Central Avenue to Interstate 40 Bosque Trail Improvement Project: 2015 Post-Construction Environmental Monitoring Report

Prepared for

City of Albuquerque, Open Space Division

Prepared by

SWCA Environmental Consultants

January 2016

CENTRAL AVENUE TO INTERSTATE 40 BOSQUE TRAIL IMPROVEMENT PROJECT: 2015 POST-CONSTRUCTION ENVIRONMENTAL MONITORING REPORT

Prepared for

CITY OF ALBUQUERQUE
OPEN SPACE DIVISION

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EXECUTIVE SUMMARY

The City of Albuquerque (City) began construction on the Rio del Norte Bosque Trail (trail), completing trail and other improvements between Central Avenue and Interstate 40 in February 2015. Trail construction included leveling the soil surface to a consistent 6-foot width and placing an aggregate base course. The base course was covered with stabilized crusher-fine gravel which was compacted to provide visitors with a level and safe surface for hiking, running, biking, and horseback riding. The City also added signs for geographic directions and for appropriate visitor use, as well as dog waste collection bags and disposal stations at the trailheads. SWCA Environmental Consultants (SWCA) completed soil surface, vegetation, and bird assemblage post-construction monitoring measurements in August 2015 along the same section of the trail that was constructed in February 2015. Soil measurement data showed no significant effects of the trail improvement to human-caused soil surface disturbances. Vegetation measurements showed no significant effects of trail construction on trail-side vegetation or vegetation 30 m away from the trail. Trees and shrubs in vegetation transects were dominated by exotic species; the herbaceous vegetation was co-dominated by native species and exotic weeds. Evaluation of repeat photo point photographs was consistent with the soil and vegetation measurement data, showing no effects of the trail construction on vegetation at trail-side or away from trail control locations. Breeding bird surveys conducted in May, June, and July 2015 showed no differences in bird species assemblages along the trail after construction in February, compared to control transects on the opposite side of the Rio Grande in the absence of construction. SWCA also established repeat photo points along with paired non-trail photo points 30 m away from the trail, every 100 m from Central Avenue to Interstate 40. Those 100-m trail photo points will be used to evaluate environmental change along the entire length of the trail into the future, in addition to the soil, vegetation, and bird sampling plots and transects.

Findings for soils, vegetation, and birds were similar to the pre-construction baseline measurement findings in 2014 (SWCA 2015). The City also closed and began restoration (native vegetation plantings) of some unofficial visitor-created side trails that were causing environmental damage to the bosque (trampling of soil and vegetation and disturbance of wildlife). SWCA began repeat photo point monitoring of soil surfaces and vegetation composition and structure of those closed and restored side trails. In summary, trail construction in 2015 had no detectable effects on trail-side soils, vegetation, or birds. These findings are based on trail monitoring evaluation criteria established in 2014 that determine whether trail construction and subsequent visitor use would have measureable positive or negative impacts to soils, vegetation, and birds. SWCA will continue the same monitoring measurements in 2016. The information obtained from this environmental monitoring will be applied to an adaptive management process by the City to adjust the project as needed to achieve its goals without causing adverse environmental impacts.

The City proposes to continue trail improvements from Interstate 40 to Campbell Road in 2016. SWCA conducted an environmental assessment of the potential environmental impacts of six proposed alternatives for this proposed work, which is presented in this report. SWCA concluded that, of the City’s proposed alternatives, Alternatives 2A – 2D would result in the least potential negative environmental impacts while providing the most positive environmental outcome for that portion of the Rio Grande Valley State Park bosque.

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1 INTRODUCTION

The City of Albuquerque (City) began improvements on the Central to I-40, Rio del Norte Bosque trail (trail) within the Rio Grande Valley State Park (RGVSP) in Albuquerque, New Mexico, in February 2015. Construction consisted of leveling the soil surface of the existing trail to a width of 6 feet and placing a base course of aggregate. Stabilized crusher-fine gravel (rock material 0.64 cm [0.25 inch] in diameter or smaller) was then placed on the prepared surface and compacted to provide a uniform and firm trail tread. Figure 1.1 shows the newly surfaced trail near Central Avenue. Information signs for visitors were added (Figure 1.2 and Figure 1.3) along with dog waste disposal stations (Figure 1.4). Vegetation restoration also was initiated along the trail with plantings of native shrubs and grasses. Additionally, several unofficial side trails were closed (Figure 1.5), and some those closed trails were seeded with native grass and plantings of native shrubs (Figure 1.6). SWCA Environmental Consultants (SWCA) measured soil surfaces, vegetation, and bird communities in the spring and summer months following the trail improvement treatments. This was part of an environmental monitoring effort begun in 2014, and also when SWCA prepared and submitted a report to the City that provided background environmental information on the Middle Rio Grande bosque, along with findings of the baseline environmental study along the proposed trail alignment from Central Avenue to Montaño Boulevard (SWCA 2015). In that study, SWCA found no indications that the proposed trail improvement project would negatively impact any environmentally sensitive habitats or special status plant or animal species, and that the entire project area was already considerably disturbed by human activities. Existing disturbance included human alteration of the Rio Grande bosque, resulting from changes to Rio Grande flow regimes from dams and levees, the establishment of exotic and invasive plant species, previous exotic tree removal and mastication of woody materials, and soil impacts from visitors both on and off the trail.

Figure 1.1. The Rio del Norte Bosque Trail about 0.25 mile north of Central Avenue. Note the crusher fine gravel surface and approximate 6-foot width of the newly leveled and surfaced trail. SWCA photograph, October 2015.

Figure 1.2. Trail sign identifying official trails to visitors. SWCA photograph, October 2015.

Figure 1.3. Trail sign requesting visitors to share the path with horses, people with disabilities, bicycles, pedestrians, and dogs. SWCA photograph, October 2015.

Figure 1.4. Example of a dog waste disposal station and plastic bag dispenser at the head of the Rio del Bosque Trail at Interstate 40. SWCA photograph, October 2015.

Figure 1.5. Example of an unofficial visitor-created unofficial side trail that was closed for restoration. SWCA photograph, October 2015.

Figure 1.6. A New Mexico olive shrub (upper left foreground) and grass seedlings (lower right foreground to upper center) planted along a closed unofficial side trail in 2015. SWCA photograph, October 2015.

SWCA conducted baseline pre-construction measurements of soils, vegetation, and birds in 2014 from Central Avenue to Montaño Boulevard (SWCA 2015), but the timing and the spatial extent of upcoming 2015 construction was uncertain (potentially occurring in the spring of 2015 from Central Avenue to Montaño Boulevard, or some portion of that distance). The trail improvement plan was finalized and slightly modified by the City in January 2015 following a public comment period. Rather than completing trail improvements from Central Avenue to Montaño Boulevard in one phase, the project was partitioned into three annual phases. Phase I called for main trail improvements and amenities from Central Avenue to the Atrisco Siphon in February 2015, Phase II from the Atrisco Siphon to Interstate 40 (I-40) in early 2016, and Phase III from I-40 to Campbell Road in early 2017. Phase IV from Campbell Road to Montaño Boulevard remained an option with no planned construction date. Figure 1.7 shows the locations of the different phases planned in January 2015.

In February 2015, the City completed both Phase I and Phase II from Central Avenue to I-40. The actual construction in February 2015 took a slightly different route, leaving the existing Rio del Norte Riverside Trail as it was (with the addition of information signs), and instead improving an interior route from Central Avenue to the intersection with the riverside trail. Other improvements were made near the Rio del Norte Picnic Area, and several unofficial side trails between Central Avenue and I-40 were closed (Figure 1.8). Parking areas at Central Avenue that were planned to be improved in 2015 were not improved, so evaluations of parking area improvements were not performed by SWCA in 2015. SWCA conducted post-construction measurements of birds in May, June, and July of 2015, and soil and vegetation measurements in August 2015. Since the new construction schedule resulted in trail improvements only between Central Avenue and I-40 in 2015, SWCA limited 2015 post-construction monitoring measurements to the trail area between those two points. Three pairs of 2014 baseline survey soil and vegetation plots and bird transects (transects 1, 2, and 3) were in place between Central Avenue and I-40, and one of those three existing plot/transect sites (transect 1) was along the Rio del Norte Riverside Trail that originally had been planned for improvement, but was not improved. SWCA installed an addition set of three new paired plots/transects in 2015 to provide more robust data for comparisons of trail treatments to control locations between Central Avenue and I-40 (transects 0a, 1, 2a, and 3a). Plot and transect pair 0a also was established along the Rio del Norte Riverside Trail that was originally planned to be improved, but along with site 1, both of these sites were not improved and were not measured in 2015. Instead, sites 0a and 1 were moved east to the Rio del Norte Bosque Trail that was improved for continued monitoring. All six of the plot/transect pair locations that were measured in 2015 for post-construction data are shown in Figure 1.8.

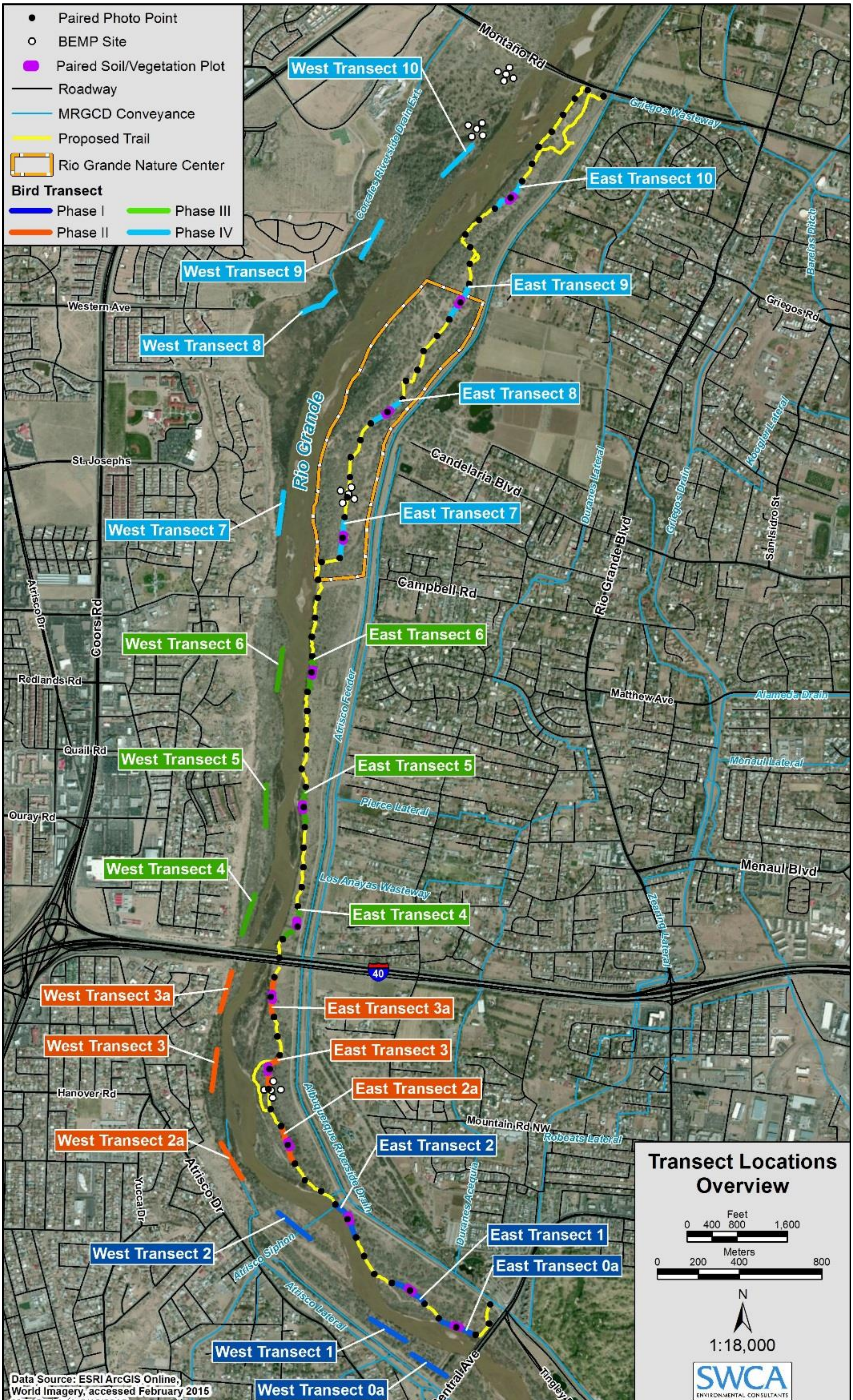

Figure 1.7. Map of the original trail improvement plan provided to SWCA by the City in early 2014, between Central Avenue and I-40. Note new soil and vegetation plots and bird transects 0a, 2a, and 3a that SWCA added in 2015 to the baseline plots and transects installed in 2014 to increase sample sizes for Phases I and II.

