2019 Vegetation Success Monitoring for the

Deming Mill Tailing Impoundment

Deming, Luna County, New Mexico

Prepared for
Geo Southwest, Ltd.
PO Box 353
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Silverton, TX 79257

Prepared by
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HDNP Project Number 2019-029

May 25, 2021

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May 25, 2021

Geo Southwest, Ltd.
PO Box 353, 9751 Hwy 86
Silverton, TX 79257

Attn: Gerald Smith

Re: HDNP Project 2019-029
2019 Vegetation Success Monitoring - Revision 1
Deming Mill Tailings Impoundment, MMD Permit LU009RE
Deming, Luna County, New Mexico

Dear Mr. Smith:

High Desert Native Plants LLC (High Desert) is pleased to submit this Revised Vegetation Success Monitoring Report for the above Referenced project. This report includes a description of the methods utilized and results obtained during the vegetation monitoring study conducted at the subject property. The report was prepared in accordance with specifications outlined by the New Mexico Energy, Minerals, and Natural Resources Department Mining and Minerals Division and requested by the client in order to determine if revegetation was successful in this revegetation success monitoring survey of the subject property. The enclosed report was revised based on comments received from MMD We appreciate the opportunity to provide our services to you on this project. Please contact us at your convenience if you have questions or comments.

Sincerely,

Lara Barnes
Staff Biologist

Reviewed by

Michael D. Gaglio
Biologist/Managing Member

High Desert Native Plants LLC

"Everything with conservation in mind"

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EXECUTIVE SUMMARY

High Desert Native Plants, LLC (HDNP) was contracted by Geo Southwest Ltd. (Geo SW) to conduct vegetation success monitoring surveys at the Deming Mill Tailing Impoundment and Borrow Pit sites located on the outskirts of Deming, Luna County, New Mexico in October 2019. The Deming Mill was authorized by the Mining and Minerals Division of the New Mexico Energy, Minerals, and Natural Resources Department under Permit LU009RE. The original permit and subsequent Closeout Plans did not contain detailed revegetation standards and monitoring methods, therefore MMD authorized Geo SW to utilize Permit No. LU008RE and Modification 18-1, issued to Cyprus Pinos Altos Corporation for the Cyprus Pinos Altos Tailings Site, located south adjacent to the Deming Mill Tailings Impoundment, as a reference for guidance on the revegetation standards and monitoring methods for this project. Botanical surveys were conducted at three sites on the Deming Mill Property: reference site, the tailings impoundment, and the borrow pit. The reference site was authorized by MMD in Permit LU008RE, Modification 18-1 and was the basis for the revegetation success performance standards required by MMD guidance. The permit modification established three relevant performance standards for the project: 1) canopy coverage percentage equal to or greater than 70% of the canopy cover at the reference site, 2) shrub density equal to or greater than 60% of the shrub density at the reference site, and 3) measures of species diversity and relative abundance. Additional measurements of perennial canopy cover, basal vegetation cover, and perennial basal cover were recorded during the surveys and analyzed, though MMD guidelines do not consider these measurements as success criteria. The measurements obtained from the tailings site and borrow pit site were individually compared to the reference site measurements. Statistical analyses following MMD protocols were run on the data. Canopy cover at both vegetation treatment sites did not exceed the performance standard of 70% of the mean canopy cover of the reference site. Shrub density at both treatment sites was significantly greater than that of the reference site and exceeded the performance standard of 60% of the mean shrub density at the reference site. In addition, perennial canopy cover, basal cover, and perennial basal cover at the tailings site was significantly greater than basal cover at the reference site. At the borrow pit site perennial canopy cover was greater than the reference site perennial canopy cover. The species diversity index was greatest at the borrow pit site and least at the reference site. Two out of three species diversity and relative abundance criteria were met for each of the three sites, however the same sets of criteria were not met for any pair of sites. The results of this first round of monitoring suggest that the sites are all unique in terms of vegetation community. It is proposed that, although the MMD performance standards were not all fully met, revegation has nonetheless been successful at both the tailings and borrow pit sites due to the establishment of several species of perennial grasses, a variety of shrubs.

1.0 INTRODUCTION

High Desert Native Plants, LLC (HDNP) was contracted by Geo Southwest Ltd. (Geo SW) to conduct vegetation success monitoring surveys at the Deming Mill Tailing Impoundment and Borrow Pit sites located on the outskirts of Deming, Luna County, New Mexico in October 2019. This report documents the relevant background information, methods & materials utilized, and results of the surveys. The surveys were performed in accordance with guidance set forth by the Mining and Minerals Division (MMD) of the New Mexico Energy, Minerals and Natural Resources Department (EMNRD).

