.9 MAXIMUM LENGTH OF OPEN TRENCH

In developed areas, no more than 300 feet of trench shall be opened in advance of pipe laying operations. This distance may

be reduced due to traffic control considerations. Backfilling shall begin as soon as pipe is laid and inspected and shall keep pace with the pipe laying. In advance of trenching operations in undeveloped areas, the CONTRACTOR shall submit in writing or on plans for the ENGINEER'S approval, the maximum length of trench that will be open at any one time. Except by permission of the ENGINEER, the maximum length of open trench in any one location where concrete structures are cast in place will be that which is necessary to permit uninterrupted progress. Construction shall be pursued as follows: excavation, formwork, and setting of reinforcing steel, placing of floor slab, walls, and cover slab or arch shall follow each other without any one of these operations preceding the next nearest operation by more than 200 feet. Failure by the CONTRACTOR to comply with the limitations specified herein or as may be specifically authorized by the ENGINEER may result in a written order from the ENGINEER to halt progress of the work until such time as compliance with this paragraph has been achieved and the work can be proceeded in an orderly sequence of operations.

701.10 WIDTH OF TRENCHES

Trench widths will vary according to the type of pipe used, size of pipe, depth of trench, and soil conditions. The minimum width requirements, indicated below, are for proper laying, aligning and jointing of pipe as well as trench grading, bedding preparation, and backfilling.

701.10.1 TRENCH WIDTH FOR RIGID PIPE MATERIALS: Trench widths from bottom of pipe to a point 12 inches above the top of the pipe shall be kept to the practical minimum required for properly laying, aligning, grading, jointing, and backfilling of the pipe, but no less width than pipe outside diameter plus 16 inches. For stable soils which will stand a vertical cut, the maximum trench width at a point 12 inches above the top of pipe or at a point 5 feet above the bottom of the trench, whichever is less, shall be as follows:

701.10.1.1 The pipe outside diameter plus 2 feet for pipes 27 inches in diameter and smaller.

701.10.1.2 1.6 times the nominal diameter for pipes 30 inches in diameter or larger.

701.10.1.3 When soil will not stand vertical, the trench sides shall be sloped to provide not less than the outside diameter plus 16 inches at the pipe invert.

701.10.2 TRENCH WIDTH FOR NON-RIGID PIPES: The minimum clear width of the trench measured at the springline of the pipe should be 1 foot greater than the outside diameter of the pipe. The maximum clear width of the trench at a point 1 foot above the top of the pipe is equal to the

pipe outside diameter plus 2 feet. If the maximum recommended trench width must be exceeded or if the pipe is installed in a compacted embankment, then pipe embedment should be compacted to a point of at least 2-1/2 pipe diameters from the side of the pipe or to the trench walls.

701.11 ROCK EXCAVATION

701.11.1 Rock is defined as material which cannot be excavated without drilling and blasting. All stone or boulders less than 8 cubic feet in volume will be classified as earth; all larger boulders shall be classified as rock. If blasting is necessary to excavate such materials as shale, hardpan, soft sandstone, cemented gravel, or loose rock which normally can be classified as earth excavation, then this excavation shall be classified as rock excavation. Whenever a ledge of solid rock encountered with earth below it or where alternate layers of solid rock and earth occur, the earth shall be

included in the allowance for rock when the thickness of the layer of earth is less than 12 inches, thus requiring it to be removed by blasting along with the ledges of rock. Blasting will be considered necessary when the soil and rock cannot be excavated at a rate of 50 cubic yards per hour by a competent operator with a back-hoe that has a minimum bucket curling force of 25,000 pounds (John Deere 690 or equivalent).

701.11.2 Whenever rock is encountered in the trench or elsewhere in any excavation required to be made, it shall be excavated to the line and grade as shown on the plans and within the limits described therein, unless otherwise authorized, in writing, by the ENGINEER.

701.11.3 For trenches, rock shall be excavated to a depth of 6 inches minimum below the outside bottom of the conduit except at points of rock and earth transitions at which points the rock shall be excavated to a minimum of 12 inches below the outside bottom of the conduit as shown on the detail sheets for trench cuts and backfill of rock. Any depression in the bottom of the trench caused by overshoot and/or excavating and being 6 inches or greater in depth from a theoretical bottom of trench grade shall be filled to the theoretical bottom of the trench with select soils. The trench shall be backfilled with select backfill material to a point 1 foot above the top of the conduit. The remainder of the trench shall be backfilled as specified herein. The complete trench backfill from the bottom through to the top of the subgrade shall meet the compaction and/or moisture requirements as specified herein.

701.11.4 BLASTING: Suitable weighted covering or mats shall be provided to confine all materials lifted by the blasting within the limits of the trench and to prevent injury of persons or damage

to property. Blasting shall be under the supervision of a person qualified and experienced in the use and handling of explosives. All blasting operations shall be done in accordance with applicable local, state, and federal laws, ordinances, and codes regulating the transportation, storage, and use of explosives. Forty-eight hours prior to blasting operations, the CONTRACTOR shall notify the New Mexico One Call Center, telephone 260-1990 and the Albuquerque Police Department.

701.12 FOUNDATION

701.12.1 All pipe shall be bedded on a stable foundation in a trench which is completely free of water. The ENGINEER shall determine the adequacy of the foundation. Class V soils shall not be used as a foundation. If Class V soils are encountered at the bottom of the trench it shall be removed to the depth authorized by the ENGINEER and replaced with Class I, II or III soils.

701.12.2 Where an unstable foundation condition is encountered, it must be stabilized before laying pipe or alternative foundation methods utilized. The CONTRACTOR will be paid for foundation stabilization when required by the ENGINEER. Failure to notify the ENGINEER of an obvious unstable foundation condition prior to proceeding with placement of the pipe shall result in complete removal of the affected pipe, foundation stabilization, and replacement of the pipe at the CONTRACTOR'S expense.

701.12.3 Should the trench be inadvertently over-excavated below the foundation, the area of over-excavation shall be filled with select material in 6 inch lifts and compacted to a density of not less than 95 percent of maximum density, as determined by ASTM D 1557.

701.12.4 Unless specifically approved in writing by the ENGINEER, the CONTRACTOR shall not proceed with pipe embedment in a trench where water is present or the foundation is saturated. Adequate dewatering, as specified in Section 701.7, shall be utilized.

701.13 PIPE EMBEDMENT

701.13.1 GENERAL:

701.13.1.1 The class of bedding used for each pipe shall be as shown on the plans or as specified in the Supplemental Technical Specifications.

701.13.1.2 The CONTRACTOR may request a change in the class of bedding required on a pipe, if authorized by the ENGINEER, all increase in the cost of labor and materials required to include upgrading of the pipe class will be at the CONTRACTOR'S expense with no additional cost to the OWNER.

701.13.2 RIGID PIPE EMBEDMENT:

701.13.2.1 The trenches shall be excavated in conformance with the trench width requirements in Section 701.10 and 701.5.

701.13.2.2 Embedment material shall be Class I, II, III, or IV soils, or lean fill as specified in Section 207.

701.13.2.3 All soil in the embedment zone shall be placed in lifts not exceeding 8 inches in uncompacted depth, except that material along the side of the pipe shall not be placed above the springline until the haunch area of the pipe is adequately filled and sliced such that no voids remain.

701.13.2.4 All soil shall be compacted to a density not less than 90 percent of maximum density, as determined by ASTM D 1557. The CONTRACTOR shall take care to assure that the pipe is not damaged or misaligned during compaction of the embedment.

701.13.3 FLEXIBLE PIPE EMBEDMENT:

701.13.3.1 Proper placement of soils in the embedment zone is extremely important in achieving a satisfactory installation of flexible pipe. The CONTRACTOR shall be aware that the soil classes have differing requirements relative to embedment. There are also differing requirements for embedment in dry and wet conditions (wet conditions meaning that the embedment zone will be subject to ground water).

701.13.3.2 Embedment material shall be Class I, II, or III soils, or lean fill as specified in Section 207.

701.13.3.3 Embedment soil shall be placed in lifts not exceeding 8 inches loose depth. The haunch shall be properly compacted by hand tampers utilizing due caution such that the pipe is not damaged or misaligned. Mechanical tampers shall not be utilized directly over the pipe in the embedment zone.

701.13.3.4 The CONTRACTOR may utilize acceptable on site soils in the embedment area which are in conformance with these specifications. The CONTRACTOR has the option of importing a different soil, however, additional compensation will only be allowed if the on site soils are Class IV or V.

701.13.3.5 Class I soil shall comply with the requirements of Section 302, AGGREGATE BASE COURSE.

701.13.3.6 Class II and III soils shall be compacted to a density of not less than 95 percent of maximum density in the embedment area, as determined by ASTM D 1557. The moisture content shall not exceed 5 percent above optimum.

701.14 FINAL BACKFILL

701.14.1 Final backfill shall consist of homogeneous soil except that boulders, frozen clumps, rubble, and Class V soils are excluded.

701.14.2 Final backfill shall be compacted to a density of not less than 90 percent of maximum density, as determined by ASTM D 1557 unless otherwise specified in the Contract Documents.

701.14.3 The upper portion of the final backfill may require specific soils and compaction in order to provide a suitable foundation for pavements, curb and gutter, sidewalk, or other type of structure.

701.15 COMPACTION METHODS

701.15.1 The CONTRACTOR shall be responsible for the compaction method utilized during foundation preparation, embedment placement, and final backfill except as otherwise specified herein or in the Supplemental Technical Specifications.

701.15.2 The use of mechanical vibratory compactors directly over the pipe is prohibited in the embedment area. Extreme care shall be taken when utilizing mechanical compactors in the haunch and initial backfill area in order to avoid damage to or misalignment of the pipe. The ENGINEER shall examine any damaged pipe and has the authority to direct that it be replaced with new pipe at no additional cost to the OWNER.

701.15.3 Flooding or jetting shall be allowed if the subsurface soils are compatible to its usage, as authorized by the ENGINEER. It shall not be used for compaction of flexible pipe, when the soil has a plastic limit of 7 or greater, and in areas of collapsible soils. The CONTRACTOR shall take any necessary precautions to minimize to negligible flotation of the pipe.

701.15.4 The CONTRACTOR shall, at the direction of the ENGINEER, excavate the compacted fill as necessary for the purpose of determining the adequacy of the compaction.

701.16 PAVEMENT

701.16.1 Either new street construction or pavement replacements shall satisfy the following design and construction requirements:

701.16.1.1 Unless permanent pavement is specified to be placed immediately, a temporary dust-free patch shall be placed wherever excavation is made through existing pavements, sidewalks, or driveways. The patch shall be placed, rolled, and maintained by the CONTRACTOR to provide a smooth surface for traffic until a permanent pavement is constructed within the time frame specified by the ENGINEER.

701.16.1.2 The subgrade preparation of the area to be paved shall be in accordance with Section 301 of these specifications. The asphalt pavement placed shall be in accordance with Section 336 and the concrete pavement shall be in accordance with Section 337. The placement of the other roadway items shall be in accordance with Section 340.

701.16.1.3 Material thickness for all pavement replacements within residential or arterial streets shall conform to the plans or the Standard Detail Drawings or match the existing pavement as authorized by the ENGINEER.

701.16.1.4 Pavement cuts of 8 ft. or more in width and 100 ft. or more in length shall be paved with a laydown machine.

701.16.1.5 When authorized by the ENGINEER, asphalt concrete base course may be used to replace surface course thickness requirements on streets that are scheduled for overlay.

701.16.1.6 The edges of all trenches at the base course level shall be neatly trimmed before beginning any paving replacement. All edges of the existing pavement adjacent to the trench cut shall be inspected. Undermined, broken, cracked, or unevenly cut portions shall be removed and the pavement edges retrimmed prior to pavement replacement. All vertical edges of the existing asphalt pavement adjacent to the trench cut and all surface areas for a width of at least 4 inches and no greater than 8 inches, shall be thoroughly cleaned and a tack coat applied prior to placing any hot mix asphalt. The finished surface of the pavement replacement shall be graded to conform to the existing contour both in cross section and profile.

701.16.1.7 Concrete pavement to replace cuts made in concrete paved streets, arterials, etc., shall conform to the Standard Detail Drawings for concrete pavement or in accordance with New Mexico State Highway Department requirements where applicable.

701.16.1.8 When more than one-half of the surface area of a manhole, lamphole or valve box is found to extend into the area to receive a permanent asphaltic hot-mix surfacing and/or base pavement replacement, the existing pavement surrounding the manhole, lamphole, or valve box shall be removed to within those limits which will permit a permanent pavement replacement to be made in accordance with the approved plans.

701.16.1.9 Asphaltic hot mix shall not be placed upon the concrete collar, nor shall traffic be permitted upon the collar for at least 24 hours, or longer, if so directed by the ENGINEER. A tack coat of asphaltic emulsion may be applied after the concrete has taken its final set. During this time adequate barricading of the area shall be maintained by the CONTRACTOR.

701.16.1.10 If in the course of a pavement removal, a manhole, lamphole, and/or valve box is encountered and has a concrete collar about it and the collar is performing adequately, no special construction need be made in the permanent pavement replacement.

701.16.1.11 The CONTRACTOR shall make any small grade or alignment adjustment of the manhole, lamphole, and/or valve box encountered that is necessary to provide a smooth riding surface between the existing pavement and the patch and/or within the patch itself.

701.16.1.12 TESTING

701.16.1.12.1 A sample of each type of soil encountered shall be classified in accordance with the requirements of ASTM D2487, and the moisture density relationship determined in accordance either ASTM D698 or D1557, whichever is applicable.

701.16.1.12.2 A compaction test shall be taken for each 2 feet depth per 200 feet trench length or less, as directed by the ENGINEER. Compaction tests shall be taken in accordance with ASTM D2922 and D3017. Areas represented by non-complying tests shall be reworked and re-tested for compliance.

701.17 MEASUREMENT AND PAYMENT

701.17.1 TRENCHING, BACKFILLING, AND COMPACTION:

701.17.1.1 Trenching, backfilling, and compaction shall be combined into one unit and shall be measured and paid for as follows:

701.17.1.2 Measurement shall be made along the centerline of the pipe.

701.17.1.3 The unit of measurement shall be by the linear foot per pipe diameter per specified increment of depth.

701.17.1.4 The following depth increments will apply:

701.17.1.4.1 For water line installations the costs for trenching, backfilling and compaction shall be included in the unit price per linear foot of pipe per pipe diameter for maximum depth, such as: 4 to 14 inch diameter at 6 feet, 16 to 24 inch diameter pipe at 7 feet and all pipe larger than 24 inch at 8 feet. Separate payment will be specified in the Bid Proposal when required depths exceed the above depths.

701.17.1.4.2 For sewer installations the increments shall be 8 feet or less, 8 feet to 12 feet, 12 feet to 16 feet, 16 feet to 20 feet and thereafter at 4 foot intervals.

701.17.1.4.3 All depths shall be measured to the nearest foot.

701.17.1.5 All depths shall be measured from the invert of the pipe to the top of existing ground elevation. The existing ground elevation shall be the elevation of the surface that exists along the centerline of the pipe at the time of construction staking for said trenching.

701.17.1.5.1 Whenever a special pipe embedment detail is specified, on the plans, the trench depth shall be measured from the bottom of the embedment to the top of existing ground elevation. However, no additional trench depth shall be measured as a result of inadvertent over-excavation nor to accommodate trench dewatering.

701.17.1.6 Payment will be made at the unit price per linear foot per diameter of pipe per depth increment as specified in the Bid Proposal, and will include trenching, backfilling, and compaction for all trench zones. No additional payment will be made for compacted materials to bring trench backfill up to required depth.

701.17.2 OVER-EXCAVATION: Required over-excavation for foundation stabilization shall be measured by the cubic yard of material removed and replaced with compacted suitable material. Payment will be made at the unit price per cubic yard of compacted replacement material and shall include excavation, backfill material, and compaction.

701.17.3 ROCK EXCAVATION: Rock excavation will be measured by the cubic yard within the specified limits of the trench configuration. Blasting will be included in the rock excavation. Payment will be made at the unit price per cubic yard.

701.17.4 UNSUITABLE MATERIALS: Removal and disposal of unsuitable materials from the construction site shall be measured by the cubic yard of excavated material. Payment will be made at the unit price per cubic yard of excavated material.

701.17.5 PAVEMENT, SIDEWALK, AND DRIVEWAYS: Removal and disposal of existing pavement, sidewalks, and driveways will be measured by the square yard or square foot whichever is apropos. Payment will be made at the unit price per square yard or square foot as specified in the Bid Proposal.

701.17.6 SELECT MATERIALS: Where selected material is required in the backfilling operations, the quantity of material will be measured by the cubic yard of compacted material in place in the trench. Payment will be made at the unit price per cubic yard of select material as indicated above.

701.17.6.1 Whenever a special pipe embedment detail is specified, measurement and payment shall be as identified in the Bid Proposal.

701.17.7 DEWATERING: Dewatering

operations for trench work shall be measured by the linear foot along the center-line of that portion of the trench which requires dewatering. Payment will be made at the unit price per linear foot of dewatered trench.

701.17.8 PAVEMENT:

701.17.8.1 Permanent or temporary pavement surfacing shall be measured and paid for in accordance with the paving section elements as defined under Section 300 for the specific item of work.

701.17.8.2 Permanent resurfacing or permanent surface patching will be measured on the basis of the square yard for new surfacing as provided in the applicable section of these specifications. For payment purposes, the normal maximum pavement cut width shall be as defined in the Table No. 701.17.8.2

TABLE No. 701.17.8.2
NORMAL MAXIMUM PAVEMENT CUT WIDTHS ALLOWED FOR PAYMENT PURPOSES

Soil Stability	Trench Depth (TD)	Pipe Size	Max. Pavement Cut Width
Stable. Soil stands in a vert. cut	Less than or equal to 5 feet	ND less than or equal to 27"	OD + 2 feet
"	Greater than 5'	ND less than or equal to 54"	TD + 2 feet
"	"	ND greater than 54"	1.6 X ND + TD + 3'
Unstable. Soil does not stand in vert. cut	Any	Any	2 X TD + OD

- NOTES: 1. TD is trench depth; ND is nominal pipe diameter; and OD is outside pipe diameter.
2. Individual locations or conditions may warrant greater cut widths than those specified above. The ENGINEER shall authorize in writing the increase in the above pavement cut widths.

SECTION 710

BORING, DRILLING AND JACKING

710.1 GENERAL

Boring, drilling or jacking operations defined in this section are related to the installation of water pipe, sanitary sewer pipe, storm sewer pipe, and traffic conduit in areas where trenching is not feasible.

710.2 REFERENCES

710.2.1 This publication:
SECTION 129

710.3 BORING

710.3.1 Boring shall be performed to alignment and grade as shown on the construction drawings. The earth and/or rock augers shall not exceed the O.D. (outside diameter) of the steel casing by more than 1/4 of an inch. The boring and insertion of the steel casing shall be performed with equipment capable of simultaneous operation. The feed rate of augers and hydraulic pushing of the casing shall be the same. Under no circumstances will boring be allowed unless operations are simultaneous. Every effort shall be made to avoid loss of earth. Excavated material shall be removed from the casing as excavation progresses and no accumulation of such material within the casing shall be permitted. Upon completion of the boring operations, all voids around the outside face of the casing shall be filled by grouting. Grouting equipment and material shall be on the job site before boring operations are started in order that grouting around the bored casing may be started immediately after the boring operations have finished. The allowable tolerance as to grade and alignment of the installed casing shall not exceed 1/10 of a foot per hundred feet of casing length.

710.3.2 The CONTRACTOR shall be responsible for locating any underground utilities and for any damage resulting thereto. The CONTRACTOR shall be fully responsible for producing a sound, tight installation, true to line and grade. Carrier pipe shall be skidded through the casing on redwood, stainless-steel tied skids. A suggested method is shown in the Standard Detail Drawings. Other methods shall be approved in writing by the ENGINEER.

710.4 STEEL CASING

710.4.1 The steel casing shall be seamless or electric resistance-welded tubing for sizes under 24-inch O.D. and standard double-submerged arc-weld for sizes over 24". Tubing shall be A-106, Grade B with bevelled ends.

710.4.2 Table 710.4.2 shows the steel casing size and thickness as related to the ductile iron carrier pipe.

710.5 INSTALLATION DETAILS

710.5.1 Prior to the start of the boring operations, the CONTRACTOR shall submit the following details to the ENGINEER:

710.5.1.1 Boring pit bracing

710.5.1.2 Casing boring head

710.5.2 Only workmen experienced in boring operation shall perform the work.

710.6 DRILLING AND JACKING FOR ELECTRICAL CONDUIT

Metallic conduit shall be installed under existing pavement by approved jacking or drilling methods. Non-metallic conduit shall not be installed by jacking. Non-metallic conduit may be installed by drilling if a hole larger than the conduit is pre-drilled and the conduit is hand-installed. Jacking or drilling pits shall be at least 2 feet from the edge of any type of any pavement, measured from the side of the pit nearest to the pavement.

710.7 MEASUREMENT AND PAYMENT

710.7.1 BORING:

Measurement shall be per linear foot of bored casing, and shall include furnishing all labor, materials, equipment, and work involved in the boring operations. The unit measurement shall also include skids, steel ties, grouting, and other items associated with the boring and casing. Payment shall be made at the unit price per diameter of casing per linear foot, as specified in the Bid Proposal. Payment for the carrier pipe shall be in accordance with Section 129.

710.7.2 DRILLING AND JACKING FOR ELECTRICAL CONDUIT:

Measurement shall be per linear foot of installed electrical conduit and shall

include all labor, materials, equipment,
and work required for the operation.
Payment shall be made at the unit price
per diameter per linear foot, as indi-
cated in the Bid Proposal.

TABLE 710.4.2

CASING SIZE VERSUS CARRIER SIZE

<u>Steel Casing Diameter and Wall Thickness</u>	<u>Ductile Iron Carrier Pipe (Inside Diameter)</u>
14" Schedule 30	6"
16" Schedule 30	8"
18" Standard Class	10"
22" Standard Class	12"
24" Schedule 20	14"
26" Schedule 20	16"
30" 0.375" Wall	18"
36" 0.375" Wall	24"

SECTION 800

WATER TRANSMISSION, COLLECTOR, DISTRIBUTION AND SERVICE LINES

800.1 GENERAL:

This section is related to linear water facilities which apply to the conveyance of water from the well site to reservoir, from pumping station to reservoir, and from reservoir to user.

800.2 CONTENTS

<u>Section No.</u>	<u>Title</u>
801	Installation of Water Transmission, Collector, and Distribution Lines
802	Installation of Water Service Lines

SECTION 801

INSTALLATION OF WATER TRANSMISSION, COLLECTOR, AND DISTRIBUTION LINES

801.1 GENERAL:

The water facilities and materials, specified herein, are associated with water transmission, collector and distribution lines.

801.2 REFERENCES:

801.2.1 American Water Works Association (Latest Edition) (AWWA):

- C110 American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids
- C203 Coal-Tar Protective Coatings and Linings for Steel Water Pipelines -- Enamel and Tape-Hot-Applied
- C206 Field Welding of Steel Water Pipe
- C207 Steel Pipe Flanges for Waterworks Service-Size 4-inch through 144-inch
- C502 Dry Barrel Fire Hydrants
- C504 Rubber-Seated Butterfly Valves
- C509 Resilient-Seated Gate Valves for Water and Sewerage Systems
- C515 Reduced-Wall, Resilient-Seat Gate Valve
- C600 Installation of Ductile-Iron Water Mains and Their Appurtenances
- C604 Installation of Steel Water Pipe -- 4-inch (100 mm) and Larger
- C605 Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
- C651 Disinfection Water Mains
- C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4-inch through 12-inch, for Water Distribution
- C905 Polyvinyl Chloride (PVC) Water Transmission Pipe Nominal Diameter 14-inch through 36-inch
- M9 Concrete Pressure Pipe
- M23 PVC Pipe-Design and Installation

801.2.2 This Publication:

- Section 18 Utilities
- Section 121 Plastic Pipe
- Section 127 Steel Water Pipe
- Section 128 Concrete Cylinder Pipe
- Section 129 Ductile Iron Pipe
- Section 130 Gray Iron, Ductile Iron, and Steel Fittings
- Section 161 Gray Iron Castings
- Section 163 Ductile Iron Castings
- Section 170 Electronic Markers
- Section 340 Portland Cement Concrete Curbs, Gutters, Walks, Driveways, Alley Intersections, slope paving, and Median Paving
- Section 343 Removal and Disposal of Existing Pavement, Curbs, Gutters, Sidewalks & Driveways
- Section 701 Trenching, Excavation and Backfill
- Section 1502 Submittals

801.2.3 American Association of State Highway and Transportation Officials (AASHTO)

- M 245 Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
- M 246 Standard Specification for Steel Sheet, Metallic-Coated and Polymer-Precoated, for Corrugated Steel Pipe

801.2.4 American Society for Testing and Materials (ASTM)

- A 742 Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
- A 762 Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains

SECTION 801

INSTALLATION OF WATER TRANSMISSION, COLLECTOR, AND DISTRIBUTION LINES

801.3 MATERIALS

801.3.1 GENERAL

801.3.1.1 The CONTRACTOR shall submit certification from the manufacturer of the pipe as specified in Section 1502 as to the pipe material and that the pipe meets or exceeds the required testing. Only pipe listed on the Water Authority Approved Product List shall be accepted unless otherwise approved in writing by the Water Authority Field Division Manager.

801.3.1.2 Main line pipe and fittings shall be as specified in the Reference Section in this publication as listed above or as specified in the Supplemental Technical Specifications and/or as authorized by the ENGINEER.

801.3.2 PIPE

801.3.2.1 Limitations of pipe materials versus pipe sizes will be as follows, unless otherwise specified on the plans or Supplemental Technical Specifications:

801.3.2.1.1

<u>PIPE TYPE</u>	<u>SIZES</u>
Ductile Iron	4-inch to 64-inch
Concrete Cylinder	24-inch and larger
Plastic (Blue - PVC – C900)	4-inch to 12-inch
Plastic (Blue - PVC – C905)	14-inch to 24-inch
Plastic (Purple- PVC–C900)	4-inch to 12-inch
Plastic (Purple – PVC – C905)	14-inch to 24-inch

801.3.2.2 The type of pipe used shall be approved by the ENGINEER. Steel pipe shall be used only where specified on the drawings. Unless otherwise approved by the ENGINEER, all pipe installed shall be identical from valve to valve.

801.3.3 GATE VALVES:

801.3.3.1 Gate valves shall only be used for pipe sizes of 12-inches and smaller, unless otherwise noted on the plans or in the Supplemental Technical Specifications.

801.3.3.2 All gate valves shall be resilient seat valves and shall conform to AWWA C515. The valve shall be a non-rising stem type with inside screw and “O” ring seals. The valve shall have a standard hub which opens counter-clockwise. Type valve ends shall be mechanical joints, unless otherwise specified on the plans. “O” ring retainer shall be secured with nuts and bolts.

801.3.3.3 The resilient seat shall be mechanically retained or bonded on the valve gate (wedge disc).

801.3.3.4 All brass or bronze parts used on gate valves shall comply with AWWA C515.

801.3.3.5 The outside of the valve body shall be painted with a corrosion-resistant coating. The inside shall be protected with corrosion resistant coating, approved for potable water.

801.3.3.6 The valve stem shall comply with AWWA C515. The material for the valve stem shall be brass or bronze, and shall have a minimum yield strength of 20,000-psi and minimum tensile strength of 60,000 psi.

801.3.3.7 Gate valves shall have a 2-inch square operating hub nut. Gate valves in vaults with valve covers at ground level shall have a handwheel with the 2-inch nut welded to the center. For a 4-inch, 6-inch, 8-inch, 10-inch, and 12-inch valve, the minimum outside diameter of the handwheel will be 10-inch, 12-inch, 14-inch, 16-inch, and 16-inch respectively. Handwheel diameters shall not be less than those stated in AWWA C509, Table 5.

801.3.3.8 Maximum input torque to open and/or close the valve shall be 200 foot-pounds for a 4-inch valve and 300 foot-pounds for 6-inch through 12-inch under a working pressure of 200 psi.

801.3.3.9 No project shall be accepted by the OWNER until all valves are operational and accessible.

801.3.3.10 Before the work will be accepted, water valve GPS coordinates shall be provided on the Record Drawings. GPS coordinates obtained by a Professional Surveyor licensed in the state of New Mexico shall be taken at the valve operating nut. Use the NAD 1983 NM STATE PLANE CENTRAL ZONE for x and y coordinates and NAVD 1988 for z coordinate.

801.3.4 RUBBER SEATED BUTTERFLY VALVES:

801.3.4.1 Butterfly valves shall be used for sizes of 14 inches and larger, and shall comply with AWWA C504.

801.3.4.2 Only short body, Class 150B or 250B valves are acceptable. Wafer type valves are not acceptable. Valve ends may be either mechanical joint or flanged.

801.3.4.3 The rubber seat shall be field replaceable on valve sizes 24 inches and larger. The rubber seat may be mechanically retained or bonded on the disk or valve body.

801.3.4.4 Butterfly valves shall have a 3-inch square operating hub nut. Butterfly valves in vaults with valve covers at ground level shall have a hand wheel with the 3-inch nut welded to the center.

801.3.4.5 The valve shaft and disk shall be installed horizontally. The valve disc shall pivot and rotate on the horizontal axis.

801.3.4.6 The maximum input torque to open and/or close the valve shall not exceed 150 ft-lb on the wrench

SECTION 801

INSTALLATION OF WATER TRANSMISSION, COLLECTOR, AND DISTRIBUTION LINES

nut and 80 lb on the handwheel under a minimum working pressure of 150 psi. The butterfly operator shall be compatible with the pressure. Manual actuators shall be provided from the same manufacturer as the valve. Maximum operating torques shall be in accordance with AWWA C504.

801.3.4.7 No project shall be accepted by the OWNER until all valves are operational and accessible.

801.3.4.8 Before the work will be accepted, water valve GPS coordinates shall be provided on the Record Drawings. GPS coordinates obtained by a Professional Surveyor licensed in the state of New Mexico shall be taken at the valve operating nut. Use the NAD 1983 NM STATE PLANE CENTRAL ZONE for x and y coordinates and NAVD 1988 for z coordinate.

801.3.5 VALVE BOXES:

Valve boxes shall consist of polymer coated steel pipe (CMP). The CMP pipe shall be polymer coated and conform to AASTO M 246 or ASTM A 742. Pipe galvanized material shall have a minimum coating thickness of 3 mils. Acceptable coating material is Trenchcoat Protective Film (Dow) or approved equal. Valve box shall be cut to accommodate the required depth. No joints shall be allowed in boxes less than 10 feet in depth. The pipe shall be manufactured in accordance with the applicable requirements of AASTO M 245 or ASTM A 762. Pipe material shall have a 12 gauge minimum thickness and be 12 inches in diameter to accommodate the cover and lid specified herein. The pipe shall be centered and placed true to vertical around the axis of the operating nut. Valve covers and lids for re-use water shall be as shown in Standard Drawings and shall be shown on project construction plans.

801.3.6 COMBINATION AIR AND VACUUM VALVES:

Air and vacuum valves shall be the type and size shown on the plans. Only combination air and vacuum valves listed on the Water Authority Approved Product List shall be used.

801.3.7 FIRE HYDRANTS

801.3.7.1 Hydrants shall be limited to those on the Water Authority Approved Product List.

801.3.7.2 Fire hydrants and their extensions shall be in accordance with AWWA C502, traffic type. Fire hydrants shall have one (1) 5¼-inch diameter valve opening; one (1) 6-inch mechanical joint inlet connection; two (2) ½-inch hose nozzle connections; and one (1) 4½-inch steamer nozzle with National Standard Fire Hose Coupling Screw Threads. Fire hydrants shall have a bronze or cast iron pentagon operating nut, be designed for 150 psi working pressure service, and have a normal bury of 4 to 4½ feet unless field conditions require a deeper bury, in which case

extensions will be used so as to bring the bottom of the break-off flange 2 to 8 inches above the top of finish grade.

801.3.7.3 The pipe fittings and fire hydrants starting at the street main and ending at the fire hydrant itself shall be lying in a line perpendicular to the street's centerline or radially on a curvilinear installation, unless otherwise approved in writing by the Water Authority. Fire hydrants shall have no more than ½-inch variation from a vertical line between the breakaway flange and the top of the fire hydrant.