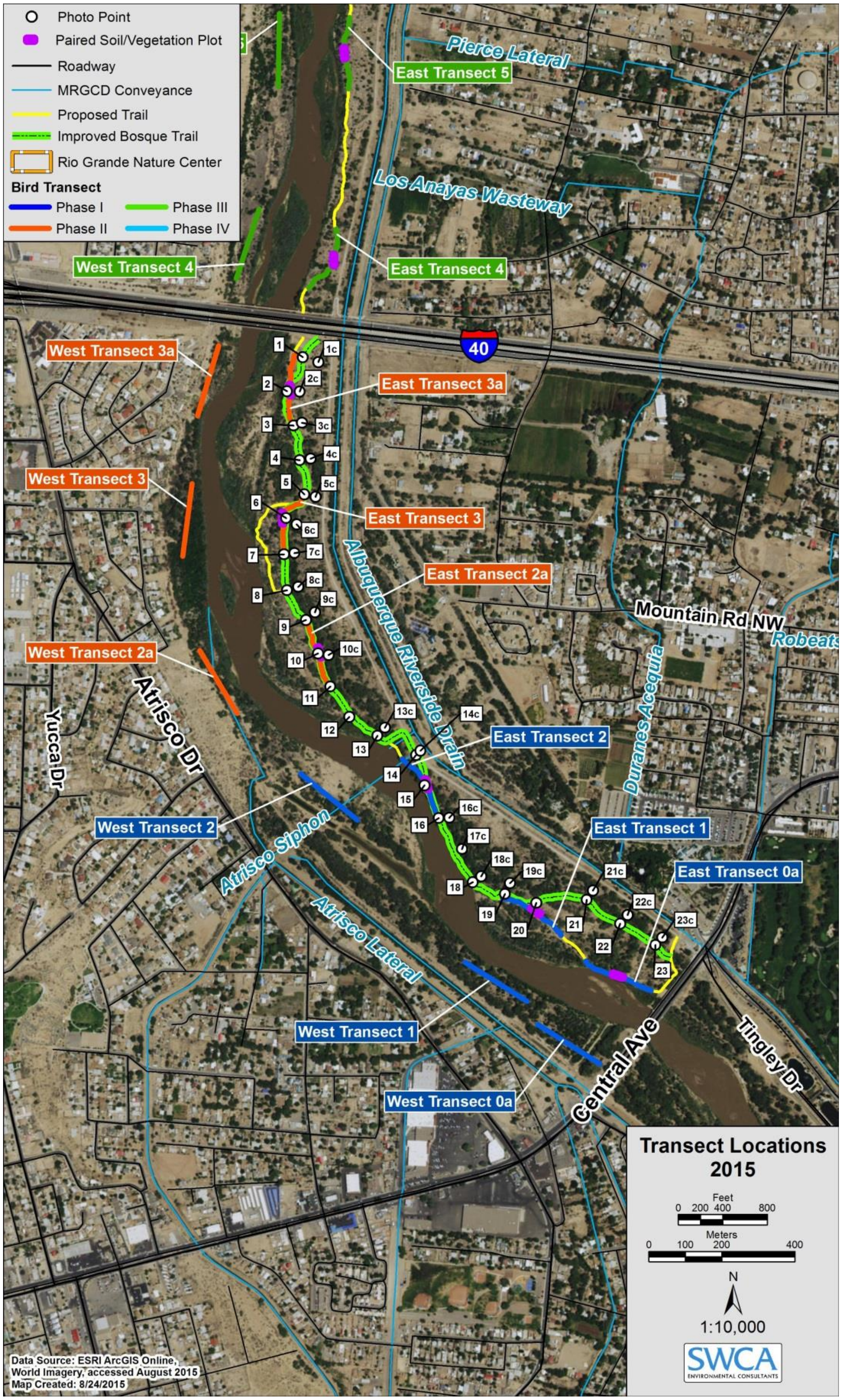

Figure 1.8. Map of the final and implemented trail Phases I and II showing the actual route of the trail construction implemented by the City in February 2015 (green). Note how the trailhead section at Central Avenue differs from that planned in 2014 (yellow).

This report presents findings on the status of soils, vegetation, and birds following Phase I and II trail improvements in early 2015 between Central Avenue and I-40. The primary purpose of this report is to provide information on how trail improvements in 2015 affected trail-side soils, vegetation, and birds. The following text (Sections 1.1. and 1.2 below) was presented in the SWCA baseline report (SWCA 2015) and is again presented here to provide context for the environmental monitoring approaches.

1.1 POTENTIAL ENVIRONMENTAL IMPACTS

The trail improvement project is intended to manage the bosque environment by keeping visitors (including pet dogs) along a main trail route that will be constructed to accommodate many visitors, while at the same time keeping visitors out of the surrounding bosque away from the trail to prevent further degradation of soils, vegetation, and disturbance to wildlife. This type of trail management is common to parks and other public recreation lands and wildlife refuges. Evaluation of the project requires comparisons of potential impacts against potential benefits from the project over an adequate period of time. The primary anticipated environmental impacts of the trail enhancement will be

1. During the construction/improvement phase (e.g., trucks, noise and activity),
2. Post-construction impacts by visitors (e.g., noise, potential off-trail impacts such as soil, vegetation, and wildlife disturbance), and
3. Future trail maintenance activities (e.g., regrading and resurfacing, and boardwalk/viewing platform repair as needed).

Natural resources that may be affected by these activities include 1) landscape geomorphology, 2) soils, 3) vegetation, and 4) wildlife. Table 1.1 presents a cross matrix of impacts and resources with intersecting cells showing anticipated effects or impacts.

Table 1.1. Principal Anticipated Impact Categories and Natural Resources That May Be Affected by Those Impacts and Expected Outcomes

<table>
<tr><th rowspan="2">Impact Categories</th><th rowspan="2">Impacts</th><th colspan="4">Natural Resource Categories Potentially Affected and Mitigation Efforts</th></tr>
<tr><th>Geomorphology</th><th>Soils</th><th>Vegetation</th><th>Wildlife</th></tr>
<tr><td>Construction</td><td>Grading and leveling, limited trail-side vegetation removal, noise, possible fuel and lubricant spills.</td><td>Resource effect
Minor initial but permanent impacts due to grading and leveling.

Mitigation
Sensitive areas such as wetlands will not be impacted.</td><td>Resource Effect
Soil disturbance along trail route and parking areas. Protection of soils in areas away from trail and parking.

Mitigation
Soils restoration on closed side trails. Best management practices will be used to avoid fuel and lubricant spills.</td><td>Resource Effect
Some vegetation removal along trail route and parking areas.

Mitigation
Vegetation protection away from trail and parking areas. Native vegetation restoration on closed side trails. Trail margin revegetation with native plant species.</td><td>Resource Effect
Temporary noise and disturbance during construction activities.

Mitigation
Construction will take place during winter months so as not to affect breeding birds and other wildlife.</td></tr>
<tr><td>Visitors</td><td>On-trail and parking area activities (desired), off trail activities (discouraged).</td><td>None.</td><td>None, except for off-trail visitor use that will be discouraged.</td><td>Resource Effect
Off-trail visitor use could damage native vegetation and will be discouraged. Potential for wildfire ignition is possible.

Mitigation
Closing side trails will be beneficial to vegetation.</td><td>Resource Effect
Disturbance from sound and human and dog activity along the trail route and adjacent to parking areas.

Mitigation
Off-trail use will be discouraged.</td></tr>
<tr><td>Maintenance</td><td>Regrading and applying fine-crush gravel as needed; removal of fallen trees, exotic weeds as needed.</td><td>None.</td><td>None, other than already disturbed trail bed and parking area soils.</td><td>Resource Effect
Limited removal of fallen trees, branches, and exotic weeds along trail and parking areas and margins.

Mitigation
Off-trail and parking area activities will be avoided.</td><td>Resource Effect
Temporary noise and disturbance during maintenance activities.

Mitigation
Maintenance will be scheduled to avoid sensitive breeding periods.</td></tr>
</table>

1.2 Trail and Associated Recreational Amenities Environmental Monitoring

SWCA is conducting environmental monitoring of the project effects on soils, vegetation, and bird communities in order to determine whether the enhancement and use of the trails and associated recreation amenities has a measureable effect on those resources. The monitoring is consistent with the requirements of the Bosque Action Plan, Policy 1, Action H (City 1993). The monitoring follows an experimental design, where trail and trail amenity enhancements are the "treatments." Data on soils, vegetation, and birds are being collected from the proposed treated areas and compared to adjacent untreated or impacted areas, including pre-treatment baseline and several years of post-treatment data collection. The monitoring schedule was meant to accommodate the construction schedule; the City completed both Phase I (Central Avenue to the Atrisco Siphon) and Phase II (Atrisco Siphon to Interstate 40) by April 2015.

1.2.1 Objectives of Environmental Monitoring

The objectives of environmental monitoring for the main trail, trail-related, and trailhead parking area enhancements are to document environmental conditions prior to construction, and then again following construction, both within the areas to be developed and in the adjacent surrounding areas that will not be developed.

The objective of monitoring closed trails is to document whether those restored trails trend toward natural soil surface and vegetation conditions. Soil surface conditions and vegetation are measured by use of photographic monitoring (use of permanent repeat photo points) and rapid assessment methods for categorically scoring environmental conditions over time. This monitoring will be conducted from three points at each of two trailhead locations and from five to 10 locations to be determined once the trail closure plan has been completed.

Trail enhancement and trail closure/restoration activities will most likely affect the surrounding environment through

1. Direct impacts related to new trail construction and closing and restoring informal trails (e.g., vehicles and workers impacting soils, vegetation, and wildlife),
2. Post-construction/restoration impacts of hikers and bicyclists on trailside environments trampling soils and vegetation and harassing wildlife, and
3. Trail maintenance.

1.2.2 Evaluation Criteria for Environmental Monitoring

Criteria used to evaluate the effects of the project on the environment are based on the objectives of the project and the objectives of environmental monitoring. The objectives of the trail improvement project are to manage and encourage users to visit and enjoy the natural resources of the project area, while at the same time protecting those natural resources. This environmental monitoring focuses on the later objective of protecting the environment with a goal that construction activities, visitor use, and maintenance activities should have no measureable negative effects. This monitoring project further focuses on the effects of construction and visitors on the initial enhancement and use of the main trail and amenities, and the closing of side trails.

Environmental impact evaluations for the initial construction of the trail enhancement and amenities, as well as visitor use, will be based on statistical comparisons of

1. Soil surface disturbance,
2. Native vegetation canopy cover, species richness, and proportion of native versus exotic species, and
3. Breeding season bird numbers, species diversity (richness and evenness), and changes in key species.

An experimental monitoring design is employed with control (areas with no impacts) and treatment (areas including and adjacent to impacts), with before-impact and after-impact measurements. Table 1.2 provides a matrix of how the impacts of the project will be evaluated for impacts to soils, vegetation, and birds relative to the construction and visitor use phases. In most cases, statistical tests of measured values will be compared for change between treated (developed or restored) locations and control (non-developed or restored), both before and after treatment activities. SWCA has chosen to focus monitoring efforts on soil surfaces, vegetation, and birds because they are the most indicative natural resources to monitor in terms of providing measurable responses to the project. Soils and vegetation will likely be the most affected natural resource, and some bird species are sensitive to human activity and disturbance. Mammals, amphibians, reptiles, and arthropods that occur in the project area are indirectly affected by impacts to soil and vegetation that constitute their habitats. Attempting to quantify indirect effects is much more difficult to measure and appropriate sampling efforts to acquire useful data would be very expensive and potentially inconclusive.

Table 1.2. Evaluation Criteria for Environmental Monitoring Determinations of the Project Impacts to Soils, Vegetation, and Birds

Activity		Soils (surface disturbance)				Vegetation (native canopy cover and number of native species [opposite for exotic species])				Birds (numbers of individuals and species, number of individuals of key species)			
		Control		Treatment		Control		Treatment		Control		Treatment	
		Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Construction	Main trail (enhanced)	BL	NC, <	BL	NC, <	BL	NC	BL	NC, >	BL	NC	BL	NC, >
	Parking areas (enhanced)	BL	NC, <	BL	NC, <	BL	NC	BL	NC, >	BL	NC	BL	NC, >
	Side trails (closed)	BL	<	BL	<	BL	NC	BL	>	-	-	-	-
Visitor Use	Main trail (enhanced)	BL	NC, <	BL	NC, <	BL	NC	BL	NC, >	BL	NC	BL	NC, >
	Parking areas (enhanced)	BL	NC, <	BL	NC, <	BL	NC	BL	NC, >	BL	NC	BL	NC, >
	Side trails (closed)	BL	<	BL	<	BL	NC	BL	>	-	-	-	-

Note: BL = Baseline conditions, NC = No change in measured values, < = Values less than baseline and treatment conditions, > = Values greater than baseline and treatment conditions, - = Will not be measured. Statistical testing of data will be performed to test for significant differences (5%; $p < 0.05$) between control and treatment locations over time.

1.2.3 Environmental Monitoring Design and Methods

Environmental monitoring is being conducted by using a Before-After-Control-Impact (treatment) (BACI) experimental sampling design, with paired (adjacent pairs in similar environments) treatment and control study plots/transects. BACI designs are considered to be the most powerful ways to measure for impact effects (Green 1979; Elzinga et al. 2001; Downes et al. 2002). Statistical testing is applied to data collected from monitoring to test for significant differences (at the 5% level or chance of obtaining the observed result if no real difference exists) in soil, vegetation, and bird measurements between control and treatment locations. That level of testing precision may be adjusted down (less precision) depending on the nature of the data collected, and no statistical testing may be appropriate in some cases. Lowering testing precision or not using statistical testing will favor detecting differences between control and treatment locations. Parametric and non-parametric testing are both being performed, depending on which is most appropriate given the nature of the data collected (normally distributed with equal variances or not).