The results of the Vegetation Success Monitoring conducted at the site in 2019 were initially presented to MMD in a report dated January 29, 2020. Comments to the draft report were received via conference call with MMD staff on July 6, 2020, and in writing via email on July 8, 2020. Comments and suggestions were incorporated into this revised draft of the 2019 survey results, and also taken into consideration when developing the 2020 monitoring surveys. The results of the 2020 monitoring surveys were submitted separately.

The Deming Mill was authorized under MMD Mining Operation Permit No. LU009RE (currently in standby status) which was transferred from ASARCO Multi State Custodial Trust to Geo SW on August 5, 2014. On September 18, 2014, Geo SW submitted the “Deming Mill and Mill Tailings Closeout Plan And Financial Assurance Proposal” to MMD. Following a series of correspondence and directives from MMD, an updated “Closeout Plan and Financial Assurance Proposal” (Closeout Plan) dated October 17, 2016 was submitted to MMD. As of October 2019, when HDNP was contracted to perform the vegetation success monitoring, no additional correspondence was available and it is believed that the permit currently remains in Standby Status.

Permit LU009RE does not contain detailed revegetation standards and monitoring methods, therefore MMD authorized Geo SW to utilize Permit No. LU008RE and Modification 18-1, issued to Cyprus Pinos Altos Corporation on behalf of Freeport McMoRan Copper and Gold, inc. for the Cyprus Pinos Altos Tailings Site (Cyprus Tailings site), located south adjacent to the Deming Mill Tailings Impoundment, as a reference for guidance on the revegetation standards and monitoring methods for this project (Myers 2019). It is understood that Permit LU008RE will be used as a template for Permit LU009RE with respect to revegetation standards and Post Mining Land Use (PMLU) decisions.

1.1 Site Description

Revegetation Success Monitoring Surveys (the surveys) were conducted at three (3) sites (see Figure 1) associated with the Deming Mill, shown on the Survey Plat dated October 4, 2018 provided by the client. All three sites are located in Sections 20 & 21, T23S R9W, N.M.P.M. and are part of a larger group of properties collectively known as the Deming Mill (the Property) that was owned and operated by ASARCO from approximately 1949 through 2014. In 2014, Geo Southwest Ltd. acquired the property from the ASARCO Multi State Custodial Trust. The Property is located northwest of Deming near the intersection of Arrowhead Dr. NW and Peru Mill Rd (County Road 394).

The first of the survey sites was the Reference Site, an approximately 3.5-acre parcel of land referred to as “Proposed Vegetation Area” on the Survey Plat (see Figure 3). The use of this Reference Site was approved by MMD in Permit LU009RE, Mod 18-1 and was recommended to be used for this project as well. The two treatment sites that were surveyed were both located within the 99.4-acre Tract 2 and were referred to as Recovered Tailings Area and Borrow Pit (approximately 40 acres) on the survey plat. In this report, the sites are called Reference, Tailings, and Borrow respectively. The Tailings site and Borrow site were surveyed separately because they will likely become subjects of separate future real estate transactions and possibly separate permit actions (see Figure 2). There were also differences in past land treatments at each of the two areas which may have affected the revegetation success at each of the sites. The tailings site occupies approximately 55 acres and is a mound of soil that contains tailings from past mill operations as well as impacted soils that were removed from the mill site during mill site remediation activities in the 1990s and 2000s. The Tailings Site was covered with a cap of soil and gravel obtained from the Borrow Pit. The Borrow Pit, as the name suggests, is the area located north adjacent to the Tailings Site that was excavated during the reclamation efforts in order to obtain soil and gravel used for the cap at the tailings site. Each of the two sites were seeded in an effort to revegetate the sites after disturbances associated with remediation and site closeout.

The property has been in use since approximately 1949 when the mill was constructed. The property has been owned, leased, and operated by several different companies generally for the purpose of processing zinc, copper, and lead ore. The milling operations impacted the site by wind blown materials from the impoundment. Remediation activities at the Deming Mill began in 1993 and included the removal and transport of impacted soil to the tailing impoundment, placement of the impacted soil, and overlying with a protective earthen cap that was seeded for revegetation. Remediation occurred again in 2007 due to construction at the site for improvements to the cap and the Tailings impoundment was once again revegetated. The remediation efforts were completed in 2009 when NMED determined that it was successful.