801.3.7.4 Hydrants shall be dry barrel, post-type with compression main valve closing with pressure. They shall have a field lubrication capability. Hydrants shall have a bronze seat ring threaded into a bronze drain ring or bronze or cast iron bushing.

801.3.7.5 Exterior of hydrant, below the ground line, shall be coated with asphalt varnish, and the exterior painted from the top to a point one foot below the ground level flange, consisting of one coat rust inhibitive primer and one coat "safety yellow" enamel. The bonnet shall then be painted with a reflectorized paint using a color as close to "safety yellow" as possible.

801.3.7.6 The bottom plate of the main valve shall be epoxy coated. The shoe of the fire hydrant shall have a 6-inch mechanical joint connection and the inside shall be epoxy coated to prevent corrosion. The nozzle shall be threaded in place and retained by stainless steel locks. Hydrant body shall be threaded to receive the threaded nozzle. Nozzle shall be secured by a stainless steel locking device.

801.3.7.7 Fire hydrant shall contain two drain outlets. The drain outlets shall be constructed of bronze. Hydrant shall be provided with a pentagon operating nut to open counter clockwise and shall have an anti-friction washer between the hold-down nut and the operating nut.

801.3.7.8 To prevent loss of brass operating nuts due to theft or vandalism, the following shall be included in or on the fire hydrant:

801.3.7.8.1 The bonnet must be removed in order to remove the operating nut; or

801.3.7.8.2 Use a cast iron or bronze operating nut.

801.3.7.9 Fire hydrants shall be installed at locations as shown on construction plans and in accordance with Standard Detail Drawings.

801.3.7.10 Fire hydrants shall be fully restrained in accordance with Section 130.

801.3.7.11 All fire hydrant legs shall include an isolation valve.

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801.3.7.12 Hydrants shall be functional and capable of being opened or closed without difficulty following application of an operating torque of 200-foot-pounds at the operating nut.

801.3.7.13 Removal of existing fire hydrants – Where noted in the construction plans, existing fire hydrants and appurtenances shall be removed and salvaged. The pipe from the main to the fire hydrant shall be removed back to the main and the tee capped per 801.12. The CONTRACTOR shall note this on the record drawings.

801.3.7.14 Before the work will be accepted, fire hydrant GPS coordinates shall be provided on the Record Drawings. GPS coordinates obtained by a Professional Surveyor licensed in the state of New Mexico shall be taken at the valve flange. Use the NAD 1983 NM STATE PLANE CENTRAL ZONE for x and y coordinates and NAVD 1988 for z coordinate.

801.3.8 PRESSURE REDUCING VALVE (PRV): Pressure reducing valve shall be limited to those on the Water Authority Approved Product List. Submittals for approval shall be made to the ENGINEER and approval must be received before installation. The following items are required in the PRV:

801.3.8.1 Materials:

801.3.8.1.1 Main valve

801.3.8.2 Pilot Control System:

801.3.8.2.1 Adjustment from 15 psi to 75 psi.

801.3.8.2.2 Shut-off lever on all pilot control system lines.

801.3.8.2.3 Inlet flow strainer.

801.3.8.2.4 Closing speed control.

801.3.8.2.5 Opening speed control.

801.3.8.2.6 Flow stabilizer.

801.3.8.2.7 Tubing shall be copper.

801.3.8.3 Sizing shall be approved by the Water Authority. Installation shall be as per the construction plans. The Water Authority shall adjust final settings on PRV.

801.3.8.4 PRV operating criteria of elevation and normal downstream pressure setting shall be engraved on a stainless steel plate and mounted inside the vault. Numerical values shall be verified and approved by the Water Authority prior to installation of plate.

801.3.8.5 Before the work will be accepted, PRV GPS coordinates shall be provided on the Record Drawings. GPS coordinates obtained by a Professional Surveyor licensed in the state of New Mexico shall be taken at the PRV. Use the NAD 1983 NM STATE PLANE CENTRAL ZONE for x and y coordinates and NAVD 1988 for z coordinate.

801.3.9 TAPPING SLEEVES:

(For other than Concrete Cylinder Pipe) Only approved, long body, fully-gasketed tapping sleeves shall be allowed. They shall be ROMAC SST Series, or JCM 432 Series, or approved equal. During installation of the tapping sleeve, the pipe shall be fully supported to support the weight of the tapping sleeve and tapping machine. Taps greater than 2/3 line size will not be allowed unless otherwise approved in writing by the Water Authority.

801.3.9.1 Tapping sleeves of heavy welded steel bodies shall meet the following requirements:

801.3.9.1.1 Epoxy Coated

801.3.9.1.2 Bolts and nuts to be stainless steel and shall be Grade 8 minimum

801.3.9.1.3 Gaskets to be Buna-N rubber

801.3.9.1.4 Flange to be flat face steel and comply with AWWA C-207

801.3.9.1.5 Class D-ANSI 150 lbs. drilling

801.3.9.1.6 Designed to sustain an operating pressure of 150 psi

801.3.9.1.7 May be used on all water mains, 4-inch and larger

801.3.9.2 Tapping sleeves of cast iron bodies shall meet the following requirements:

801.3.9.2.1 Mechanical joint type with a working pressure of 200 psi

801.3.9.2.2 Outlet flange to be Class 125, ANSI B16.1

801.3.9.2.3 Sleeves to include side and end gaskets of Buna-N rubber

801.3.9.2.4 Eight high strength steel bolts and nuts to secure the halves of the sleeve to the pipe

801.3.9.2.5 May be used on all mains 4-inch and larger

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801.3.9.3 Tapping sleeves of short sleeve cast iron shall meet the following requirements:

801.3.9.3.1 Working pressure of 150-psi

801.3.9.3.2 Outlet flange to be Class 125, ANSI B16.1

801.3.9.3.3 Outlet half to have an enclosed gasket in a groove for a pressure seal

801.3.9.3.4 Four high strength steel bolts to secure halves of tapping sleeve to pipe

801.3.9.3.5 May be used on all water mains, 4-inch and larger

801.4 CORROSION MONITORING STATIONS

801.4.1 When corrosion monitoring stations are encountered in the field or on the construction plans, the CONTRACTOR shall protect the station from damage.

801.4.2 The ENGINEER shall provide a design to the CONTRACTOR that will include relocations, if needed, adjustment to grade, and a testing plan to comply with the National Association of Corrosion Engineers (NACE) requirements.

801.4.3 The CONTRACTOR shall provide all materials, equipment, labor and supervision necessary for the completion of the installation, relocation, or adjustment, and testing. The CONTRACTOR shall employ a Corrosion Construction Supervisor, with experience in the installation of similar type systems, to supervise the corrosion monitoring facilities installation, relocation, or adjustment. The Corrosion Construction Supervisor shall be under the direct supervision of a licensed professional Corrosion Engineer or a NACE certified Cathodic Protection Specialist. The Corrosion Construction Supervisor shall instruct the CONTRACTOR on site during the initial installation and shall revisit the site as required.

801.4.4 All construction projects within the vicinity of corrosion monitoring stations will coordinate with the Water Authority to ensure the integrity and functionality is preserved.

801.6 WATER LINE CONNECTIONS

801.6.1 GENERAL:

All new water line tie-ins to the existing water system shall be directly inspected and approved by the ENGINEER. This includes non-pressurized or pressurized connections that will result in extension of the existing system.

801.7 LOCATIONS OF WATER MAINS AND SEWER LINES

801.7.1 Unless otherwise authorized by the ENGINEER, parallel water and sewer lines shall be installed at least 10-feet apart horizontally, and the water line shall be at a higher elevation than the sewer. Separate trenches will be required in all cases (this shall be effective even though one line has been installed prior to the other), and the water line shall be at least 18-inches above the sewer; when water and sewer lines cross each other, the water line shall be at least 18-inches above the sewer; otherwise the sewer shall be of pressure class pipe extending between manholes, or concrete encased for 10-feet on each side of the water line as shown in the Standard Detail Drawings. The crossings shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints.

801.7.2 Water mains shall not be constructed under walkways, sidewalks, curbs and gutters, drivepads, or similar concrete structures by tunneling underneath them. Trenchless technologies may be allowed with prior approval by the Water Authority. The CONTRACTOR may cut concrete structures or remove and replace the section of the concrete structure to the nearest full expansion joint or edge.

801.8 TRENCHING AND BACKFILLING

801.8.1 All trenching, bedding, and backfilling activities shall conform to Section 701. Compaction shall be no less than 95% of maximum density as defined by ASTM D 1557 modified proctor.

801.9 GENERAL INSTALLATION ITEMS

801.9.1 The minimum cover over distribution lines shall be 3 feet; and 4 feet of cover over transmission and well collector lines at finished grade.

801.9.2 Pipe and accessories shall be new and unused and shall be handled in such a manner as to insure delivery to the trench in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating. No other pipe or material of any kind shall be placed inside of a pipe or fitting after the factory coating has been applied.

801.9.3 The interior of the pipe shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during operations by plugging or other approved methods. When work is not in progress, open ends of pipes and fittings shall be securely closed so that no other substances will enter the pipes or fittings. Any section of the pipe found to be defective before or after laying shall be replaced with sound pipe without additional expense to the OWNER.

801.9.4 All nuts and bolts utilized in underground pipe connections shall be stainless steel, high strength cast iron or high grade, high strength steel. The full length of each section of pipe shall rest solidly upon the bed, with recesses excavated to accommodate bells and joints. Any pipe that

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has the grade or joint disturbed after laying shall be taken up and re-laid. Pipes shall not be laid in water or when trench or weather conditions are unsuitable for the work except by as authorized by the ENGINEER. All unconnected ends of pipes shall have a valve, plug, or cap installed on it.

801.9.5 Pipe shall be laid to line and/or grade shown on the plans or as staked in the field. Changes in horizontal or vertical alignment of the pipe at a joint shall not exceed the manufacturer's recommended deflection for the type and size pipe being laid. When the change required is more than the recommended deflection, a fitting or several short joints of pipe shall be used.

801.9.6 When new pipe is to be connected to an existing pipe or when crossing an existing pipe line, the CONTRACTOR shall excavate the existing lines well in advance of the laying of the new pipe line to enable the ENGINEER to verify their elevation and placement and to make any changes in grade and/or alignment of the new pipe line that may be required.

801.9.7 On all push-on-joints (e.g., bell and spigot, fluid-tite, and ring-tite) the rubber gasket shall be removed, cleaned, the groove cleaned, the gasket replaced, and the bell or plain end cleaned before jointing. The gasket and the bell or plain end of the pipe to be jointed shall both be lubricated with a suitable soft vegetable soap compound to facilitate jointing. Care shall be taken to insure that neither the bell or collar, or the pipe being jointed is damaged as it is being pushed securely into place.

801.9.8 Flanged and mechanical joints shall be made with machine bolts and nuts of the proper size only. All components of these types of joints shall be cleaned before jointing. Only one (1) gasket will be permitted in a flange joint. In a mechanical joint, the plain end pipe shall be fully seated before the gasket and gland is slipped up to the bell. Nuts on both types of joints shall be tightened by alternating nuts 180-degrees apart. The CONTRACTOR shall be responsible for assuring that proper torque is achieved and shall have a torque wrench available for verification by the ENGINEER.

801.9.9 When laying pipe, a metalized detectable warning tape shall be installed a minimum of 1-foot above the top of pipe and 2 to 6 feet below the final surface. The tape shall be detectable with a standard metal pipe locator. The color of tape shall be safety precaution blue and will be inscribed at 10-foot intervals with the words, "CAUTION BURIED WATER LINE BELOW." Tape shall be 2 inches wide. The tape shall be constructed of material that is impervious to alkalis, acids, chemical reagents, and solvents found in the soils.

801.9.10 When laying pipe, Electronic Marker Devices (EMD's) shall be installed in accordance with Section 170.

801.9.11 TEMPORARY WATER MAIN

801.9.11.1 The CONTRACTOR may install a temporary water main (shoo-fly), if approved by the Water Authority, to provide a water service during replacement of the existing water main in a street or alley if authorized by the Water Authority. The shoo-fly shall be installed at locations as agreed with the Water Authority. The temporary water main size shall be determined by the ENGINEER and designed for traffic and above ground use. Access to all driveways shall be maintained. Cost shall be considered incidental to the work.

801.10 SPECIFIC PIPE LAYING REQUIREMENTS

801.10.1 Ductile iron pipe shall be installed in accordance with AWWA C600 and as herein specified.

801.10.2 Steel pipe shall be installed in accordance with AWWA C604, AWWA C206 for welded joint and as herein specified. All field-welded joints shall have one coat of coal tar enamel of 3/32-inch thickness.

801.10.3 Plastic pressure pipe shall be installed in accordance with AWWA M23, C900, C905, C605 and/or manufacturer's printed recommendations, whichever is applicable. Trenching, excavation and backfill is specified in Section 701. Compaction shall be no less than 95% of maximum density as defined by ASTM D 1557 modified proctor. A reference mark (a distinct circumferential line) is placed on the pipe's spigot by the manufacturer to indicate the correct depth of the spigot penetration into the pipe's gasket joint. If the pipe is seated too deep or too shallow, the pipe may buckle or separate due to thermal expansion/contraction, therefore particular attention shall be exercised when jointing pipe. The reference mark must be showing and not farther than 1/2-inch from the leading edge of the bell. The CONTRACTOR shall verify that the manufacturer's reference mark is correct per manufacturer's literature.

801.10.4 All concrete cylinder pipe shall have two small bond wires of low resistance, or other approved method, welded across the joint to make the joint electrically continuous. Where rigid joints are specified, they shall be provided as specified herein. The outside joint recess shall be completely filled with a rich low shrinkage cement grout. The concrete surface in contact with the joint mortar shall be moistened with water just prior to pouring the joint recess. The mortar shall be poured into the joint recess against a water proof paper or cloth diaper laid around and lapping the outside field joint. The diaper shall completely and snugly enclose the joint recess, being held in place by metal box strapping or wire. The mortar shall be poured into an opening slightly to one side on the top of the pipe and rodded by a flexible wire rod onto place until it appears on the opposite side completely. After the joint recess has been filled with mortar, adjoining pipe section shall not be disturbed. After the joint has been made, the concrete lining surfaces of the joint shall be moistened and the interior recess tightly jointed and troweled flush and

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smooth with the inside pipe surface. Grout for painting the interior joints shall be of a stiff consistency and shall have low shrinkage characteristics. In sizes of pipe smaller than 24 inches, the mortar shall be buttered all around the shoulder inside the bell before the spigot is entered. A backing-up tool, such as an inflated rubber ball wrapped with burlap, shall be pulled through the joint to compact the mortar, completely fill the inside annular space and wipe off the excess mortar. Each joint will be inspected by the ENGINEER for proper and complete closure prior to final acceptance. Flanges shall be protected by "cocoon" type protection coating of coal tar and felt in accordance with AWWA C203. When moving individual pipe section, the pipe shall be lifted using two web or belt type slings which support the pipe between the third and outside quarter points.

801.10.5 All fittings and valves shall be installed as per the type of joint as stated herein and/or as shown on the plans.

801.10.6 All couplings, clamps, sleeves, etc shall be installed as per the manufacturer's printed recommendations and as approved by the ENGINEER. The CONTRACTOR shall properly restrain all appurtenances as necessary.

801.10.7 All water lines installed as part of a re-use system or other non-potable use shall be purple in color or shall be encased in purple PVC wrap.

801.11 CUTTING: The cutting of any type of pipe shall be done as per the manufacturer's printed recommendations, as approved by the ENGINEER. Care shall be taken in cutting any pipe that has an internal and/or external lining or coating.

801.12 BLOCKING AND RESTRAINED JOINTS

801.12.1 All restrained joints shall be by mechanical means unless directed or approved otherwise by the ENGINEER.

801.12.2 All tees and bends shall be restrained by mechanical means. Valves in runs shall be mechanically restrained. Butterfly valves shall be flanged. Where rigid joints are called for on concrete cylinder pipe, the joints shall be flanged or field welded bell and spigot joints in accordance with the manufacturer's recommendation.

801.12.3 All caps and plugs on dead end lines shall be mechanically restrained when feasible. Blocking may also be required when adequate restrain length is not available.

801.12.4 Where restrained joints on ductile iron pipe or PVC pipe are called for on the plan, the mechanical restraining system employed shall conform to the recommendations of the pipe manufacturer.

801.13 RESTRAINING JOINTS

FOR CONCRETE CYLINDER PIPE

801.13.1 Restrained joints in concrete cylinder pipe for thrust restraint shall be produced by continuous welding the pipe joints.

801.14 CONNECTIONS TO EXISTING CONCRETE CYLINDER PIPE

801.14.1 OBJECTIVE: The intent of this Subsection is to establish procedural and design criteria for making connections to existing concrete cylinder pipe for water distribution line extensions, and will be applicable to 4-inch and larger size connections.

801.14.2 NEW WATER LINES: Non-factory taps are prohibited.

801.14.3 EXISTING WATER LINES

801.14.3.1 New connections to existing concrete cylinder pipe must be approved in writing by the Water Authority Field Division Manager. Hot taps and service connections will not be allowed. The requester shall provide the following information:

801.14.3.1.1 Justification for the connection

801.14.3.1.2 City Project name and number

801.14.3.1.3 Date connection to be performed
(Minimum 30-day notice)

801.14.3.1.4 Name of the CONTRACTOR who will be installing the connection

801.14.3.1.5 Scheduling of connections is subject to the moratorium requirements of the Water Authority

801.14.3.2 The CONTRACTOR shall coordinate the work with the Water Authority Field Division before commencing work. The Water Authority Field Division shall inspect and approve the entire installation of the connection prior to backfilling and returning to service.

801.16 HYDROSTATIC TESTS:

801.16.1 The CONTRACTOR shall be required to perform hydrostatic tests in all water mains, laterals, dead ends, and service lines in accordance with AWWA C600. The test shall be conducted in the presence of the ENGINEER, or his authorized representative. The testing of the lines shall be done without being connected to existing lines. The CONTRACTOR shall provide all temporary plugs required. Water used for disinfecting may be used for hydrostatic testing. Leakage through connections to the existing system, leaks in the existing lines, or leaking existing valves under the test pressure will invalidate the test. The lines shall be tested at 150-pounds, or 1.5 times the normal working pressure of the line,

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whichever is greater, for not less than two hours. All taps, gauges, and necessary equipment shall be provided by the CONTRACTOR as approved by the ENGINEER, however, the ENGINEER may utilize gauges provided by himself if he so elects. Each section of the new line between valves shall be tested to demonstrate that each valve will hold the test pressure. No installed pipe shall be accepted if the leakage is greater than that determined by page 801-12 Hydrostatic Test sheet calculations. If the total leakage is less than the allowable, the line can be accepted. All visible leaks shall be repaired regardless of the amount of leakage and the test reconducted.

801.16.2 The CONTRACTOR shall submit a testing plan to the ENGINEER for approval. In cases where a new main is being connected to an existing main without the installation of a new valve, the end of the new main shall be temporarily capped and restrained and a hydrostatic test performed. Hydrostatic tests should not be made such that an existing valve or existing main is included in the test section. Test Sheet on page 801-12 is the standard form which must be completed at the time of the test, signed by the ENGINEER and delivered to the Water Authority prior to acceptance of the Project.

801.17 DISINFECTING, FLUSHING, AND BACTERIA TESTING OF WATER LINES:

801.17.1 New water lines shall be installed in such a manner as to not require cleaning by flushing. This shall require capping stockpiled line, capping lines at night and any other time work is not in progress, visual inspection of interior of lines, and cleaning as necessary prior to placing in the trench. Every effort shall be made to prevent the entry of dirt and debris into pipelines under construction.

801.17.1.1 Mains shall be disinfected in accordance with AWWA C651 with chlorine liquid solution, which shall be added by an approved method at one end of the lines as water is drawn through the lines and service connections. The chlorine solution shall remain in the line for at least 24 hours. The lines shall then be flushed until the chlorine residual is equal to the normal residual in the existing system or at 0.5 parts per million for un-chlorinated water. Dry chlorine shall not be used for disinfection of water lines. The flushed water shall be disposed of by the CONTRACTOR appropriately. Should results of the bacteriological analysis be unsatisfactory, the disinfection procedure shall be repeated.

801.17.1.2 The CONTRACTOR shall be granted three free volumes of water for testing, disinfecting, and flushing the new installation. All water used for testing, disinfecting, and flushing shall be metered. If additional water is needed for these purposes, the water shall be paid for by the CONTRACTOR at the current water rates. An approved backflow prevention system shall be used when withdrawing water from any waterlines and hydrants. Unmetered connection to the water system shall not be

used for providing water for disinfecting, testing, or flushing.

801.17.1.3 Water Authority or the ENGINEER will collect the water sample to test the water in the existing lines at the point of delivery for assurance of clean and potable water. The water in the existing lines will be used for testing and flushing.

801.18 INTERFERENCE WITH SERVICE AND SCHEDULE OR WORK

801.18.1 The CONTRACTOR shall obtain the permission of the ENGINEER before making any connections with existing mains. The required operation of existing valves will be performed by the Water Authority as per Section 18.

801.18.2 Work shall be started after authorization from the Water Authority and the ENGINEER and shall be completed in a prompt efficient manner in coordination and cooperation with other utilities concerned.

801.18.3 The CONTRACTOR shall be required to arrange his construction to maintain continuous service to water users, from existing facilities, to the fullest extent possible. CONTRACTOR shall, at all times, withhold construction work where any conflicts in the service requirements occur.

801.19 NOTIFICATION OF COMPLETION:

801.19.1 The CONTRACTOR shall notify the ENGINEER, in writing, when the CONTRACTOR has completed construction of a water line. This notification should be submitted immediately upon completion; the water line shall not be placed in service by the Water Authority before the sewer service and the paving, if applicable, are in place and until the Water Authority has received and accepted all adequate documentation submittals per 801.21. Water Authority inspection shall consider, on a case by case basis, exceptions for fire protection purposes.

801.20 VALVE BOX REHABILITATION

801.20.1 The rehabilitation of existing valve boxes as shown on the plans or as authorized by the ENGINEER shall include the following:

801.20.1.1 Removing and disposing the existing valve box, concrete collar, ring, and cover and installing the new type box, concrete collar, ring, and cover.

801.20.1.2 Installation of a new concrete collar is required in paved and unpaved areas. Main line pipe size and direction of the line shall be scribed on the collar.

801.20.1.3 Install a new electronic marker device.

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801.20.1.4 Removal, disposal, and replacement of the pavement.

801.20.1.5 Excavation, backfill, and compaction.

801.20.1.6 All materials, labor, and equipment necessary to do the work.

801.20.2 The work under this item shall be constructed per the Standard Detail Drawings

801.21 DOCUMENTATION SUBMITTALS

801.21.1 At the time of the final inspection, the following documentation will be submitted to the ENGINEER and to the Water Authority:

801.21.1.1 Hydrostatic test data of the new water line system

801.21.1.2 Microbiological test reports which were taken at representative locations along the system.

801.21.1.3 All valves at that time shall be in the open position, unless otherwise authorized by the ENGINEER and Water Authority.

801.21.1.4 A marked-up set of construction drawings reflecting as-built conditions. This does not supplant the requirements for record or as-built drawings.

801.22 MEASUREMENT AND PAYMENT

801.22.1 PIPE:

Payment for all sizes and types of pipe shall be made on the basis of measurement per linear foot, including the length of fittings, valves, etc. The contract unit price of pipe shall include all jointing and coupling materials necessary for its installation and connections to other sections of pipe, except for fittings, valves or other appurtenances. The cost of hydrostatic testing, flushing and disinfecting of new water lines shall be included in the contract unit price for the item in place. Pipe locator tape for pipe shall be included in the contract unit price of the pipe. Joint restraint shall be paid for separately.

801.22.2 DEPTH OF TRENCH:

801.22.2.1 The contract unit price for pipe and appurtenances in all cases shall include the trenching, installation, and compacted backfilling for trench cuts as specified in Section 701.

801.22.2.2 Payment for additional excavation deeper than the specified limits shall be made on the contract unit price per vertical foot per linear foot, and shall include trenching, installation of pipe and appurtenances, and compacted backfilling in the deeper trench.

801.22.3 REMOVAL AND DISPOSAL OF PIPE

801.22.3.1 The payment for removal shall be made on a unit price per linear foot; there shall be no additional cost to the OWNER for disposal.

801.22.3.2 The payments for removal and disposal shall include trenching and compacted backfilling.

801.22.4 CAST IRON AND DUCTILE IRON FITTINGS:

801.22.4.1 All cast iron and ductile iron fittings shall be measured and paid for at the contract unit price per pound based on weights of an all mechanical joint ends fitting for the type and size of fitting used as specified in AWWA C110, regardless of the type of ends on the fitting installed. The contract unit price per pound of fittings shall include all gaskets, glands, bolts, and nuts required. No separate payment will be made for these items.

801.22.4.2 When the CONTRACTOR installs a Water Authority-furnished fitting and replaces that fitting in the Water Authority's inventory, the CONTRACTOR shall be paid the full contract unit price of that fitting as outlined above. If the CONTRACTOR does not replace the fitting in the Water Authority's inventory, the payment to the CONTRACTOR will be at the contract unit price of the fitting less the cost of the fitting itself.

801.22.4.3 Fitting Insertion: The insertion of a fitting into an existing pipe line shall be measured and paid for at the contract unit price per pound based on weights of an all mechanical joint end fitting and if required on all mechanical joint connecting piece (coupling) of the type fitting and size used, as specified in AWWA C110, regardless of the type of ends on the fitting and coupling installed. This payment shall include all compensation for the excavation, cutting and removal of the existing pipe, installation of the fitting and coupling, if required, the re-cutting of the existing pipe or new pipe installed between the fitting and coupling, and backfill and compaction complete in place. In addition to the payment for the fitting insertion, the CONTRACTOR shall be paid for each non-pressurized connection and if pavement, curb and gutter, sidewalk, drive pad, etc., are removed, these items will be paid for as part of the appropriate item.

801.22.5 REMOVAL AND DISPOSAL OF PIPE AND APPURTENANCES:

801.22.5.1 The payment for removal and disposal shall include trenching and compacted backfilling.

801.22.6 CONCRETE CYLINDER FITTINGS:

Concrete cylinder pipe fittings, such as flanged outlets, bends, reducers, etc., shall be considered as incidental to the contract unit price for installation of the pipe, as shown on the construction plans.

801.22.7 COUPLINGS:

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The measurement for steel or cast iron couplings shall include payment for all gaskets, bolts, and incidental materials as may be needed for its complete installation. Payment shall be made on the contract unit price per each size of coupling required.

801.22.8 STEEL FITTINGS:

Steel fittings shall only be used when authorized by the ENGINEER and when needed to connect to an existing steel water line. Measurement and payment for steel fittings, when authorized, shall be made at the contract unit price per pound based on weights of an all mechanical joint ends fitting of the type fitting and size used, as specified in AWWA C110. This payment shall include all fabrication and welding required on the fitting.

801.22.9 VALVE AND VALVE BOXES:

801.22.9.1 Valves shall be measured and paid for at the contract unit price per each size of valve. The contract unit price for valves 24-inch and larger shall include the bypass valve, fittings and piping, complete in place.

801.22.9.2 Valve Boxes shall be measured and paid for at the contract unit price per each per type of valve box. Payment shall include the polymer coated corrugated metal pipe, new ring, cover, new concrete pad, and new EMD complete in place.

801.22.10 FIRE HYDRANTS

801.22.10.1 Fire Hydrants shall be measured and paid for at the contract unit price per each per depth of bury. Payment shall include excavation, gravel drain pocket, mechanical restraining system, backfilling, and compaction complete in place.

801.22.10.2 Measurement and payment for removal of existing fire hydrant shall be per each and shall include excavation and salvage of the existing fire hydrant, valve and pipe back to the water main, capping the tee, backfilling and compaction as required for the location of the fire hydrant and appurtenances. Removal and replacement of existing paving, curb, gutter, and sidewalk will be covered under those bid items.

801.22.11 VALVE BOX ADJUSTMENTS:

801.22.11.1 Valve box adjustment using the adjustment collar and insert shall be measured and paid for per each complete in place including the concrete pad and EMD. If existing ring and cover do not match current approved standards, a new ring and cover that does comply with the Standard Specifications shall be installed and the cost shall be considered incidental to the valve box adjustment.

801.22.11.2 When the adjustment height required on a valve box exceeds the height of the adjustment collar or the valve box has been previously adjusted, the valve box shall

be rehabilitated. Measurement and payment shall be made as specified under Valve Box Rehabilitation.

801.22.12 WATER LINE CONNECTIONS:

801.22.12.1 Non-pressurized Connections:

Non-pressurized connections shall be measured and paid for at the contract unit price per each for any size or type of pipe, complete in place, which shall include any extra excavation required, shut-off coordination, the removal of any caps or plugs or the cutting of the existing pipe any number of times required to make the connection, drainage plan (if required), pumping or handling of the water, backfilling and compaction. Fittings shall be measured and paid for per pound as specified herein, including all types of couplings.

801.22.12.2 Pressurized Connections:

Pressurized connections shall be measured and paid for at the contract unit price per each per location shown on the plans, complete in place, which shall include excavation, the cleaning or removal of existing pipe coatings and coverings, hydrostatic testing, the tapping, any grouting required, backfilling and compaction. The installation of the tapping sleeve and gate valve is to be paid under separate item or as indicated on the plans.

801.22.12.3 Connection to Steel Water Lines:

All connections to existing steel water lines shall be made by using a transition coupling. The measurement and payment for this type of connection shall be made per pound of fitting for a Mechanical-Joint Connecting Piece of the size used based on the weights specified in AWWA C110.

801.22.13 THRUST RESTRAINTS:

801.22.13.1 CONCRETE BLOCKING:

When concrete blocking is used, as authorized by the ENGINEER, the blocking shall be measured and paid for at the contract unit price per cubic yard placed to the neat lines shown on the plans or per the Standard Detail Drawings.

801.22.13.2 RESTRAINING JOINTS FOR CONCRETE CYLINDER PIPE:

Measurement and payment for this item shall be at the contract unit price per linear inch of circumferential welded, complete in place, including protective coating of the weld.

801.22.13.3 MECHANICALLY RESTRAINED JOINTS:

Mechanically restrained joint assemblies shall be measured and paid for at the contract unit price per each assembly per size of the pipe per each type (pipe to pipe, pipe to mechanical joint, pipe to fitting, etc.) complete in place.

801.22.13.4 VALVE ANCHORAGE:

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No separate measurement nor payment shall be made for valve anchorage as per Standard Detail Drawing. The cost of this work shall be included with the cost of the valve.

801.22.14 PRESSURE REDUCING VALVE (PRV):
Measurement and payment for furnishing and installing a PRV shall be made at the contract unit price per each per size, complete in place as shown on the plans or in the Standard Detail Drawings. The payment shall include all labor, gauges, equipment and material required for the excavation, the PRV, all by-pass piping, fittings and valves both inside and outside the structure, the structure, backfilling and compaction.

801.22.15 AIR RELEASE VALVE (ARV):
Measurement and payment for furnishing and installing an ARV shall be made at the contract unit price per each per size of ARV, complete in place as shown on the plans or in the Standard Detail Drawings. The payment shall include all labor, equipment and materials required for the excavation, ARV, piping, fittings, gate valve, structure, backfilling, compaction, EMD, valve box, and concrete collar.

801.22.16 VALVE BOX REHABILITATION:
Valve box rehabilitation shall be measured and paid for at the contract unit price per each, complete in place which shall include the removal of the existing valve box, excavation, the new valve box installed, EMD, backfilling, compaction and the installation of the concrete collar. If existing ring and cover do not match current approved standards, a new ring and cover that does comply with the Standard Specifications shall be installed and the cost shall be considered incidental to the valve box rehabilitation.

801.22.17 CONCRETE STRUCTURES:
The removal and replacement of concrete structures such as sidewalks, drive pads, wheelchair ramps, and curb and gutters, as required for the installation of water lines shall be measured and paid for as specified in Section 340 and 343.