The specific sampling design was installed in 2014 and consists of 20 modified 5 m × 30 m Bosque Ecosystem Monitoring Program (BEMP) plots (Eichhorst et al. 2012) to measure vegetation and soils (Figure 1.9), and referred to here as soil and vegetation measurement plots. Ten sampling sites were systematically located at equal distances apart along the main trail to provide unbiased and consistent sampling throughout the project area between Central Avenue and Montaño Boulevard (Figure 1.10). At each of the sampling sites, a trail-side treatment plot (exposed to direct trail enhancement activities) was located with one side of the plot precisely along the edge of the existing trail, extending 5 m away from the trail to the other side of the plot (hereafter called treatment or trail-side plots). The locations of the treatment plots are intended to provide measurements of trail construction and visitor activities on the soils and vegetation immediately adjacent to the trail (trail edge) compared to paired control plot soils and vegetation away from the trail edge. Each of the 10 treatment plots was paired with a control plot (not directly affected by main trail activities), located 30 m away from each treatment plot. If a human-created structural feature (e.g., unofficial side trail, jetty jacks) was situated in the position where a control plot was meant to be, it was moved north or south to the nearest location so as not to be influenced by that feature. Figure 1.11 is a diagram showing how control and treatment soil and vegetation plots were positioned relative to the main trail. Vegetation and soil surface features were first measured in August 2014 and will be measured in August of subsequent years within the soil and vegetation plots.

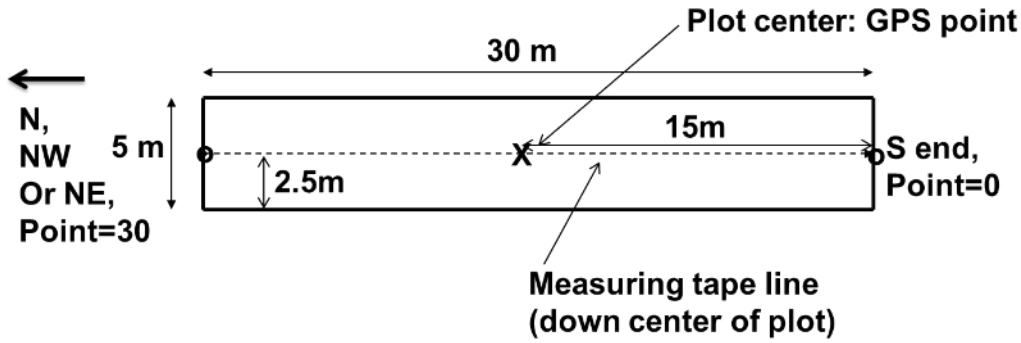

Figure 1.9. Diagram of a BEMP-style soil and vegetation measurement plot used for soil and vegetation monitoring.

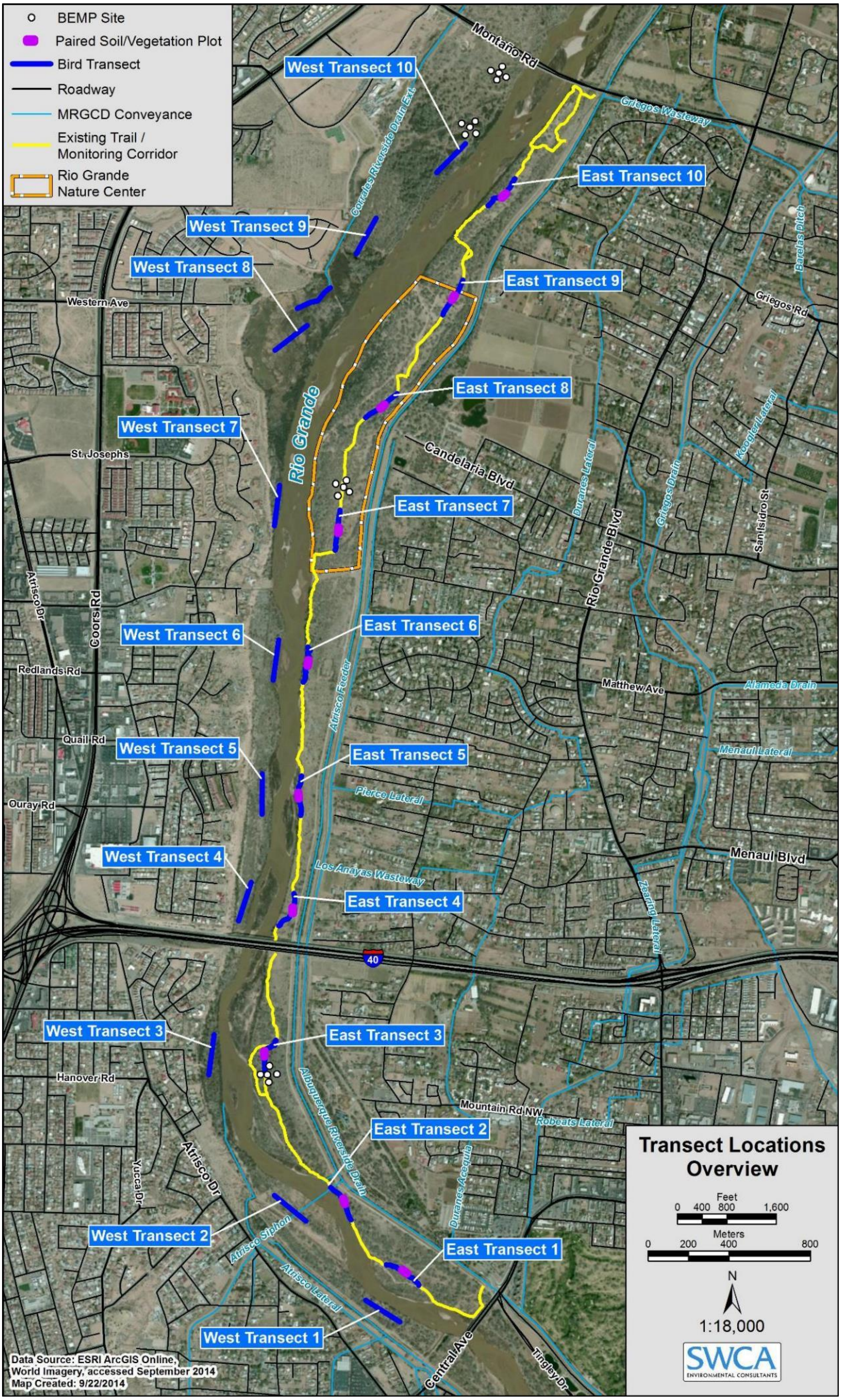

Figure 1.10. Locations of original baseline vegetation and soil measurement plots and bird transect locations across the project area that were measured in 2014 prior to trail construction between Central Avenue and I-40 in February 2015. BEMP sites are actual Bosque Ecosystem Monitoring Program sites.

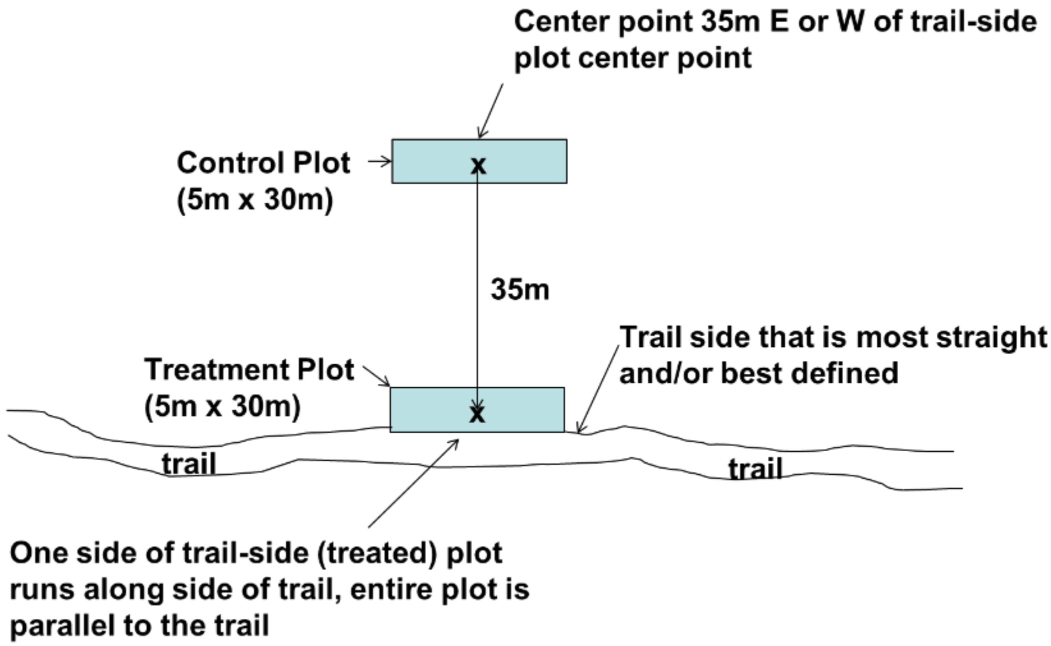

Figure 1.11. Diagram of control and treatment soil and vegetation plot placements.

Herbaceous and woody vegetation was measured along a 30 m line down the center of each soil and vegetation plot using the line-point-intercept method following the protocols of Herrick et al. (2005), at 1 m intervals along the line, for a total of 30 point measurements per plot. Note that BEMP uses continuous line-intercept measurements for vegetation; this is one way that SWCA modified the BEMP sampling design. Line-point-intercept was chosen because it is much more efficient, is subject to less observer bias, and is as accurate as the continuous line-intercept method (Elzinga et al. 2001). Each plant species intercepted at each of the 30 points per plot was recorded, and the condition of the soil surface at each of the 30 points per plot was recorded as bare ground, biotic soil crust, organic leaf litter, dead and downed wood (>2 cm in diameter), and whether there was indication of human-caused soil disturbance (e.g., human or domestic animal foot prints, vehicle tire tracks).

Trees and large shrubs with diameters at breast height (DBH) of 2 cm or greater were counted and tallied by species over each entire plot to provide counts of trees and shrubs by species. Note that BEMP tags and measures cottonwood (*Populus* sp.) trees; this is the other way that SWCA modified the BEMP sampling design. Trees and shrubs were further categorized by three size classes based on DBH measurements of: 1) <10 cm, 2) 10–20 cm, and 3) >20 cm. Additionally, human-caused soil surface disturbance was measured as a percentage of the area of each entire plot to supplement the line-point-intercept measures of soil surface disturbance.

Repeat photo points were established at the north and south ends of each plot, providing photographic views of each plot, with a view from each end of the plot looking into and across each plot. Repeat photo points will used in addition to the actual measurements to evaluate changes in vegetation and soils over time (see repeat photo points below).

Bird community sampling is conducted using a design similar to vegetation and soils, where ten 100-m-long pedestrian survey bird transects are centered at the 10 soil and vegetation plot locations. The project area on the east side of the river is too narrow to include control bird transects since birds are affected by human activity from greater distances than plants and soils, so control bird transects were located in the bosque on the west side of the Rio Grande, where each of the 10 control transects are located directly across the river from each of the 10 treatment transects (see Figure 1.10). Bird transects were sampled in 2014 once during the winter (February) for year-round and winter resident bird species, and three times during the early summer breeding season (May, June, July) for year-round and summer resident bird species. All 20 bird transects were sampled in the morning hours after sunrise and all within a 1-week time period. One qualified observer conducted all of the bird transect surveys to avoid multi-observer biases. The observer walked each 100-m transect slowly, recording all individual birds observed or heard. Detection was recorded as visual, by song or call, or both. All birds detected were recorded including individuals flying over the transects. Distance to each bird from the observer was not estimated because most of the detections were by sound, and estimating distance by sound in woodland habitat is highly imprecise and introduces considerable error for estimating density using distance based formulas. All surveys were conducted by a single observer, who recorded the occurrence and abundance of bird species while walking the length of each transect. The same sampling will be employed for post-treatment bird monitoring surveys in subsequent years.

Analysis of bird count and relative abundance data collected by the above field methods are summarized and analyzed in two different ways. Univariate data analysis for testing differences in mean (parametric) or sums of scores (non-parametric) values of parameters or variables measured are used to test for significant differences in the values of those variables between paired control and treatment plots (vegetation and soils) and transects (birds). SAS 9.3 (SAS Institute 2013) statistical software is being used for those univariate statistical testing analyses. Multivariate community data analyses are used to compare the plant and bird entire community species compositions between control and treatment plots and transects. Cluster analysis (McCune and Grace 2002), based on similarities of plant or bird species assemblages between all possible pair-wise combinations of the plots or transects, produces dendrograms (tree diagrams) showing groupings of plots or transects with similar species compositions for qualitative, visual evaluations. The closer terminal branches are in those diagrams; the more similar the corresponding sets of species are in terms of composition and relative abundance. The Multi-Response Permutation Procedures (MRPP) (McCune and Grace 2002) are used (PC-ORD 5.10, McCune and Medford 1999) to determine whether treatments are different from controls. MRPP multivariate analysis is used to test for statistically significant differences in the species compositions of vegetation and birds of the control and treatment plots or transects, also based on the assemblages of species found at all plots or transects. Indicator Species Analysis (ISA) is then used to test for statistically significant associations of individual species between control and treatment plots or transects (Dufrêne and Legendre 1997; McCune and Grace 2002). An indicator value is calculated for each species and for each clustering level. It is highest when all individuals of a species are found in a single group of sites and when the species occurs in all sites of that group.