The abandoned Deming Mill facilities are located on the Property west of Peru Road and the Luna County Power Station lies northeast adjacent to the property, past Arrowhead Drive. The tailings impoundment area and borrow pit are located north of the Mimbres River on the property. Otherwise, the property and surrounding area are generally vacant desert land.

1.2 Climate Conditions

The site is located in the Chihuahuan Desert of the southwest U.S. which is characterized by long hot summers, cold winters, and a monsoon season that generally occurs from June to September (US Department of Commerce & NOAA, 2019). The year of 2019 was much warmer and drier than 2018. The Deming area had approximately 10.13 inches of rain, and an average temperature of 60.3 °F in 2018. By contrast, the average temperature for 2019 was 63.41°F and the average temperature during the growing season months was 76.68°F. Cumulative annual precipitation in 2019 was 8.55 inches (WRCC 2019). The growing season precipitation in 2019 was 4.88 inches as compared to 6.03 inches in 2018. Climate data was obtained from the Deming Airport Weather station located within 5 miles of the site and is displayed in Table 1. Long term climate data is also available from the airport weather station. The long-term climate data consists of a thirty-seven year long span of weather data dating from 1961-1981 and 2001-2019. The long-term climate data mean annual temperature is about 60.87°F, during the growing season the average long-term temperature is 75.5°F. The mean annual precipitation is about 8.75 inches. The 2019 annual temperature and the average temperature during the growing season were higher than the long-term averages. Additionally, the precipitation was slightly lower in 2019 than the long term annual and growing season averages.

Table 1 - Average Temperature and Precipitation Data from Deming Airport

Year	Annual Temperature (°F)	Growing Season Temperature (°F)	Annual Precipitation (in)	Growing Season Precipitation (in)
2018 Average	60.3	74.8	10.13	6.03
2019 Average	63.4	76.7	8.55	4.88
Long-term Average (1961-2019)	60.9	75.5	8.75	5.35

1.3 Habitat Setting

The site is situated in the Chihuahuan desert and the vegetation type is Chihuahuan Desert Scrub. Chihuahuan Desert Scrub is characterized by creosotebush (*Larrea Tridentata)*, and tarbush (*Flourensia cernua*), and other common plants including soaptree yucca (*Yucca elata)*, Lechuguilla (*Agave lechuguilla*), and Ocotillo (*Fouquieria splenden*s). Trees such as honey mesquite (*Prosopis glandulosa*) are also common. This plant community category is dominated by drought tolerant shrubs along with perennial grasses and annual forbs (Dick-Peddie, 2000).

1.4 Revegetation Success Criteria

For the purposes of bond release and to meet the Post Mining Land Use (PMLU) standard as a wildlife area as required in Permit LU008RE and Modification 18-1, revegetation success monitoring surveys must be performed to determine if the revegetation efforts were successful. Revegetation success is monitored by performing surveys over the course of 2 years, the first of which can be no sooner than the 11th year following revegetation efforts. The revegetation success monitoring requires measurement of the variables plant canopy cover, shrub density, and plant species diversity on the revegetation sites and comparison of the measurements to a performance standard. The performance standard is based on either baseline data, an established or calculated technical standard, or measurements of the same variable on a reference site. The vegetation measurements at the Deming Tailings and Borrow sites were compared to measurements obtained at the approved Reference Site located south of the revegetation sites as depicted in Figure 1. The reference site is considered an undisturbed area and is assumed to be a self-sustained ecosystem representative of the pre-disturbance condition of the Tailing and Borrow sites.

For this vegetation survey, the MMD revegetation guidelines for an adjacent site owned by Cyprus Pinos Altos Corp (Cyprus) under permit LU008RE and Modification 18-1 were used since formal revegetation guidelines were not established by the MMD for the Deming Mill tailings and borrow sites. Based on verbal directives from MMD Staff, the terms of this permit modification are to be utilized as the basis for the revegetation success monitoring at the subject property. Permit LU008RE outlines the revegetation standards that would determine if the site is considered a self-sustaining ecosystem as stated by the PMLU wildlife description and the 18-1 modification defines the reference site jointly used by both Cyprus and Geo SW.

The revegetation success criteria for this project were outlined in Permit LU008RE and Modification 18-1 and summarized in Table 2. Mean canopy cover at each of the revegetation sites must be equal to or greater than 70% of the mean canopy cover measured at the reference site and shrub density on the treatment sites must be equal to or greater than 60% of the density measured at the reference site. In addition, at least three species of warm-season perennial grasses with a minimum individual percent coverage of 1% must be present at each of the revegetation sites. Two species of perennial shrubs must be present with a 0.5% individual coverage, and finally, two species of non-weedy native forbs must be present at the sites with an individual percent cover of 0.1%.