801.22.18 BEDDING MATERIAL:
No separate measurement nor payment shall be made for bedding material required when shown on the plans or when required due to the type of pipe supplied by the CONTRACTOR. The cost of the bedding material shall be included in the unit price of the pipe. If bedding material is not required by the conditions above, but is required due to the conditions encountered during construction, then the bedding material shall be measured and paid for as specified in Section 701.

801.22.19 SURPLUS MATERIALS:
No separate measure nor payment will be made for the removal and disposal of surplus material generated by the pipe, bedding material or the use of lean fill.

**801.22.20 CORROSION MONITORING
STATION ADJUSTMENTS TO FINISHED GRADE**

801.22.20.1 Corrosion monitoring station
adjustments to grade shall be measured and paid per each complete in place including electrical connections or extensions needed, pea gravel, concrete collar, and traffic rated box and cover to comply with current standard detail drawings.

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AND DISTRIBUTION LINES

Test No.: _____ HYDROSTATIC TEST

PROJECT NAME: _____ DATE: _____

PROJECT NUMBER: _____ CONTRACTOR: _____

LOCATION: _____

PIPE MATERIAL: _____ DIP _____ PVC _____ CCP _____ Fabricated Steel

Test: Length (S) = _____ ft.

Size (D) = _____ inches

Pressure (P) = _____ psi - gauge (average test pressure during the hydrostatic test)

Leakage Allowed (L_{ALL}) - _____ gal / hr ($L_{ALL} = SD \sqrt{P} / 133,200$ per AWWA C600-99)

Basis: Only resilient seated gate valves and/or rubber seated butterfly valves are used. No metal seated valves are allowed.

Total Leakage Allowed for 2 hour Test Period: $L_{ALL} * 2 \text{ hours} =$ _____ gallons

Actual Amount of Water ADDED to maintain 150 psi \pm 5 psi for 2 hours = _____ gallons

If actual amount of water added is LESS THAN total leakage allowed, test PASSED

If actual amount of water added is GREATER THAN total leakage allowed, test FAILED

_____ Test Passed _____ Test Failed

Contractor _____ Date _____

Inspector _____ Date _____

Project Manager _____ Date _____

COMMENTS: _____

Note: See Section 801.16 for the Specification for test procedure.

SECTION 802

INSTALLATION OF WATER SERVICE LINES

802.1 GENERAL:

This section pertains to the water service line which extends from the distribution line to the water meter.

802.2 REFERENCES

802.2.1 American Society for Testing and Materials (Latest Editions) (ASTM)

A-536 Specifications for Ductile Iron Castings

B-62 Specifications for Composition Bronze or Ounce Metal Castings

B-88 Specification for Seamless Copper Water Tube

D-2000 Classification System for Rubber Products in Automotive Applications

802.2.2 American Water Works Association (Latest Editions) (AWWA)

802.2.3 This publication:

Section 163 Ductile Iron Castings

C-800 Underground Service Line Valves and Fittings

802.3 MATERIALS

802.3.1 SERVICE LINE FITTINGS:

All service line fittings shall be in full compliance with the latest version of AWWA Standard C800, except as modified herein. Fittings shall be of the type required for the type of service line being installed. All stops shall be of the round, full opening type with no restriction in the opening less than the nominal size. Fittings incorporating a threaded plastic gripper and "O" ring seal may be utilized in lieu of the flared configuration. All service pipe and fittings shall be designed to sustain an operating pressure of 150-psi.

802.3.2 COPPER SERVICE PIPE: The ¾-inch to 2-inch copper service pipe shall conform to ASTM B 88 and shall be Type K, unless otherwise specified. Copper tubing shall be bent with approved tube benders without any kinks or sharp bends. Cutting of tubing will be performed with cutters designed for that purpose. Couplings used to join two pieces of tubing together shall not be installed anywhere on the service line between the water meter and the water main.

802.3.3 TAPPING SADDLES:

802.3.3.1 Service saddle bodies shall be of cast iron, ductile iron, or bronze. The type of saddle used must be listed on the current Water Authority Approved Products List. Straps, nuts, bolts, and washers shall be of stainless steel or bronze. Gaskets shall be vulcanized elastomeric rubber or synthetic rubber compound.

802.3.3.2 The saddles shall be tapped for the type of thread being used on the corporation stop.

802.3.3.3 Tapping saddles for PVC C900 pipe shall have bronze straps and shall be installed as per the manufacturer's printed recommendations.

802.3.4 METERS:

Meters are furnished and installed by the Water Authority for new service installations. For replacement and relocation work, the existing meters shall be reinstalled by the CONTRACTOR.

802.3.5 METER

802.3.5.1 METER BOXES FOR ¾-INCH TO 1-INCH METERS:

802.3.5.1.1 Meter boxes with two meters shall be centered on adjacent property lines.

802.3.5.1.2 The meter box is to be part of an underground enclosure for water meters and shall have a ductile iron cover plate and lid.

802.3.5.1.3 Meter box shall be cast in one piece to form a hollow rectangle and new material or recycled materials shall be used in its manufacture.

802.3.5.1.4 The box material shall have the following minimum mechanical properties at variable ambient temperatures of -20°F to 120°F, compressive strength equal to 10,000 psi, tensile strength equal to 1,500 psi and flexural strength equal to 7,500 psi.

802.3.5.1.5 Meter boxes to be installed shall have no visual cracking, crazing, checking, blistering, surface pitting, or deformation.

802.3.5.1.6 The finished meter box shall have the following physical properties:

802.3.5.1.6.1 Maximum wall deflection shall not exceed 1/8 inch at any one point when subject to earth pressures or forces created during backfilling.

802.3.5.1.6.2 Material used for making the box shall be non-biodegradable when buried and/or exposed to water. Life expectancy of the box shall be at least 20 years.

802.3.5.1.6.3 Overall weight of the box component shall not exceed 80 pounds.

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802.3.5.1.6.4 Inside dimensions of the box shall conform to the current Standard Detail Drawings. This meter box is for one and two meter installations.

802.3.5.1.6.5 Inside and outside surfaces of the walls shall be reasonably smooth and free of burrs.

802.3.5.1.6.6 All materials used for box construction shall be approved for use in the domestic water supply system.

802.3.5.2 METER BOX COVER AND LID:

802.3.5.2.1 The size, dimensions, and details of the meter box cover and lid are as shown in the Standard Detail Drawings.

802.3.5.2.2 The casting shall conform to ASTM A536. The castings shall be true to pattern in form and dimensions and be free from pouring faults, sponginess, cracks, blowholes, or other defects. Castings shall be filleted boldly at angles and arises shall be sharp and true. Edges shall be rounded or chamfered. The castings shall be thoroughly cleaned and the parting lines, grates, and risers ground flush. The lid shall seat firmly in the cover without rocking. The lid top surface shall be flush with the top surface of the cover. The lid shall be easily removed from the cover.

802.3.5.2.3 The cover and lid shall have, integrated in the casting top, a corrugated design to provide a non-slip surface. The lid shall have, integrated in the top of the casting, the words "WATER AUTHORITY".

802.3.5.3 METER BOX FOR 1 1/2-INCH AND 2-INCH METERS:

802.3.5.3.1 The meter box is to be part of an underground enclosure for water meters.

802.3.5.3.2 The meter box and cover with lid shall be selected from those on the Water Authority Approved Product List.

802.3.5.3.3 The material used for manufacturing the box, cover and lid shall be new or recycled materials and shall have the following minimum mechanical properties at ambient temperatures from -20°F to 120°F: Compressive Strength = 11,000 psi., Tensile Strength = 1,700 psi., and Flexural Strength = 7,500 psi.

802.3.5.3.4 Meter boxes to be installed shall have no visual cracking, crazing, checking, blistering, surface pitting, or deformation.

802.3.5.3.5 The finished meter box shall have the following physical properties:

802.3.5.3.5.1 Box, cover, and lid shall be rated for a load capacity of 1,000 lbs. over a 4-inch by 4-inch (4" x 4") area.

802.3.5.3.5.2 The overall weight of the box, cover, lid, and extension shall not exceed 80 lbs.

802.3.5.3.5.3 Maximum wall deflection shall not exceed 1/8 inch at any one point when subjected to earth pressures or forces created during backfilling.

802.3.5.3.5.4 The material used for making the box shall be non-biodegradable when buried underground and exposed to water.

802.3.5.3.5.5 The minimum dimensions of the box, cover, and lid shall conform to the current Standard Detail Drawings.

802.3.5.3.5.6 The walls inside and outside of the box shall be reasonably smooth and free of burrs.

802.3.5.3.5.7 The cover of the meter box shall have a non-skid surface and have "WATER AUTHORITY" inscribed on the top. The cover shall be secured to the box by bolts.

802.3.5.3.5.8 All materials used for constructing the box, cover, and lid, shall be approved for use in domestic water supply systems.

802.3.5.4 LOCATIONS OF METER BOXES:

Meter boxes shall be located within the right-of-way as shown on the Standard Detail Drawings or within easements as approved by the Water Authority.

802.3.6 CORPORATION STOP:

The corporation stop shall be AWWA thread inlet by compression-type outlet or Pack Joint to fit 3/4-inch, 1-inch, 1.5-inch, and 2-inch copper tubing, as allowed on the Water Authority Approved Product List.

802.3.7 TAILPIECE:

The service shall be placed in the meter box with a copper tubing tailpiece for 3/4-inch to 2-inch services, protruding from the standard concrete pad into the owner's property with a Pack Joint capped fitting to which the plumber can connect. Maintenance of the tailpiece is the responsibility of the customer.

802.3.8 COPPERSETTERS:

Coppersettors shall have pipe connections for Type K Copper Tubing. The coppersetter shall be an assembly of brass and copper tubing with a bottom bar, shall have a bronze ball valve on the inlet side of the meter, and shall be furnished with coupling gaskets. The coppersettors shall be selected from the Water Authority Approved Product List. Coppersettors shall have temporary threaded plugs in the meter connections and shall be furnished free of

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INSTALLATION OF WATER SERVICE LINES

excess grease. A stabilizer bar of 12-inches by ½-inch galvanized pipe shall be inserted in the yoke assembly as shown on the Standard Detail Drawings. A coppersetter with dual check valve shall be installed as per the Cross Connection Control section.

802.3.9 CROSS CONNECTION CONTROL:

802.3.9.1 Approved dual check valves shall be installed on all services within pressure zones 0-W, 1-W, and 1-E. Water customers having private wells located within water pressure zones other than zones 0-W, 1-W, and 1-E, that connect to the municipal water system shall: a) agree to permanently abandon the use of private wells by plugging the wells in accordance with the State Engineer's procedures prior to connecting to the municipal water system; or b) agree to completely sever the private well from the premise's existing plumbing system and install a USC approved reduced pressure principal backflow prevention assembly at the water meter.

802.3.9.2 All customers connected to a non-potable water system and the public water system shall install a USC approved reduced pressure principal backflow prevention assembly approved by the Water Authority at the potable service connection.

802.3.9.3 All fire line services to fire protection systems shall be equipped with a USC approved reduced pressure principal backflow prevention assembly approved by the Water Authority and Fire Marshal having jurisdiction at each service connection.

802.3.9.3.4 A USC approved double check valve assembly approved by the Water Authority and Fire Marshal having jurisdiction may be installed instead of a reduced pressure backflow prevention assembly provided the fire protection system contains ANSI/NSF Standard 60 or 61 water piping throughout the entire fire protection system, the fire sprinkler drain discharges into atmosphere, and there are no reservoirs, fire department connections, connections from auxiliary water supplies, antifreeze nor other additives.

802.4 SERVICE LINE INSTALLATIONS

802.4.1 NEW ¾-INCH TO 2-INCH SERVICE LINES:

802.4.1.1 New service lines shall be completed in accordance with Standard Detail Drawings and shall include the following:

802.4.1.1.1 Furnish and install tapping saddle, EMD, corporation stop, tubing, coppersetter, meter box, cover, lid, tailpiece, and concrete collar, complete in place, including excavation, backfill, and flushing.

802.4.1.2 Meters shall not be installed as part of this work. However, construction of the meter box and placement of the yoke shall be such that at a later date, the meter may be installed properly and easily.

802.4.1.3 The CONTRACTOR shall be responsible for proper vertical and horizontal location of the box over the meter yoke.

802.4.2 REPLACEMENT OF ¾-INCH TO 2-INCH SERVICE LINES:

802.4.2.1 Replacement service lines are essentially new services installed in conjunction with the replacement of the water main. Unless otherwise specified in the Contract Documents, all existing services shall be replaced with new material between the water main and the meter yoke.

802.4.2.2 Replacement service line work does not include any relocation or rehabilitation of the meter. The work shall consist of the following:

802.4.2.2.1 Furnish and install tapping saddle, EMD, corporation stop, coppersetter and tubing, complete in place, including flushing.

802.4.2.2.2 Re-connection to the meter.

802.4.2.2.3 All necessary excavation, backfill, including sidewalk, curb, gutter, pavement removal and replacement.

802.4.3 ¾-INCH TO 2-INCH METER RELOCATION

802.4.3.1 A meter relocation is the relocation of an existing meter to a position closer to the water main. The meter relocation item is to be used when the service line is not replaced.

802.4.3.2 A new meter box and cover shall be furnished and installed.

802.4.3.3 A coppersetter shall be used in the reinstallation of the meter, for services sized ¾-inch thru 2-inch, and shall be of a height to properly position the meter vertically within the box, as shown in the Standard Detail Drawings.

802.4.3.4 When moving the meter further from the water main, refer to section 802.4.1. The existing line shall be abandoned and the corporation stop shall be closed.

802.4.3.5 When determined by the Water Authority, the existing meter shall be replaced by the CONTRACTOR with a meter furnished by the Water Authority. Any 1¼ -inch meters found in the field shall be replaced with 1-inch meters by the Water Authority.

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802.4.3.6 The work and materials shall include the coppersetter, connector pieces, excavation, tubing, backfill, removal and replacement of meter, installation of new meter box, and concrete pad. The work shall also include all necessary disconnections, and connections of the house and meter box service lines, complete restoration of the affected site (including landscaping) and adjustment of the meter to the level shown in the Standard Detail Drawings.

802.5 Meter boxes shall not be located or relocated in driveways or driveways unless authorized by the ENGINEER.

802.6 ¾-INCH TO 2-INCH METER REHABILITATION AND REPLACEMENT

802.6.1 ¾-INCH TO 2-INCH METER REHABILITATION:

802.6.1.1 Meter rehabilitation is applicable where the meter box deficiency exists. Deficiencies include obsolete, broken above or below grade, improperly sized, or existing location does not allow access to the meter, curb stop, or connector pieces (does not meet new installation standards). When any of these conditions exist, the meter box and meter installation shall be rehabilitated, as authorized by the ENGINEER.

802.6.1.2 The work and materials shall include:

802.6.1.2.1 Furnish and install a new coppersetter, meter box, cover and lid, and concrete pad.

802.6.1.2.2 Furnish and install any reconnection pieces necessary for a complete service restoration.

802.6.1.2.3 Flushing out of the service line.

802.6.1.2.4 Site restoration (including any necessary landscaping) and cleanup.

802.6.2 ¾-INCH THRU 2-INCH METER REPLACEMENT:

Meters to be replaced under "Service Line Replacement" and "Meter Relocation" work shall be performed in accordance with the following procedure:

802.6.2.1 All existing meters involved with "Service Line Replacement" and "Meter Relocation" work shall be replaced by the CONTRACTOR with a meter provided by the Water Authority.

802.6.2.2 The replacement meter shall be requested, in writing by the CONTRACTOR, to the Water Authority, with documentation of address and meter size for each meter to be replaced, project name and number, and CONTRACTOR'S name.

802.6.2.3 The request shall be received at least seven days prior to issuance of meters.

802.6.2.4 A meter replacement worksheet must be filled out by the CONTRACTOR and submitted to the Water Authority which will include the date of installation, address of service, old meter brand, old meter serial number, old meter size, old meter reading, new meter brand, serial number, size, and reading.

802.6.2.5 The CONTRACTOR shall handle all meters so as not to damage them and shall be responsible for the meters from the time of receipt to turn in. Stolen or lost meters shall be replaced at the CONTRACTOR'S expense.

802.7 SERVICE LINE REMOVAL

802.7.1 When an existing service line is to be decommissioned, the CONTRACTOR shall remove and dispose the meter box and service line back to the main where the corporation stop will be turned to the closed position and buried.

802.8 MEASUREMENT AND PAYMENT

802.8.1 METERED SERVICE LINE INSTALLATIONS:

For ¾-inch through 2-inch, new service line, service line replacements and transfer, meter relocation, meter replacement, and meter rehabilitation shall be measured and paid for as a completed unit of installation in accordance with the applicable items contained in the Bid Proposal, which payment shall include all materials, labor and equipment required to install, flush and place into service the applicable item.

802.8.2 SERVICE LINES:

Unless otherwise authorized in the Contract Documents or by the ENGINEER, service line materials and fittings shall be considered incidental to the applicable pay item established in the Bid Proposal.

802.8.3 PAVEMENT REMOVAL AND REPLACEMENT:

Unless otherwise authorized in the Contract Documents or by the ENGINEER, pavement removal and replacement shall be considered incidental to the applicable pay item established in the Bid Proposal.

802.8.4 SERVICE LINE REMOVAL

802.8.4.1 Service line removals shall be measured and paid for at the contract unit price per each, which shall include removal of the existing meter box, removal of the existing service line, and closing the corporation stop. Removal and replacement of any subgrade or asphalt is considered incidental to the removal.

SECTION 900

SANITARY AND STORM SEWER FACILITIES

900.1 GENERAL

This section pertains to the collection and conveyance facilities for sewage and storm runoff in underground piping systems

900.2 CONTENTS

<u>Section No.</u>	<u>Title</u>
901	Sanitary Sewer Collector and Interceptor Facilities
905	Sanitary Service Lines
910	Storm Sewer Pipe Installations
915	Storm Sewer Drainage Appurtenances
920	Sanitary and Storm Sewer Manholes
925	Vacuum Sewer Collector, Interceptor and Force Main Facilities

SECTION 901

SANITARY SEWER COLLECTOR AND INTERCEPTOR FACILITIES

901.1 GENERAL

The construction items, specified in this section, are common to sanitary sewer collector and interceptor facilities.

901.2 REFERENCES

901.2.1 ASTM

C 43	D 2321
C 425	D 3034
C 443	F 679
C 478	F 794

901.2.2 AWWA

C 603

901.2.3 This publication per SECTIONS:

101	123
102	124
105	125
106	129
108	701
121	

901.3 MATERIALS

802.3.1 PIPE: Sewer line pipe and fittings shall be as specified in other sections, as follows:

Plastic Pipe	Section 117
Reinforced Concrete Pipe	Section 123
Reinforced Concrete Pressure Pipe	Section 124
Vitrified Clay Pipe	Section 125
Ductile Iron Pipe	Section 129

901.4 CERTIFICATION

The OWNER/ENGINEER will be supplied with a certification on each item or type of material required in the sewer line, as to that item meeting the specifications and/or the reference specifications before that item is installed.

901.5 INSTALLATION

901.5.1 GENERAL:

901.5.1.1 Pipe and appurtenances shall be new and unused. The type of pipe to be installed shall be as approved by these specifications or unless otherwise shown on the drawings. Pipe and appurtenances shall be handled in such a manner as to insure delivery to the trench in sound, undamaged condition. Particular care shall be taken to prevent damage to any pipe coating.

901.5.1.2 The interior of the pipe shall be thoroughly cleaned of foreign material before being lowered into the trench and shall be kept clean during construction operations. When work is not in progress, the open ends of pipe shall be securely closed so that no foreign materials will enter the pipe. Any section of pipe found to be defective before or after laying shall be replaced with sound pipe, or repaired in a manner satisfactory to the ENGINEER, without additional expense to the OWNER.

901.5.1.3 The CONTRACTOR shall install a plug in the new sewer at any point of connection to an existing system. The plug shall remain in place until the ENGINEER and Liquid Waste Division authorize its removal in writing. The CONTRACTOR shall not flush or otherwise discharge any flow into an existing system unless approved in writing by the ENGINEER.

901.5.1.4 Pipe shall be laid to line and grade as shown on the plans and as staked in the field. The bedding of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe barrel. Suitable excavation shall be made to receive the bell of the pipe and the joint shall not bear upon the bottom of the trench. All adjustment to the line and grade shall be made by scraping away or filling in with pipe zone material under the body of the pipe, and not by wedging or blocking. When connections are to be made to any existing manhole, pipe, or other improvement, the actual elevation or position of which cannot be determined without excavation, the CONTRACTOR shall excavate for and expose the existing improvement before laying the connecting pipe or conduit. When existing underground improvements may reasonably be expected to conflict with the line or grade established for the new sewer line, the ENGINEER shall request the CONTRACTOR to excavate as necessary to expose and locate such potentially conflicting underground improvements prior to laying the new pipe. Any adjustment in line or grade which may be necessary to accomplish the intent of the plans will be made, and the CONTRACTOR will be paid for any additional work resulting from such change in line or grade in the manner provided for in the General Conditions.

901.5.1.5 Connections to existing manholes shall be made by core drilling through the manhole wall. The CONTRACTOR shall take care to avoid unnecessary damage to the existing manhole.

901.5.1.6 Pipe shall be laid upgrade in a continuous operation from structure to structure, with the socket or collar ends of the pipe upgrade unless otherwise permitted by the ENGINEER.

901.5.1.7 Sanitary sewer mains shall not be constructed under walkways, sidewalks, curbs and gutters, drivepads, or similar concrete structures by tunneling underneath them. The CONTRACTOR will cut these concrete structures by using a concrete saw or, at his option, he may remove the section of the concrete structure to the nearest full expansion joint or edge.

901.5.2 PLASTIC PIPE INSTALLATION:

901.5.2.1 Plastic sewer pipe shall be connected and placed in the trench in accordance with the manufacturer's recommendations. Where a conflict arises with this Specification, this Specification shall control. Trenching, embedment, and backfill shall be as specified in Section 701.

901.5.2.2 The reference mark (a distinct circumferential line) is placed on the pipes spigot end by the manufacturer to indicate the correct depth of spigot penetration into the pipe gasket joint. If the pipe is seated too deep or too shallow the pipe may buckle or separate due to thermal expansion/contraction. Spigot penetration shall be within 1/4" of the manufacturer's recommended mark.

901.5.2.3 For plastic pipe connection to manholes the CONTRACTOR shall install an appropriately sized press seal gasket, such as PS-10 by Press Seal Gasket Corporation, Large Diameter Waterstops for Concrete Manhole Adapters by Fernco, or approved equal. The gasket shall be installed per manufacturer's directions. No direct payment shall be made for this item; this cost shall be included in the pipe bid item price.

901.5.2.4 Not less than thirty (30) days after the installation and backfilling of plastic sewers, including any service connections, the CONTRACTOR shall, in the presence of the ENGINEER, test deflection of the pipe with a mandrel (GO-NOGO device). The mandrel shall be hand pulled. All pipe with deflections in excess of five (5) percent of the base internal diameter, as determined by ASTM

D 3034, ASTM F 679, or ASTM F 794 shall be excavated, rerounded, backfilled and retested after an additional period of at least thirty days. Mandrels shall have 9 ribs and be only hand pulled through the test section. The CONTRACTOR shall furnish the mandrels. The length of the minimum radius portion of the mandrel shall not be less than the one-third of the nominal diameter of the pipe tested. The pipe shall be flushed and cleaned by the CONTRACTOR prior to testing. No flow will be permitted in the pipe while testing for deflections.

901.5.2.5 All expense for trenching, backfill, compaction, paving, and related work that is required because of failure to meet deflection test requirements shall be borne by the CONTRACTOR.

901.5.2.6 Acceptance of plastic pipe sewers will be made only after these deflection test requirements have been met.

901.5.2.7 Minimum Diameters of Mandrels

901.5.2.7.1

<u>Nominal Pipe Size</u>	<u>Min. Mandrell Diam.</u>
8 in.	7.28 in.
10 in.	9.08 in.
12 in.	10.80 in.
15 in.	13.20 in.
18 in.	16.13 in.
21 in.	19.00 in.
24 in.	21.36 in.
27 in.	24.07 in.

901.6 JOINTS FOR PIPE

901.6.1 JOINTS FOR CLAY PIPE (FACTORY FABRICATED AND INSTALLED COMPRESSION-TYPE JOINTS FOR VITRIFIED CLAY PIPE):

901.6.1.1 Joint material shall be any one of the types specified in ASTM C 425 and shall meet all requirements of that specification and Section 125.

901.6.1.2 The CONTRACTOR shall furnish the ENGINEER complete information concerning the type and make of all joint material which he intends to use under the contract including certification that the joint material meets the requirements of these specifications.

901.6.1.3 In addition to all other tests required, the ENGINEER may select at random and perform the test on 2 joints for

each 250 feet of pipe or fraction of each size of any lot of pipe to be tested.

901.6.1.4 The pipe joints shall not leak when subjected to the shear loading and hydrostatic tests as per ASTM C 425.

901.6.2 JOINT FOR CONCRETE PIPE:

901.6.2.1 The type of joint to be used shall be as shown on the drawings or as specified in the Supplementary Specifications.

901.6.2.2 Gasketed type of joints for reinforced concrete pipe shall be used.

901.6.2.3 The ends of the pipe shall be so formed that when the pipes are laid together and joined, they shall make a continuous and uniform line of pipe with a smooth and regular surface.

901.6.2.4 Rubber gaskets for making compression type joints for concrete pipe shall be factory fabricated in accordance with ASTM C 443 and C 361; for pipes 12 inches in diameter and larger shall be O-Ring and shall be handled, primed, installed, etc. in strict accordance with the manufacturer's recommendations.

901.6.2.5 The CONTRACTOR's attention is particularly called to ASTM C 443, regarding storage of gaskets.

901.6.2.6 The sealing of the plastic liner at the pipe joints shall be in strict accordance with Section 122.

901.6.2.7 The CONTRACTOR shall furnish the ENGINEER complete information concerning the type and make of all joint material which he intends to use under the contract,, including certification that the joint material meets the requirements of these specifications.

901.6.3 JOINT FOR PLASTIC SEWER PIPE (PVC):

901.6.3.1 Refer to ASTM D 2321 and ASTM F 794 for pipe laying and joining of pipe guidelines.

901.6.3.2 Prior to the laying of pipe, each pipe component shall be inspected for damage and cleaned. Damaged components shall be rejected or repaired.

901.6.3.3 All joints will be assembled in accordance with manufacturer's published recommendations. If a lubricant is required to facilitate assembly, it shall have no detrimental effect on the gasket or on the pipe when subjected to prolonged exposure. Proper jointing may

be verified by rotation of the spigot by hand or with a strap wrench. If unusual joining resistance is encountered or if the insertion mark does not reach the flush position, disassemble the joint components and repeat the assembly steps. Note that fitting bells may permit less insertion depth than pipe bells. When mechanical equipment is used to assemble joints, care should be taken to prevent over insertion.

901.7 TESTING FOR LEAKAGE

901.7.1 GENERAL:

901.7.1.1 Unless otherwise shown on the drawings or specifically deleted by the ENGINEER, in writing, all sanitary sewers shall be tested for leakage.

901.7.1.2 The CONTRACTOR may, at his option, Air Test the sanitary sewer line before backfilling the trench to aid the CONTRACTOR in checking the installation for any defects. Such testing is at the option of the CONTRACTOR and shall not constitute an acceptance test under these specifications.

901.7.1.3 The test for acceptance and compliance with these specifications shall be performed after the pipe zone backfilling has been completed. In the case of new sanitary sewer lines with house laterals included as an integral part of the project, the test for acceptance and compliance with these specifications shall be performed after the house laterals or stubs have been completed and backfilled. The CONTRACTOR has the option to leave the end of the service line exposed.

901.7.1.4 If the leakage, as shown by the test, is greater than allowed by these specifications, the pipe shall be overhauled by the CONTRACTOR at his expense and, if necessary, relaid until the pipe will satisfactorily pass the test.

901.7.1.5 The CONTRACTOR shall, at his own expense, furnish all water, material, tools and labor for making the test required. All tests shall be made under observation of the ENGINEER.

901.7.2 INFILTRATION TEST:

901.7.2.1 An Infiltration Test shall be used only when excessive ground water prevents satisfactory testing by either the Exfiltration Test or the Air Test. In addition, the Infiltration Test must be performed after backfilling, before any service connections are functioning and at a time when the ground water is

over the entire section of pipe and at or near its maximum level.

901.7.2.2 The procedure for conducting an Infiltration Test shall be as follows:

901.7.2.2.1 The pipe section shall be cleaned.

901.7.2.2.2 Determine the groundwater table. The groundwater table shall be determined for each section of sanitary sewer tested.

901.7.2.2.3 Plug the upstream pipe outlet from upstream manhole of the sections being tested with a plug which will assure a tight seal against flow from the upstream portion of the sewer system. Also plug all house laterals and any other connections to the section being tested.

901.7.2.2.4 Install a 90 degree V-notch weir in the downstream manhole of the section being tested. Weir must be installed plumb and sealed to the pipe wall surface.

901.7.2.2.5 A sufficient period of time must be allowed to permit the infiltrated waters to collect and flow over the weir. Water shall flow over the weir for at least thirty minutes prior to taking measurements.

901.7.2.2.6 The head (H) of water flowing over the weir must be measured accurately and the measurement taken at least 18 inches upstream from the crest of the weir.

901.7.2.2.7 Discharge over the 90 degree V-notch weir shall be calculated according to:

$$Q = 3240 H^{2.5}$$

H = Head in inches
Q = Discharge in gallons per day

901.7.2.3 The allowable infiltration shall be 200 gallons per inch of pipe diameter per mile of pipe per day. When there is significantly more than two feet of groundwater above the top of the pipe at the highest point of the section being tested, ten percent additional infiltration above the permitted 200 gal/in.-dia/mi/day limit will be allowed for every 2 foot of additional head.

901.7.3 EXFILTRATION TEST

901.7.3.1 An Exfiltration Test may be conducted wherever the groundwater level is below the crown of the pipe at the highest elevation of the section of

sanitary sewer being tested. If the groundwater level is above the crown of the pipe either the Air Test, properly adjusted, or Infiltration Test should be used.

901.7.3.2 The procedure for conducting an Exfiltration Test shall be as follows:

901.7.3.2.1 The pipe section shall be cleaned.

901.7.3.2.2 Plug the downstream pipe outlet to the manhole with a plug which will assure a tight seal against water leakage. Also plug all house laterals and any other connections to the section being tested.

901.7.3.2.3 If the upstream manhole is to be used as a reservoir for maintaining the pressure head on the sewer pipe, the inlet sewer pipe or pipes must be plugged. If a standpipe is to be used as a reservoir for maintaining the pressure head on the sewer pipe, the standpipe must be connected to the sewer pipe in the upstream manhole by a tightly sealed connection.

901.7.3.2.4 The amount of water (volume required to fill the section of sewer under test plus the manhole or standpipe) shall be calculated.

901.7.3.2.5 Water shall then be introduced through the manhole or standpipe. The amount of water introduced shall be metered. The amount of water introduced to fill the sewer should be approximately equal to the calculated amount. If the amount of water required to fill the sewer pipe is significantly greater than the calculated amount, it is an indication of a leak or leaks and consequent saturation of the backfill around the sewer pipe. Saturation of the backfill will invalidate the test.

901.7.3.2.6 The level of water in the manhole or standpipe shall be at least two feet above the crown of the pipe at the highest section of the section of sanitary sewer being tested.

901.7.3.2.7 After filling the pipe at least one hour shall be allowed for water absorption in the pipe. For some materials, up to six hours may be required. After the absorption period, the manhole or standpipe shall be refilled to the established measuring mark and the test begun.

901.7.3.2.8 If the upstream manhole is used as a reservoir for maintaining the pressure head on the sewer pipe, the dif-

ference in water surface elevation from original to final level in a two hour period shall be used to calculate the water lost. The water lost in the two hour period shall be converted into gallons per day. If a standpipe is used as a reservoir for maintaining the pressure head on the sewer pipe, the standpipe shall be refilled periodically during the two hour test period to maintain an essentially constant head on the test section of pipe. The amount of water added shall be measured and shall be used to calculate the loss in gallons per day.