Repeat photo point monitoring is used to evaluate change in vegetation and soils at two locations where trailhead parking areas will be expanded: one on the west side of the Rio Grande at

Central Avenue and one on the east side of the Rio Grande at Central Avenue. Repeat photo monitoring also is being used to evaluate change in vegetation and soils from a series of unofficial side trails that are proposed to be closed and restored. A rapid assessment change scoring procedure will be used to compare the scenes of photographs taken at each photo point to score change in vegetation and soil features as positive, negative, or neutral relative to visible impacts to vegetation and soil caused by construction and/or visitors over time. All initial baseline photo point photographs were taken in August 2014. Time series comparisons of repeat photos and analysis of those photographs will first be conducted in future after construction and after the second set of post-treatment repeat photographs are taken.

In addition to this experimental monitoring, data from existing BEMP study sites (Eichhorst et al. 2012) and from Hawks Aloft bird transects in the area also will be used for comparison of long-term trends in vegetation and birds of the greater bosque of Albuquerque Subreach of the Rio Grande to provide larger-scale context for this particular monitoring study.

2 ENVIRONMENTAL MONITORING RESULTS

Rresults of 2015 post-treatment environmental monitoring of the trail from Central Avenue to I-40 for soil surface disturbance, vegetation, birds, and photo point photographs are presented below. Results from 2015 following trail surface improvements are presented to document the pre-treatment (main trail enhancements, side trail closures) baseline conditions for the comparisons to future post-treatment monitoring data.

2.1 SOIL AND VEGETATION MONITORING RESULTS

2.1.1 SOIL SURFACE FEATURES

Both parametric t-tests for differences in mean values and non-parametric Wilcoxon tests for differences in rank-sum values revealed that there were no significant differences in the percent ground cover of 1) bare soil, 2) biotic soil surface crusts, 3) organic leaf litter, 4) dead and downed woody material, and 5) human-caused soil disturbance between control and treatment (trail-side) soil and vegetation measurement plots. Figure 2.1, Figure 2.2, Figure 2.3, Figure 2.4 and Figure 2.5 respectively, display the means and associated standard error bars for each of those variables. These results on ground cover features measured in 2015 were very similar to the findings prior to construction in 2014 (SWCA 2015) and show no effects of trail construction on trail-side soil and other ground cover features. Comparing the findings of no significant changes in soil surface features in 2015 to the predicted possible impacts (see Table 1.1) and the evaluation criteria for determining success of failure of the trail improvements (see Table 1.2) reveal the that the 2015 trail construction had no significant environmental impacts, positive or negative.

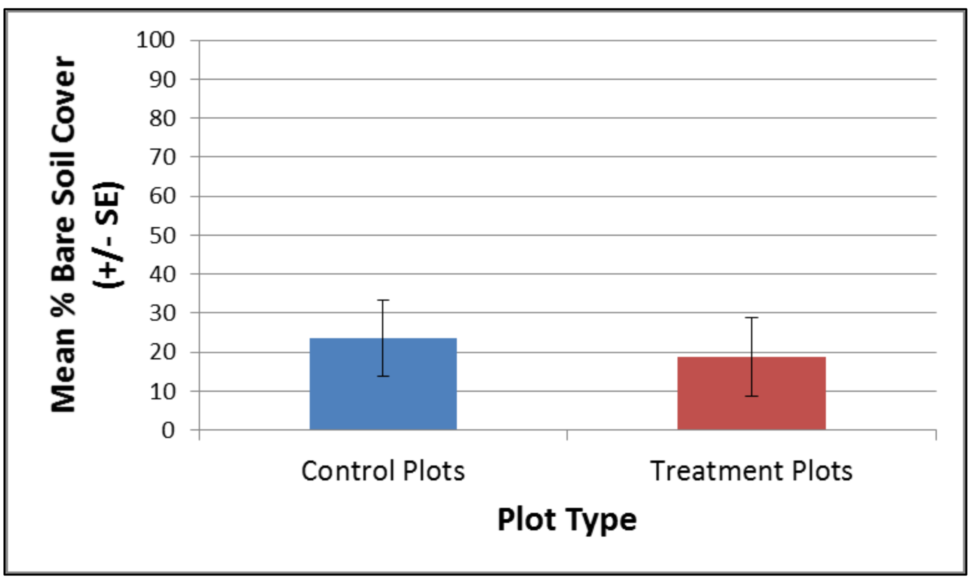

Figure 2.1. Mean percent cover of bare soil measured from control and treatment vegetation and soils plots.

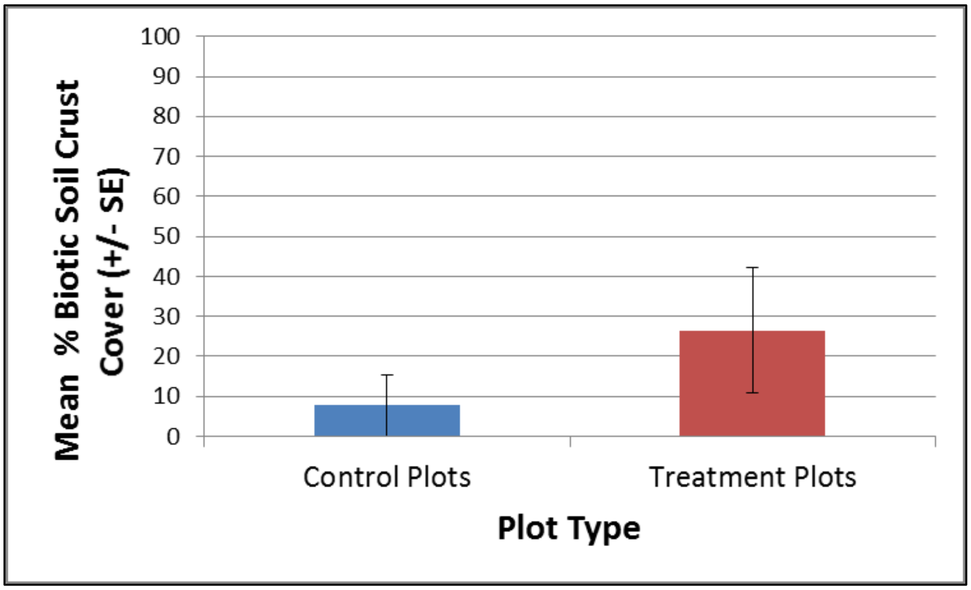

Figure 2.2. Mean percent canopy cover of soil surface biotic crust measured from control and treatment vegetation and soils plots.

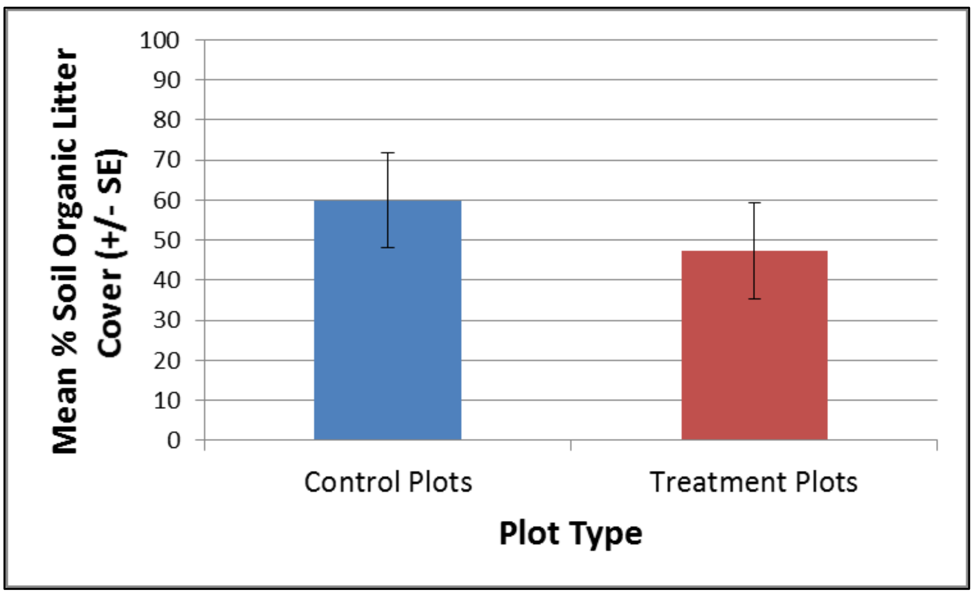

Figure 2.3. Mean percent canopy cover of soil surface organic litter measured from control and treatment vegetation and soils plots.

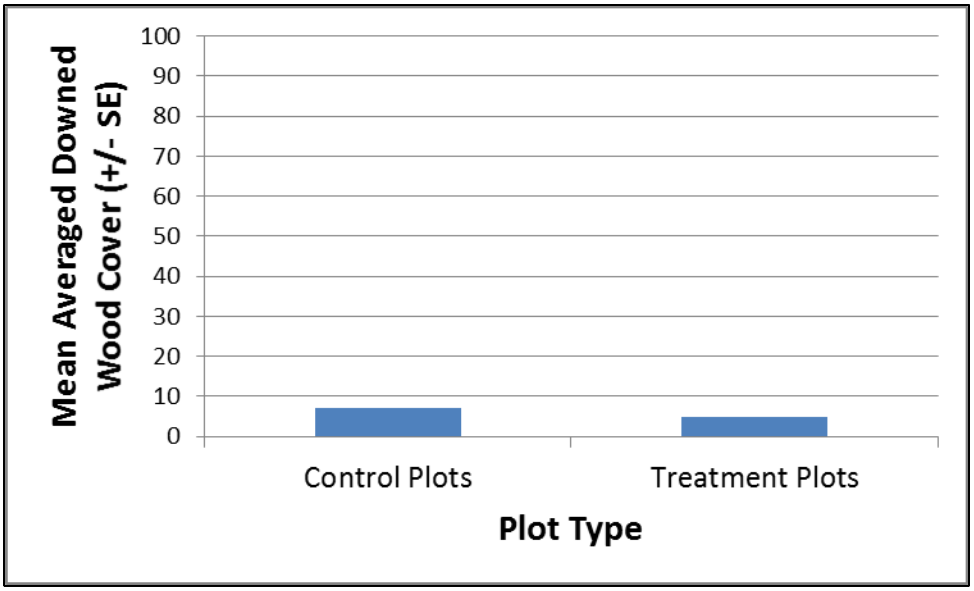

Figure 2.4. Mean percent canopy cover of soil surface dead and downed woody material measured from control and treatment vegetation and soils plots.

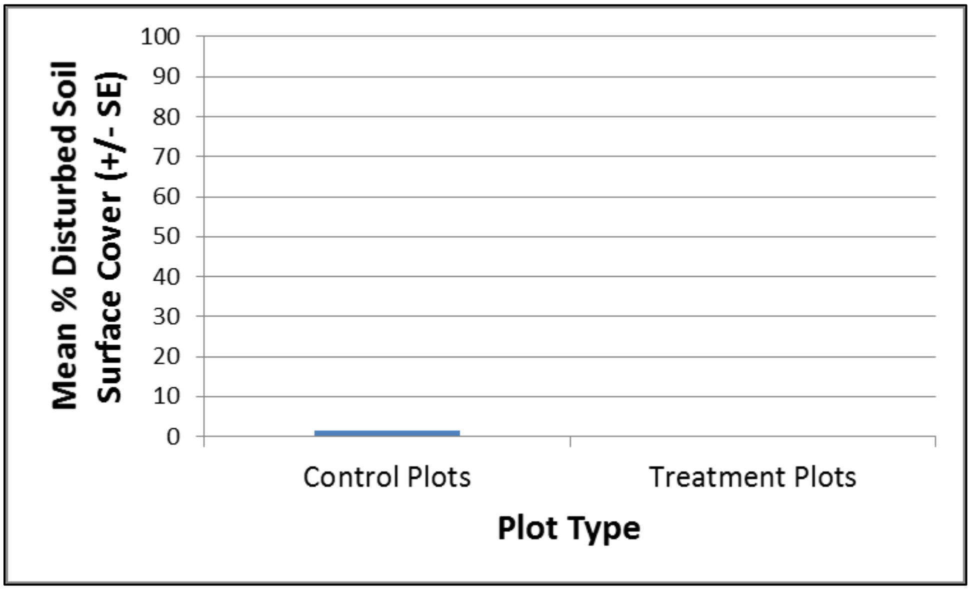

Figure 2.5. Mean percent canopy cover of human-caused soil surface disturbance measured from control and treatment vegetation and soils plots.

2.1.2 VEGETATION

A list of all plant species found across the six paired vegetation and soils plots that were measured in 2015 is presented in Table 2.1. All plant common names, scientific names, codes, growth form and native status follow the U.S. Department of Agriculture (USDA) PLANTS Database (USDA 2016).