Table 2 - Revegetation Success Criteria required by MMD Permit LU008RE Mod 18-1

Proportion of Reference Area		Plant Diversity		
		Vegetation Class	Number of Species	Minimum Occurrence
Attribute	**Value**	Perennial Warm Grass	3	1%
Canopy Cover	70% of Standard	Perennial Shrub	2	0.5%
Shrub Density	60% of Standard	Non-weedy Native Forb	2	0.1%

2.0 FIELD SURVEYS

2.1 Methods

Biologist Lara Barnes performed vegetation surveys of the Reference, Tailings, and Borrow sites over multiple days between the 23rd and the 31st of October 2019; near the end of the growing season but before the first freeze. Two systematic random sampling methods to quantify variables measured were selected using MMD guidelines based on the factors being examined and vegetation habit type. The line-point intercept method was selected to measure percent cover of the plant canopy, basal coverage, and bare ground. The belt transect method was selected to quantify shrub density on the survey sites.

Random GPS (Global Positioning System) coordinates were generated using a randomization website (Random Point Generator, 2019) for each site before beginning field work. These GPS coordinates were the starting point for each transect for both methodologies and semi-permanent markers were placed at the coordinate locations in the field. Ten GPS points were generated for each method at each site for a total of thirty line-point intercept transects and thirty belt transects across the two revegetation sites and the reference site.

Canopy cover was measured utilizing the Line-Point Intercept Method (Herrick, 2005). Other variables measured with this method included plant basal cover, bare ground, rock cover, and litter cover (Herrick, 2005). Shrub density was measured using a belt transect method (Herrick, 2005). Species diversity was measured by calculating diversity indices based on the species recorded in the line-point intercept surveys. Diversity was also quantified by determining if mean cover percentages exceeded the performance standard for specific plant classes.

2.1.1 Line Point Intercept Method

The line-point intercept method is a consistent and repeatable measure to collect data for the variables canopy cover, basal cover, litter cover, rock cover, and bare ground. This method was conducted using guidelines from the Jornada Institute (Herrick, 2005). This method is a preferred method for desert and grassland habitats due to its fine resolution and ability to detect small low-lying grasses, and forbs in sparsely populated vegetation communities. The method is easily repeatable and increases precision by limiting bias by the surveyor that is possible in other ocular estimation methods. The line-point intercept method can gather information at multiple layers in the plant canopy and ground level using one sample point, making it an efficient data collection procedure. These attributes of the line-point intercept method make it the preferred choice according to MMD guidance.

The line-point intercept method was performed by laying out 15 meter-long (15m) transects, oriented from west to east, beginning at the given random GPS coordinates. Data collection points were located at the beginning of the transect and at 1-meter intervals along the transect. A pin consisting of a 3-foot long, ⅛-inch diameter brass rod pin was dropped vertically at each data collection point. The pin was dropped from an approximate height of 2-feet above the ground surface while standing on the south side of the line and dropping the pin on the north side of the line. Fifteen-meter lines with one-meter intervals were selected rather than longer transects in order to minimize changes in vegetation type along individual transects that could be caused by slopes at the site. Each transect line comprised a single sample for statistical analysis. Vegetation, litter, rock, and soil type that comes into contact with the dropped pin is recorded from the top of the pin downward. Any foliage that contacts the pin is recorded as either a canopy hit or a basal hit. Any vegetation coming into contact with the pin that is not at the soil level is considered a canopy hit. There may be multiple canopy hits of different species in areas where there are multiple canopy layers. Each plant species is only recorded once even if it is in contact with the pin at multiple points. However, each plant species can be recorded as a canopy hit and a basal hit. Basal hits are recorded when the pin comes into contact with a plant at the base of the plant (*e.g.* grass crowns or a stem instead of soil or rock). The base of the pin contacts either plants, litter (*i.e.* woody or herbaceous plant material), rock (*i.e.* rock particles >5mm dia. including bedrock), or bare ground (*i.e.* soil). Plants that were encountered during the survey that could not be identified in the field were collected and identified using plant guides. Ten lines made up of fifteen individual pin drops were conducted at each site. A total of thirty lines were surveyed across the reference and revegetation sites which equates to a total of four-hundred and fifty pin drops.