901.7.3.2.9 The allowable exfiltration shall be computed based upon the average pressure head above the crown of the pipe for the section tested as follows:

$$\text{Allowable leakage} = \frac{\sqrt{h}}{\sqrt{3}} \times 200$$

Allowable leakage in gallons per inch of pipe diameter per mile of pipe per day.

h = average pressure head above the crown of the pipe, in feet
(elevation of water at center of run)

901.7.3.2.10 When the upstream manhole is used as a reservoir for maintaining the pressure head, the allowable leakage from the manhole shall be added to the allowable leakage calculated for the sewer pipe.

901.7.3.2.11 If the sanitary sewer line fails to pass the Exfiltration Test, a re-test shall be permitted only after the groundwater conditions surrounding the pipe return to a condition similar to those existent at the beginning of the test period. The groundwater elevation shall be determined prior to initiation of the second test.

901.7.4 AIR TEST:

901.7.4.1 An Air Test may be conducted under all conditions of groundwater levels surrounding the sanitary sewer pipe. If the groundwater is above the crown of the pipe, the air pressure shall be increased by an increment equal to the pressure exerted by the groundwater over the pipe.

901.7.4.2 The procedure for conducting an Air Test shall be as follows:

901.7.4.2.1 Clean the pipe section (manhole to manhole reach of sewer) being tested by propelling a snug-fitting inflated ball, or other adequate method, through the pipe with water. It is

important that the pipe be thoroughly wetted if consistent results are to be expected.

901.7.4.2.2 Plug all pipe outlets with pneumatic plugs. The pneumatic plugs shall be able to resist internal testing pressures without requiring external bracing. Give special attention to house laterals.

901.7.4.2.3 Determine the groundwater level surrounding the section of sewer under test. If the groundwater level is above the crown of the pipe, the test pressures shall be increased by 0.43 psig for each foot of water above the average elevation of the crown of the pipe. Test pressures shall not exceed 10 psig.

901.7.4.2.4 Introduce air slowly to the section of pipe under evaluation until the internal air pressure is raised to 4.0 psig plus any increase required by a high groundwater level.

901.7.4.2.5 Allow the air pressure to stabilize. Air may be added slowly to maintain a pressure in the 3.5 to 4.0 psig (plus groundwater allowance) for two minutes.

901.7.4.2.6 After the stabilization period, when the pressure reaches exactly 3.5 psig (plus groundwater allowance) the stopwatch is started and when the pressure reaches exactly 2.5 psig (plus groundwater allowance) the stopwatch is stopped.

901.7.4.2.7 If the time required for a one pound pressure drop is not less than the allowable time for the pipe section under test to lose air, the section shall pass the leakage test.

901.7.4.2.8 In all cases where an Air Test is conducted, the manholes shall be tested separately as previously specified.

901.7.4.2.9 All persons conducting an Air Test must be made aware of the fact that an Air Test may be dangerous if improperly conducted.

901.7.5 AIR TESTING TABLES: Tables 901.7.5.1 and 901.7.5.2 will be used to determine the required test duration for the section of line being tested.

901.8 CLEANING AND INSPECTION

901.8.1 CLEANING: No pipe spalls, rocks, dirt, joint compounds, cement mortar and other trash or obstructions shall be left in a sewer pipe of any size or type. During the flushing operations the

TABLE 901.7.5.1

SPECIFICATION TIME REQUIRED FOR 1.0 PSIG PRESSURE
 DROP FOR SIZE AND LENGTH OF PIPE
 INDICATED FOR Q=0.0015

(A) Pipe Diam- eter (in.)	(B) Mini- mum Time (min: sec)	(C) Length for Mini- mum Time (ft)	(D) Time for length (sec)	(E) Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

Table from: UNI-B-6-79, "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe"; Uni-Bell Plastic Pipe Assoc.

TABLE 901.7.5.2

SPECIFICATION TIME REQUIRED FOR LOSS OF PRESSURE
FROM 3.5 PSIG TO 2.5 FOR SIZE AND
LENGTH OF PIPE INDICATED FOR Q=0.003

(A) Pipe Diam- eter (in.)	(B) Mini- mum Time (min: sec)	(C) Length for Mini- mum Time (ft)	(D) Time for length (sec)	(E) Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:48	11:24	12:49
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	23:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23
39	18:25	61	18.054 L	30:57	45:09	60:11	75:14	90:16	105:19	120:22	135:24
42	19:50	57	20.039 L	34:54	52:21	69:48	87:15	104:42	122:09	139:36	157:05

Table from: WPCF Journal, Vol. 44, No. 4, April 1972; Ramseier, "Testing New Sewer Pipe Installations"; pp. 557-564.

901.7.5.3 EXPLANATION AND USE OF TABLES

Explanation of Tables

- Column A Nominal diameter of pipe (any pipe material).
- Column B Minimum duration of air test regardless of length of line segment being tested. (e.g., 250' of 8" PVC: test duration 3 min. 47 sec.)
- Column C Length of Line associated with minimum duration of air test (Column B).
- Column D L = length of line in feet; product of computation yields duration of air test (e.g., 250' of 12" PVC where ground water is not present ([Table 901.7.5.1]: test duration-- $1.709 (250) = 427.25$ sec. = 7 min. 8 sec.)
- Column E Duration of air test for given incremental lengths of line.

Use of Tables

Table 901.7.5.1 is based on an air loss rate of 0.003 cfm/sf of internal surface area. Use for line installations where ground water (and subsequent infiltration is not present.

Table 901.7.5.2 is based on an air loss rate of 0.0015 cfm/sf of internal surface area. Use for line installations where ground water (and subsequent infiltration) is present.

manhole outlet shall be bagged or plugged so that this debris will not be carried into or contaminate an existing or active line.

901.8.2 TELEVISION:

901.8.2.1 All completed sewer lines shall be inspected by a television camera before lines become operational or final acceptance of the installation.

901.8.2.2 After the CONTRACTOR has cleaned flushed and retrieved all debris in the line, the CONTRACTOR will notify the project engineer that the line is ready for television inspection. The CONTRACTOR in the presence of the ENGINEER or the engineer's representative shall televise the line with televising equipment specifically designed and constructed for sewerline visual inspection.

The television camera shall be of color and equipped with a rotating lens capable of 360-degree rotation with zoom focus and a wide-angle optical lens permitting spontaneous focal adjustments, allowing viewing of service lateral connections, joints, pipe walls, etc.

A television report log, completed on the OWNER'S log form, shall be maintained during the television inspection. This log shall be completed to the OWNER'S satisfaction noting the location, project title, name of OWNER, date, type of pipe material, line size, location of services (live or stubouts), manhole or station numbers, and any abnormal or line defects within the line segment. The CONTRACTOR shall be responsible for subsequent televising when line repairs are required or when the previous televising is not satisfactory to the OWNER.

When the televising is complete, the CONTRACTOR shall turn over to the OWNER complete television report logs and the VHS videotape recordings.

901.9 MEASUREMENT AND PAYMENT

901.9.1 SANITARY SEWER PIPE: Installed pipe shall be measured and paid for as follows:

901.9.1.1 For straight lines the pipe length shall be the intervening distance between the centers of manholes along a line parallel to the pipe invert.

901.9.1.2 For curvilinear lines the pipe length shall be the intervening arc distance between the centers of manholes along a line parallel to the pipe invert.

901.9.1.3 For lateral lines, such as from main or manhole to a storm inlet, the pipe length shall be the distance between the center of a manhole or centerline of the main to the interior wall face of the storm inlet along a line parallel to the pipe invert.

901.9.1.4 Payment for pipe will be in accordance with the unit price per linear foot per size and material as defined in the Bid Proposal, and shall include: pipe installed in the trench, jointing and coupling materials, and other materials necessary to connect to other sections of pipe, manholes, and other appurtenances.

901.9.2 CONNECTIONS: Connections, tying new sewer lines into existing manholes, shall be measured and paid for on a unit price per each within the size increments as specified in the Bid Proposal. Connections to the shelf section of the floor will not be considered for payment under this bid item.

901.9.3 VERTICAL DROPS: Vertical drops at manholes shall be measured by the linear foot of pipe from the invert of the sewer line to be dropped to the spring line of the receiving main. Payment will be made on the unit price per linear foot per size and type of pipe as specified in the Bid Proposal.

901.9.4 TESTING:

901.9.4.1 Infiltration, exfiltration, and air tests of sewer mains shall include sewer service lines to the property lines or right-of-way lines as installed per the construction plans. No payment will be made for the initial test or subsequent tests.

901.9.4.2 Television inspection is defined in Subsection 801.8.2.

901.9.4.3 There will be no payment for required testing of sanitary sewer manholes.

901.9.4.4 No payment will be made for deflection tests after the required waiting period for PVC sewer pipe installations.

901.9.5 REMOVAL AND DISPOSAL OF SEWER PIPE: Removal and disposal of sanitary or storm sewer lines shall be measured by the linear foot within the specified pipe size increments. Payment will be made on the unit price per linear foot of specified pipe size in the Bid Proposal. No payment will be made until delivery of salvageable materials is verified by Liquid Waste Division. Trenching, backfilling, and pavement removal and replacement will be paid for based on the unit prices for each appropriate bid item in the Bid Proposal. If new pipe is to be installed in the same trench as the removed pipe, only one payment will be made for trenching, backfilling, and pavement removal and replacement.

SECTION 905

SANITARY SEWER SERVICE LINES

905.1 GENERAL

905.1.1 The requirements of this section apply only to sanitary sewer service lines installed or reconnected within the public right-of-way or easement. Although the maintenance of sanitary sewer lines is the responsibility of the property owner, including the portion within the public right-of-way as established by City Ordinance, the CONTRACTOR shall be responsible for the integrity of the installation or reconnection of all sanitary sewer service lines during the warranty period.

905.1.2 Sanitary sewer service lines shall be installed at all locations shown on the plans. The CONTRACTOR shall be aware of the importance of accurately recording the horizontal and vertical location of sanitary sewer service lines.

905.2 REFERENCES

905.2.1 ASTM:

D 1557
D 2661
D 2665

905.2.2 This publication:
SECTION 801

905.3 MATERIALS

905.3.1 The materials listed herein are considered pre-approved. The CONTRACTOR shall submit to the ENGINEER a certified list of all sanitary sewer service materials which will be utilized on the project. All materials not listed must be submitted to the ENGINEER for approval no less than thirty (30) calendar days prior to the proposed date of use.

905.3.2 The following saddles have been pre-approved for use in the connection of sanitary sewer service lines to collection lines. The CONTRACTOR shall be responsible for assuring that the supplied saddle is compatible with the size and type of both the collection line and service line. Saddles shall be so constructed to have a positive stop to prevent service line from protruding into the main.

905.3.2.1 "Pioneer Sewer Branch Connector" (Hersey) 90 degree (tee) type only, with alignment ring and elastomeric gasket.

905.3.2.2 "Sealtite Sewer Pipe Saddle" (Geneco), Type "S", Type "D" Model "DD", Type "E" Models "EO" and "EBG" and Type "C" Model "CO" (if 4" service is required a 4" x 6" reducer must be used).

905.3.2.3 For all saddles with a 2 1/2" wide strap will be required when saddle is attached to plastic pipe.

905.3.3 The following saddles have been pre-approved for use in the connection of sanitary sewer services to manholes. Manhole connections shall only be allowed if shown on the plans or approved by the ENGINEER.

905.3.3.1 "Fowler Quick-Way Sewer Tap" Models 4-41, 4-42, 6-41, and 6-42.

905.3.4 Service risers, if required, shall be PVC Schedule 40 pipe conforming to ASTM D 2665 cast iron soil pipe (service weight), or ABS Schedule 40 sewer pipe conforming to ASTM D 2661. Only PVC or ABS shall be used when connecting to flexible pipe.

905.3.5 Fittings shall be compatible with the service line material. PVC or ABS fittings shall be schedule 40 injection molded only.

905.3.6 Service line laterals shall be cast iron soil pipe (service weight), PVC Schedule 40, or ABS Schedule 40.

905.4 INSTALLATION (NEW CONSTRUCTION STUB-OUTS)

905.4.1 Service lines shall be installed to the right-of-way line or 5 feet beyond any existing or proposed improvements (i.e., pavement, curb and gutter, sidewalk, etc.).

905.4.2 Saddle connections shall be installed at a 45 degree angle (upward) above the springline of the main sewer and shall be spaced a minimum of 3 feet apart (centerline to centerline).

905.4.3 Service lines shall be installed at a minimum slope of 2 percent with a minimum bury at the terminus of 4 feet, unless otherwise authorized by the ENGINEER. The pipe shall be placed on suitable bedding having a density of not less than 90 percent of maximum density, as determined by ASTM D 1557. The pipe shall be uniformly supported by the

bedding. Backfill of the service line shall be carefully placed and compacted per the requirements of Section 801.

905.4.4 The terminus of the service line shall be plugged with an end cap compatible with the pipe size and material. An electronic marker disk shall be placed over the end of the service line and an "S" (3 inches high and 1/4 inch depth) shall be stamped or saw-cut into top of the curb surface directly over the service.

905.5 RISERS

905.5.1 Risers shall be utilized where the sewer main is 15 feet or greater in depth. The riser shall extend to an elevation such that the service line can be installed as specified in Subsection 905.4.3.

905.5.2 The riser shall be installed in accordance with the Standard Detail Drawings. The riser shall be one length of pipe cut to the appropriate length as necessary, unless otherwise approved by the ENGINEER.

905.6 SERVICE RECONNECTIONS

905.6.1 On replacement/rehabilitation type projects, all existing services shall be reconnected to the new sewer main utilizing new saddles and service line pipe. The length of removed existing service line shall be as necessary to accommodate the trench excavation and backfill conditions.

905.6.2 The CONTRACTOR shall visually observe the condition of the existing service line and notify the ENGINEER of any obviously deteriorated or defective conditions. The ENGINEER or CONTRACTOR shall notify the property owner of the situation and the property owner shall be afforded the opportunity to visually observe the service within a reasonable amount of time as dictated by normal construction activity.

905.6.3 The CONTRACTOR shall connect the new service line pipe to the existing pipe at the same slope and alignment as the existing service. Particular care shall be taken to assure a sound connection. The service line shall be uniformly supported on suitable bedding compacted to a density of not less than 90 percent of maximum density, as determined by ASTM D 1557. If service lines are reconnected such that the pipe is not fully supported, hand tampers shall be used to properly compact under the pipe.

905.6.4 The CONTRACTOR shall stamp or saw-cut an "S" (3 inches high and 1/4 inch depth) into top of curb surface directly over the service line.

905.7 RECORD INFORMATION: The CONTRACTOR shall provide accurate record information to the ENGINEER regarding both the horizontal and vertical location of the service. The horizontal location shall be by the distance to the nearest foot from both the upstream and downstream manhole lid center. Elevations to the nearest 0.10 foot shall be provided for the saddle, top of riser and invert of the service stub-out, as applicable.

905.8 MEASUREMENT AND PAYMENT

905.8.1 Sanitary sewer service lines installed on new construction shall be measured by the linear foot horizontally from the center of the sewer main, or top of riser, if applicable, to the end of the service line. Payment shall be made at the unit price per linear foot and shall include the saddle connection, pipe, trenching, compaction and backfill, electronic marker disk, testing, and all incidental work necessary to complete the installation.

905.8.2 Sanitary sewer service risers shall be measured by the vertical foot from the top of the sewer main to the top of the riser. Payment shall be made at the unit price per vertical foot, and shall include the pipe and casing (if required).

905.8.3 Sanitary sewer service reconnections shall be measured per each. Payment shall be made at the unit price per each reconnection shall include the saddle connection, new service pipe, connection to the existing service line, and all incidental work necessary for a complete reconnection.

SECTION 910

STORM SEWER PIPE INSTALLATIONS

910.1 GENERAL

910.1.1 The construction items, specified in this section, are common to storm sewer pipe installation and pipe type culverts.

910.1.2 Reinforced concrete pipe may be used for storm sewer pipe installations or pipe type culverts. Corrugated metal pipe will only be used for pipe-type culverts.

910.2 REFERENCES

910.2.1 ASTM

C 43	C 478
C 361	D 3034
C 425	F 679
C 443	

910.2.2 AWWA C 603

910.2.3 This publication per SECTIONS:

101	125
102	129
105	135
106	136
108	137
121	161
123	801
124	

910.3 MATERIALS

910.3.1 PIPE: Sewer line pipe and fittings shall be as specified in other sections, as follows:

Reinforced Concrete Pipe	Section 123
Reinforced Concrete Pressure Pipe	Section 124
Corrugated Metal Pipe and Arches	Section 135
Structural Plate for Pipe, Arches, and Pipe Arches	Section 136
Corrugated Aluminum Pipe and Arches	Section 137

910.4 CERTIFICATION

The OWNER/ENGINEER will be supplied with a certification on each item or type of material required in the sewer line, as to that item meeting the specifications and/or the reference specifications before that item is installed.

910.5 INSTALLATION

910.5.1 GENERAL:

910.5.1.1 Pipe and appurtenances shall be new and unused. The type of pipe to be installed shall be as approved by these specifications or unless otherwise shown on the drawings. Pipe and appurtenances shall be handled in such a manner as to insure delivery to the trench in sound, undamaged condition. Particular care shall be taken to prevent damage to any pipe coating.

910.5.1.2 The interior of the pipe shall be thoroughly cleaned of foreign material before being lowered into the trench and shall be kept clean during construction operations. When work is not in progress, the open ends of pipe shall be securely closed so that no foreign materials will enter the pipe. Any section of pipe found to be defective before or after laying shall be replaced with sound pipe, or repaired in a manner satisfactory to the ENGINEER, without additional expense to the OWNER.

910.5.1.3 The CONTRACTOR shall install a plug in the new sewer at any point of connection to an existing system. The plug shall remain in place until the ENGINEER and Liquid Waste Division authorize its removal in writing. The CONTRACTOR shall not flush or otherwise discharge any flow into an existing system unless approved in writing by the ENGINEER.

910.5.1.4 Pipe shall be laid to line and grade as shown on the plans and as staked in the field. The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe barrel. Suitable excavation shall be made to receive the bell of the pipe and the joint shall not bear upon the bottom of the trench. All adjustment to the line and grade shall be made by scraping away or filling in with pipe zone material under the body of the pipe, and not by wedging or blocking. When connections are to be made to any existing manhole, pipe, or other improvement, the actual elevation or position of which cannot be determined without excavation, the CONTRACTOR shall

excavate for and expose the existing improvement before laying the connecting pipe or conduit. When existing underground improvements may reasonably be expected to conflict with the line or grade established for the new sewer line, the ENGINEER shall request and the CONTRACTOR shall excavate as necessary to expose and locate such potentially conflicting underground improvements prior to laying the new pipe. Any adjustment in line or grade which may be necessary to accomplish the intent of the plans will be made, and the CONTRACTOR will be paid for any additional work resulting from such change in line or grade in the manner provided for in the General Conditions.

910.5.1.5 CONTRACTOR shall submit to the ENGINEER the proposed method for making connections to existing manholes. Connection methods will be dependent upon manhole size and pipe sizes. Unnecessary damage to the existing manhole should be avoided.

910.5.1.6 Pipe shall be laid upgrade in a continuous operation from structure to structure, with the socket or collar ends of the pipe upgrade unless otherwise permitted by the ENGINEER. Concrete pipe with elliptical reinforcement shall be laid with the minor axis of the reinforcement cage in a vertical position. Corrugated metal pipe shall be laid with the external laps of the circumferential seams toward the inlet end.

910.6 JOINTS FOR PIPE

910.6.1 JOINT FOR CONCRETE PIPE:

910.6.1.1 The type of joint to be used shall be O-ring rubber gasket joints conforming to ASTM C 361 and C 443.

910.6.1.2 Gasketed Type of Joints for Reinforced Concrete Pipe

910.6.1.2.1 General--The ends of the pipe shall be so formed that when the pipes are laid together and joined, they shall make a continuous and uniform line of pipe with a smooth and regular surface.

910.6.1.2.2 Rubber gaskets for making compression-type joints for concrete pipe shall be factory fabricated in accordance with ASTM C 443; for pipes 12 inches in diameter and larger shall be O-ring and shall be handled, primed, installed, etc. in strict accordance with the manufacturer's recommendations.

910.6.1.2.3 The CONTRACTOR'S attention is particularly called to ASTM C 443, regarding storage of gaskets.

910.6.1.2.4 The CONTRACTOR shall furnish the ENGINEER complete information concerning the type and make of all joint material which he intends to use under the contract, including certification that the joint material meets the requirements of the specifications.

910.6.2 JOINTS FOR CORRUGATED METAL PIPE:

910.6.2.1 The seams of the pipe are to be placed at the sides, not on the bottom. The inside circumferential seams should be placed pointing downstream. Care should be taken to insure that dirt or other particles do not get between the outside of the pipe and the pipe coupling. Paved inverts should be placed and centered on the bottom of the trench. Any damage to the protective lining and coating shall be repaired prior to the backfilling around the pipe.

910.6.2.2 If waterproof joints are called for on the plans or specified in the Supplementary Specifications, the caulking compound or other waterproofing material used shall be subjected to the approval of the ENGINEER.

910.7 TESTING FOR LEAKAGE

Normally storm sewer lines need not be tested, but if in the opinion of the ENGINEER, the workmanship or materials do not appear to be satisfactory, the ENGINEER may require that a section of the storm sewer line be tested in a similar manner as that for a sanitary sewer line, see Section 805.

910.8 CLEANING AND INSPECTION

910.8.1 CLEANING: No pipe spalls, rocks, dirt, joint compounds, cement mortar and other trash or obstructions shall be left in a sewer pipe of any size or type. During flushing operations the manhole outlet shall be bagged or plugged so that the debris will not be carried into an existing active line.

910.8.2 INSPECTION: Before lines become operational or final acceptance of the installation, small size lines shall be inspected by a television camera and larger size lines will be inspected by walking through the line.

910.8.3 TELEVISION: After the CONTRACTOR has cleaned and flushed the line, the CONTRACTOR will notify the ENGINEER that the line is ready for television inspection. Prior to the television inspection (possibly during flushing operation) the CONTRACTOR will insert a 1/4-inch nylon rope in the line for the

purpose of towing the television unit through the pipe. The OWNER will perform the first television inspection at no cost to the CONTRACTOR. If during the first inspection debris is found in the line, the television inspection will cease. When further cleanup has been completed, the CONTRACTOR will request the ENGINEER to have a second inspection performed. The cost of the second inspection and any subsequent inspections of that segment of the line will be paid for by the CONTRACTOR at the rate of \$50.00 per hour while the television crew is at the line site.

910.9.3 TESTING OF PIPE: No payment will be made for required initial or subsequent tests on sections of the storm sewer line.

910.9 MEASUREMENT AND PAYMENT

910.9.1 STORM SEWER PIPE: Installed pipe shall be measured and paid for as follows:

910.9.1.1 For straight lines the pipe length shall be the intervening distance between the centers of manholes along a line parallel to the pipe invert.

910.9.1.2 For curvilinear lines the pipe length shall be the intervening arc distance between the centers of manholes along a line parallel to the pipe invert.

910.9.1.3 For lateral lines, such as from main or manhole to a storm inlet, the pipe length shall be the distance between the center of a manhole or centerline of the main to the interior wall face of the storm inlet along a line parallel to the pipe invert.

910.9.1.4 Payment for pipe will be in accordance with the unit price per linear foot per size and material as defined in the Bid Proposal, and shall include pipe installed in the trench, jointing and coupling materials, and other materials necessary to connect to other sections of pipe, manholes, and other appurtenances.

910.9.2 REMOVAL AND DISPOSAL OF SEWER PIPE: Removal and disposal of storm sewer pipe shall be measured by the linear foot within the specified pipe size increments. Payment will be made on the unit price per linear foot of specified pipe size in the Bid Proposal. Trenching, backfilling, and pavement removal and replacement will be paid for based on the unit prices for each appropriate bid item in the Bid Proposal. If new pipe is to be installed in the same trench as the removed pipe, only one payment will be made for trenching, backfilling, and pavement removal and replacement.

SECTION 915

STORM SEWER DRAINAGE APPURTENANCES

915.1 GENERAL

The construction items, specified in this section, are related to the storm sewer underground facilities.

915.2 REFERENCES

915.2.1 This publication:
SECTION 300 SECTION 701
SECTION 501

915.3 MATERIALS

915.3.1 The construction plans will specify the size and material for the pipe between the storm sewer main and the storm water collection structure.

915.3.2 The various types of storm inlets and their relation to curb and gutter, or valley gutter are shown on the Standard Detail Drawings. Construction plans will identify the type to be constructed.

915.3.3 Grating size, material, and configuration shall conform to the Standard Detail Drawings.

915.4 INSTALLATION OF DRAINAGE FACILITIES

915.4.1 Excavation and backfilling for the storm inlet shall be accomplished in accordance with Section 501.

915.4.2 Trenching, backfilling, and compaction for the connecting pipe between the storm sewer main and the storm inlet shall conform to the specifications contained in Section 801. Pipe shall be installed in accordance with Section 802.

915.4.3 All pipe and structures shall be installed per location and elevations, as shown on the construction plans. If during the course of installation, an underground obstruction (i.e., existing utility line) the work shall stop and the ENGINEER shall be immediately notified so that the problem can be resolved.

915.4.4 Direct connection to storm sewer main will be permitted if the main is a minimum of 36 inches in diameter (I.D.) and the connecting line is not greater than 12 inches (I.D.). If storm sewer mains are 48 inches (I.D.) or larger, the connecting line diameter may be increased to 18 inches (I.D.). For connecting line sizes greater than those specified above, the connection to the main will be made into a manhole or by inserting into the

main a factory constructed wye. Connection to the main will comply with the Standard Detail Drawings.

915.4.5 Removal of curb and gutter, and sidewalk for installation of a storm inlet shall be made at a scored or full depth joint.

915.4.6 Existing pavement removal and replacement shall conform to Sections 300 and 801 and shall conform to residential or arterial pavement sections of the same material (asphalt or Portland Cement concrete) as the existing pavement.

915.4.7 No width greater than 1/2 inch will be permitted between the inlet grate and the roadside portion of the inlet frame.

915.5 Private drainage facility installations, which are to be constructed under the authorization of "Drainage Facilities Within Public Right-of-Way," shall comply with the Standard Detail Drawings and appropriate sections of this publication.

915.6 MEASUREMENT AND PAYMENT

915.6.1 Pavement removal and replacement will be measured by the square yard. Payment will be made at the unit price per square yard per type of replacement paving material, as specified in the Bid Proposal.

915.6.2 Trenching, backfilling, and compaction shall be measured by the linear foot from the main side wall of the inlet to the centerline of the main. Payment will be made at the unit price per linear foot per the average depth increment between connection points, as defined in the Bid Proposal.

915.6.3 Connecting pipe shall be measured by the linear foot along centerline of pipe from the main side wall of the inlet to the centerline of the main. Payment will be made at the unit price per linear foot per type and size of pipe, and shall include pipe in place and all necessary jointing materials.

915.6.4 Storm inlets shall be measured on a unit basis. Payment will be made at the unit price per each type of storm inlet, and shall include structure, grating, excavation, backfilling and compaction, and curb removal and replacement, as defined in Bid Proposal.

915.6.5 Removal and replacement of sidewalk shall be measured by the square foot and payment will be made at the unit price per square foot.

915.6.6 Measurement and payment for man-holes will be as indicated in Section 920.

SECTION 920

SANITARY AND STORM SEWER MANHOLES

920.1 GENERAL

This section contains items which are relative to the installation of sanitary and storm sewer manholes.

920.2 REFERENCES

920.2.1 ASTM

C 43	C 497
C 139	C 1557
C 478	

920.2.2 This publication

SECTION 101	SECTION 106
SECTION 102	SECTION 161
SECTION 105	

920.3 MANHOLE MATERIALS

Sewer manhole materials shall be as specified in other sections, as follows:

Portland Cement Concrete	Section 101
Steel Reinforcing	Section 102
Concrete Curing Compound	Section 105
Cement Mortar and Grout	Section 106
Gray Iron Castings	Section 161

920.4 MANHOLE CONSTRUCTION

920.4.1 GENERAL:

920.4.1.1 Soil Foundations for manhole base shall be compacted to a density of 95 percent of the maximum density per ASTM D 1557. Compaction limits shall be one foot beyond the perimeter of the concrete base and shall be a minimum of one foot in depth.

920.4.1.2 Manholes shall be constructed in accordance with the Standard Detail Drawings and as shown on the construction plans. Precast reinforced concrete units, concrete blocks or formed in place, reinforced concrete may be used to construct the manhole.

920.4.1.3 Invert elevation of the pipes entering or exiting the manhole and interior inverts shall not vary more than 0.05 foot from the elevations indicated on the construction plans.

920.4.1.4 All cement used for poured foundations, mortar, fillets, grout, and concrete shelf construction shall be Type II or approved equal.

920.4.1.5 All concrete for formed in place foundations or bases, concrete shelves, and pipe supports shall be 3000 psi compressive strength concrete.

920.4.1.6 Depending on the size of the pipe, connections to existing and new manholes shall be made by either core drilling through the manhole wall, performed for new precast units, or for large-size pipe the manhole wall may be removed by carefully chipping the wall segment which will permit entry of the pipe. In the latter operation, exposed manhole reinforcement should be bent and tied to the reinforcement of the pipe collar. If core drilling is not practical, the CONTRACTOR shall request the ENGINEER to authorize the chipping operation. During either operation the CONTRACTOR shall take care to avoid unnecessary damage to the manhole surfaces or walls.

920.4.2 PRECAST CONCRETE MANHOLES:

920.4.2.1 The vertical sections of the

manhole may be of different dimensions in order that manholes of various depths can be readily assembled.

920.4.2.2 Concrete, used for precast bases, vertical sections, and eccentric cones, shall be 4000 psi compressive strength concrete.

920.4.2.3 Vertical sections of the manhole shall conform to the requirements of ASTM C 478.

920.4.2.4 The CONTRACTOR shall submit shop drawings of the precast base and eccentric cone to the ENGINEER for review and approval.

920.4.2.5 Circular precast manhole sections shall be provided with mastic gasket to seal joints between sections, such as RAM-NEK, KENT SEAL, or approved equal.

920.4.2.6 All lifting holes, except Type "C" manhole covers, and gaps at joints shall be filled with a nonshrink grout.

920.4.2.7 Precast concrete manhole bases may be used when approved by the ENGINEER. If approved, it shall be with the understanding that the CONTRACTOR shall be responsible for placing the bases at the specified elevation, location, and alignment.

920.4.3 FORMED INPLACE REINFORCED CONCRETE MANHOLE:

920.4.3.1 The CONTRACTOR shall submit preconstruction drawings of the proposed

manholes to the ENGINEER for review and approval.

920.4.3.2 Concrete used for this type of manhole construction shall be 4000 psi compressive strength concrete.

920.4.3.3 If desired, a precast eccentric cone or a flat cover can be used.

920.4.4 CONCRETE BLOCK MANHOLE:

920.4.4.1 The CONTRACTOR shall submit preconstruction drawings of the proposed manhole to the ENGINEER for review and approval.

920.4.4.2 Concrete masonry units for the construction of this type of manhole shall conform to ASTM C 139 and the Standard Detail Drawings. All blocks shall be mortared into place.

920.4.4.3 Eccentric cone or flat-type cover shall be used.

920.4.5 TEE PIPE MANHOLE:

920.4.5.1 Tee pipe manholes will be used for all 4-foot-diameter mainline pipes and larger. Horizontal section of the tee pipe shall be the same class of pipe as the adjacent sections. The vertical sections shall comply with the requirements set forth in ASTM C 478.

920.4.5.2 Top of the vertical portion of tee pipe unit will extend a minimum of 18 inches above the outside diameter of the horizontal pipe. The 4-foot-diameter vertical section of the tee pipe shall be connected at the longitudinal center point of the horizontal pipe section. The minimum length of horizontal pipe section shall be 8 feet.

920.4.5.3 The CONTRACTOR shall submit to the ENGINEER for review and approval preconstruction shop drawings on the fabrication of the tee pipe section as developed by a precast reinforced concrete pipe manufacturer. Field fabrication of this eccentric pipe unit will not be accepted. Shop drawings for the eccentric cone will also be submitted for review and approval.

920.4.5.4 RAM-NEK, Kent Seal, or Liquid Waste Division-approved equal sealants shall be used to seal the joints in the vertical portion of this manhole.