Table 2.1. List of All Plant Species Found on All Six Paired Vegetation and Soils Plots

Common Name	Scientific Name	Family	Code	Growth Form	Native Status
Blue grama	*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths	Poaceae	BOGR2	Grass	Native
Canada wildrye	*Elymus canadensis* L.	Poaceae	ELCA4	Grass	Native
Copper globemallow	*Sphaeralcea angustifolia* (Cav.) G. Don	Malvaceae	SPAN3	Forb	Native
Coyote (narrowleaf willow)	*Salix exigua* Nutt.	Salicaceae	SAEX	Shrub	Native
Field bindweed	*Convolvulus arvensis* L.	Convolvulaceae	COAR4	Forb	Exotic
Fourwing saltbush	*Atriplex canescens* (Pursh) Nutt.	Chenopodiaceae	ATCA2	Shrub	Native
Indian ricegrass	*Achnatherum hymenoides* (Roem. & Schult.) Barkworth	Poaceae	ACHY	Grass	Native
James' galleta	*Pleuraphis jamesii* Torr.	Poaceae	PLJA	Grass	Native
Kochia (burningbush)	*Bassia scoparia* (L.) A.J. Scott	Chenopodiaceae	BASC5	Forb	Exotic
Prickly Russian thistle	*Salsola tragus* L.	Chenopodiaceae	SATR12	Forb	Exotic
Rio Grande cottonwood	*Populus deltoides* ssp. *wislizenii* (S. Watson) Sarg.	Salicaceae	PODEW	Tree	Native
Russian olive	*Elaeagnus angustifolia* L.	Elaeagnaceae	ELAN	Tree	Exotic
Sand dropseed	*Sporobolus cryptandrus* (Torr.) A. Gray	Poaceae	SPCR	Grass	Native
Saltcedar (five-stamen tamarisk)	*Tamarix chinensis* Lour.	Tamaricaceae	TACH2	Tree	Exotic
Siberian elm	*Ulmus pumila* L.	Ulmaceae	ULPU	Tree	Exotic
Silverleaf nightshade	*Solanum elaeagnifolium* Cav.	Solanaceae	SOEL	Forb	Native
Spike dropseed	*Sporobolus contractus* Hitchc.	Poaceae	SPCO4	Grass	Native
Squirreltail	*Elymus elymoides* (Raf.) Swezey	Poaceae	ELEL5	Grass	Native
Thymeleaf sandmat	*Chamaesyce serpyllifolia* (Pers.) Small	Euphorbiaceae	CHSE6	Forb	Native
Tree of heaven	*Ailanthus altissima* (Mill.) Swingle	Simaroubaceae	AIAL	Tree	Exotic
White mulberry	*Morus alba* L.	Moraceae	MOAL	Tree	Exotic

Note: Some locally established common names follow Catron et al. (2008) when the second common name (USDA) is in parentheses.

WOODY VEGETATION

Woody trees and shrubs were dominated by exotic Siberian elm (*Ulmus pumila*), saltcedar (*Tamarix chinensis*), white mulberry (*Morus alba*), and tree of heaven (*Ailanthus altissima*) on both the control (plots 30 m from the trail) and the trail-side treatment plots. Control and treatment plots differed little in tree size class counts and percentages. Exotic species accounted for 78% of the trees counted on control plots and 75% of the trees on treatment plots. Siberian elm, white mulberry, and saltcedar dominated the control plots, and saltcedar, tree of heaven, and Siberian elm dominated the treatment plots (Figure 2.6 and Figure 2.7). Rio Grande cottonwood (*Populus deltoides* ssp. *wislizenii*) was the most abundant native tree on control plots, and narrowleaf (coyote) willow (*Salix exigua*) was the most abundant native tree on treatment plots, but both considerably less abundant than exotic species. Most of the trees on both control (68%) and treatment (88%) plots were small trees (size class 1 = <10-cm DBH stems), mostly exotic species (Figure 2.8 and Figure 2.9). The few large size class 3 (>20-cm DBH stems) were mostly mature Rio Grande cottonwoods and some Siberian elms.

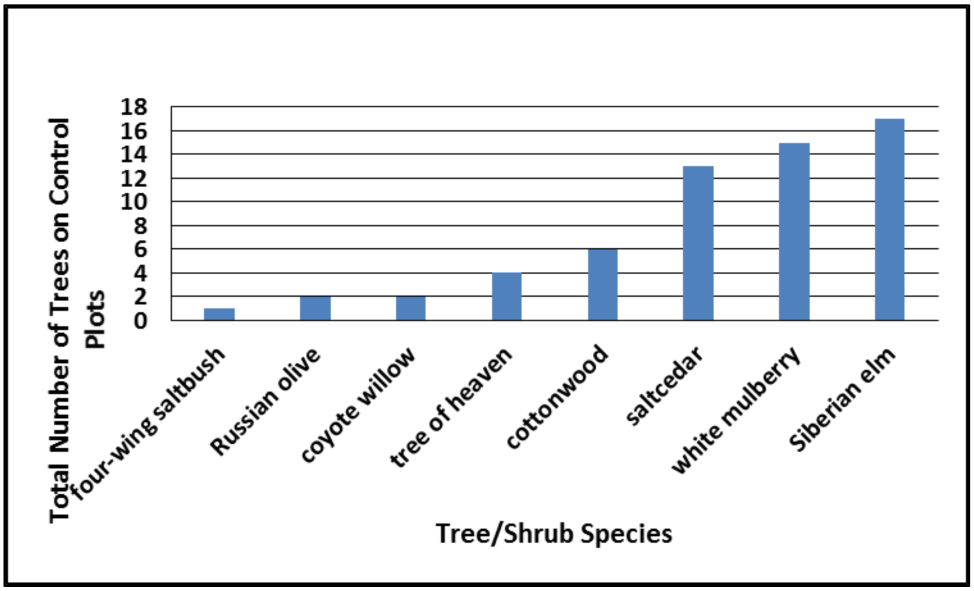

Figure 2.6. Total numbers of woody trees and shrubs by species counted on control vegetation plots.

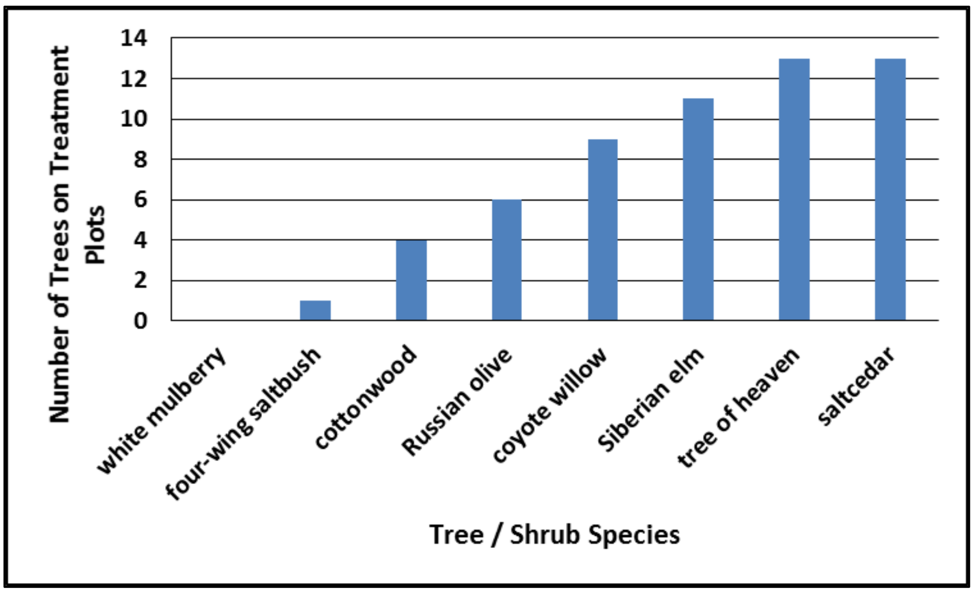

Figure 2.7. Total numbers of woody trees and shrubs by species counted on treatment vegetation plots.

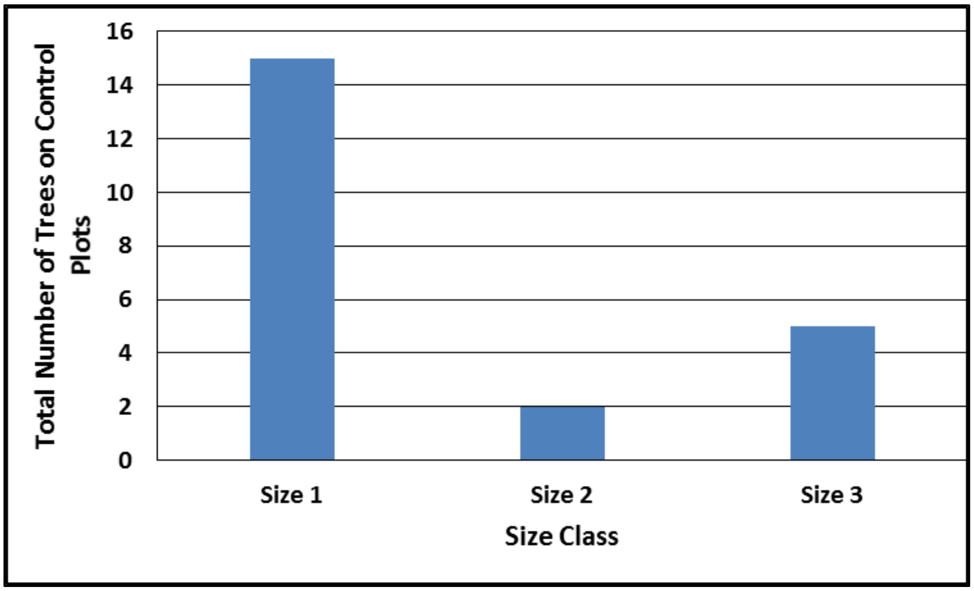

Figure 2.8. Sum counts of woody trees and shrubs across all control vegetation plots by size class. Size class DBH: 1) <10 cm, 2) 10–20 cm, 3) >20 cm.

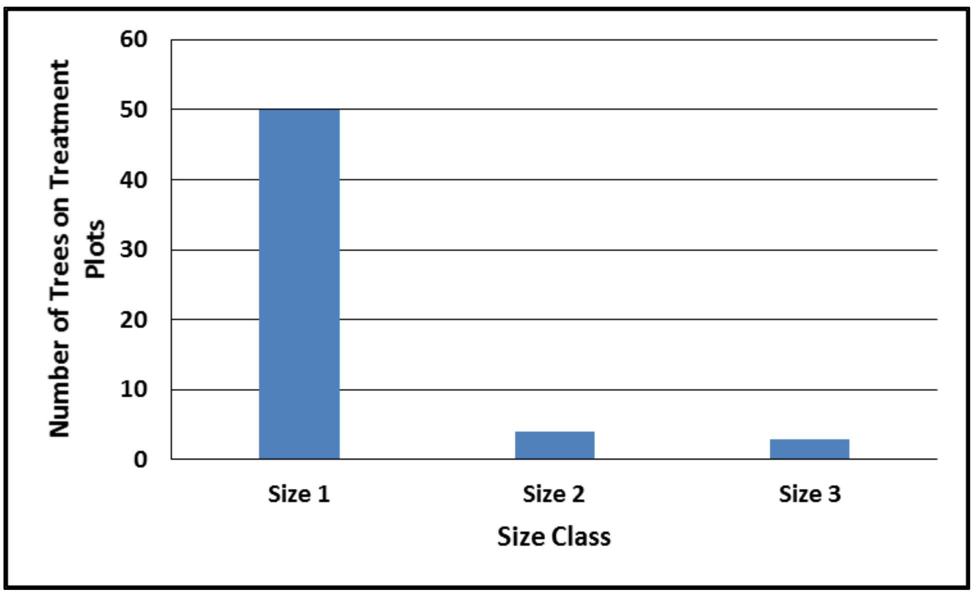

Figure 2.9. Sum counts of woody trees and shrubs across all treatment vegetation plots by size class. Size class DBH: 1) <10 cm, 2) 10–20 cm, 3) >20 cm.

HERBACEOUS VEGETATION

Multivariate cluster analysis of all 12 (six pairs) control and treatment soil and vegetation plots revealed no groupings of control or treatment plots, indicating that there were no patterns of particular species associated with control or treatment locations (Figure 2.10). Results of MRPP analysis revealed that there were no significant differences in the plant species compositions between the six control and six treatment vegetation and soils plots (Table 2.2), and ISA revealed that no plant species were significantly associated with or significant indicators of either control or treatment plots (Table 2.3).

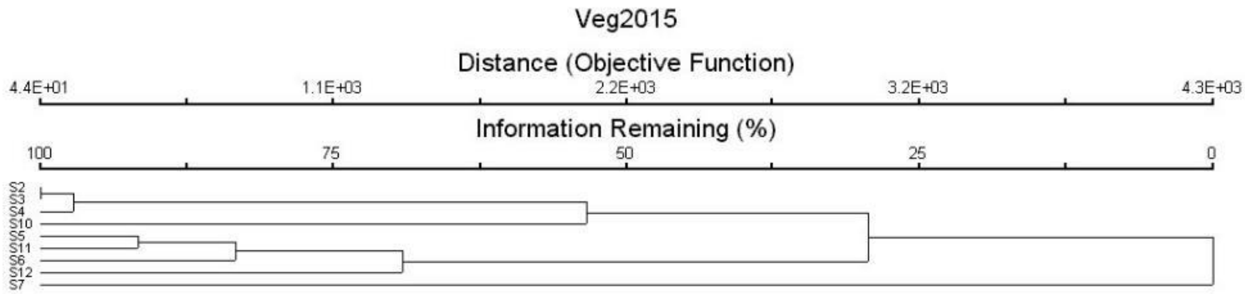

Figure 2.10. Dendrogram resulting from cluster analysis of all 12 control and treatment vegetation and soils plots based on similarities in species composition. Numeric values on the vertical axis represent site locations; numbers 1–6 are control plots and numbers 7–12 are treatment plots. Similarity distance is Euclidean distance.

Table 2.2. Results of Multi-Response Permutation Procedures Testing for Differences in Herbaceous Plant Species Compositions between All Control and Treatment Plots

Observed Delta-value	Expected Delta-value	Probability of a smaller or equal Delta
35.7	35.3	P=0.46

Table 2.3. Observed Species Indicator Analysis Value of Plant Species Measured From All Control and Treatment Vegetation Plots

Species	Observed Indicator Value	P value[1]
Squirreltail	25.0	0.7360
Indian ricegrass	16.7	1.0000
James' galleta	33.3	0.4390
Blue grama	16.7	1.0000
Field bindweed	16.7	1.0000
Copper globemallow	22.2	1.0000
Sand dropseed	33.3	0.4390
Thymeleaf sandmat	16.7	1.0000
Prickly Russian thistle	47.4	0.4180
Canada wildrye	8.3	1.0000
Silverleaf nightshade	8.3	1.0000
Kochia	36.9	0.6630
Spike dropseed	16.7	1.0000

Indicator values range from 0.0 to 100.0, and significant indicator species must have a P value < 0.05.
[1] proportion of randomized trials with indicator value equal to or exceeding the observed indicator value.
p = (1 + number of runs >= observed)/(1 + number of randomized runs)

Total herbaceous vegetation canopy cover was not significantly different between control and treatment plots in 2015, as was the case for the entire trail from Central Avenue to Montaño Boulevard in 2014 (SWCA 2015). Both total forb and total grass (herbaceous vegetation) cover was higher, but not statistically significantly along the trail edges (treatment plots) or at control plots 30 m away from the trail (Figure 2.11 and Figure 2.12). Forb canopy cover averaged about 10% greater than grass canopy cover both on treatment plots along the trail and on control plots 30 m away from the trail.

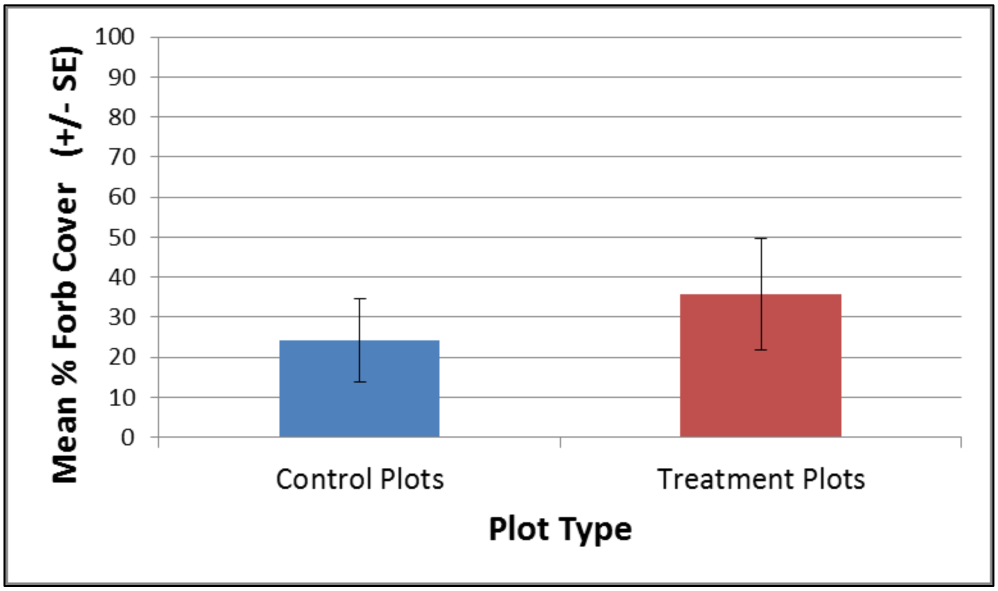

Figure 2.11. Mean percent canopy cover of all forbs measured from control and treatment vegetation and soils plots.

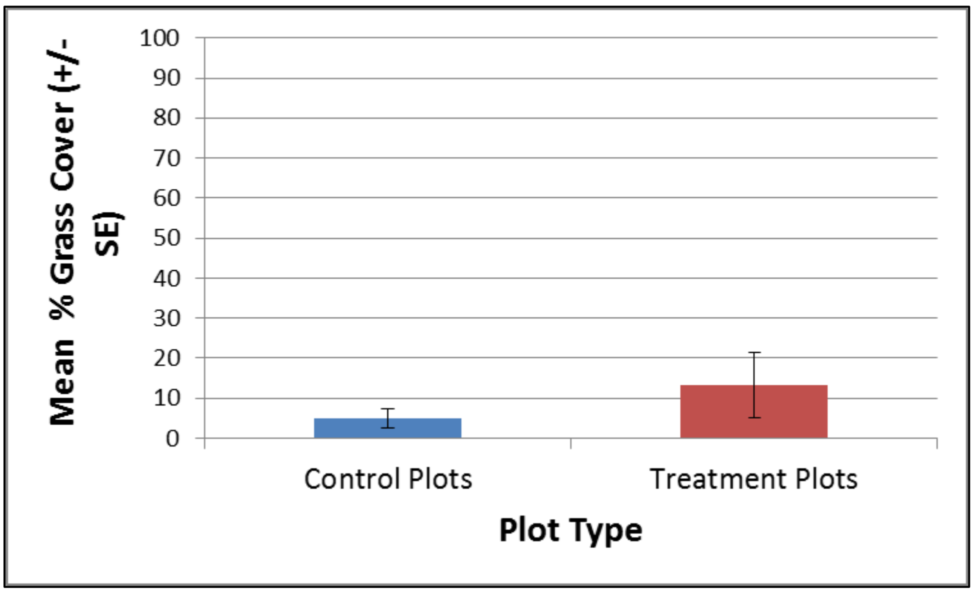

Figure 2.12. Mean percent canopy cover of all grasses measured from control and treatment vegetation and soils plots.

Native and exotic herbaceous vegetation canopy cover was not significantly different between control and treatment plots in 2015, as was the case for the entire trail from Central Avenue to Montaño Boulevard in 2014 (SWCA 2015). Both native and exotic total grass and forb cover were higher, but not statistically significantly along the trail edges (treatment plots) or at control plots 30 m away from the trail (Figure 2.13 and Figure 2.14). As mentioned above, forbs, not grasses, accounted for the greatest amount of herbaceous vegetation cover. Comparing the findings of no significant changes in vegetation in 2015 to the predicted possible impacts (see Table 1.1) and the evaluation criteria for determining success of failure of the trail improvements (see Table 1.2) reveal the that the 2015 trail construction had no significant environmental positive or negative impacts on woody or herbaceous vegetation.

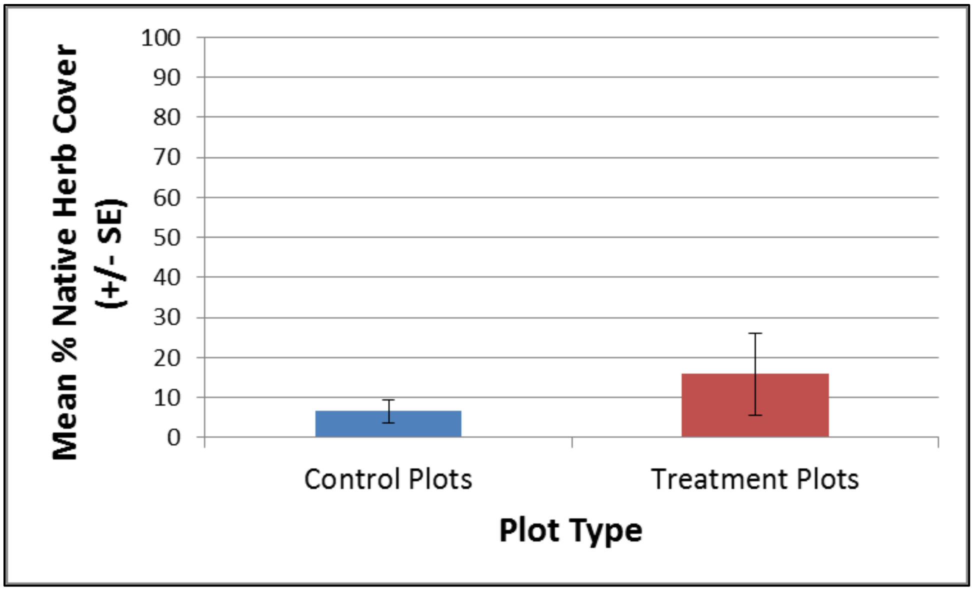

Figure 2.13. Mean percent canopy cover of native herbaceous vegetation measured from control and treatment vegetation and soils plots.

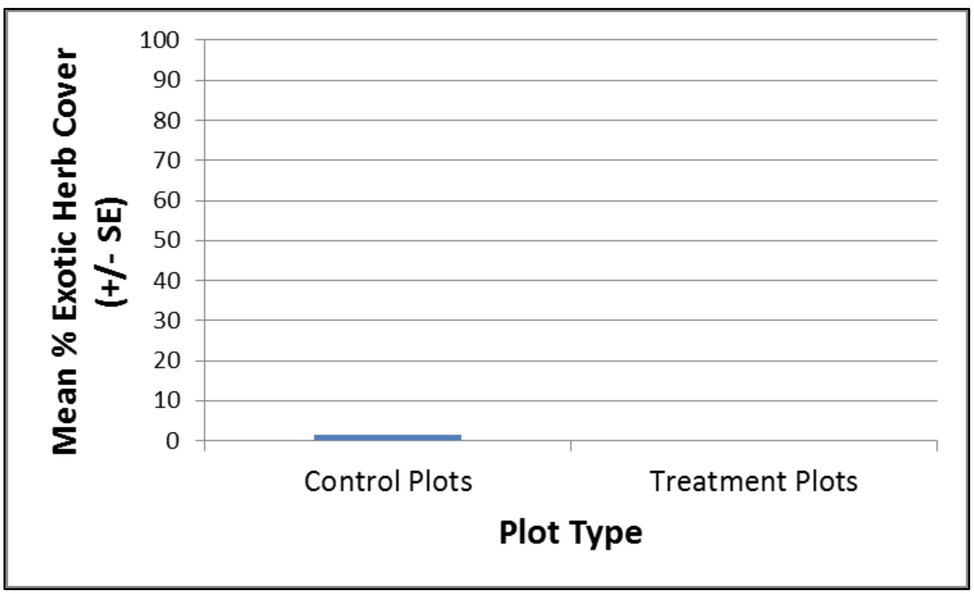

Figure 2.14. Mean percent canopy cover of exotic herbaceous vegetation measured from control and treatment vegetation and soils plots.

2.2 Bird Community Monitoring Results

Three paired bird transects between Central Avenue and I-40 (see Figure 1.8, transects 0a, 1, and 2) were sampled in May, June, and July 2015. No significant differences were found in the composition of birds (species and individuals) between the three transects along the trail and the three paired control transects on the west side of the Rio Grande directly across the river from each of the three trail treatment transects.

Cluster analysis dendrograms examining the similarities of all transects over the three breeding season months, in terms of their associated sets of species, are presented in Figure 2.15 through Figure 2.17. No trend existed toward transect clusters composed of groupings of control transects or groupings of treatment transects, based on similarities in bird species compositions.

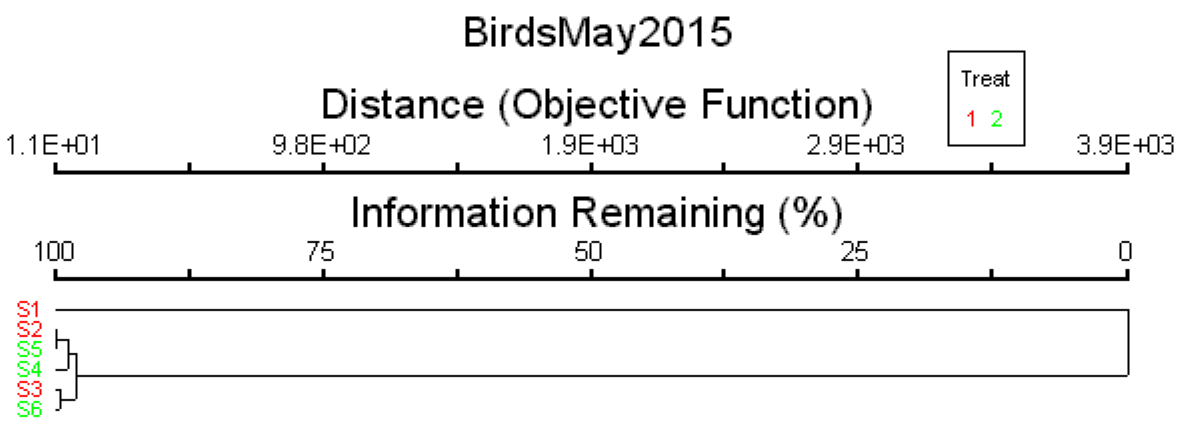

Figure 2.15. Dendrogram representing similarities among transects based on species relative abundance and relative frequency of occurrence during May 2015 surveys. Site numbers are on the left side: control transects are numbers 1–3 in red, and treatment transects are numbers 4–6 in green.