920.4.5.5 All lifting holes, except for Type "C" manhole covers, and gaps at joints shall be filled with a nonshrink grout.

920.4.5.6 Standard Detail Drawings show some of the components of the tee-type pipe manhole.

920.4.6 COATING OF MANHOLES:

920.4.6.1 Exterior of Manholes: Exterior coating of manholes shall be required in areas where ground water is present. The coating shall be a water-proofing type of bitumastic or asphaltic material, as approved by the ENGINEER. Application shall be in accordance with the manufacturer's published recommendations.

920.4.6.2 Interior of Manholes: Interior coating of manholes shall be required only when specified on the construction plans. The coating shall be an epoxy resin-type material, such as: "Zebron," "Plastite 7122," or approved equal, and shall be capable of protecting the concrete from deterioration due to a gaseous environment. Application shall be in accordance with the manufacturer's published recommendations.

920.4.6.3 Plastering of Manholes: The work shall include the coating of the surface of existing block manholes with plaster as required on the plans.

920.4.7 MANHOLE STEPS:

920.4.7.1 Manhole steps shall be 1/2" diameter, grade 60, reinforcing rod completely encapsulated in copolymer polypropylene or corrosion resistant rubber compound. Steps shall be designed to be cast in place or hammered into holes in manhole walls.

920.4.7.2 Approved manhole steps of only one manufacturer model shall be used on any specific project and shall not be intermixed with other approved steps. Approved steps must bear the manufacturer name and model on the exposed surface of the step and shall be one of the following products or approved equals:
M.A. Industries, Inc. - Model PS-2-PFS
H. Bowen Co.-Bowco, Model 81213 or 93813
Delta Pipe Products - WEDG-LOK, Model W-11

920.4.7.3 The minimum width of step tread shall be 11 inches. Steps will be spaced uniformly in each manhole. Spacing may be between 12 inches to 16 inches on center. Lower step will be 12 inches above manhole shelf or top of main. The upper step shall be 6 inches below the top portion of the eccentric cone or 6 inches below the bottom of the flat cover. Also the steps shall be aligned vertically with the opening of the cone or cover.

920.4.7.4 Steps shall be embedded in the manhole wall a minimum of 3" inches and protrude from the manhole interior surface a minimum of 4 3/4 inches.

920.4.7.5 Holes for step installation shall be drilled or precast per manufacturer's recommended size, or of sufficient size to allow for step insertion into the wall. Cast-in-place sockets or tapered holes recommended by the step manufacturer may be used with prior approval of ENGINEER. If the hole has been drilled too large, then the step shall be secured in place by using epoxy grout for the full depth of the drilled hole.

920.4.6 Acceptable manhole step installations must be capable of withstanding a 400 pound, horizontal, pull out load applied in accordance with ASTM C-497.

920.4.8 ADJUSTMENT BRICKS:

920.4.8.1 Manhole adjustment bricks shall conform to the requirements for manhole bricks, per ASTM C 32 for Grade MS.

920.4.8.2 Mortar shall be used to lay the bricks, as well as coating the interior and exterior surfaces of the laid brick. Thickness of the mortar coating shall be 1/2 inch.

920.4.9 MANHOLE FRAME AND COVER:

The manhole frame and cover for either the sanitary or storm sewer manholes shall conform to the specifications contained in Section 161.

920.5 TESTING OF SEWER MANHOLES:

920.5.1 All sanitary sewer manholes shall be tested for leakage by either a water exfiltration test or a vacuum test. Whichever test is utilized it is recommended that the test be performed prior to backfilling around the manhole and prior to placement of the manhole frame and cover. All inlet and outlet lines shall be properly plugged and the lift holes and barrel joints filled and sealed as specified. The CONTRACTOR shall be responsible for all materials and equipment necessary to perform the test and shall conduct the test in the presence of the ENGINEER or his representative. The CONTRACTOR has the option of performing a manhole test in increments appropriate to the depth of the manhole.

920.5.2 The water exfiltration test shall consist of filling the entire manhole with water to the bottom of the frame elevation. A stabilization period of one hour will be allowed for absorption, after which the manhole shall be refilled as necessary before starting the test. The test period shall be two (2) hours, after which the manhole shall be refilled, measuring the necessary quantity of

water. The allowable leakage shall be 0.25 gallons per foot diameter per vertical foot per day, and is represented by the following formula:

$$V = 0.25 \text{ DHT}/24$$

where; V = Allowable loss in gallons
D = Manhole diameter in feet

H = Initial depth of water to invert in feet

T = Duration of test in hours

920.5.3 The vacuum test shall consist of utilizing an inflatable compression band, vacuum pump, gauges and appurtenances specifically designed for vacuum testing. Test procedures shall be in accordance with the manufacturer's printed recommendations. The ENGINEER shall be the sole judge as to the adequacy of the equipment.

920.5.3.1 A vacuum of 10" Hg shall be placed in the manhole and the time measured for a drop to 8.5" Hg. The test shall be considered to be successful if the measured time exceeds the test period. Should the test fail, the manhole shall be repaired as necessary and the test rerun. The test periods are:

920.5.3.2 Sixty (60) seconds for four (4) foot diameter manholes.

920.5.3.3 Seventy-five (75) seconds for five (5) foot diameter manholes.

920.5.3.4 Ninety (90) seconds for six (6) foot diameter manholes.

920.5.3.5 One hundred and Twenty (120) seconds for eight (8) foot diameter manholes.

920.5.4 Normally storm sewer manholes need not be tested unless specifically required by the project plans or supplemental technical specifications. However, if in the opinion of the ENGINEER, the workmanship or materials do not appear to be satisfactory, the ENGINEER may require that any storm sewer manhole be tested in a similar manner as that for a sanitary sewer manhole.

920.6 ABANDONMENT OF MANHOLES

920.6.1 Abandonment of manhole, which is part of a sewer line being abandoned, shall entail the following work and materials:

920.6.2 Manhole will not be removed but will be abandoned in place.

920.6.3 All manhole inlet and outlet lines shall be plugged with a 12-inch-thick concrete or concrete mortar plug.

920.6.4 Salvageable material shall be stockpiled on the job site. The CONTRACTOR shall contact Liquid Waste Division to arrange for a representative to inspect the materials for usability. Salvageable materials shall be transported by the CONTRACTOR to Liquid Waste Division, City Yards. CONTRACTOR will receive a receipt for the turned-in materials. Receipts will be submitted to the ENGINEER prior to final acceptance of the Project. Unusable materials will be disposed of by the CONTRACTOR.

920.6.5 Manhole bottom will be pulverized.

920.6.6 The manhole shall be filled with cement treated base (CTB) material to the bottom elevation of the asphalt base course of the pavement or to the ground surface level.

920.6.7 All labor, materials, and equipment necessary to complete this work shall be furnished by the CONTRACTOR.

920.6.8 For historical information the ENGINEER shall have a survey performed which will locate the abandoned manhole, relative to permanent survey markers.

920.7 SEWER MANHOLE REHABILITATION IN REPLACEMENT WORK

920.7.1 The work under this item shall be to replace the existing manhole frame and cover and to place a concrete pad around the existing manhole as required per the construction plans. This work will be done only when an existing manhole is encountered in the normal course of the replacement work that has a light-weight, vented, multi-holed manhole cover.

920.7.2 The work and materials shall include the following:

920.7.2.1 Remove any and all existing brick under frame and replace with new Grade MS brick as necessary to bring new frame and cover up to street grade.

920.7.2.2 Remove and replace existing concrete pad, or construct a new pad.

920.7.2.3 Remove existing steps and replace with new steps or, if steps are nonexistent, install new steps. Steps will be installed as per Subsection 815.4.7.

920.7.2.4 Remove and replace pavement.

920.7.2.5 Excavation and compaction of backfill as necessary.

920.7.2.6 All materials, labor, and equipment necessary to do the work under this item shall be furnished by the CONTRACTOR.

920.7.2.7 The work and materials under this item shall be done according to the manner set forth in the Standard Detail Drawings and other sections of these specifications.

920.7.3 Salvageable material shall be stockpiled on the job site. The CONTRACTOR shall contact Liquid Waste Division to arrange for a representative to inspect the materials for usability. Salvageable materials shall be transported by the CONTRACTOR to Liquid Waste Division, City Yards. CONTRACTOR will receive a receipt for the turned-in materials. Receipts will be submitted to the ENGINEER prior to final acceptance of the Project. Unusable materials will be disposed of by the CONTRACTOR.

920.8 MEASUREMENT AND PAYMENT

920.8.1 NEW MANHOLES:

920.8.1.1 Type "C," "E," "F," or "G" manholes of 4-foot or 6-foot diameters shall be measured per each within the following increments of depth: 3 to 6 feet, 6 to 10 feet, and 10 to 14 feet. Manholes which are greater in depth than 1 foot shall be measured by the vertical foot. Measurements will be made to the nearest foot and will be from the manhole rim elevation to the manhole invert elevation.

920.8.1.2 Payment for manholes 14 feet deep or less will be made on the unit price per manhole diameter per depth increment as specified in the Bid Proposal. Payment for manhole depths which exceed 14 feet will be made on the unit price per manhole diameter per vertical foot. This payment is in addition to the manhole unit price for the portion above the 14 foot depth.

920.8.1.3 Type "A" or Tee-type manholes shall be measured and paid for by the methods described in 920.8.1.1 and 920.8.1.2. Measurement will be from the invert of the main line to the manhole rim. Payment under this item will include the normal manhole costs described below, as well as any additional pipe costs for the precast tee and for the concrete cradle under the tee.

920.8.1.4 Payment for any type diameter or depth of manhole will include excavation, compacted backfilling, shelving, cover or cone, leveling bricks, frame and cover, and concrete pad or collar.

920.8.2 ELEVATION ADJUSTMENTS:

920.8.2.1 When a new manhole is installed, no measurement or payment will be made for rim elevation adjustments to conform to street surface grades.

920.8.2.2 The following measurements and payments for rim elevation adjustments on existing manholes will be made for indicated conditions:

920.8.2.2.1 Unit price per inch of adjustment ring for adjustment to manhole frame by the addition of adjustment ring.

920.8.2.2.2 Unit price per inch of leveling brick adjustment.

920.8.2.2.3 Unit price per manhole diameter per vertical foot of adjustment to cone and/or barrel.

920.8.2.3 As required, the following items will be included in the unit price per appropriate adjustment: pavement removal and replacement, excavation, compacted backfilling, concrete collar or pad, leveling bricks, adjusting rings, and/or frame and cover.

920.8.3 COATING OF MANHOLE: Plastering or epoxy coating for manholes shall be measured and paid for on the unit price per square foot of surface area covered.

920.8.4 MANHOLE STEPS: Unless otherwise shown on the Bid Proposal, the cost of manhole steps shall be incidental to the unit prices for construction of manholes of various types and depths.

920.8.5 ABANDONMENT OF MANHOLES: Measurement and payment for abandonment of a manhole shall be the unit price per manhole for defined work in Subsection 920.6.

920.8.6 MANHOLE REHABILITATION IN REPLACEMENT WORK: Work under this item shall be measured and paid for by the unit price per manhole for work specified in the Bid Proposal.

920.8.7 TESTING: There will be no payment for required testing of sewer manholes.

SECTION 925

VACUUM SEWER COLLECTOR, INTERCEPTOR AND FORCE MAIN FACILITIES

925.1 GENERAL: The construction items specified in this section are common to vacuum sewer facilities.

925.2 REFERENCES

925.2.1 American Society for Testing and Materials (ASTM) Standard Specifications, Latest Edition

C478 Standard Specification for Precast Reinforced Concrete Manhole Sections

D1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort

D1784 Standard Specification for Rigid Poly (PVC) Compounds and Chlorinated Poly (CPVC) Compounds

D2241 Standard Specification for Poly (PVC) Pressure-Rated Pipe (SDR Series)

D2564 Standard Specifications for Solvent Cements for Poly (PVC) Plastic Piping Systems

D2665 Standard Specifications for Poly (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

D2672 Standard Specifications for Joints for IPS PVC Pipe Using Solvent Cement

D3139 Standard Specifications for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

925.2.1 This Publication, Latest Edition

SECTION 101 PORTLAND CEMENT CONCRETE

SECTION 102 STEEL REINFORCEMENT

SECTION 105 CONCRETE CURING COMPOUND

SECTION 106 CEMENT MORTAR AND GROUT

SECTION 108 BRICK

SECTION 121 PLASTIC PIPE

SECTION 161 GRAY IRON CASTINGS

SECTION 170 ELECTRONIC MARKER DISKS

SECTION 701 TRENCHING, EXCAVATION AND BACKFILL

SECTION 710 BORING, DRILLING, AND JACKING

SECTION 801 INSTALLATION OF WATER TRANSMISSION, COLLECTOR AND DISTRIBUTION LINES

925.3 MATERIALS

925.3.1 PIPE: All buried vacuum collector lines, branch lines, force mains, vacuum service laterals, and gravity service stubs shall be SDR21 rated PVC pipe conforming to ASTM D 2241, ASTM D 1784 Cell Classification 12454-B. Pipe and appurtenances shall be new and unused.

925.3.2 JOINTS: All joints shall conform to ASTM D 2672, using solvent cement; or ASTM D 3139 using elastomeric seals. This pipe must be certified by the manufacturer that pipe and seal will operate at 24 inches of mercury vacuum and withstand a vacuum test at 24 inches of mercury vacuum with a maximum loss of 1% of initial vacuum per hour for a 4 hour period.

925.3.3 FITTINGS

925.3.3.1 Fittings shall be Schedule 40 solvent weld drain, waste and vent pipe per ASTM D 2665.

925.3.3.2 Wye fittings and 45° ells shall be used throughout; except that a long radius 3" 90° ell may be used on the 3" suction line entering the vacuum valve and at the wye connection of the vacuum service lateral to the vacuum main. Tee fittings and short radius ells are prohibited exclusively.

925.3.4 SOLVENT CEMENT: Shall conform to ASTM D 2564; primer and cement shall not be of same color. Cement shall be gray in color.

925.3.5 MANHOLE SECTIONS: Manhole sections used for buffer tanks, vacuum division valve vaults, pig launchers, and air release valves shall be reinforced precast concrete manhole sections, 48" nominal diameter, conforming to the requirements of ASTM C 478.

925.3.6 MANHOLE JOINTS: Tongue and groove in precast wall; shall conform to Section 920, PRECAST CONCRETE MANHOLES.

925.3.7 MANHOLE FRAMES AND COVERS: Frames and covers for manholes used for buffer tanks, vacuum division valve vaults, pig launchers, and air release valves shall conform to this Publication, Section 161.4. The words "SEWER" and "CITY OF ALBUQUERQUE" shall be cast on the manhole cover.

925.3.8 CAST-IN-PLACE CONCRETE: Cast-in-place concrete used for footings, flotation collars, grade-level pads, mass concrete for buffer tanks, and other installations not otherwise addressed shall be air-entrained concrete in accordance with Sections 101, 102, and 105 of this Publication, with a compressive strength of 3500 psi. Type II Portland cement shall be used for all applications where the concrete will be in contact with sewage. See Section 925, SUBMITTALS.

925.3.9 VALVES: Valves used for pig launchers and vacuum division valves shall be mechanical joint gate valves conforming to Sections 801.3.3.1 through 801.3.3.9 of this Publication. Vacuum division valves shall be equipped with five-sided nuts, sockets and extension bars per Standard Drawing 2169.

925.3.10 AIR RELEASE VALVES: Air release valves shall be APCO or approved equal, the model number per the construction drawings.

925.3.11 VACUUM VALVES AND APPURTENANCES: Vacuum valves shall be AIRVAC Model No. AVD-3-83D or approved equal. Furnish all mechanical appurtenances required for a complete installation per manufacturer specifications. Vacuum valves and appurtenances are to be delivered to the OWNER's warehouse, unloaded, and stored as directed by the ENGINEER in complete packages.

925.3.12 VACUUM VALVE PITS

925.3.1.2.1 Vacuum valve pits shall be either "standard" or "deep" per the appropriate bid item.

925.3.1.2.2 The standard valve pit shall have a sump 30" deep and shall be per AIRVAC Model No. AVD3-83D/40-30 or approved equal. The deep valve pit shall have a sump 54" deep and shall be per AIRVAC Model No. AVD3-83D/40-54 or approved equal.

925.3.13 STAINLESS STEEL: Stainless steel for brackets and fasteners shall be AISI Type 304.

925.4 SUBMITTALS

925.4.1 The following shall be submitted for the ENGINEER'S approval prior to incorporation in the work of the corresponding item:

- a) Concrete Mix Design(s)
- b) Material and method of sealing pipe penetrations in buffer tank walls
- c) Pipe certification for vacuum service

925.4.2 The OWNER/ENGINEER will be supplied with a certificate of compliance for each item or type of material required in the system, as to that item meeting the specifications and/or the reference specifications before that item is installed.

925.4.3 The following records shall be maintained by the CONTRACTOR, shall be kept available at all times for

inspection by the ENGINEER, and shall be submitted to the ENGINEER at his request or as provided in these Specifications.

925.4.3.1 Vacuum tests performed daily or as otherwise stipulated. These tests shall be recorded on charts provided by the OWNER or in hard-board notebooks as stipulated herein depending on the type of test.

925.4.3.2 Record Drawing markups and related survey notebooks kept current by the CONTRACTOR to record work performed and to reflect any and all revisions made from the original drawings.

925.5 INSTALLATION

925.5.1 GENERAL

925.5.1.1 Handle pipe and appurtenances in such a manner as to insure delivery to the trench in sound, undamaged condition. Particular care shall be taken to prevent damage to any coating.

925.5.1.2 Prior to installation, store plastic pipe and protect from prolonged periods of sunlight per Section 121.

925.5.1.3 The interior of the pipe, pits, and all appurtenances shall be thoroughly cleaned of foreign material before being lowered into the trench and shall be kept clean during construction operations.

925.5.1.4 Install a plug in the new system at any point of connection to an existing system. The plug shall remain in place until the ENGINEER and OWNER authorize its removal in writing. The CONTRACTOR shall not flush or otherwise discharge any flow into an existing system unless approved in writing by the ENGINEER.

925.5.1.5 Perform trenching, backfilling, and compaction in accordance with Section 701.

925.5.2 PIPE INSTALLATION

925.5.2.1 All vacuum sewers shall be laid to line and grade as shown on the drawings with the use of construction laser beam equipment. All pipe which has been designed to slope downward shall slope uniformly downward, with a tolerance of no more than 0.01' per 20 feet of line. Abrupt sags or bellies will not be permitted. The elevation of each joint of pipe shall be recorded by the CONTRACTOR in bound field books which shall be submitted to the ENGINEER.

925.5.2.2 All sanitary sewer force mains shall be laid to line and grade as shown on the drawings with the use of

construction laser beam equipment. Particular care shall be taken to avoid crests in the profile at locations other than those shown on the drawings. Elevations shall be recorded by the CONTRACTOR at 100-foot intervals, and at each change in grade, in bound field books which shall be submitted to the ENGINEER.

925.5.2.3 Handle and install pipe and fittings in accordance with manufacturer's recommendations.

925.5.2.4 Prevent entrance of dirt or foreign matter or damage to pipe lining or coating. Plug the pipe any time work is stopped.

925.5.2.5 No defective pieces are permitted. Defective pieces discovered after use will be removed and replaced with a sound piece.

925.5.2.6 Place bedding, embedment and backfill in accordance with Section 701 unless otherwise indicated on the drawings. The bedding of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe. Suitable excavation shall be made to receive the bell of the pipe and the joint shall not bear upon the bottom of the trench. All adjustments to the line and grade shall be made by scraping away or filling in with pipe zone material under the body of the pipe, but not by wedging or blocking. When connections are to be made to any existing pipe, valve pit, or any other improvement, the actual elevation or position of which cannot be determined without excavation, excavate and expose the existing improvement before laying the connecting pipe or conduit. When existing underground improvements may reasonably be expected to conflict with the line or grade established for the new sewer line, the ENGINEER shall request the CONTRACTOR to excavate as necessary to expose such potentially conflicting underground improvements prior to laying the new pipe. Any adjustment in line or grade which may be necessary to accomplish the intent of the plans will be made, and the CONTRACTOR will be paid for any additional work resulting from such change in line or grade in the manner provided for in the GENERAL CONDITIONS.

925.5.2.7 Lay pipe upgrade in a continuous operation from structure to structure, with the socket ends of the pipe upgrade unless otherwise permitted by the ENGINEER.

925.5.2.8 Sanitary sewer mains shall not be constructed under walkways, sidewalks, curbs and gutters, drive pads, or similar concrete structures by tunneling underneath them. Cut concrete by using a concrete saw or, at the CONTRACTOR'S option, remove the entire section of concrete to the nearest full expansion joint or edge.

925.5.2.9 Place and hand-tamp fill to 95% of maximum dry density per ASTM D 1557, in entire space between the pipe or fitting and the trench walls.

925.5.2.10 Prior to completely backfilling the sewer excavation, install a green metalized plastic tracer/warning tape 12" to 18" below finished grade.

925.5.2.11 Mark the ends of all wyes, branch lines, and gravity service stubs that are installed for future connections to the system. Attach a stainless steel marker with stainless wire to the stubout end and place the marker within 8" to 12" of finished surface for future relocation of stubout.

925.5.2.12 Provide pipe through casing with support skids as shown on the drawings and Standard Drawing No. 2380. Alternate support methods may be acceptable upon ENGINEER'S review and approval.

925.5.3 DIVISION VALVE AND GAGE TAP INSTALLATION: Division valves, vaults, and gage tap assemblies shall be installed per Standard Drawing No. 2170.

925.5.4 VACUUM VALVE PIT INSTALLATION

925.4.4.1 Install complete vacuum valve pits in accordance with manufacturer instructions and Standard Drawing No. 2165. Perform pressure testing on each valve pit assembly per the manufacturer instructions.

925.4.4.2 Stubouts for the gravity line from the collection sump should be 4" diameter, extended to the property line unless otherwise indicated. Each stub-out should have a stop glued in place 4" to 6" from the end inserted into the tank, to prevent it being pushed too far into the collection sump. A solvent welded 4" cap should be fitted and glued to each stub-out to prevent rocks and groundwater entering the sump prior to connection of the house gravity line. Expandable test plugs or rubber caps are not acceptable as temporary covers for gravity stub-outs.

925.5.5 SINGLE OR DOUBLE BUFFER TANK INSTALLATION

925.5.5.1 Install single or double buffer tank as shown on the drawings and Standard Drawing 2167 (single) or 2168 (double).

925.5.5.2 All pipe penetrations through the buffer tank walls shall be water tight. Submit manufacturers literature on material and technique for sealing to the ENGINEER.

925.5.5.3 Install suction and sensor pipes as shown on the Standard Drawings. Attach these lines to the buffer tank

side walls using Type 304 stainless steel brackets and fasteners. The 3" service lateral is to be stubbed into the buffer tank and capped or otherwise sealed until the vacuum valve is installed.

925.5.5.4 Install breather pipe through buffer tank wall as shown on Standard Drawing No. 2166. This line is to be capped or otherwise sealed to prevent any infiltration of water during construction. It shall be tested in accordance with Breather Test Procedure, Paragraph 925.8.

925.5.5.5 Buffer tanks shall be tested after assembly. The entire buffer tank shall be tested as follows:

925.5.5.5.1 Stubouts, manhole boots, and pipe plugs shall be permanently secured to prevent movement while the vacuum is drawn.

925.5.5.5.2 Installation and operation of vacuum equipment and indicating devices shall be in accordance with manufacturer's recommendations.

925.5.5.5.3 Using OWNER-furnished vacuum pump and gage, establish a measured vacuum of 10 inches of mercury in the buffer tank. Record the time for the vacuum to drop to nine inches of mercury.

925.5.5.5.4 The maximum allowable leakage rate for a four foot diameter manhole shall be in accordance with the following:

Min. Elapsed Time for a Pressure Manhole Depth Change of 1" Hg
10' or less 60 seconds
>10' but <15' 75 seconds
≥ 15' but <25' 90 seconds

925.5.5.5.5 If the buffer tank fails the test, necessary repairs shall be made and the vacuum test and repairs shall be repeated until the tank passes the test. The extent and type of repairs that may be allowed shall be subject to the approval of the ENGINEER. Leaks shall be repaired on the outside of the manhole unless otherwise approved by the ENGINEER.

925.5.5.5.6 If a buffer tank joint mastic is pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced.

925.5.5.5.7 Record test results on a calibrated chart recorder as described in Section 925.6, Field Quality Control.

925.5.6 INSTALLATION OF CASING FOR SANITARY SEWER VACUUM MAIN OR FORCE MAIN: Casing for sanitary sewer vacuum main or force main shall be per the drawings and Standard Drawing No. 2380 and per Section 710 of this Publication.

925.6 FIELD QUALITY CONTROL

925.6.1 Provide daily testing of all sewer mains and lateral connections laid. Plug all open connections with rubber stoppers or temporary caps, fitted to the pipe by "no-hub" couplings. Using OWNER-furnished vacuum pump and chart recorder, apply a vacuum to 24 inches of mercury to the pipes with pump running continuously for 15 minutes to allow vacuum to stabilize before proceeding with test. There shall be no loss in excess of 1% of initial vacuum per hour for a two hour test period. As pipe is laid the new section shall be tested in addition to the previously laid pipe on that main.

925.6.2 Leave uncovered the sewer main pipe joints until after the daily vacuum test is complete so that any leaks can be easily located and repaired. Exposed joints shall be adequately restrained.

925.6.3 Two hour Vacuum Line Test Modification Provision: If the CONTRACTOR succeeds in meeting the daily 2-hour test for seven consecutive working days or two thousand feet of pipe, the ENGINEER may amend the procedure to allow the trench to be covered as work progresses rather than the trench being kept open all day as is the norm with the daily 2-hour test. Should a line fail the vacuum test while utilizing this test modification, the CONTRACTOR shall take whatever action is necessary at his cost to pass the test including the excavation of the trench, leak detection and line repair, and additional cleanup as required by the ENGINEER. After the failure, the CONTRACTOR must re-qualify as specified above. Note this test modification is optional, and as such, the CONTRACTOR assumes all liability in its use. Allowance of this modification by the ENGINEER is not considered acceptance of the sewer line or ability to withstand test vacuum pressures.

925.6.4 Installation and operation of vacuum equipment and indicating devices shall be in accordance with manufacturer's recommendations.

925.6.5 Required Final Acceptance Testing on complete system: Provide 48 hours notice to ENGINEER prior to test. Ensure all division valves are open prior to beginning of test. Subject the entire sewerage system to a vacuum of 24 inches mercury, and allow to stabilize for 15 minutes before proceeding with test. There shall be no loss greater than 1% of initial vacuum per hour over a four hour test

period.

925.6.6 All daily testing and Final Acceptance Test shall be recorded on vacuum charts to be provided by the ENGINEER. These charts will not be considered valid unless witnessed by ENGINEER on test equipment at beginning and end of vacuum test period.

925.6.7 The ENGINEER will sign and date charts to verify witness of tests. This signature does not indicate acceptance of the system.

925.7 LINE FLUSHING

925.7.1 After acceptance testing, flush lines to remove debris and foreign materials that accumulated in the lines during construction.

925.7.1.1 Suggested procedure (This procedure requires the use of vacuum valves, coordination of installation by the OWNER is the responsibility of the CONTRACTOR):

925.7.1.1.1 Place system under vacuum to 24 inches mercury.

925.7.1.1.2 Add water to valve pits at extreme ends of system and cause vacuum valves to operate and draw water into piping system.

925.7.1.1.3 Utilize system vacuum to transport the water and debris to collection point. Continue procedure until water entering at collection point is free of contamination or debris. If vacuum station collection tank is used as collection point, monitor volume of liquid in tank and pump out as necessary by means other than system sewage pumps. After completion of flushing, clean collection tank of all collected debris.

925.7.1.1.4 Restore vacuum collection tank and collection system to permanent configuration and make ready to place into operation.

925.7.1.2 Alternate flushing procedures are subject to ENGINEER'S review and approval.

925.8 BREATHER TESTING

925.8.1 After entire breather assembly is complete from the above ground flexible extension to the interior of the valve vault or buffer chamber, it shall be pressure tested as follows:

925.8.1.1 Fabricate a test pipe using 3/4" PVC materials or approved equal; one end to be 3/4" male pipe thread, the opposite end to terminate with a 1/8" tubing connection.

925.8.1.2 Remove breather dome and install the test pipe in its place. Pressurize the breather assembly to a minimum 40" water gage as measured with a magnehelic gauge. The assembly shall remain at a constant pressure with no detectable leaks for a minimum of one minute in the presence of the on site inspector. A dated record of all testing of breather domes shall be maintained in a bound notebook, which shall be turned over to the ENGINEER upon completion of all work.

925.9 MEASUREMENT AND PAYMENT

925.9.1 SANITARY SEWER FORCE MAIN WITH BEDDING

925.9.1.1 Measurement shall be per linear foot measured horizontally along the centerline of pipeline and fittings from the collection/lift station interface to the point of discharge as shown on the construction drawings. No deduction from the total will be made for intermittent installations such as division valves, pig launchers, and associated manholes.

925.9.1.2 Payment will be in accordance with the unit price per linear foot per size and material as defined in the Bid Proposal, and shall include: unclassified excavation in open trench, backfilling, and compaction for all trench zones; hand digging; removing and replacing surface obstructions; discovery and protection of subsurface obstructions; shoring and bracing; hauling excavated material; restoration of disturbed areas not included in other pay items; all fittings, concrete thrust blocking or restrained joints; preparation of pipe subgrade; furnishing and placing granular bedding; trench dewatering; temporary connections; jointing and coupling materials; furnishing and installing pipe in open trench; flushing and cleaning the pipe; air and hydrostatic pressure testing; and all other labor, material, and equipment incidental thereto.

925.9.2 SANITARY SEWER FORCE MAIN PIG LAUNCHER

925.9.2.1 Measurement of installed pig launcher shall be per each unit installed as shown on the standard drawing.

925.9.2.2 Payment for the pig launchers will be in accordance with the unit price per each as defined in the Bid Proposal, and shall include: furnishing and installing all fittings, flanges, restraining glands, and harnesses; drilling and preparing precast manhole section for slotted opening including gaskets, sealants, and grout; furnishing and installing resilient seat gate valves; preparing and installing cast-in-place concrete footer and pad on finished ground including trenching, backfilling, and compaction, furnishing and installing reinforcing steel; furnishing and installing

precast manhole sections including trenching, backfilling, and compaction, gaskets, frame and cover; furnishing and installing gravel bed for floor of manhole; and all other labor, material, and equipment incidental thereto.

925.9.3 BORE AND JACK, CASING FOR SANITARY SEWER VACUUM MAIN OR FORCE MAIN

925.9.3.1 Measurement shall be per linear foot, measured horizontally along the centerline of the encasement pipe actually installed for the work accomplished as shown on the standard drawing and on the drawings.

925.9.3.2 Payment will be in accordance with the unit price per linear foot as defined in the Bid Proposal, and shall include: trenching, unclassified excavation, backfilling, and compaction; furnishing and installing bored steel casing, casing insulators, and casing end seals; repair and replacement of existing roadway, bridge abutments, utilities, or any other structures damaged during boring and jacking operations; removal and disposal of waste material; providing grout for backfilling; inspections or permits; and all other labor, material, and equipment incidental thereto; except that the carrier pipe will be paid for under the appropriate bid item for vacuum main or force main.

925.9.4 SANITARY SEWER AIR RELEASE VALVE

925.9.4.1 Measurement shall be per each air release valve installed as shown on the drawings and the standard drawings.

925.9.4.2 Payment will be in accordance with the unit price per each as defined in the Bid Proposal, and shall include: furnishing and installing air release valve with all necessary fittings and appurtenances; drilling and preparing precast manhole section for slotted opening including gaskets, sealants, and grout; preparing and installing cast-in-place concrete footer and pad on finished ground including trenching, backfilling, and compaction, furnishing and installing reinforcing steel; furnishing and installing precast manhole sections including trenching, backfilling, and compaction, gaskets, frame, and cover; furnishing and installing gravel bed for floor of manhole; and all other labor, material, and equipment incidental thereto.

925.9.5 VACUUM SEWER DIVISION VALVES AND VAULT

925.9.5.1 Measurement shall be per each vacuum sewer division valves and vault installed as shown on the drawings and the standard drawing.