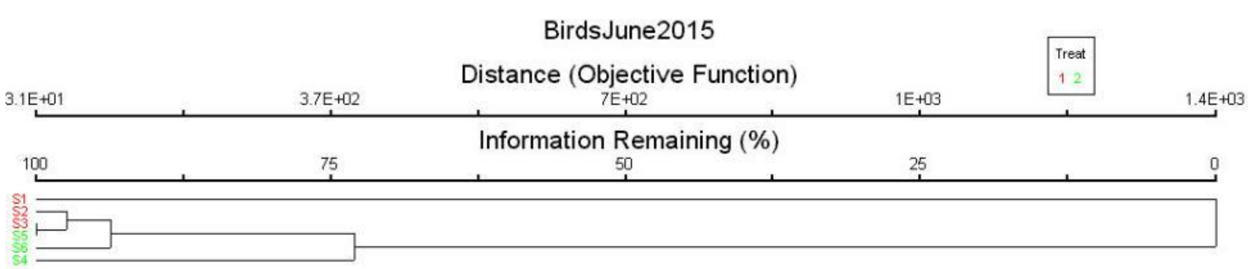

Figure 2.16. Dendrogram representing similarities among transects based on species relative abundance and relative frequency of occurrence during June 2015 surveys. Site numbers are on the left side: control transects are numbers 1–3 in red and treatment transects are numbers 4–6 in green.

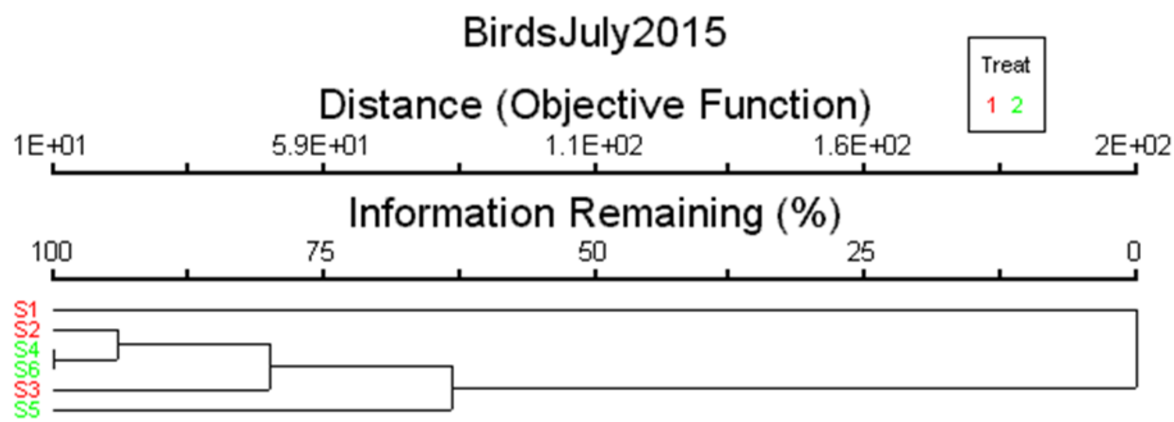

Figure 2.17. Dendrogram representing similarities among transects based on species relative abundance and relative frequency of occurrence during July 2015 surveys. Site numbers are on the left side: control transects are numbers 1–3 in red and treatment transects are numbers 4–6 in green.

The results of the MRPP analysis on bird community data comparing the composition of birds between control and trail transects in 2015 are presented in Table 2.4. MRPP analysis revealed that there were no significant differences in trail bird communities when compared to the bird communities of control transects on the west side of the Rio Grande.

Table 2.4. Results of MRPP Analysis for Bird Species Assemblages

	Observed Delta-value	Expected Delta-value	Probability of a smaller or equal Delta
May surveys	34.187	33.823	0.829
June surveys	26.941	24.337	0.799
July surveys	9.664	9.764	0.362

Table 2.5 through Table 2.7 provide the results of SIA on birds over the four sampling periods for specific associations to treatments, including lists of all bird species observed during each of the three monthly surveys. No bird species had significant ISA scores, indicating that no species of birds were more associated with control or treatment transects beyond random chance alone.

Table 2.5. Observed SIA Value of Bird Species Detected during May Surveys

Species	Observed Indicator Value	P value[1]
Ash-throated flycatcher	50.0	1.0000
Barn swallow	44.4	1.0000
Brown-headed cowbird	33.3	1.0000
Black-headed grosbeak	57.1	0.8890
Blue grosbeak	80.0	0.2830
Cliff swallow	32.6	1.0000
House finch	33.3	1.0000
Spotted sandpiper	66.7	0.4090
Summer tanager	42.9	1.0000
Yellow-breasted chat	50.0	1.0000
Black-capped chickadee	100.0	0.1010
Black-chinned hummingbird	47.6	0.7200
Bewick's wren	66.7	0.6060
Mourning dove	16.7	1.0000
Red-necked phalarope	33.3	1.0000
Black phoebe	33.3	1.0000
Mallard	70.0	0.3100
Spotted towhee	50.0	1.0000
Wood duck	33.3	1.0000
White-breasted nuthatch	20.0	1.0000
Canada goose	43.5	0.8020
Common yellowthroat	33.3	1.0000
European starling	66.7	0.4220
Yellow warbler	33.3	1.0000
American crow	33.3	1.0000
Downy woodpecker	16.7	1.0000
Warbling vireo	66.7	0.4060
Great egret	33.3	1.0000
Wilson's warbler	16.7	1.0000
Dusky flycatcher	33.3	1.0000
Cooper's hawk	16.7	1.0000
Great-tailed grackle	33.3	1.0000
Western wood-pewee	33.3	1.0000
Greater roadrunner	33.3	1.0000
Northern flicker	33.3	1.0000
Western tanager	33.3	1.0000
Green-tailed towhee	33.3	1.0000

Indicator values range from 0.0 to 100.0, and significant indicator species must have a P value < 0.05.
[1] proportion of randomized trials with indicator value equal to or exceeding the observed indicator value.
p = (1 + number of runs >= observed)/(1 + number of randomized runs)

Table 2.6. Observed Species Indicator Analysis Value of Bird Species Detected during June Surveys

Species	Observed Indicator Value	P value[1]
Ash-throated flycatcher	40.0	1.0000
Brown-headed cowbird	33.3	1.0000
Black-headed grosbeak	38.1	1.0000
Blue grosbeak	41.7	0.5250
Cliff swallow	66.0	0.3210
House finch	80.0	0.4260
Spotted sandpiper	66.7	1.0000
Summer tanager	25.0	1.0000
Yellow-breasted chat	55.6	1.0000
Black-capped chickadee	33.3	1.0000
Black-chinned hummingbird	33.3	1.0000
Mourning dove	38.1	1.0000
Red-necked phalarope	44.4	1.0000
Great blue heron	33.3	1.0000
Mallard	50.0	1.0000
Snowy egret	33.3	1.0000
Spotted towhee	20.0	1.0000
Wood duck	16.7	1.0000
White-breasted nuthatch	33.3	1.0000
Cattle egret	33.3	1.0000
Western wood-pewee	66.7	0.4260
American robin	33.3	1.0000
Common yellowthroat	50.0	0.7160
European starling	66.7	1.0000
Yellow warbler	22.2	0.4070
White-winged dove	33.3	1.0000
House sparrow	33.3	1.0000
Rock dove	33.3	1.0000
American crow	33.3	1.0000
Downy woodpecker	33.3	1.0000
Warbling vireo	33.3	1.0000
Western kingbird	33.3	1.0000

Indicator values range from 0.0 to 100.0, and significant indicator species must have a P value < 0.05.
[1] proportion of randomized trials with indicator value equal to or exceeding the observed indicator value.
p = (1 + number of runs >= observed)/(1 + number of randomized runs)

Table 2.7. Observed Species Indicator Analysis Value of Bird Species Detected during July Surveys

Species	Observed Indicator Value	P value[1]
Ash-throated flycatcher	71.4	0.2860
Barn swallow	58.3	0.3900
Brown-headed cowbird	66.3	0.3900
Black-headed grosbeak	33.3	1.0000
Blue grosbeak	50.0	1.0000
Bullock's oriole	33.3	1.0000
Cliff swallow	66.7	0.3900
House finch	75.0	0.4000
Spotted sandpiper	33.3	1.0000
Summer tanager	33.3	1.0000
Yellow-breasted chat	50.0	1.0000
Black-capped chickadee	33.3	1.0000
Black-chinned hummingbird	60.0	0.3900
Bewick's wren	16.7	1.0000
Mourning dove	44.4	1.0000
Red-necked phalarope	26.7	1.0000
Black-crowned night-heron	16.7	1.0000
Black phoebe	25.0	1.0000
Great blue heron	33.3	1.0000
Mallard	16.7	1.0000
Snowy egret	33.3	1.0000
Spotted towhee	50.0	0.6660
Wood duck	33.3	1.0000
White-breasted nuthatch	100.0	0.0960
Bushtit	33.3	1.0000
Canada goose	33.3	1.0000

Indicator values range from 0.0 to 100.0, and significant indicator species must have a P value < 0.05.
[1] proportion of randomized trials with indicator value equal to or exceeding the observed indicator value.
p = (1 + number of runs >= observed)/(1 + number of randomized runs)

Overall findings from the first year of post-construction breeding season bird survey data revealed that the species compositions of the control and treatment transects were not significantly different in 2015. These are the same findings from pre-construction baseline data and analyses in 2014 (SWCA 2015). Comparing the findings of no significant changes in bird species assemblages in 2015 to the predicted possible impacts (see Table 1.1) and the evaluation criteria for determining success of failure of the trail improvements (see Table 1.2) reveal the that the 2015 trail construction had no significant positive or negative impacts on bird species assemblages.

2.3 Repeat Photo Point Monitoring

SWCA developed a rapid assessment repeat photo point evaluation procedure to assess change in soil surface disturbance and vegetation composition and structure over time by comparing those features in time-sequence paired photographs and scoring change (Figure A.1–Figure A.8, Table A.1, in **Error! Reference source not found.**). Only two of the paired plots and transects established and measured in 2014 were located between Central Avenue and I-40: pairs 2 and 3 (see Figure 1.8). Repeat photographs taken in 2015 were compared to the original photo point photographs taken from those plots in 2014 to evaluate changes in soil disturbance and vegetation composition and structure. Two repeat photo points were taken from each of the paired plots: one photograph with a view south to north along the 30-m centerline of each plot where vegetation point-intercept measurements were taken (see Figure 1.8).

The results of comparing repeat photo point photographs revealed little change in soil surface disturbance and vegetation composition and structure (see **Error! Reference source not found.**, Figure A.1–Figure A.8, Table A.1). The overall findings of average scores for the two pairs of control and treatment plots (sites or plots 2 and 3; see Figure 1.8) are presented in Table 2.8. Both treatment plots had low negative scores and both control plots showed little to no change. The negative scores for the trailside treatment plots resulted from initial observable surface disturbance from widening the trail to 6 feet. However, the visible removal of saltcedar from both of those treatment plots partially countered the negative soil disturbance scores (see **Error! Reference source not found.** for details). These findings are consistent with the actual measurements of soil surface features and vegetation on the same plots (see above), except that the soil disturbance from trail widening was not evident on the treatment plots that were positioned along the edge of the existing trail, and the widening was on the opposite side of the trail. The trail widening was visible in the photo point photographs, which provided a view beyond the sides of the measurement plots.

Table 2.8. Overall Repeat Photo Point Environmental Status Scores for Soil and Vegetation Plots Comparing 2014 Baseline Conditions to 2015 Post-construction Conditions

Site	Control Plot Average Score	Treatment Plot
2	0	-3
3	1	-0.5

For details and explanations, see Appendix B. Scores could have ranged from a maximum of 10 for maximum positive change, to -10 for maximum negative change.

A series of new repeat photo points was established along the trail at 100-m intervals from Central Avenue to I-40 in 2015 (see Figure 1.8). From the trailhead at Central Avenue, a point was established along the trail every 100 m, and paired control points were established 30 m to the east of each trail point for comparison. At each trail (treatment) and control point, a photograph was taken providing a view to the north and another photo taken providing a view to the south. Figure 2.18 is an example of one set of such photographs from location 10, 1 km north of Central Avenue (see Figure 1.8). The 100-m photo points will be re-photographed each year, and new ones added as trail improvements extend north of I-40. In addition to the plot and transect monitoring, these 100-m photo points will provide almost continuous views of the trail over the coming year to help evaluate the environmental effects of the trail.

a. b. c. d.