925.9.5.2 Payment will be in accordance with the unit

price per each as defined in the Bid Proposal, and shall include: furnishing and installing resilient seat gate valve with all necessary fittings and appurtenances; furnishing the OWNER with one five sided extension socket with 6-foot long T-handle extension bar for every five valves installed; furnishing and installing the gage tap assembly consisting of rubber tubing, fittings, supports, tapping saddle, and all other appurtenances for measuring vacuum in vacuum main; drilling and preparing precast manhole section for slotted opening including gaskets, sealants, and grout; preparing and installing cast-in-place concrete footer and pad on finished ground including trenching, backfilling, and compaction, furnishing and installing reinforcing steel; furnishing and installing precast manhole sections including trenching, backfilling, and compaction, gaskets, frame, and cover; furnishing and installing gravel bed for floor of manhole; and all other labor, material, and equipment incidental thereto.

925.9.6 VACUUM SEWER BUFFER TANK

925.9.6.1 Measurement shall be per each installed buffer tank (single or double per the respective bid item) as shown on the drawings and the standard drawings.

925.9.6.2 Payment will be in accordance with the unit price per each as defined in the Bid Proposal, and shall include: furnishing and installing all necessary equipment, including pipe and breather connections, breather vent piping and flexible breather pipe assembly; preparing and installing cast-in-place concrete footer and pad on finished ground including trenching, backfilling, and compaction, furnishing and installing reinforcing steel; furnishing and installing precast manhole sections including trenching, backfilling, and compaction, gaskets, frame, and cover; furnishing and installing all fittings, pipe, and all appurtenances; connection of the new or existing sanitary sewer gravity lines including drilling precast manhole sections, gaskets, sealants, and grout; furnishing and installing concrete grout for shelf; air and vacuum testing as required; and all other labor, material, and equipment incidental thereto.

925.9.7 INSTALLING VACUUM VALVE PIT

925.9.7.1 Measurement shall be per each vacuum pit (standard or deep, Type A or Type B per the respective bid item) installed as shown on the drawings and the standard drawings.

925.9.7.2 Payment will be in accordance with the unit price per each as defined in the Bid Proposal, and shall include: furnishing and installing all necessary equipment including unclassified excavation in open trench, backfilling, and compaction for all trench zones; hand digging; removing

and replacing surface obstructions including fencing, landscaping, and all other obstructions; discovery and protection of subsurface obstructions; shoring and bracing; hauling excavated material, restoration of disturbed areas not included in other pay items; all fittings and concrete anti-flotation collar; installation of flexible breather pipe assembly and all appurtenances; stubouts for connection of gravity and vacuum lines; air, vacuum, and all other testing as required; and all other labor, material, and equipment incidental thereto.

925.9.8 VACUUM COLLECTION LINES AND VACUUM SERVICE LATERALS

925.9.8.1 Measurement of vacuum collection lines and vacuum service laterals shall be per linear foot measured horizontally along the centerline of pipeline as shown on the drawings.

925.9.8.2 Payment will be in accordance with the unit price per linear foot per size and material as defined in the Bid Proposal, and shall include: unclassified excavation in open trench, backfilling, and compaction for all trench zones; hand digging; removing and replacing surface obstructions; discovery and protection of subsurface obstructions; shoring and bracing; hauling excavated material, restoration of disturbed areas not included in other pay items; all fittings, concrete thrust blocking or restrained joints; preparation of pipe subgrade; furnishing and placing granular bedding; trench dewatering; temporary connections; jointing and coupling materials; furnishing and installing pipe in open trench; flushing and cleaning the pipe; field quality control testing including daily vacuum testing of lines using OWNER furnished trailer mounted vacuum pump, breather testing, and all other testing required; making all required submittals; and all other labor, material, and equipment incidental thereto.

925.9.9 VACUUM VALVES AND APPURTENANCES: Measured and paid for per each as a separate pay item as included in the associated Vacuum Pit or Buffer Tank as specified and provided in the Bid Proposal.

SECTION 1000

LANDSCAPING

1000.1 GENERAL

This section pertains to the various horticultural and associated installations that are related to street-scapes and parks.

1000.2 CONTENTS

<u>Section No.</u>	<u>Title</u>
1001	Landscape Irrigation System
1005	Plantings
1010	Grass Sodding
1011	Turf Grass Seeding
1012	Native Grass Seeding
1015	Trash and Litter Receptacles

SECTION 1001
LANDSCAPE IRRIGATION SYSTEM

1001.1 GENERAL:

The work consists of installing a complete underground sprinkler system as shown on the drawings and as specified hereafter. The CONTRACTOR performing this work shall furnish all labor, equipment, materials, and permits necessary for the completion of the system, except those specified to be furnished by others. Unless otherwise specified or indicated on the drawings, or authorized by the ENGINEER. The construction of the sprinkler system shall include the furnishing, installing, and testing of all pipe, fittings, valves, heads, controllers, wires, air release and vacuum valves, backflow preventers inlet and discharge piping, automatic drain valves, manual drain valves, valve boxes, and all other components pertinent to the drawings and specifications of this system. The CONTRACTOR shall perform all trenching, excavating, boring, backfilling, compacting, concrete pouring, electrical work, welding, and any other work necessary for the completion of the project.

1001.2 REFERENCES:

- 1001.2.1 American Society for Testing and Materials (Latest Editions)(ASTM)
- D-1784 Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
 - D-1785 Specification for Poly (Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80 and 120.
 - D-1875 Test Method for Density of Adhesives in Fluid Form
 - D-2241 Specifications for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe
 - D-2466 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
 - D-2467 Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, schedule 80.
 - D-2564 Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
 - D-2774 Recommended Practices for Underground Installation of Thermoplastic Pressure Piping
 - D-2855 Recommended Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride)(PVC) Pipe and Fittings.
 - D-3139 Specification for Joints for Plastic Pressure Pipe Using Flexible Elastomeric Seals

1001.2.2 This Publication:

Section 1502 - Submittals

1001.3 MATERIALS

1001.3.1 GENERAL:

1001.3.1.1 All materials shall be new and without flaws or defects of any type and shall be the best of their class and kind.

All materials shall have a minimum guarantee of one year against material defects or defective workmanship.

1001.3.1.2 All materials shall be of the brands and types noted on the plans or as specified herein, or approved as equal by the ENGINEER in accordance with Section 6.

1001.3.1.3 For reasons of equipment compatibility, all sprinkler heads, automatic valves and the sprinkler control system shall be of the same manufacturer, unless otherwise noted and approved by the ENGINEER.

1001.3.1.4 The irrigation system was designed around equipment manufactured by specific companies as a standard. Approved as equal equipment by other manufacturers may be used only with the approval of the ENGINEER and the OWNER five days prior to the opening of bids.

1001.3.2 PLASTIC PIPE AND FITTINGS

1001.3.2.1 PLASTIC PIPE:

1001.3.2.1.1 All mainline plastic pipe which is 2" or smaller, shall be Schedule 40 PVC and shall conform to ASTM D 1785. All mainline pipe which is larger than 2" diameter shall be PVC 1120 or 1220 (SDR-PR) pipe, SDR-21 with a 200 psi pressure rating and conforming to ASTM D 2241, with flexible joints conforming to ASTM D 3139. All lateral lines plastic pipe shall be schedule 40 PVC and shall conform to ASTM D 1785.

1001.3.2.1.2 PVC pipe shall be continuously marked with identification of the manufacture, type, class, size and material and shall conform to ASTM D 1784. Solvent joints shall meet ASTM D 2774 and D 2855 requirements. Pipe shall be produced in 20 foot lengths. All plastic pipe shall be continuously and permanently marked with the following information: manufacturer's name, nominal pipe size, schedule, kind of material, kind of pipe, and the pressure rating in psi in accordance with the standards of the National Sanitation Foundation. Pipe shall be free of holes, foreign material, blisters, wrinkles, dents, or sun scald.

1001.3.2.2 PVC Fittings: Fittings on PVC mainlines larger than 2" shall be ring and gasket fittings. Fittings on PVC mainlines 2' in diameter and smaller and on all PVC laterals, shall be Schedule 40 PVC, Type 1, Cell Classification 12454-B, and shall comply with ASTM D 2466, D 2467, and D 1784.

1001.3.2.3 Risers and Threaded Nipples: All threaded PVC nipples and risers shall be Schedule 80 PVC pipe. All galvanized nipples and risers shall be Schedule 40 galvanized steel pipe.

1001.3.3 VALVES AND VALVE BOXES:

1001.3.3.1 Valves: Valves for use in electrically controlled automatic control systems shall be diaphragm activated and hydraulically operated solenoid valves as specified on the plans.

1001.3.3.2 Valve Boxes: Valve boxes shall be as specified on the plans.

1001.3.4 SPRINKLER HEAD AND BUBBLERS: Sprinkler heads and bubblers shall be as specified on the plans and shall be installed on schedule 80 PVC threaded risers.

1001.3.5 CONTROLLERS: Controllers shall be as specified on the plans.

1001.3.6 BACKFLOW PREVENTER: The backflow prevention device shall be as specified on the plans.

1001.3.7 CEMENTS, CLEANERS/PRIMERS AND JOINT COMPOUNDS:

1001.3.7.1 Cement shall be No. 2200 series Uni-Weld or Rectorseal Gold low temperature plastic pipe cement or approved equal for use on all sizes and schedules of PVC pipe and fittings. Cement must be NSF approved and meet ASTM D 2564 specifications.

1001.3.7.2 Cleaner/primer shall be No. 8700 United Elchem hi-etch cleaner/primer or approved equal. Cleaner/primer must be any color other than clear.

1001.3.7.3 All threaded connections between PVC and metal pipe shall be made using Rectorseal No. 100 virgin heavy duty sealing past of plasto-joint stick as manufactured by Lake Chemical company or teflon tape.

1001.3.7.4 All metal to metal connections shall be made using Rectorseal No. 5, slow dry, soft set pipe thread compound or approved equal. All PVC to PVC threaded connections shall use teflon tape.

1001.3.7.5 "O"-ring gasket and pipe spigot ends shall be lubricated using the lubricant recommended or supplied by the pipe manufacturer. If the pipe manufacturer does not provide a lubricant for the pipe, use IPS Weld-On No. 787 gasket lube as manufactured by Industrial Polychemical Service or approved equal.

1001.3.8 WIRE(120 VOLTS): Wire for the 120 volt wiring shall be solid copper (or stranded copper in larger wire sizes) underground feeder for direct burial and PVC insulated. Size of wire shall be No. 12 AWG.

1001.3.9 WIRE(24 volts): Wire for the 24 volt wiring shall be solid copper wire, PVC insulated, UL approved underground feeder wire for direct burial in ground. Common wires shall be No. 12, white, except as noted on drawings. The wire shall be

supplied in either 500 feet or 2,500 feet rolls.

1001.3.10 WIRE SPLICING MATERIALS: All wire splices shall be made watertight using 3M Scotchlok wire connectors or approved equal. All wiring installed under sidewalks, roadways, parking lots, etc., shall be installed in a 1 1/4 inch or larger Class 200 PVC sleeve.

1001.3.11 OTHER MISCELLANEOUS FITTINGS AND MATERIALS: All other miscellaneous fittings and materials shall be as specified on the plans.

1001.4 SUBMITTALS AND RECORD DRAWINGS

1001.4.1 SUBMITTALS: The CONTRACTOR shall submit all material and/or information as specified in Section 1502 of the Supplemental Technical Specification or as required by the ENGINEER in accordance with Section 6 of these specifications.

1001.4.2 RECORD DRAWINGS:

1001.4.2.1 The CONTRACTOR in conjunction with the ENGINEER, shall provide and keep up to date a complete set of "as-built" drawings which shall be corrected daily to show all changes in the location of sprinkler heads, controllers, backflow preventers, valves, drains, meters, points of connection, wire splice points, pipe and wire routing and other changes that may have been made from the original drawings and specifications as provided to him. All gate valves, manual drains, wire splices, automatic and manual valve locations, controllers, power supply, and mainline piping shall be shown with actual measurements to reference points so they may be easily located in the field.

1002.4.2.2 At the time of final acceptance the CONTRACTOR shall furnish to the OWNER a reproducible "as-built" record drawing(s) prepared by a qualified drafts-person showing the entire completed irrigation system. The CONTRACTOR shall also provide and install in each of the controller vaults on the project a legible reduction, laminated in plastic, layout drawing of the irrigation system that the controller operates.

1001.5 PREPARATION AND INSTALLATION FOR IRRIGATION SYSTEM:

1001.5.1 GENERAL:

1001.5.1.1 All materials and equipment shall be installed in a neat and workmanlike manner according to manufacturer's published recommendations and specifications, local, and state codes, as shown on the detail drawings, plans and as specified herein.

1001.5.2 PRODUCT HANDLING: The CONTRACTOR shall be responsible for correct procedures in loading, unloading, staking,

transporting, and handling all materials to be used in the system. The CONTRACTOR shall avoid rough handling which could affect the useful life of equipment. Pipe shall be handled in accordance with the manufacturer's published recommendations on loading, unloading, and storage.

1001.5.3. EXCAVATION AND TRENCHING:

1001.5.3.1 The CONTRACTOR shall stake out the location of each run of pipe and all sprinkler heads and valves prior to trenching. Each run of the system shall be approved by the ENGINEER before actual installation is started. Prior to trenching the Contractor shall contact the New Mexico One Call, 260-1990, two (2) working days in advance of any excavation.

1001.5.3.2 Excavation and trenching for pipe lines shall be true to line. The width of the trenches shall not be greater than necessary to permit proper jointing, tamping, backfilling, bedding or any other installation procedures that may be necessary. Trench widths shall also be wide enough so that there will be a minimum horizontal separation of 4 (four) inches between pipes in the same trench.

1001.5.3.3 In areas where trees are present, trench lines will be adjusted on the site to install trenches beyond the drip line of the tree.

1001.5.3.4 Trench depths shall be sufficient to provide the specified pipe cover as described in these specifications or as noted on the plans. In rocky areas the trenching depth shall be 6 (six) inches below normal trench depth to allow for pipe bedding as described in these specifications.

1001.5.4 DEPTH OF BURY: There shall be a minimum of 28" and a maximum of 30" of cover for all constant pressure mainline. There shall be a minimum of 18" and a maximum of 20" of cover for all mainline located downstream of the master valve. There shall be a minimum of 18" and a maximum of 20" of cover for all lateral lines.

1001.5.5. PIPE AND FITTINGS:

1001.5.5.1 Installation of plastic pipe and fittings shall be in accordance with the manufacturer's published recommendations and procedures and as specified herein. Manufacturer's published recommended procedures for making solvent weld fittings shall be strictly adhered to.

1001.5.5.2 Caution shall be exercised by the CONTRACTOR in handling, loading, unloading and storing of PVC pipe and fittings. All PVC pipe shall be stored and transported in a vehicle with a bed long enough to allow the pipe to lie flat without subjecting it to undue bending or concentrated external load at any point.

Any section of pipe that has been dented or damaged or in any other way found to be defective, either before, or after laying shall be replaced with sound pipe without additional expense to the OWNER.

1001.5.5.3 Before installation, the inside of the pipe shall be cleaned of all direct and foreign matter and shall be kept in cleaned condition during and after laying of the pipe. When work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth or other foreign substances will enter the pipe or fittings. Where pipe ends are left for future expansion or connections, they shall be valved and capped, as directed on the plans and or by the ENGINEER.

1001.5.5.4 All PVC pipe and fittings shall be assembled to permit the pipe or fittings to be joined at the true parallel position of the fitting. Placement of pipe in curving trenches which causes bending and stress on pipe and fittings will not be permitted. No excess piping or fittings shall be permitted in the installation of the system, which may increase pressure loss or potential blockage.

1001.5.5.5 Excavation and trenching shall be true to line and depth specified in these specifications or indicated on the plans. Before installing the pipe, all rubbish and rocks shall be removed from the trenches. If the soil is extremely rock, the trenches shall be padded with dirt or sand as outlined in these specifications. Material used for pipe padding shall be approved by the ENGINEER. The full length of each section of the pipe shall rest solidly upon the bottom of the trench or bedding material.

1001.5.5.6 Pipe shall not be laid in water or when trench or weather conditions are unsuitable for the work. Any water which may be encountered or may accumulate in the trenches or excavation shall be pumped out or otherwise removed as necessary to keep the bottom of the trench or excavation free and clear of water during the progress of the work.

1001.5.5.7 PVC pipe will expand or contract at the rate of 1 (one) inch per 100 feet per 10 degrees F change in temperature. Therefore, the pipe shall be installed in a manner so as to provide for expansion and contraction as recommended by the manufacturer.

1001.5.5.8 Unless otherwise specified on the plans, all piping passing under sidewalks, roadways, parking lots, etc., shall be sleeved in a Class 200 PVC pipe two sizes larger than the pipe to be sleeved.

1001.5.5.9 When more than one pipe is installed in the same trench, in no case shall one pipe be installed above or below

another. Pipe can be installed in the same trench if pipes are laid side by side. In no case shall mainline and lateral pipe be installed in the same trench.

1001.5.5.10 The minimum horizontal clearance between lines in the same trench shall be 4 (four) inches.

1001.5.5.11 After all sprinkler piping, risers, valves, thrust blocks, etc., have been installed and partial backfilled as specified herein, the control valve shall be opened and a full head of water used to flush out the system. After the system is thoroughly flushed, risers shall be capped off and the system pressure tested in accordance with the testing section. At the conclusion of the pressure test the heads shall be installed and the backfill operation completed.

1001.5.6 SOLVENT WELDING PROCEDURE:

1001.5.6.1 PVC plastic pipe shall be squarely cut.

1001.5.6.2 Burrs left from cutting shall be wiped off with a clean, dry cloth.

1001.5.6.3 Utilizing a cleaner/primer, thoroughly clean the mating pipe end and the fitting socket with a clean dry cloth.

1001.5.6.4 Apply a uniform coat of solvent cement to the outside of the pipe end with a non-synthetic brush or dauber.

1001.5.6.5 In like manner, apply a thin coating of solvent cement to the inside of the fitting socket.

1001.5.6.6 Re-apply a light coat of solvent cement to the pipe and quickly insert it into the fitting to the full depth of the fitting socket.

1001.5.6.7 Rotate the pipe or fitting approximately 1/4 turn to insure even distribution of the solvent cement.

1001.5.6.8 Hold in position for approximately 30 seconds.

1001.5.6.9 Wipe off any excess solvent cement that forms as a bead around the outer shoulder.

1001.5.6.10 Care should be taken so as not to use an excess amount of solvent cement that could cause burrs or obstructions to form on the inside of the pipe joint.

1001.5.6.11 Solvent weld joints shall be allowed to cure for at least 24 hours before pressure is applied to the system.

1001.5.7 BACKFILLING:

1001.5.7.1 Upon completion of a particular section of the irrigation system, and after sufficient time has elapsed for the curing of solvent weld joints, partial backfilling

can begin, leaving all joints, risers and connections exposed for visual inspection during the hydrostatic test. After completion and acceptance of the hydrostatic test by the ENGINEER for a particular section of the irrigation system the backfill operation can be completed.

1001.5.7.2 All backfill material shall be subject to approval by the ENGINEER. Backfill materials shall be free from rubbish, rock, large stones, brush, sod, frozen material or other unsuitable substances that may damage pipe during the backfilling operations.

1001.5.7.3 In the event that the material from the excavation or trenching is found to be unsuitable for use in backfill, it shall be removed from the site and properly disposed of by the CONTRACTOR and at his own expense. The CONTRACTOR shall then, at no additional cost to the OWNER, arrange for, purchase and/or furnish suitable backfill material consisting of earth, loam, sandy clay, sand, or other approved materials free of large clods of earth or sharp stones, approved by the ENGINEER.

1001.5.7.4 In rocky areas, the trench depth shall be 6 (six) inches below the normal trench depth to allow for 6 (six) inches of suitable backfill as padding for the pipe. In like manner, there shall be at least 6 (six) inches of padding on either side of the pipe as a padding against the rock wall of the trench.

1001.5.7.5 Backfill shall be placed in horizontal layers not exceeding 6 (six) inches in depth and shall be thoroughly tamped, rolled or otherwise compacted to original density or better so that no settling will result. Backfill shall be placed to the original ground level or to the limits designated on the plans. If settlement of trenches occurs within one year from date of completion, it shall be the CONTRACTOR'S responsibility to refill trenches and re-seed or sod the repaired areas.

1001.5.8 SADDLE TAPS: No saddle taps shall be permitted.

1001.5.9 SLEEVED CROSSING:

1001.5.9.1 Unless otherwise noted on plans, all piping installed under sidewalks, roadways, parking lots, etc., shall be sleeved in a Class 200 PVC pipe two sizes larger than the pipe to be sleeved. Wiring shall be placed in a separate sleeve from that of the pipe crossing and shall be 1 1/4 or larger Class 200.

1001.5.9.2 Every effort shall be made by the CONTRACTOR to install sleeving prior to the pouring or construction of the sidewalks, roadways, parking lots, etc., if at all possible. If prior sleeving is not possible, all crossings must be bored

unless authorization for an open cut is obtained from the ENGINEER.

1001.5.9.3 Sleeving ends, with the inner pipe or wire installed, shall be taped closed using a good quality duct tape to prevent the entrance of dirt into the sleeve.

1001.5.9.4 Arroyo crossings, if necessary, shall be sleeved in a Class 200 PVC pipe two sizes larger than the pipe to be sleeved and shall be installed a minimum of 36 inches below the flow line of the arroyo.

1001.5.10 THRUST BLOCKS: Concrete thrust blocks shall be provided where necessary to resist system pressure. Thrust blocks shall be constructed at all direction changes, size changes, valves and terminations, or at any other points of the system that will result in an unbalanced thrust line for equipment 2 (two) inches and larger. Do not obstruct the outlets of fittings which are intended for future connections. Thrust blocks shall be poured against undisturbed earth and in accordance with the plans or standard details.

1001.5.11 SPRINKLER HEADS:

1001.5.11.1 Sprinkler heads shall be the type and make specified and shall be installed to grade unless otherwise specified. Sprinkler heads shall be installed a maximum of 2 (two) inches from curbs, walls, driveways, building walls, etc.. Heads shall be installed in the vertical positions, hand backfilled and compacted to original density or better.

1001.5.11.2 Sprinkler head spacing shall not exceed the spacing shown on the plans and shall be in the approximate locations and configuration as shown on the plans. CONTRACTOR shall verify area dimensions while staking sprinkler head location. Sprinkler heads shall be spaced so that they are equidistant from one another for the given lengths and widths of the area to achieve uniform coverage.

1001.5.11.3 After all piping and risers are in place and connected and before installation of the sprinkler heads, all control valves for a given section shall be fully opened and a full head of water shall be used to flush out the system.

1001.5.11.4 If water pressure without the heads installed is not sufficient to provide adequate water flow from end risers, the CONTRACTOR shall cap off enough heads closest to the water source to provide adequate flushing of the end riser assemblies.

1001.12 CONTROLLER:

1001.12.1 The Controller location is indicated on the plans. The CONTRACTOR shall familiarize himself with the

requirements of making the power connections at the locations noted (120 volt supply to the controller) and shall include the cost to complete this portion of the contract.

1001.5.12.2 The controller shall be mounted and wired according to the manufacturer's recommended procedures and as specified in these specifications and on the plans.

1001.5.12.3 Electric control valves shall be connected to controller in the numerical sequences as shown on the plans.

1001.5.12.4 Controller shall be installed in a locking controller enclosure as specified on the plans.

1001.5.13 ELECTRIC CONTROL VALVES:

1001.5.13.1 All electric control valves shall be of the type and size as indicated on the plans and shall be installed where shown on the plans, following the published recommendations of the manufacturer and in accordance with these specifications and plans.

1001.5.13.2 The valve boxes shall be locking and of the size and type as shown on the plans. Valve boxes shall be installed as shown on the plans.

1001.5.13.3 Valve wire splices shall be waterproofed using 3M Scotchlok Connectors or approved equal and the CONTRACTOR shall leave 24 (twenty-four) inches of coiled slack to facilitate raising splices to ground level without cutting wires.

1001.5.14 24 VOLT CONTROL VALVE WIRING:

1001.5.14.1 All wire installation procedures as described herein shall be checked to conform to local electrical codes.

1001.5.14.2 All wire used for the 24 volt wiring from the controller to the electric control valves shall be type "UF", 600 volt, solid copper, single conductor, PVC insulated and bear UL approval for direct burial underground feeder cable. Unless otherwise specified on the plans, the 24 volt common wires shall be wire No. 12 A.W.G. and the remaining 24 volt control wires shall be No. 12 A.W.G., and of colors other than white. These colors shall be noted on the "as-built" record drawings.

1001.5.14.3 Whenever possible, the CONTRACTOR shall install the 24 volt control valve wiring in the same trench as the sprinkler system mainline piping. All wires shall be laid on the bottom on one side of the pipe only and 2 (two) inches below the pipe. The wires shall be laid loose in the trench to allow for contraction of the wire. Control wires shall be taped together in 10'0" increments. When trenches used for piping

are not appropriate for routing of wire, a trench, 18" deep, shall be provided by the CONTRACTOR for 24 volt wires and shall be identified with dimensions on the "as-built" record drawings.

1002.5.14.4 Wire splices, other than at valve box locations, shall be kept to a minimum and if needed shall be made only at common splice points and placed in a wire splice box as shown on the plans or as approved by the ENGINEER. The location of these wire splice boxes shall be shown on the "as-built" record drawings. There shall be a 24" coil in the wires placed in the wire splice boxes so that the splices can be pulled out above ground level to facilitate testing and trouble shooting. No buried wire splices shall be permitted. All wire splices shall be made waterproof using 3M Scotchlok Connectors or approved equal.

1001.5.14.5 In no case shall wires of different colors be spliced together.

1001.5.14.6 Control wires shall be identified with E-Z Coder WDR Series Tape at each valve and at the Controller and at splices. Valves shall be numbered on the "as-built" record drawings.

1001.5.15 120 VOLT CONTROLLER POWER WIRING:

1001.5.15.1 The CONTRACTOR shall familiarize himself with the work required to complete this portion of the installation. All 120 volt wiring shall be installed in accordance with local electrical codes. The 120 volt service shall consist of one black and one white wire. The neutral wire must be bonded.

1001.5.15.2 120 volt power shall be supplied to the controller location by a licensed electrician.

1001.5.16 MANUAL DRAIN VALVE-MAINLINE:

1001.5.16.1 Manual drain valves of the size and type indicated on the plans shall be installed at all low points of mainline piping, or at any other points that may be indicated on the irrigation system plans or as specified herein.

1001.5.17 TESTING:

1001.5.17.1 Upon completion of the irrigation system's mainline, the entire mainline shall be tested for a 4 (four) hour period at 150 psi. Prior to testing the mainline shall be partially backfilled leaving all joints and connections exposed for visual inspection. All dirt shall be flushed from the system and the line filled with water to remove air. The mainline shall be brought to static pressure. A pressure gauge and temporary valve shall be installed at the end of the mainline to permit hydrostatic pressure to be applied to the main. A pressure of 150 psi must be retained for a 4 (four) hour period. Any

leaks resulting in the 4 (four) hour pressure test shall be repaired and the system retested until the system passes the test.

1001.5.17.2 Upon completion of the irrigation system's lateral sections and after sufficient time has been allowed for solvent weld joints to cure, the entire system shall be hydrostatically tested by capping off all sprinkler head risers. On systems using flex nipples, or swing joints, the lateral line shall be tested prior to installation of the flex nipples or swing joints. Prior to capping, all air and dirt shall be flushed from the system and the pipe partially backfilled by center loading, leaving all joints, risers, swing joints and connections exposed for visual inspection. All lateral irrigation piping must be pressure tested for 1 (one) hour at 100 psi. The procedure shall be the same as used for the mainline. If after one hour no visible leakage has occurred and the 100 psi pressure has been retained, the heads shall be installed, and the backfill operation completed. Any leaks resulting from the hydrostatic test shall be repaired and the system retested until the system passes the test.

1001.5.18 ADJUSTING OF SYSTEM:

Upon completion of the installation, the CONTRACTOR shall adjust all heads and valves and program controller to provide optimum sprinkler system performance. It will be the OWNER'S responsibility to make any minor adjustments to the system during the guarantee period.

1001.5.19 CLEAN UP: The CONTRACTOR shall continuously keep a neat and orderly area in which he is installing the system. Disposal of rubbish and waste material resulting from the installation shall be continual. Upon completion of the system, the CONTRACTOR shall remove from the OWNER'S property at his own expense, all temporary structures, rubbish, waste material, tools, and equipment resulting from or used in the installation of the system.

1001.5.20 PROTECTION OF EXISTING UTILITIES: The CONTRACTOR shall be responsible for locating all cables, conduits, piping, and any other utilities or structures that may be encountered either above or below ground. All necessary precautions must be taken by the CONTRACTOR to prevent any damage to these existing improvements. In the event that such damage should occur from his operations, the CONTRACTOR shall repair or replace or bring to original condition the damaged utilities or improvements at his own expense.

1001.5.21 ROCK: If the CONTRACTOR encounters rock or other unfavorable trenching conditions, no additional compensation will be paid. When material

from the excavation or trenching is unsuitable for use as backfill, additional backfill material suitable for this purpose and approved by the ENGINEER, shall be brought in at the expense of the CONTRACTOR. It shall also be the CONTRACTOR'S responsibility to remove and dispose of all unsuitable materials removed from the trench that cannot be used in the backfill operation.

1001.5.22 FINAL ACCEPTANCE:

1001.5.22.1 When the CONTRACTOR is satisfied that the system is operating properly, that it is balanced and adjusted, that all work and cleanup is completed, he shall request an inspection of the irrigation system by the ENGINEER and OWNER. At that time, the CONTRACTOR shall demonstrate each system in its entirety. In inspecting the work, no allowance for deviation from the original plans and specifications will be made unless prior approval has been obtained. This system review must be completed prior to beginning planting operations.

1001.5.22.2 Any inconsistencies to the specifications shall be noted by the ENGINEER and the OWNER and a written copy of corrections needed shall be given to the CONTRACTOR. Any work deemed not acceptable shall be reworked to the complete satisfaction of the OWNER and the ENGINEER at no additional cost to the OWNER.

1001.5.22.3 When all work is completed to the satisfaction of the OWNER, a written acceptance of the total project will be given to the CONTRACTOR upon furnishing, by the CONTRACTOR of a complete "as-built" record drawing of the irrigation system that is acceptable to the OWNER.

1001.5.23 OPERATIONAL INSTRUCTION: After the system has been tested and accepted, the CONTRACTOR, along with the ENGINEER shall instruct the OWNER in the operation and maintenance of the system.

1001.5.24 SYSTEM MAINTENANCE AND WARRANTY:

1001.5.24.1 For a period of one year from final acceptance of the system, the CONTRACTOR will promptly furnish and install, without cost to the OWNER, any and all parts or materials which prove defective in material or workmanship. All damage due to irrigation system line breaks caused by defective material or workmanship shall be repaired and brought to original condition by the CONTRACTOR at no expense to the OWNER. The CONTRACTOR shall complete all repairs within 24 hours of receipt of notification from the OWNER of system failure.

1001.5.24.2 Minor maintenance of the system shall be the responsibility of the OWNER.

1001.5.24.3 For a period of one year from final acceptance of the system, the CONTRACTOR shall repair any settlement of the trenches by one of the following methods as directed by the ENGINEER and the OWNER.

1001.5.24.3.1 Bring to grade by top dressing (raking top soil into the grass).

1001.5.24.3.2 Bring to grade with top soil and seed.

1001.5.24.3.3 Remove existing sod, fill depression with top soil, and replace with new sod to match existing sod.

1001.5.24.4 Repair by any of the above methods must result in a smooth, level area. Maintenance of repaired areas shall be the responsibility of the OWNER. Repair shall be completed by the CONTRACTOR within 48 hours after notification from the OWNER of trench settlement problems.

1001.6 INSPECTIONS

1001.6.1 The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the ENGINEER or OWNER. It shall be the responsibility of the CONTRACTOR to notify the ENGINEER in writing 48 hours in advance of each required inspection. The sequence of required inspection shall not be changed from the sequence listed below. The CONTRACTOR shall not proceed with work in the next sequence without written approval of the previous sequence. Payment will not be approved for items which have not been inspected and approved in writing.

1001.6.1.1 Inspect staked locations of mainline, valves, laterals, and sprinkler heads.

1001.6.1.2 Inspect 24 volt control wire installation.

1001.6.1.3 Inspect and pressure test mainline and electric control valve installation.

1001.6.1.4 Inspect and pressure test lateral irrigation line installation.

1001.6.1.5 Inspect automatic controller installation and operation.

1001.6.1.6 Inspect sprinkler and bubbler head placement, coverage and operating pressure prior to planting.

1001.6.1.7 Final project inspection and acceptance.

1001.6.1.8 Inspect at end of the maintenance period.

1001.7. MEASUREMENT AND PAYMENT

1001.7.1 Measurement of the landscape irrigation system shall be lump sum or by units of the major components of the system as specified in the Supplemental Technical Specifications and/or the Bid Proposal and shall include the entire irrigation system from the water meter.

1001.7.2 Payment shall be at the contract price per lump sum or per unit as specified in the Supplemental Technical Specifications and in the Bid Proposal, which shall include all material, equipment and labor required to install and make operational the irrigation system.

SECTION 1005

PLANTING

1005.1 GENERAL:

1005.1.1 SCOPE: Work under this section consists of the planting of trees, shrubs, and groundcovers, including the furnishing of all labor, equipment, and materials and performing all work in connection therewith in accordance with the plans and specifications, or as authorized by the ENGINEER.

1005.1.2 The scientific and common names used for the plants called for on the drawings are generally in conformity with the approved names given in Standardized Plant Names, 1942 Edition published by the American Joint Committee on Horticultural Nomenclature. The names of varieties not included therein are generally in conformity with the names accepted in the nursery trade.

1005.2 REFERENCES:

1005.2.1 U.S.A. Standard for Nursery Stock, published by Committee on Horticultural Standards of the American Association of Nurserymen, Inc.

1005.2.2 Standardized Plant Names, published by the American Joint Committee on Horticultural Nomenclature.

1005.3 MATERIALS:

1005.3.1 PLANT MATERIALS: A complete list of plants, including a schedule of quantities, sizes and other requirements is shown on the plans. In the event that discrepancies occur between quantities of plants indicated in the schedule of plants and the planting plan, the plant quantities indicated on the planting plan shall govern.

1005.3.2 PLANT MATERIAL SUBSTITUTION:

1005.3.2.1 Plant material substitutions shall not be made without the written approval of the ENGINEER. The use of materials differing in kind, quality, or size from that specified will be allowed only after the ENGINEER is convinced that all means of obtaining the specified materials have been exhausted. At the time bids are submitted, the CONTRACTOR is assumed to have located the materials necessary to complete the job as specified. All requests for substitutions must be submitted no later than five days prior to the opening of bids.

1005.3.2.2 Plant material quality, size, and condition shall be in accordance with U.S.A. Standard for Nursery Stock, latest edition, as published by the Committee on Horticultural Standards of the American Association of Nurserymen, Inc., the plans and the following requirements:

1005.3.2.2.1 All plants shall be typical of their species or variety. All plants shall have normal, well developed branches and vigorous root systems. They shall be sound, healthy, vigorous, free from defects, disfiguring knots, abrasions of the bark, sunscald injuries, plant diseases, insect eggs, bores, and all other forms of infections.

1005.3.2.2.2 Unless otherwise stated on the plans or approved by ENGINEER, all plants shall be nursery grown and shall be tagged with nursery labels indicating species and variety.

1005.3.2.2.3 Container grown plant material shall have been established in its delivery container for not less than six months, but for not more than two years. Any rootbound material will not be accepted.

1005.3.2.2.4 Balled and burlapped plant material shall have a solid ball of earth of minimum specified size and held in place securely by burlap and a stout twine or rope. Broken or loose balls will be rejected.

1005.3.2.2.5 Unless specifically noted on the plans, all trees shall have a single trunk that is straight and free of "dog-legs," "crooks," "y-crotches," or other disfiguring shapes. The central leader of all trees shall not have been pruned. Trees with double leaders are not acceptable.

1005.3.2.2.6 All plant material shall have a uniform shape around its complete circumference. Plant material with irregular branching patterns or with branching patterns more highly developed on one side than on other sides shall not be acceptable.

1005.3.2.2.7 The ENGINEER shall inspect all plant material at the CONTRACTOR'S yard prior to delivery to the job site. All materials shall then be inspected at the job site prior to planting and after planting.

1005.3.2.2.8 At the option of the CONTRACTOR the ENGINEER will inspect plant material at a wholesale nursery of the CONTRACTOR'S choice prior to delivery of materials to the CONTRACTOR'S yard. However, at no additional expense to the OWNER, the CONTRACTOR shall be responsible for all travel expenses incurred by the ENGINEER for any travel outside the Albuquerque Metropolitan Area.

1005.3.2.2.9 The ENGINEER shall be the judge of the quality and acceptability of all plant materials. All rejected material shall be immediately removed from the site

and replaced with acceptable material at no additional cost to OWNER.

1005.3.3 PLANTING SOIL MIXTURES:

Specification for complete planting backfill. Planting soil mixture shall be a premixed, homogeneous soil. It will consist of sand and organic matter and meet performance characteristics outlined below.

Sand, 60% by volume of clean masonry sand with a sieve analysis of:

<u>sieve size</u>	<u>% passing</u>
3/8"	100%
#4	93-99%
#8	82-88%
#16	73-79%
#30	55-61%
#50	24-30%
#100	6-12%
#200	7-2%

Organic Matter, 40% by volume of compost material specified as follows:

Compost, or mulch, shall be a combination organic carbon sources such as straw, hay, bark, sawdust or wood shavings and nitrogen sources such as manure, blood meal, or chemical fertilizers. Nitrogen sources must be added prior to composting. It is recommended this mixture be aerobically composted at temperatures between 120 F and 160 F for a period of not less than 100 days. Weed seeds are to be destroyed during composting and urea and ammonia form nitrogen ratio shall be as listed below. Finished compost is to be screened to provide less than 2% remaining on a 1/2" screen. Carbon to Nitrogen Ratio of organic matter shall be less than 50 parts carbon to one part nitrogen.

1005.3.3.1 The complete PLANTING SOIL MIXTURE shall have the following characteristics:

Calcium to magnesium ratios shall not exceed 20 parts calcium to one part magnesium.

Potash (Potassium)(K) shall be present at a rate of at least 200 parts per million of exchangeable potassium.

Salinity (EGXK) not to exceed 2 AMHOS/CM Nitrate nitrogen (NO3-N) shall be present at a rate of at least 30 parts per million.

Phosphorus as measured by the Olson sodium bicarbonate measurement method shall be at greater than 25 parts per million.

Ph of the planting soil mixture shall be between 6.5 and 7.5.

Organic matter by weight (by simple combustion) shall be more than 5% Available moisture capacity in the one third to 15 bar tension shall be greater than 15%.

TKN2 or Total Kjeldahl Nitrogen shall

be 250 ppm or greater.

NH4 shall be 25 ppm or less.

1005.3.3.2 The ENGINEER reserves the right to adjust the above characteristics and waive all irregularities.

1005.3.3.3 The PLANTING SOIL MIXTURE shall be tested by the CONTRACTOR at an approved solid testing laboratory. Test results shall be submitted to and approved by the ENGINEER prior to delivery of the planting soil mixture. Test Results shall list the as tested qualities of the above characteristics and any recommendations the testing Lab has.

The OWNER will also test the final product as delivered or installed to verify the mixture matches the listed characteristics and the submitted solid report.

Approved Soil Testing Laboratories are:

IAS(Inter Ag Services)
2643 East University Drive
Station 113
Phoenix, Arizona 85034
(602)273-7248
or
ASSAGAI Labs
P.O. Box 90430
Albuquerque, N.M. 87199-0430
(505)345-8964

1005.3.3.4 Potential sources for compost and the PREPARED SOIL MIXTURE is:

WAPCO
RR9, Box 862
2nd and Bates Rd., SW
Albuquerque, N.M. 87105
(505)877-8670

1005.3.3.5 Each Delivery shall have a load ticket. The load ticket shall list:

Source of Mixture.

Approximate volume of load.

Date of delivery or loading.

Typed name of individual representing the source.

Inked original signature of individual representing the source.

Area of site product delivered to.

Tickets shall be collected and provided to the ENGINEER.

1005.3.4 MULCH: Bark mulch shall be fresh, shredded mixture of 1/2" - 5" pieces of wood, cambium and bark nuggets from coniferous trees, as available from Western Agricultural Products Company or approved equal.

1005.4 PLANTING OPERATIONS:

1005.4.1 Planting operations as specified herein shall begin only when other work including placing of topsoil to finished grade has progressed sufficiently to permit planting and shall be performed only during favorable weather conditions in accordance with accepted practice.

1005.4.2 In any one day, only those plant materials intended to be planted that day shall be delivered to the project site, unless otherwise approved by ENGINEER. All plant materials shall be located where shown on the plans except when adjustments due to field conditions are required. The location of all trees and shrubs shall be staked by the CONTRACTOR before making any excavations, and locations shall be inspected by the ENGINEER prior to installation. All plants shall be placed as specified except for minor adjustments made necessary by underground obstructions or other unforeseen causes.

1005.4.2.1 All balled and burlapped plant materials shall be planted between March 1 and June 1.

1005.4.3 PLANTING: All planting and backfilling shall be performed in accordance with accepted nursery practice, the plans, and the following requirements:

1005.4.3.1 Prepare all planting pits and planting beds as shown on the plans. Set all plants plumb and straight unless otherwise indicated on plans and in the center of pit such that the top root ball sits flush with finish grade. No filling will be permitted around trunks or stems.

1005.4.3.2 Backfill for planting pits shall consist of the planting soil mixture as specified in these specifications. The plant shall be positioned in the hole and backfilled no more than halfway up the root ball. The backfilling shall be completed, and material tamped. When pit is nearly filled, water thoroughly and allow water to soak away. If settling of the backfill occurs after watering, add more backfill to bring to finish grade.

1005.5 MULCHING: Unless shown on the plans or specified otherwise, after completion of planting operations, a 4 inch thick layer of mulch shall be applied to all planting beds.

1005.6 MAINTENANCE AND PROTECTION:

Maintenance and protecting of trees, shrubs, and groundcover shall begin immediately following the last operation of installation for each plant and shall continue through the duration of the maintenance period specified for turf. If the project does not include turf, the trees, shrubs and groundcover shall be maintained for a period of 30 days after substantial completion. Maintenance shall include watering, weeding, cultivating, removal of dead material and debris, resetting of trees to upright positions, restoration of earth basins, and such other operations as may be necessary for the health of the planted stock and the general appearance of the landscaped areas. Protection shall include care of the

planted stock from damages resulting from trespass, erosion (including watering), weather, vandalism, disease and the like.

1005.6.1 PRUNING: The CONTRACTOR shall not prune any plant material except under the specific direction of the ENGINEER.

1005.6.2 WATER: The CONTRACTOR shall be responsible for the cost of water during the installation and maintenance of plant material until final acceptance.

1005.7 GUARANTEE:

All plant materials shall be guaranteed to be in a live, healthy, and normal growing condition following the date of acceptance by the ENGINEER through 12 months or one growing season whichever comes first. A growing season shall be defined as May 15 through September 15. Such plant materials that are dead or in an unhealthy, impaired growth condition, shall be replaced by the CONTRACTOR within 10 days after the end of the guarantee period.

1005.8 INSPECTIONS:

1005.8.1 The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made at any time at the discretion of the ENGINEER.

1005.8.2 It shall be the responsibility of the CONTRACTOR to notify the ENGINEER, in writing, 48 hours in advance of each required inspection.

1005.8.3 The sequence of required inspections shall not be changed from the sequence listed below. The CONTRACTOR shall not proceed with work of the next sequence without written approval of the work of the previous sequence. Payment will not be approved for items which have not been inspected and approved in writing.

1005.8.3.1 Inspect plant material at CONTRACTOR'S yard prior to delivery to job site.

1005.8.3.2 Inspect staked locations of material prior to planting.

1005.8.3.3 Inspect material at the job site prior to and during planting.

1005.8.3.4 Inspect at end of maintenance period.

1005.8.3.5 Final inspection of the project and acceptance.

1005.8.3.6 Inspect at end of growing season or 12 months, whichever comes first.

1005.9 MEASUREMENT AND PAYMENT:

1005.9.1 MEASUREMENT: The measurement

shall be made per each size of a particular species of tree, shrub and/or ground cover plant.

1005.9.2 PAYMENT: Payment shall be made at the contract unit price for each size of a particular species of plant as specified in the bid proposal or approved by the ENGINEER, which shall include all materials, equipment and labor required in furnishing and planting the landscape plants.

SECTION 1010
GRASS SODDING

1010 GENERAL

Work under this section consists of preparing all areas for grass sodding indicated on the plans furnishing and installing all sod, fertilizer and soil amendments in accordance with the plans and specifications or as authorized by the ENGINEER.

1010.2 REFERENCES

1010.3 MATERIALS

1010.3.1 GRASS SOD:

1010.3.1.1 Sod shall be a mixture of Olympic or falcon tall fescue and bluegrass unless otherwise specified on the plans. A sample of sod and a written submittal of the seed mix shall be submitted a minimum of 30 days prior to laying of sod. It shall be vigorous, well-rooted healthy turf free from disease, insect pests, weeds, other grasses, stones, and other harmful or deleterious matter.

1010.3.1.2 Sod shall be a cut by an approved mechanical sod cutter to a thickness of not more than 1 3/4 inch, or less than 1 1/2 inch. Sod pieces shall be cut a maximum of 19 inches wide. Handling of sod shall be done in a manner that will prevent tearing, breaking, drying, or any other damage. Sod shall be installed in place on the site not more than 24 hours after cutting.

1010.3.2 FERTILIZER: Fertilizer shall be a granular from starter fertilizer with a guaranteed analysis of 18-24-16.

1010.3.3 ORGANIC AMENDMENTS: Organic amendment shall consist of well aged screened bark fines from coniferous trees as available from Western Agricultural Products Co., or approved equal. Material shall be 1/2" minus with 90% passing a 1/4" screen. Amendment pH shall not exceed 6.5. Salinity shall not exceed 1.5 mnhos/cm. Percentage of organic matter shall not be less than 80% tested by simple combustion.

1010.4 SODDING OPERATION:

1010.4.1 PREPARATION: Prior to start of soil preparation all finish grades shall be established and approved as meeting the requirements of the grading plan. Apply a uniform one inch layer (3 C.Y./1000 square feet) of organic amendment and 4 lbs. of starter fertilizer per each 1000 square feet to the entire area to be sodded. After application of organic amendment and starter fertilizer all areas to be sodded shall be thoroughly rototilled to a minimum depth of 6 inches. After rototilling is

complete at cross directions, drag to an even grade, then roll for firmness.

1010.4.2 INSTALLATION:

1010.4.2.1 Before laying sod, the finish grade shall be brought to a firm, even surface, free from stones or lumps, in excess of one inch diameter, and shaped to provide drainage. The finish grade shall be inspected and approved by the ENGINEER prior to laying any sod.

1010.4.2.2 Lay sod over moistened soil lightly raking the soil ahead of each sod strip. Sod shall be laid across the slope with staggered joints. Pieces shall be fitted together tightly so that no joint is visible, and sod tamped firmly and evenly by hand. After all the sodding has been laid it shall be rolled with a hand roller.

1010.4.2.3 Water all sodded areas immediately after final rolling with a fine spray to a depth of 4 inches. Irrigate by means of the automatic underground irrigation system all sodded areas as often as necessary to promote healthy grass growth until a thick, even stand of grass has been obtained.

1010.4.2.4 Mow the lawn when the grass is over 2 inches tall, keeping lawn mower blades minimum 2 inches high for the first cutting.

1010.4.3 PROTECTION AND MAINTENANCE: Protection and maintenance shall continue for thirty days, or until the entire landscape project is accepted. Sod shall be maintained at a height of 2". The maximum height between cuttings shall not exceed 3". Final acceptance shall only occur after all sod is well rooted.

1010.4.3.1 WATER: The CONTRACTOR shall be responsible for the cost of water during the installation and maintenance of sod until final acceptance.

1010.5 INSPECTIONS:

1010.5.1 The following inspections shall be the minimum required inspections during the course of construction. Additional inspections shall be made any time at the discretion of the ENGINEER or OWNER.

1010.5.2 It shall be the responsibility of the CONTRACTOR to notify the ENGINEER in writing, 48 hours in advance of each required inspection.

1010.5.3 The sequence of required inspections shall not be changed from the sequence listed below. The CONTRACTOR shall not proceed with work of the next sequence without written approval of the

work of the previous sequence. Payment will not be approved for items which have not been inspected and approved in writing.

1010.5.3.1 Automatic irrigation system, if required, shall be installed, tested, and approved.

1010.5.3.2 Each phase of soil preparation shall be inspected in process.

1010.5.3.3 Finish grade shall be inspected.

1010.5.3.4 Sod shall be inspected prior to laying.

1010.5.3.5 Sod shall be inspected after completion.

1010.5.3.6 Sod shall be inspected at end of maintenance period.

1010.5.3.7 Final inspection of the project and acceptance.

1010.5.3.8 Sod shall be inspected 12 months after completion.

1010.6 MEASUREMENT AND PAYMENT:

1010.6.1 MEASUREMENT: The measurement of grass sodding shall be by the square foot or square yard as indicated in the bid proposal.

1010.6.2 PAYMENT: Payment shall be made at the contract unit price per square foot or square yard for grass sodding complete in place, which shall include all material, equipment and labor required in preparation, final grading and fertilizing the area to be sodded, sod, sod placement, watering and maintenance as specified herein.

SECTION 1011
TURF GRASS SEEDING

1011.1 GENERAL:

Work under this section consists of preparing all areas indicated on the plans for turf grass seeding and furnishing and installing all seed, fertilizer and soil amendments as specified herein and on the plans, or as authorized by the ENGINEER.

1011.2 REFERENCES:

1011.2.1 This publication:

Section 1001 Landscaping Irrigation

1011.3 MATERIALS:

1011.3.1 SEED:

1011.3.1.1 Turf grass seed shall consist of Falcon Fescue, Pennfine Perennial Rye, and Adelphi Blue Grass. The mixing ratio of the above listed grasses shall be 1:1:1 by weight. The ENGINEER shall receive all labels from seed bags for verification. Purity of seed shall not be less than 98% and germination shall not be less than 85%.

1011.3.1.2 Each bag of seed shall be sealed and labeled by the seed dealer in accordance with Federal Seed Laws and New Mexico Department of Agriculture Labeling Laws. This includes: variety, kind of seed, lot number, purity, germination, percent crop, percent inert, percent weed (including noxious weeds), origin, test data and net weight. Federal Seed laws require that analysis shall be no older than 5 months for seed shipped interstate and no older than 9 months for seed shipped intra-state.

1011.3.2 FERTILIZER: Fertilizer shall be granular form starter fertilizer with a guaranteed analysis of 18-24-16.

1011.3.3 ORGANIC AMENDMENTS: Organic amendment shall consist of well aged screened bark fines from coniferous trees as available from Western Agricultural Products Company. Material shall be 1/2" minus with 90% passing a 1/4" screen. Amendment pH shall not exceed 6.5. Salinity shall not exceed 1.5 mnhos/cm. Percentage of organic matter shall not be less than 80% tested by simple combustion.

1011.4 SEED BED PREPARATION:

1011.4.1 PREPARATION: Prior to start of soil preparation all finish grades shall be established and approved as meeting the requirements of the grading plan. Apply a uniform 1" layer of organic amendment and 4 lbs. of starter fertilizer per each 1000 square feet to the entire area to be seeded. After application of organic amendment and starter fertilizer all areas to be seeded shall be thoroughly rototilled to a minimum depth of 6 inches. After

rototilling is complete at cross directions, drag to an even grade, then roll for firmness. Before seeding, the finish grade shall be brought to a firm, even surface, free from stones or lumps in excess of one inch diameter, and shaped to provide drainage. The finish grade shall be inspected and approved by the ENGINEER prior to seeding.

1011.5 SEEDING FOR TURF

1011.5.1 GENERAL

1011.5.1.1 The seeding rate shall be 250 lbs. PLS per acre or as shown on the plans. The specific mix shall be uniformly applied over the area to be seeded.

1011.5.1.2 CONTRACTOR'S vehicles and other equipment shall not travel over the seeded areas. If, as determined by the ENGINEER, rain or some other factor occurs over prepared surfaces prior to seeding which prevents seeding to the proper depth, the CONTRACTOR shall again prepare the seed bed without additional compensation.

1011.5.2 TIME OF SEEDING: (SEEDING SEASON) Turf grass seeding shall only be accomplished in the Spring from April 1 through May 30 or in the Fall from August 15 through September 30. If seeding is not accomplished during the "time of seeding" the CONTRACTOR shall accomplish the seeding at the "time of seeding" during the next calendar year. Extension of the CONTRACT to meet the "time of seeding" shall be accomplished at no additional expense to the OWNER.

1011.5.2.1 All soil slopes which have been completed prior to the seeding season shall be seeded immediately after the opening of the current seeding season.

1011.5.2.2 All soil slopes which are completed during the seeding season shall be seeded that same season.

1011.5.3 DRILL SEEDING: All seed shall be drilled in cross directions, where practical, with 50% of the seed applied in each direction. The second pass of the seeder when seeding in cross directions shall be across the slope. In areas where seeding in cross directions is impractical, seeding shall be accomplished by drilling and shall be across the slope. Seed shall be planted approximately 1/4 inch deep, with a maximum depth of 1/2 inch unless otherwise specified on the plans. The distance between the drilled furrows shall not be more than 2 inches. Seeding shall be done with grass seeding equipment in good working order with double disc openers, depth bands, drop tubes, packer wheels or drag chains, rate control attachments, seed boxes with agitators for trashy seed.

1011.5.4 BROADCASTING: The seed will be broadcast by a mechanical spreader at a rate as specified or as indicated on the plans. Seeds shall be to a minimum depth of 1/4" depth and no more than a 1/2 of an inch. Broadcasting shall only be used when specified on the plans and/or approved by the ENGINEER.

1011.6 WATERING

1011.6.1 PERMANENT IRRIGATION SYSTEMS FOR TURF GRASSES: Seeded areas having a permanent irrigation system as specified on the plans will be watered by said system. Watering of the seed will be the responsibility of the CONTRACTOR. All seeded areas shall be watered immediately after completion of seeding, keeping the top two inches of soil evenly moist until seed has uniformly germinated and grown to a height of two inches.

1011.7 PROTECTION AND MAINTENANCE FOR SEEDED TURF: Protect and maintain all turf seeded areas until a dense uniform stand of grass has been established, which shall be defined as when the density of the turf is such that there are no bare areas of soil greater than three inches in diameter and the majority of the seeded area has no bare areas whatsoever. Additionally, the grass shall have been cut a minimum of three times at a height of 2 inches. After completion of second mowing, apply an additional 4 pounds per 1000 square feet of starter fertilizer.

1011.7.1 WATER: The CONTRACTOR shall be responsible for the cost of water during seeding and maintenance of seeded turf until final acceptance.

1011.8 INSPECTION FOR SEEDED TURF GRASSES:

1011.8.1 The following inspections shall be the minimum required inspections to seeded turf grass during the course of construction. Additional inspections shall be made at any time at the discretion of the ENGINEER or OWNER.

1011.8.2 It shall be the responsibility of the CONTRACTOR to notify the ENGINEER, in writing, 48 hours in advance of each required inspection.

1011.8.3 The sequence of required inspections shall not be changed from the sequence listed below. The CONTRACTOR shall not proceed with work of the next sequence without written approval of the work of the previous sequence. Payments will not be approved for items which have not been inspected and approved in writing.

1011.8.4. Automatic irrigation system where required shall be installed, tested, and approved in accordance with Section 1001, if required.

1011.8.5 Each phase of soil preparation shall be inspected in process.

1011.8.6 Finish grade shall be inspected.

1011.8.7 Seed shall be inspected prior to seeding.

1011.8.8 Seeded area shall be inspected after completion.

1011.8.9 Seeded area shall be inspected at the end of the maintenance period.

1011.8.10 Final inspection of the project and acceptance.

1011.9 MEASUREMENT AND PAYMENT

1011.9.1 MEASUREMENT: The measurement of turf grass seeding shall be by the acre.

1011.9.2 PAYMENT: Payment shall be made at the contract unit price per acre of turf grass seeding complete in place, which shall include the seed, fertilized, area preparation, seeding, watering, and maintenance.

SECTION 1012
NATIVE GRASS SEEDING

1012.1 GENERAL:

Work under this section consists of preparing all area indicated on the plans for native grass seeding, furnishing and installing all seed, fertilizer and soil amendments as specified herein and on the plans, or as authorized by the ENGINEER.

1012.2 REFERENCES:

1012.2.1 This Publication:

Section 1011 Turf Grass Seeding

1012.3 WORK AREA/TIMING:

1012.3.1 Areas that are disturbed by the CONTRACTOR that are outside the construction limits shown on the plans or authorized by the ENGINEER shall be seeded with native grasses as specified herein at no cost to the OWNER.

1012.3.2 The seeding of disturbed areas shall commence upon completion of the other work in the area.

1012.4 MATERIALS:

1012.4.1 Native Seed: The native seed species and rate of application shall be as shown below and shall be used based on the type of soil or as specified on the plans or in the Supplemental Technical Specification.

1012.4.1.1 Sandy Soils: (mainly west side areas). Seed rate is given in pounds of pure live seed (P.L.S.) per acre.

<u>Variety/ Common Name</u>	<u>Genus/ Species</u>	<u>P.L.S./Acre</u>
"Paloma" Indian rice grass	Oryzopsis hymenoides	5.0
"Viva" Galleta grass	Hilaria jamesii	1.0
"Niner" Side oats grama	Bouteloua curtipendula	3.0
"Hatchita" Blue grama	Bouteloua gracilis	1.0
Sand dropseed (NM Region)	Sporobolus cryptandrus	1.0
Fourwing saltbush (NM Region)	Atriplex canescens (de-winged)	1.0
Total rate		12.0 lbs/acre

1012.4.1.2 Clay, Clay Loam, and Sandy gravelly clay loam soils: (mainly valley and east side areas). Seed rate is given in pounds of pure live seed (P.L.S.) per acre.

<u>Common Name</u>	<u>Genus-species</u>	<u>PLS/acre</u>
"Paloma" Indian rice grass	Oryzopsis hymenoides	2.0
"Viva" Galleta grass	Hilaria jamesii	2.0
"Niner" Sideoats grama	Bouteloua curti pendula	2.0
"Hatchita" Blue grama	Bouteloua gracilis	3.0
Sand dropseed (NM Region)	Sporobolus cryptandrus	1.0
Four-wing saltbush (NM Region)	Atriplex canescens (de-winged)	1.0

Total rate 11.0 lbs/ac

NOTE: If the area to be seeded is along a recreational trail of any type the seed mixes for either type of soil listed above shall exclude the one (1) pound per acre of Four-wing saltbush. The seeding rate shall be lowered by one (1) pound per acre.

1012.4.1.3 Seeds may be pre-mixed by a seed dealer. Each bag of seed shall be sealed and labeled by the seed dealer in accordance with Federal Seed Laws and New Mexico Department of Agriculture Labeling Laws. This includes: variety, kind of seed, lot number, purity, germination, percent crop, percent inert, percent weed (including noxious weeds), origin, test data and net weight. Federal Seed Laws require that analysis shall be no older than 5 months for seed shipped interstate and no older than 9 months for seed shipped intra-state. The ENGINEER shall receive all labels from all bags of seed used for verification.

1012.4.2 Fertilizer and Soil Amendments: Unless otherwise specified on the plans or in the Supplemental Technical Specification, no fertilizer or other soil amendments are required on areas specified to receive native seeding. If fertilizer and/or other soil amendments are required they shall be in accordance with Section 1011 of these specifications.

1012.4.3 MULCH:

1012.4.3.1 Hay Mulch: Perennial native or introduced grasses of fine-stemmed varieties shall be used unless otherwise specified on the plans. At least 65 percent of the herbage by weight of each bale of hay shall be 10 inches in length or longer. Hay with noxious seed or plants will not be acceptable. Rotted, brittle, or moldy hay will not be acceptable. Marsh grass or prairie hay composed of native grass of species to be seeded will be acceptable. Tall wheat grass, intermediate wheat grass, switch grass, or orchard hay will be acceptable if cut prior to seed formation. Marsh grass hay shall be composed of mid and tall native, usually tough and wiry grass and grass-like plants found in the lowland areas within the Rocky Mountain region. Hay shall be properly cured prior to use. Hay which is brittle, short fibered or improperly cured is not acceptable.

1012.5.2 Straw Mulch: Small grain such as wheat, barley, rye, or oats will not be allowed except by prior approval of the ENGINEER and with the concurrence of the Air Division, Environmental Health Department. Alfalfa or the stalks of corn, maize or sorghum is not acceptable. Material which is brittle, shorter than 10 inches or which breaks or fragments during the crimping operation will not be acceptable.

1012.4.3.3 Gravel Mulch: Gravel mulch shall be crushed or screened gravel 3/4" to 1" maximum size with a minimum of one angular face unless otherwise specified.

1012.4.3.4 Erosion Control Mats, Fabric or Blankets: The type of erosion control mats, fabric or blankets used shall be as specified or allowed on the plans or in the Supplemental Technical Specifications.

1012.5 SEED BED PREPARATION:

1012.5.1 General:

1012.5.1.1 Prior to the starting of any seed bed preparation the final grades of all earth work shall be inspected and approved by the ENGINEER.

1012.5.1.2 No preparation shall be performed when the surface is wet or muddy or when the soil moisture content is such that the soil is not fully loosened by the discing operation.

1012.5.1.3 The extent of seed bed preparation shall not exceed the area on which seeding, mulching and crimping operations can be completed prior to crusting or wind or water erosion of the prepared surface - if erosion, crusting or re-compaction occurs, the affected area shall be re-worked beginning with seed bed preparation. Depth of preparation must be approved by the ENGINEER prior to the seeding and mulching operations.

1012.5.2 Mechanical Preparation: The seed bed shall be loosened to a minimum depth of 6" (six inches) by means of disc or harrow. Area of heavy or compacted soil may require additional preparation such as chiseling or ripping if discing alone does not result in preparation to the full minimum depth of 6". The soil shall be worked to a smooth surface free of clods, stones 4" and larger or any other debris or foreign material that could interfere with seeding or crimping equipment operations.

1012.5.3 Hand Preparation: Areas which cannot be prepared with mechanized equipment because of small size irregular shape or slope angle may be prepared to a minimum depth of 2" using hand tools or a rototiller. Any such areas will be specified on the plans.

1012.6 SEEDING:

1012.6.1 General:

1012.6.1.1 Seeding shall not start until the seed bed preparation has been inspected and approved by the ENGINEER.

1012.6.1.2 No more area may be seeded than can be covered with mulch and crimped, or covered with gravel mulch or erosion control mats by the end of the work day. No seeding operations may be conducted when steady wind speed exceeds 10 miles per hour. If winds exceed 10 mph while seeding is underway, seeding operations will be halted and any areas seeded to that point completed.

1012.6.2 Seed Application:

1012.6.2.1 Drill Seeding: Drill seeding is required unless otherwise specified on the plans or in the Supplemental Technical Specifications. Seed shall be applied with a "rangeland" type seed drill equipped with packer wheels. Seed shall be drilled to a maximum depth of 1/2" unless otherwise specified. Direction of seeding shall be across slopes and on the contour whenever possible.

1012.6.2.2 Broadcast Seeding: Seed may be applied using the broadcast method when size, irregular shape or slope angle exceeding 3:1 prevents the use of a seed drill. Seed may be broadcast by hand or by means of a mechanical seeder provided that the seed is evenly distributed over the seeding area. Areas of broadcast seeding will be hand raked to cover seed. Areas which are broadcast seeded shall be seeded at rate which is double that used for drill seeding.

1012.6.2.3 Seeding With Gravel Mulch: Areas to receive gravel mulch will be seeded at the broadcast seed rate with 1/2 the seed applied prior to application of gravel and 1/2 the seed applied on the surface of the gravel. Water shall be applied in quantity sufficient to wash seed from the surface and into the gravel.