Figure 2.18. Example 100-m trail repeat photo point photographs along the trail at point 10, 1 km north of Central Avenue a. Trail view north. b. Trail view south. C. Control 30 m east of the trail view north. d. Control 30 m east of the trail view south.

2.4 Side Trail Closures and Restoration Treatments

Unofficial side trails created by visitors cause environmental degradation of the bosque, and the City has begun to close and restore soil surfaces and vegetation as part of the trail improvement project. The map in Figure 2.19 shows the location of side trails adjacent to the trail that were closed in early 2015. Figure 2.20 shows some examples of permanent photo point views of closed site trails that were photographed in 2015. Due to construction schedule changes, SWCA was not able to obtain pre-closure baseline photographs. SWCA has begun to monitor those closed side trails with repeat photo points using the same photo point evaluation criteria used to evaluate the main trail. These criteria are also used to evaluate the success of closing side trails and restoration of the soil surfaces and native vegetation. Photo points will be evaluated each year from now on to monitoring change in soil surfaces and vegetation composition and cover, and the first comparative evaluations will be conducted in 2016.

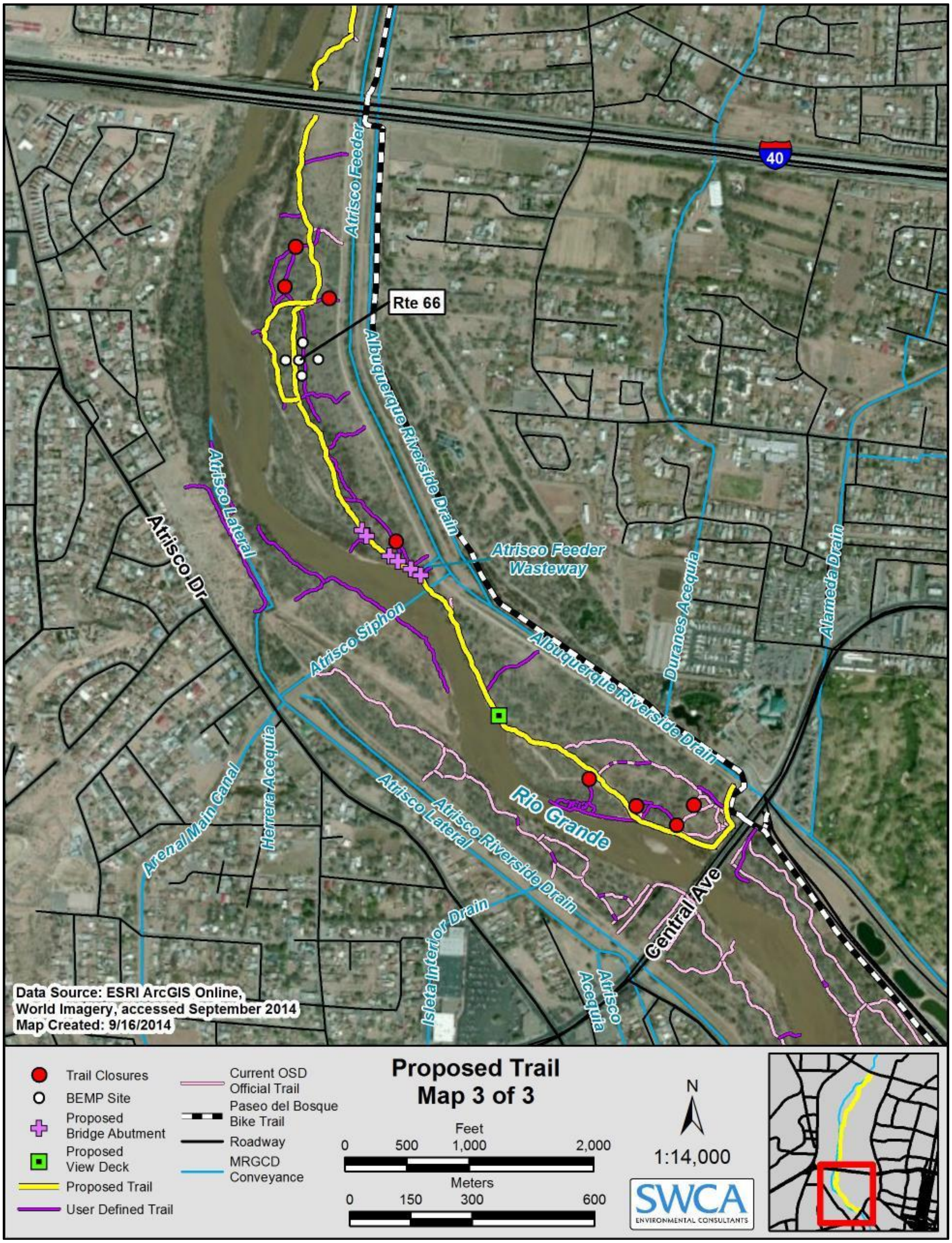

Figure 2.19. Map of the south end of the trail between Central Avenue and I-40 showing the locations of unofficial closed side trails that SWCA began monitoring in 2015 with repeat photo points.

a. **b.** **c.** **d.**

Figure 2.20. Unofficial visitor created side trails that connect to the trail. a. side trail with wood debris placed to discourage access and to stabilize soil surfaces. b. Sign asking visitors to stay off closed trail. c. Closed side trail that was seeded with native grass. d. New Mexico olive and seeded grass on closed side trail.

2.5 RIO DEL NORTE BOSQUE TRAIL IMPROVEMENT PLANS FOR PHASE III: I-40 TO CAMPBELL ROAD, 2016

The City proposes to improving the existing trail and to conduct restoration along the trail from I-40 north to Campbell Road in early 2016. The City requested that SWCA evaluate the potential environmental impacts of six proposed plans for this next phase of trail improvement. **Error! Reference source not found.** contains maps produced by the City that show the six proposed routes for continuing an improved trail north from I-40 to Campbell Road. SWCA personnel conducted pedestrian surveys of the proposed trail improvement alternatives in January 2016. SWCA used the environmental impact categories presented in Table 1.1 above to make potential impact assessments based on field survey findings. Table 2.9 provides a comparative assessment of the potential impacts of the six proposed alternatives, based potential impacts to geomorphology, soils, vegetation, wildlife, and additional sensitive habitats (for particular special status species or overall environmental health).

Table 2.9. Rio del Norte Bosque Trail Planned Improvement Alternatives Proposed for 2016 and Potential Natural Resources Impacts: A Comparative Evaluation

Alternatives	Impacts	Natural Resource Categories Potentially Affected				
		Geomorphology	Soils	Vegetation	Wildlife	Sensitive Habitats
Existing conditions; no improvements	Trail would continue to erode, off-trail travel would continue.	River bank edges may be impacted by off-trail use by humans and domestic dogs.	Current user-defined off-trail use would continue. Soil erosion on existing trails would continue.	Visitors would continue to damage off-trail vegetation; exotic species would continue to dominate.	Disturbance related to intermittent human activity and associated domestic dogs throughout the bosque would continue.	Disturbance by humans and domestic dogs along trail may negatively affect nesting/ migratory birds or wildlife seeking cover in vegetation along river bank.
Alternative 1	Regrading and applying stabilized crusher-fine gravel; removal of fallen trees, revegetation of access roads and user-defined trails.	River bank edges may be impacted by construction activities, as well as off-trail humans and domestic dogs.	None, except for off-trail visitor use that will be discouraged.	Removal of dead “snags” or live trees in bosque. Exotic vegetation removal as-needed in trail footprint.	Temporary noise disturbance during construction activities. Disturbance related to intermittent human activity and associated domestic dogs along trail. Removal of snags would impact avian and mammal habitat.	Disturbance by humans and domestic dogs along trail may negatively affect nesting/ migratory birds or wildlife seeking cover in vegetation along river bank.
Alternative 2A	Regrading and applying stabilized crusher-fine gravel; revegetation of access roads and user-defined trails.	None.	None, except for off-trail visitor use that will be discouraged.	Exotic vegetation removal as-needed in trail footprint.	Temporary noise disturbance during construction activities. Disturbance related to intermittent human activity and associated domestic dogs along trail.	None. Trail avoids sensitive forested and river bank habitat.
Alternative 2B	Regrading and applying stabilized	None.	None, except for off-trail visitor use	Exotic vegetation removal as-	Temporary noise disturbance	None. Trail avoids sensitive

Alternatives	Impacts	Natural Resource Categories Potentially Affected				
		Geomorphology	Soils	Vegetation	Wildlife	Sensitive Habitats
	crusher-fine gravel; revegetation of access roads and user-defined trails.		that will be discouraged.	needed in trail footprint.	during construction activities. Disturbance related to intermittent human activity and associated domestic dogs along trail.	forested and river bank habitat.
Alternative 2C	Regrading and applying stabilized crusher-fine gravel; revegetation of access roads and user-defined trails.	None.	None, except for off-trail visitor use that will be discouraged.	Exotic vegetation removal as-needed in trail footprint.	Temporary noise disturbance during construction activities. Disturbance related to intermittent human activity and associated domestic dogs along trail.	None. Trail avoids sensitive forested and river bank habitat.
Alternative 2D	Regrading and applying stabilized crusher-fine gravel; revegetation of access roads and user-defined trails.	None.	None, except for off-trail visitor use that will be discouraged.	Exotic vegetation removal as-needed in trail footprint.	Temporary noise disturbance during construction activities. Disturbance related to intermittent human activity and associated domestic dogs along trail.	None. Trail avoids sensitive forested and river bank habitat.
Alternative 3	Regrading and applying stabilized crusher-fine gravel; removal of fallen trees, revegetation of access roads and user-defined trails.	Bank edges may be impacted by construction activities, as well as off-trail humans and domestic dogs.	None, except for off-trail visitor use that will be discouraged.	Removal of dead “snags” or live trees in bosque. Exotic vegetation removal as-needed in trail footprint.	Temporary noise disturbance during construction activities. Disturbance related to intermittent human activity and associated domestic dogs along trail. Removal of	Disturbance by humans and domestic dogs along trail may negatively affect nesting migratory birds, or wildlife seeking cover in vegetation along river

Alternatives	Impacts	Natural Resource Categories Potentially Affected				
		Geomorphology	Soils	Vegetation	Wildlife	Sensitive Habitats
					snags would impact avian and mammal habitat.	bank.

2.5.1 Summary

Based on the analysis of potential alternatives proposed by the City, SWCA recommends all variations of Alternative 2 (2A, 2B, 2C, or 2D) as the environmentally preferred alternative(s) because it minimizes impact to wildlife, vegetation (trees), and geomorphology by avoiding the established cottonwood riparian forest (bosque) in the northwestern part of the project area. Any of the Alternatives 2 would require the construction of a new segment of trail in the northeastern portion, but that area is already disturbed by human activity. Alternative 1 proposes a trail through or along sensitive forested and river bank habitat, entailing possible risk and disturbance to nesting and migratory birds and other wildlife. Alternative 3 avoids the riverbank area but introduces the potential for new disturbances that could cancel out any benefits of closing the existing riverside trail.

2.5.2 Evaluation of Alternatives

The existing conditions consist of a user-defined trail running north-sound near the ordinary high water mark of the Rio Grande. The trail cuts west from the levee road near I-40 and follows the tree line north along the bank of the Rio Grande to the edge of the Rio Grande Nature Center. No access roads would be revegetated, and existing dispersed human impact both on and off the trail would continue.

Alternative 1 follows existing trail along Rio Grande. In the northern section, this trail passes through dense cottonwood bosque, with numerous snag and derelict cottonwood trees that would pose a threat to construction personnel and users of the trail and would have to be removed. Construction of a trail through dense riparian vegetation would entail the removal of vegetation and concern about possible impacts to nearby banks of the Rio Grande. Existing access roads would be revegetated.

Alternative 2 follows the existing trail along the Rio Grande and then, in the northern section, turns to the east to avoid the thick cottonwood bosque. Alternatives 2A through 2D take slightly different routes to turn away from the existing river trail. These trail routes would be the preferred alternative because they minimize impact to living and dead/dying cottonwood trees in the bosque. The choice of Alternatives 2A – 2D is basically equivalent, with some variation related to the length of trail near the existing bankline. Shorter bankline edges, such as Alternative 2A or 2B, have a slightly lower potential to affect the existing habitat (which already has existing trail usage). Whichever of the Alternatives 2A – 2D is chosen should route around the unofficial “labyrinth” feature created by visitors near the intersection of the northern access road and the trail. Known sensitive areas such as coyote dens and trees frequented by porcupines should also be avoided, as is the intended alignment of Alternatives 2A – 2D. Existing access roads would be closed and revegetated.

Alternative 3 is very similar to Alternative 2A, but would also include construction of three access trails linking the northern inland section of trail to the edge of the Rio Grande. This alternative would entail vegetation disturbance through the bosque area in the northern section, possibly including dead and/or live tree removal. It might also impact the river bank where the trails reach the river. This alternative seems designed to increase pedestrian access to the river; however, this seems unnecessary because the southern part of the trail in this area follows the river bank, and there are numerous other access routes to the river immediately north and south of this section of trail. Existing access roads would be closed and revegetated.

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