1012.6.2.4 Hydro Seeding: Hydro seeding will not be allowed on areas of non-irrigated native grass seeding unless specified on the plans or in the Supplemental Technical Specifications or authorized by the ENGINEER.

1012.7 MULCHING:

1012.7.1 General:

1012.7.1.1 All seeded areas shall be mulched unless otherwise specified on the plans or in the Supplemental Technical Specifications.

1012.7.1.2 On seeded areas that are level or have slopes 3:1 or less, any of the four (4) types of mulching or erosion control specified herein may be used. On seeded areas that have slopes steeper than 3:1 only gravel mulch or erosion control materials may be used as specified on the plans and in the Supplemental Technical Specifications.

1012.7.2 Hay Mulch: Hay mulch shall be applied at a minimum rate of 1.5 tons per acre of air dry hay.

1012.7.3 Straw Mulch: Straw mulch shall be applied at a minimum rate of 2.5 tons per acre of air dry straw.

1012.7.4 Crimping: Hay and/or Straw mulch shall be crimped into the soil. The mulch shall be spread uniformly over the area either by hand or with a mechanical mulch spreader. When spread by hand, the bales of mulch shall be torn apart and fluffed before spreading. Mulching will not be permitted when wind velocity exceeds 15 miles per hour. The mulch shall be wetted down and allowed to soften for 15 to 20 minutes prior to crimping. A heavy disc such as a mulch-tiller, with flat serrated discs at least 1/4 inch in thickness, having dull edges and the disc spaced 6 inches to 8 inches apart shall be used to crimp (or anchor) the mulch into the soil to a minimum depth of 2 inches or as specified on the plans or the Supplemental Technical Specifications. The discs shall be of sufficient diameter to prevent the frame of the equipment from dragging the mulch.

The crimping operations shall be across the slope where practical but not be parallel to prevailing Westerly winds (270 degrees magnetic). Crimping shall be in a general north-south direction or by tight interlocking "S" curves to avoid straight east-west crimp lines.

If small grain straw mulch is used it shall be crimped in two (2) directions in a cross-hatch pattern.

1012.7.5 Gravel Mulch: Gravel mulch shall be placed by hand or by mechanized equipment that provides full coverage at a uniform thickness of 2 inches in depth.

1012.7.6 Erosion Control Mats, Fabric or Blankets: the type of erosion control mats, fabric or blankets used shall be as specified on the plans or the Supplemental Technical Specifications or as approved by the ENGINEER. The anchoring of the erosion control items shall be as per the manufacturer's recommendations.

1012.8 PROTECTION OF NATIVE GRASS SEEDED AREA:

1012.8.1 GENERAL: The CONTRACTOR shall be responsible for protecting and caring for seeded areas until final acceptance of the work and shall repair at his expense any damage to seeded areas caused by pedestrian or vehicular traffic or vandalism.

1012.9 INSPECTION FOR NATIVE GRASS AREA:

1012.9.1 The following inspection shall be the minimum required inspections to native grass during the course of construction. Additional inspections shall be made at any time at the discretion of the ENGINEER.

1012.9.2 It shall be the responsibility of the CONTRACTOR to notify the ENGINEER, in writing, 48 hours in advance of each required inspection.

1012.9.3 The sequence of required inspections shall not be changed from the sequence listed below. The CONTRACTOR shall not proceed with work of the next sequence without written approval of the work of the previous sequence. Payment will not be approved for items which have not been inspected and approved in writing.

1012.9.3.1 Each phase of soil preparation shall be inspected in process.

1012.9.3.2 Finish grade shall be inspected.

1012.9.3.3 Seed shall be inspected prior to seeding.

1012.9.3.4 Seeded area shall be inspected after completion.

1012.9.3.5 Final inspection of the project and acceptance.

1012.10 MEASUREMENT AND PAYMENT

1012.10.1 MEASUREMENT: The measurement of native grass seeding shall be by the acre.

1012.10.2 Payment: Payment shall be made at the contract unit price per acre of native grass seeding complete in place, which shall include the seed, fertilizer, (if required) area preparation, seeding, soil amendments, (if required) and mulching.

SECTION 1015
TRASH AND LITTER RECEPTACLES

1015.1 GENERAL

Work under this section consists of the furnishing and installation of trash and litter receptacles including the furnishing of all associated labor, equipment and materials in accordance with the plans and specifications.

1015.2 REFERENCES

1015.3 MATERIALS AND EXECUTION

1015.3.1 Each item shall be new and without flaws or defects of any type and shall be the best of their class and kind. Each items shall be of the brand and type as noted in the specifications and on the drawings, or an approved equal.

1015.3.2 Trash receptacles shall be Rinconada III trash receptacles (TR-3329-III) with front-opening fiberglass door or approved equal. Concrete Specifications: 4000 28-day compressive strength (minimum), 4-7% entrained air, mild steel reinforcing as required, polypropylene fiber secondary reinforcing, smooth surface fiberglass forms, integral color as specified on the drawings, finish smooth as cast. Receptacles shall be as manufactured by Materials, Inc., Albuquerque, New Mexico, or approved equal.

1015.3.3 Each item specified is equipment manufactured by specific companies and has been approved by the Landscape Architect and the City of Albuquerque, Parks and General Services, Design Development and Maintenance Divisions. Approved equal equipment or other manufacturers may be used only with the written approval of the Landscape Architect and submittals for approved equal equipment shall be presented no later than five (5) days prior to the opening of the bids.

1015.4 INSTALLATION

Receptacles shall be located as shown on plans or as directed by the Landscape Architect.

1015.5 MEASUREMENT AND PAYMENT

Measurement and payment will be the unit price per each for the class and type required as specified in the Bid Proposal.

SECTION 1200

BARRICADING AND TEMPORARY TRAFFIC CONTROL

1200.1 GENERAL: The work under this section includes, but is not limited to, traffic control standards needed to ensure safety to motorists, the public, construction workers, and special event participants when City roadways are temporarily disrupted due to construction efforts or special events.

1200.2 REFERENCES

1200.2.1 Manual on Uniform Traffic Control Devices, (MUTCD), Part VI, FHWA.

1200.2.3 The American Traffic Safety Services Association (ATSSA), Quality Standards for Work Zone Traffic Control Devices.

1200.2.3 This Publication, Latest Edition

SECTION 19 CONSTRUCTION TRAFFIC CONTROL SECTION 400 TRAFFIC CONTROL

1200.3 BARRICADING STANDARDS

1200.3.1 Before construction begins all traffic control signs and barricades must be installed in accordance with the approved traffic control plan, construction plans, barricading detour plan or as directed by the Construction Coordinator. No construction signing and barricading shall commence until CONTRACTOR is assured that all equipment, manpower, and resources are available to start and complete the work. Where applicable, all signs, barricades, and/or barrels will be moved forward as the construction progresses.

1200.3.2 The name and telephone number of the owner shall be permanently stenciled on all barricades and traffic control equipment. The name and telephone number shall be a non-retroreflective color not over 2 inches in height, and be placed on a non-retroreflective surface of all equipment. Graffiti shall be promptly removed from any all barricades and traffic control equipment. If notified by the OWNER or the Construction Coordination Division, graffiti shall be removed, or the equipment replaced with clean equipment, within four hours or the barricade permit is subject to revocation.

1200.3.3 All advance warning signs approaching a construction zone shall be double indicated (one sign each on left and right sides of approaching traffic) for all multiple-lane roadways with painted or raised medians and where adequate space is available. All double indicated

signs shall be the same size. When a sign is placed in a painted median, especially a two-way continuous left-turn lane, a reflectorized barricade must be placed on the back side of the sign to alert motorists approaching from the opposite direction.

1200.3.4 It shall be the responsibility of the CONTRACTOR to remove all construction barricades, signing, and traffic control devices not required at the end of the working day.

1200.3.5 All advance warning signs shall be a minimum of thirty-six inches by thirty-six inches in size with super engineering grade sheeting or better. On high-speed (posted 45mph and above), rural section roadways where adequate pedestrian space is available, forty-eight inch by forty-eight inch signs is preferred. The use of forty-eight inch signs shall be required at locations as published on a list by the Construction Coordinator. All advance-warning signs not directly applicable shall be removed when not needed, and shall not be left in public right-of-way. All construction signing shall be black on a reflectorized orange field unless otherwise specified.

1200.3.6 Existing posts may be used at some locations, with approval of the ENGINEER. Portable sign supports will be acceptable as an alternate for signs which are to be in place for less than three (3) weeks. The bottom of advance warning signs mounted on barricades or temporary sign supports shall be no less than one foot above the traveled way. All regulatory and advisory signs shall be mounted on sign stands or as otherwise approved by Construction Coordinator. The placement of portable sign supports shall not block or impede pedestrian access. All signs ground mounted on single or double posts shall have the bottom of the sign seven (7) feet above pavement level.

1200.3.7 Barrels and different types of barricades are generally not intended to be intermixed in the same series of channelization. All barrels may have sand or water ballast limited to one hundred (100) pounds. All barricades shall be placed correctly with diagonal stripes sloping downwards in the direction traffic is to pass. Where barricades extend entirely across a roadway, the stripes must slope downward in the direction toward which traffic must turn. Where both right and left turns are provided, the stripes must slope downward in both directions from the center of the barricade or barricades. Where no turns are intended, the stripes must slope downward toward the center of the barricade or barricades.

1200.3.8 The CONTRACTOR shall inspect and maintain all barricades at least once each day except for barricades on or adjacent to arterial and collector streets which shall be checked twice daily, including inspection during hours of darkness. A log of these inspections showing project, location, date, and time shall be kept and a copy sent to the Construction Coordination Division upon request. Upon request, the CONTRACTOR shall immediately produce current traffic control logs. Failure to do so may result in suspension of work or revocation of barricade permit.

1200.3.9 All traffic control devices required within traveled lanes after dark are to be equipped with warning lights. Type (A) flashing warning lights shall be used on all devices which are intended to warn motorists or pedestrians of hazards or obstructions in or near the travel path. Type © steady burn lights shall be used on all devices which are intended to define the travel path. All lights shall be operational. Traffic control devices that are damaged, dirty or have substandard reflectorization shall be immediately brought up to standard. Reflectorized sheeted panels shall not be considered as a replacement for a required warning light. Warning lights shall be incidental to payment for traffic control.

1200.3.10 Equipment and materials are not to be stored within fifteen (15) feet of a traveled lane during non-working hours, unless approved by the Construction Coordinator, which approval cannot be unreasonably withheld.

1200.3.11 CONTRACTOR shall provide and maintain a safe and adequate means of channelizing pedestrian traffic around all work areas throughout the periods of construction. All such channelization shall be arranged to prevent pedestrians from having to enter the roadway in order to pass around the work area. Where required, pedestrian detour signs will be installed by the CONTRACTOR. Where construction impedes or obstructs sidewalk access, CONTRACTOR shall barricade sidewalks and place "Sidewalk Closed" signs accompanied with the appropriate pedestrian detour signing. Pedestrian detour signs shall be incidental to payment for traffic control.

1200.3.12 CONTRACTOR shall provide and maintain a safe and adequate means of channelizing bicycle traffic around all work area throughout the periods of construction when existing bicycle trails, lanes, or routes are designated. Where possible, adequate space for bicyclists must be provided, and bicycle detour signs, including "Share the Road" signs shall be installed. When adequate space is not available to provide for bicycle access, the bicycle facilities shall be adequately detoured around the construction site. The detour route shall minimize out-of-direction travel

distance, and shall be adequately signed and directed. Bicycle detour signs shall be incidental to payment for traffic control.

1200.3.13 All barricades, signs, and traffic control equipment shall be properly and adequately ballasted for normal wind loads. For equipment placed for extended periods (seven days or more), or during the months of February through May, additional ballast shall be required.

1200.3.14 The use of roll-up advance warning signs is allowed, so long as the reflectivity required in the MUTCD is provided. Such signs shall be adequately braced to resist rotation under normal wind loads.

1200.3.15 The use of orange warning flags mounted atop construction warning signs is encouraged and is required in certain instances. Flags mounted atop construction signs is required on all "Reduced Speed Ahead (R2-5a)" signs, "Reduced Speed (R2-5b and R2-1)" signs, all "Double Fine Zone" signs, "Road Closed Ahead (W20-3)" signs, "Detour Ahead (W20-2)" signs, "Flagger Ahead (W20-7)" signs, "Flagger Symbol (W20-7a)" signs, and "Be Prepared to Stop (W20-7b)" signs.

1200.3.16 Cones are an acceptable traffic control device under certain situations. Traffic cones are not to be used to separate traffic traveling in different directions. All cones must be a minimum of 28 inches tall. The use of cones as traffic control devices is not allowed during nighttime hours; however if used, all cones used at night must include white, reflectorized bands per MUTCD standards. The use of cones is encouraged for daytime moving closure operations, projects in duration of two hours or less, and special events.

1200.3.17 Type III barricades must be used at all road closures. Multiple type III barricades of the same configuration placed next to each other in the same direction is allowed. A type III barricade or illuminated arrow panel must be used for each lane closure. A minimum of two feet of exposed railing is required on the traveled side (open lanes) of type III barricades. The minimum length of type III barricade for each lane closure is eight (8) feet per lane twelve (12) feet or less in width, and the minimum length of type III barricade required for a sidewalk closure is four (4) feet. The minimum length of type III barricades for a double lane closure is sixteen (16) feet. Additional barricades above the minimum required may be required to fill in gaps for wide lanes, multiple lane closures, or shoulder areas.

1200.3.18 Road closures shall be pre-warned by the use of a "Road Closed to Through Traffic" (R11-4) sign, where appropriate. These signs shall be placed at intersections approaching the road closure with appropriate detour

signing. When mounted on a three rail barricade support, the maximum width of sign support shall be six feet. If the detour route is more than one intersection before the road closure, then additional R11-4 signs shall be placed at each intersection between the detour route and the road closure. "Road Closed to Through Traffic" signs are encouraged to be placed on or near the center of the roadway, but R11-4 signs shall not be placed in an area that block sight distance for motorists and pedestrians. Where sight distance becomes a problem, low-volume intersections may be temporarily converted to a four-way Stop condition, with the approval of the Construction Coordinator.

1200.3.19 Illuminated arrow panels with a minimum size of 32 square feet may be used in lieu of type III barricades for lane and roadway closures. Arrow panels must be battery or solar powered. The use of diesel, or other noise generating power sources, is not allowed. For roadways with a previously posted speed limit of 35 mph or higher, the use of arrow panels is required for all lane closures. An arrow panel is required for each lane reduction, but is not required for shifting tapers. In residential areas where the arrow panel will be used at night, directional lighting limited to 30 degrees or less must be used to reduce glare into nearby properties. When illuminated arrow panels are used for a lane closure, then the use of vertical panels at the regular MUTCD minimum spacing for the lane reduction taper is allowed.

1200.3.20 For work expected to last one hour or less and for moving closures, reduced barricading may be allowed as approved by the Construction Coordinator. Reduced barricading on arterial or collector roads shall consist of a minimum of one advance warning sign, a minimum of a three barricade or cone taper, and an illuminated arrow panel.

1200.3.21 For emergency utility work on arterial or collector roadways, the CONTRACTOR must notify the traveling public. If a variable message board is not required by the Construction Coordination Division, a "Utility Emergency Ahead" sign must be installed for each direction of arterial / collector traffic approaching the work site. The "Utility Emergency Ahead" sign must be placed in addition to, and preceding, the three normally required advance warning signs at the same spacing required in the MUTCD for advance warning signs.

1200.3.2 Double fine zones shall be delineated by the use of "Double Fine Zone" signs as outlined in this section. Double fine zones shall be delineated for construction zones and construction curtilage zones at the request of either the City's Construction Coordinator or a uniformed Officer of the Albuquerque Police Department's Traffic Division with a rank of Sergeant or higher. In addition, double fine zones

are required on all arterial / collector roadways where there is a: 1.) reduced speed limit; 2.) lane reduction; 3.) reduced design speed; or 4.) traffic hazard. Double fine zones are required for all flagging operations, and work zones with an imminent danger to workers, regardless of the roadway classification. The beginning of the double fine zone shall be clearly marked with a sign stating: "Construction- Begin Double Fine Zone". The end of the double fine zone shall be clearly marked with a sign stating: "Construction- End Double Fine Zone". If the double fine zone extends beyond one-half mile in length, intermittent signs must be placed no more than one-half mile apart stating: "Construction - Double Fine Zone". Additional intermittent signs are needed following side street entrances. Details for the double fine zone signs are on file with the Construction Coordinator. Placement of the Begin Double Fine Zone sign shall be immediately following the "Road Work Ahead" sign. Placement of the End Double Fine Zone sign shall be immediately preceding the "End Road Work" sign.

1200.3.23 On arterial or collector roadways with multiple lane closures, the advance warning signs shall indicate the correct number of lanes closed. Arrow panels are required for each lane closure of multiple lane closures on arterial or collector roadways, regardless of the previously posted speed limit.

1200.4 CONFLICTS WITH EXISTING SIGNING, STRIPING, AND SIGNALS

1200.4.1 CONTRACTOR shall not remove, realign, or adjust any official City traffic control device including stop signs, warning signs, or any other traffic or parking control signs, unless approved by the OWNER. CONTRACTOR shall give the OWNER three (3) working day's prior notice of any official City traffic control device that needs to be moved. The OWNER shall take all appropriate actions as soon as practical thereafter. When CONTRACTOR places regulatory signing reducing the posted speed limit as approved by the OWNER, the CONTRACTOR must temporarily cover any and all conflicting speed limit signs. Such covers must be immediately removed once the temporary speed limit reductions are removed.

1200.4.2 The CONTRACTOR is responsible for obliteration of any conflicting striping and responsible for all temporary striping. For temporary situations lasting seven days or less, conflicting pavement markings may be addressed with the proper use of channelization devices and signing, unless otherwise approved or required by the Construction Coordinator.

1200.4.3 When the construction activity or traffic detouring plans result in less than two signals being visible

in any direction at a signalized intersection, additional temporary traffic signals shall be required. A minimum of two signals must be visible within a twenty degree horizontal and vertical cone of vision, as measured from the stop bar for each lane approaching a signalized intersection.

1200.5 STREET AND LANE CLOSURES

1200.5.1 CONTRACTOR shall maintain access to all public and private facilities adjacent to the construction area at all times, including businesses and/or residents. When denying access is unavoidable, CONTRACTOR must coordinate access restriction to times and locations that are reasonably convenient to the property owners and/or residents affected. CONTRACTOR shall construct and maintain access roads, including paved ramps, where deemed necessary by ENGINEER to maintain traffic flow. Business access signs may be required to direct traffic to existing businesses, as directed by ENGINEER or OWNER. No more than three businesses shall be placed on a single sign. In areas of multiple adjacent businesses, only generic "Business Access Only (arrow)" signs are required. For shopping centers with multiple business tenants, the name of the shopping center shall be placed on a sign at each access location. Access signs shall have 5 inch high, white letters with a directional arrow on a reflectorized blue background. Business access shall be rectangular in shape, no taller than wide, and shall be no larger than four feet wide by three feet tall. Business access signs shall not be placed where they block sight distance for either motorists or pedestrians.

1200.5.2 CONTRACTOR shall notify the following services forty-eight (48) hours in advance of any complete street or access closures: Police Department, Fire Department, U.S. Postal Service, Solid Waste Department, Ambulance Services, local schools, and the Transit Department. The CONTRACTOR shall also notify all businesses and residents directly affected by the road closure. For the total closure of arterial or collector roadways, a variable message board must be installed for a minimum of two days prior to the road closure notifying motorists of the dates and times for the closure. A minimum of one variable message board is required for each direction of closure. For the total closure of a local roadway, a sign must be installed for a minimum of two days prior to the

road closure notifying motorists and residents of the dates and times of the closure. A minimum of one sign is required for each direction of closure.

1200.5.3 The CONTRACTOR shall be responsible, and shall make appropriate accommodation, for garbage and trash collection, mail delivery, and other essential services needed by residents and businesses affected by CONTRACTOR operations. This effort shall include coordination with U.S. Post Office, City Solid Waste Department, and other agencies. Where required, CONTRACTOR shall notify all residents in writing at least two days prior. Such notice shall include at a minimum: dates and times of construction activities and the name and telephone number of the CONTRACTORS contact person. CONTRACTOR shall collect all trash and garbage in the project area and deliver to an accessible location for collection by 7:00 a.m. on the designated trash collection day. Such trash and garbage cannot be deposited onto private property, must not block access, and shall be immediately cleaned up by CONTRACTOR upon pick up by the Solid Waste Department or private trash collection company.

1200.5.4 Total or partial closure of some streets may be restricted to certain hours of the day by the OWNER. Streets having working hour limitations may be noted on the approved construction plans. In cases of emergency work or permit work, streets having working hour limitations will be designated by the Construction Coordinator. Waivers of the working hour limitations can be obtained from the Construction Coordinator with the concurrence of the ENGINEER.

1200.5.5 If construction on streets with working hour limitations is expected to extend past the allowed working hours, plating of the trench and/or temporary asphalt concrete pavement shall be provided so that the roadway is opened to traffic within the allowable work hours. Such excavations must be plated, temporarily patched or resurfaced prior to opening to traffic. A minimum width of 11 feet for each lane of traffic shall be provided, unless otherwise directed by the ENGINEER.

1200.5.6 When detouring low and moderate-volume traffic onto a previously unpaved area, see Table 1200.1 for surfacing requirements.

Table 1200.1

Time	Shoulder Residential	Shoulder (Other)	Local Residential /	Major Local	Collector	Arterial
Under one day	Compacted Subgrade	Compacted Subgrade	Compacted Subgrade	Compacted Subgrade	Gravel or millings	Gravel or millings
1-3 days	Compacted Subgrade	Gravel or millings	Gravel or millings	Gravel or millings	Treated Millings	2" Asphalt
4-7 days	Gravel or millings	2" Asphalt	Gravel or millings	Treated Millings	2" Asphalt	2" Asphalt
8 - 30 days	Treated Millings	2" Asphalt	Treated Millings	2" Asphalt	4" Asphalt	4" Asphalt

Table Notes:

The contractor shall be responsible to continually maintain all detours, providing a smooth, drained, and safe roadway surface. All compacted subgrade areas shall be graded regularly to provide a smooth driving surface, and must be treated regularly with water or other approved dust control palliative. During periods of dry and/or windy weather, a water truck must be on-site at all times, and frequent watering may be necessary.

Gravel, millings, or treated millings must be bladed and compacted to provide a stable, smooth driving surface prior to opening to traffic. Such surfacing shall be regularly maintained to provide a smooth and stable driving surface. All temporary asphalt pavement shall be placed upon a compacted subgrade which shall be graded to drain. Treated millings includes millings stabilized with an applied emulsive asphalt.

1200.6 MEASUREMENT AND PAYMENT

1200.6.1 Measurement and payment for barricading and temporary traffic control shall be per lump sum per project except for the items listed below. Payment of additional items will only be made if such traffic control device or services is either approved in the construction plan set or requested by the OWNER in writing. Payment shall include the cost of obtaining all permits and approvals; preparation of traffic control plans; working restricted or extended hours when required; notification to all affected residents, businesses, agencies, or other public contacts; setting and resetting barricades, maintaining barricades, daily removal of barricades when required, flagman operations when required, installation of temporary traffic signals when not required by the OWNER or in the construction plans; coordination with Traffic Operations on traffic signal re-timing; hiring of off-duty APD Officers; and any and all other costs associated with temporary traffic control except the following:

1200.6.1.1 Measurement and payment of the installation of temporary striping shall be made per lineal foot of striping installed per four inch wide.

1200.6.1.2 Measurement and payment of business access and special signs shall be made on a per square foot basis project duration.

1200.6.1.3 Measurement and payment of Variable Message Boards shall be made per each on a per day (24-hour period) basis.

1200.6.1.4 Measurement and payment of illuminated arrow boards required by the OWNER, or required in the construction plans, shall be made per each on a per day (24-hour) basis.

1200.6.1.5 Measurement and payment of temporary wall barrier shall be made per lineal foot of wall barrier installed and removed at each location per project.

1200.6.1.6 Measurement and payment for temporary traffic signals required by the OWNER, or required in the construction plans, shall be made per each per project duration at each location.

SECTION 1500
MISCELLANEOUS ITEMS

1500.1 GENERAL

This section contains construction activities that are considered minor in nature as compared to the activities in other sections.

1500.2 CONTENTS

<u>Section No.</u>	<u>Title</u>
1501	Monuments
1502	Submittals

SECTION 1501

MONUMENTS

1501.1 GENERAL

This work shall consist of furnishing and installing precast portland cement concrete right-of-way monuments and either precast or cast-in-place survey monuments at the locations shown on the plans or directed by the ENGINEER and as specified in these specifications and the Supplementary Specifications. Monuments shall conform to the dimensions and details on the drawings.

1501.2 REFERENCES

1501.2.1 This Publication

Section 101

1501.3 MATERIALS

The concrete portion of monuments shall be constructed in accordance with the provisions in Section 101. Marker plates, as approved by the OWNER and shown on the plans, for survey monuments will be furnished by the CONTRACTOR unless otherwise specified in the Supplementary Specifications.

1501.4 CONSTRUCTION

In constructing precast monuments, the forms shall not be removed until after the concrete has hardened. Monuments that are warped will be rejected. The exposed surface of the finished monuments shall be uniform, of even texture, and shall be free from holes, cracks, and chipped edges. The precast monuments shall not be transported to the work site until the concrete has cured. Survey monuments may be cast-in-place in drilled holes without the use of forms. The size shall be 12 inches in diameter and 3 feet in depth. Marker plates shall be placed in survey monuments before the concrete block has acquired its initial set and shall be firmly bedded in the concrete. The concrete block shall be so located that, when the plate is inserted, the reference point will fall within a 1/2 inch circle in the center of the plate. The marker plates shall be stamped with the appropriate elevation above sea level and the coordinates of the point, if applicable, or as required by the ENGINEER.

1501.5 INSTALLATION

All monuments shall be set firmly and vertically in the ground to a depth of at least 3 feet. The tops of survey monument covers, where required, shall be set flush with the ground line or pavement surface, whichever applies. The monuments shall be set in position after paving; the space around them shall be filled with earth free from rock. The filling material shall be

watered and tamped into place in such manner as to hold the monument securely in position. Pavement or concrete surfaces adjacent to monuments that have been removed for the setting of monuments shall be restored to match existing contiguous surfaces and in a manner satisfactory to the ENGINEER. The CONTRACTOR shall furnish reproducible drawings to the City of Albuquerque showing reference survey monuments as marked on curbs or otherwise located.

1501.6 MEASUREMENT AND PAYMENT

Measurement and payment will be the unit price per each for the class and type required as specified in the Bid Proposal.

SECTION 1502
SUBMITTALS

1502.1 GENERAL

The requirements of this section of the specifications consist of furnishing all manufacturer's data, shop drawings, samples, certifications, guarantees, reports, operation manuals, maintenance manuals, lubrication charts, spare parts lists, special tools and factory representative required for installation of special items, in strict accordance with the specifications and the applicable drawings, and subject to the terms and conditions of the contract.

1502.2 SUBMITTAL CHECK LIST

The Submittal Check List that will be part of the Supplemental Specifications on each project, lists items which will be required to construct the project for which submittals will be required by the ENGINEER. The list of submittals is for the convenience of the CONTRACTOR and supplier, and should not be considered as the complete and final requirements. Additional submittals and material may be required by the ENGINEER as project progresses.

1502.3 WHAT TO SUBMIT

1502.3.1 The following is an explanation of what to submit if indicated on the check list.

A. Manufacturer's Data: Any catalog type literature on the item.

B. Shop Drawings: Detail drawings with all dimensions and locations shown.

C. Samples: The item that will be supplied.

D. Certifications: Any certifications required by these specifications or standard specifications and/or requirements for that item, to cover raw materials and testing of the final product.

E. Guarantees: A copy of the guarantee to be given to the Owner on that item.

F. Lab Test Reports: Laboratory test reports required to show that the item meets all specified requirements.

G. Operation Manuals and Maintenance Manuals: The manufacturer's standard Operation and Maintenance Manuals on that item.

H. Special Tools: A list of special tools required to operate and maintain that item and the number of each tool the manufacturer will supply.

I. Lubrication Charts and Grease Specs: A list of all lubrication points on that item

with frequency and type of lubricant to be used at each point.

J. Spare Parts List: A list of spare parts that the manufacturer recommends the Owner maintains.

K. Factor Representative: A factory representative will be required to be present for installation and/or start-up of that item of equipment.

L. Field Test Reports: The field test reports are reports and/or tests that have been conducted on the item in an existing installation over a period of time.

M. Pump and Blower Curves: Certified curves based on the test performance of each pump or blower to be installed on this project.

N. Load Design: Load design calculations shall show the maximum load the item can carry under the support conditions shown on the drawings for both uniform and concentrated loads. These calculations shall be under a registered professional engineer's signature.

O. Additional literature, reports and/or tests may be required by the ENGINEER.

1502.3.2 When pumps of any type are part of the project, in addition to the other information required on pump submittals the CONTRACTOR shall submit the following data for each unit of pumping equipment.

- A. Name of manufacturer.
- B. Type of pumps.
- C. Number of stages and speed.
- D. Diameter of impeller.
- E. Type of bearings.
- F. Size of suction and discharge piping and barrel.
- G. Type of thrust bearing.
- H. Shut-off pressure.
- I. Impeller material.
- J. Pump shaft material and diameter.
- K. Capacity and head.
- L. Make and type of motor.
- M. Horsepower of motor with proper NEMA Standard insulation.
- N. Type of motor bearings.
- O. Net weight of complete unit.
- P. Guaranteed KWH required to pump 1,000 gallons against the required head.
- Q. Discharge column:
 - Material
 - Weight per foot
 - Type of Joint
 - Spacing of joints
 - Inside diameter
- R. Line shaft:
 - Material
 - Diameter
 - Length of sections

- S. Line Shaft Bearing:
 - Length
 - Spacing
 - Type
 - Material
- T. Thrust Bearing:
 - Complete computations on thrust conditions.
 - Computed pump thrust at shut-off.
 - Computed pump thrust at operating condition.
 - Rated bearing capacity.
 - Manufacturer.
 - Method of cooling.
 - Weight of bearing.
- U. Combined overall efficiency of pump and motor when operating at rated condition.
- V. Does equipment offered differ from specification requirement?
- W. Do catalogs, descriptive literature, etc., covering all equipment accompany the bid?

SUBMITTAL CHECK LIST

SUBMITTALS FOR		ITEM DESCRIPTION
		Manufacturer's Data
		Shop Drawings
		Samples
		Certifications
		Guarantees
		Lab Test Reports
		Operation Manuals
		Maintenance Manuals
		Special Tools
		Lubrication Charts & Grease Specs.
		Spare Parts List (Recommended)
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SECTION 2000

STANDARD DETAIL DRAWINGS

2000.1 GENERAL

2000.1.1 This section contains City of Albuquerque Standard Detail Drawings which are related to the construction or installation of City utilities, streets, drainage improvements, paving cuts and repairs, landscaping and certain private facilities within a right-of-way or easement

2000.1.2 These details are not required to be included in a project set of construction drawings if the individual details are properly referenced on the plan set. If a particular project design warrants additional details or modification of these details, they shall be included in the project's construction plans.

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2200	Standard Details for Drainage
2300	Standard Details for Water
2400	Standard Details for Paving
2500	Standard Details for Traffic
2600	Standard Details for N.M.S.H.T.D.
2700	Standard Details for Landscaping
2800	Standard Details for Temporary Traffic Control

SECTION 3000

BIBLIOGRAPHY

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3000.1.1 Each section within Sections 100 thru 1500 has a Subsection, titled, "References", wherein the numbered references are listed. Also a Standard Detail Drawing may note a particular reference by number. To assist in identifying the subject specification, this Bibliography lists numerically the reference numbers with their titles according to reference organization or group, i.e., ASTM, AASHTO, etc. In addition the Section where the reference is used will be shown.

3000.1.2 To maintain a currency of this publication, it shall hereby be understood that each reference shall be the most recent issue, addendum, or revision of that particular reference.

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3004	Collective Reference Groups
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