2.1.2 Belt Transect Method

Belt transects were used to measure shrub density measured in terms of shrubs per m^2 (referred to as stems/m^2). The belt transect method focuses on the presence of larger plants such as shrubs and trees and tends to disregard small forbs and grasses. Ten belt transects were counted on each site. A total of thirty belt transects were surveyed across all sites. Each belt transect was a dog-legged or “L” shaped area that was 20m in length and 2m wide for survey area encompassing 40m^2. Ten transects at each site equates to 400m^2 measured at each survey site. The dog-legged shaped transect is generally used at sites that either contain slopes or when colonially growing plants are present in order to reduce measurement bias and error resulting from slopes or plant colonies. Each transect began at the randomly generated GPS coordinate and extended out 10m east and then 10m south. A measuring tape was used to lay out a center line and a meter square quadrat was used to visualize a meter on each side of the centerline. Each individual shrub and tree rooted within the belt transect area was identified to species and recorded to determine shrub density and frequency.

3.0 FIELD SURVEY FINDINGS

Field Data collection sheets are presented in Appendix C.

3.1 Canopy Cover

3.1.1 Tailings Canopy Cover

The total percentage of canopy cover at the tailings site was 28% ± 14.2% (standard deviation [SD]), which is lower than 70% of the canopy cover of the reference site, of which, 50% of the total canopy cover was composed of perennial grasses. Perennial canopy cover at the tailings site was 21.3% ± 16.3%. Sideoats grama (*Bouteloua curtipendula*) was the most common at the site with a relative percent canopy cover of 38.1%, followed by purple threeawn (*Aristida purpurea*), and low woollygrass (*Dasyochola pulchella*). Three species of shrubs were recorded during the point-line intercept survey. The most common shrub during the survey was broom dalea (*Psorothamnus scoparius*) with a relative canopy cover of 16.7%. Two other shrubs/trees (broom snakeweed and desert willow) were recorded during the survey with a cover of 4.76% each. Two non-weedy forb species were present during the survey spectacle pod (*Dimorphocarpa wislizeni*) with a relative coverage of 2.38% and desert marigold (*Baileya multiradiata*) composing 4.76% of the total canopy coverage at the Tailings site.

3.1.1 Borrow Pit Canopy cover

The overall mean canopy cover percentage for the borrow pit site is 17.3% ± 11.6% , of which 53.95% consisted of perennial grasses. Total perennial canopy cover at the tailings site was 12.7% ± 8.7%. Five species of perennial grasses were observed at the borrow pit site, the most prevalent of which were low woollygrass (*Dasyochloa pulchella*), purple threeawn (*Aristida purpurea*), and sand dropseed (*Sporobolus cryptandrus*). Two species of native non-weedy forbs, rattlesnake weed (*Chamaesyce albomarginata*) and woolly tidestromia (*Tidestromia lanuginosa*) were observed at the borrow pit, comprising 11.56% of the relative total canopy cover. Only one shrub species, broom snakeweed (*Gutierrezia sarothrae*), was recorded at the borrow pit composing 11.54% of the relative total canopy cover.

3.1.2 Reference canopy cover

The percentage of canopy cover at the tailings site was 42.7% ± 15.3%. The reference site was dominated by forbs with a relative canopy coverage of 45.31%. A total of six forbs native non-weedy forbs were recorded on the reference site. The dominant forb present at the reference site was Coulter's spiderling (Boerhavia coulteri) with 23.44% relative cover. Other species observed at the reference site were green stripe amaranth, spectacle pod, spurge, woolly tidestromia, and rattlesnake weed. Three species of shrubs including fourwing saltbush (Atriplex canescens), soaptree yucca (Yucca elata), and longleaf jointfir (Ephedra trifurca) were recorded for the reference site. Each species had one occurrence each which equates to each having a relative canopy coverage of 1.56%. No perennial warm season grasses were recorded for the site. Total perennial canopy cover at the tailings site was 2.7% ± 3.3%. However, 50% of the vegatative canopy cover for the reference site consists of needle grama (Bouteloua aristidoides) which is an annual grass.

Table 3 - Canopy Cover Total Percentages by Species for Sites at Deming Mill Property for 2019 Vegetation Monitoring

Scientific Name	Common Name	Duration	Native Status	Code	Borrow Pit Site	Tailings Site	Reference Site
Grasses							
Dasyochloa pulchella	Low woollygrass	P	N	DAPU7	3.33	0.67	--
Aristida purpurea	Purple threeawn	P	N	ARPU	2.00	2.67	--
Bouteloua aristidoides	Needle grama	A	N	BOAR	2.67	3.33	21.33
Bouteloua barbata	Six-weeks grama	A	N	BOBA2	1.33	1.33	--
Sporobolus cryptandrus	Sand dropseed	P	N	SPCR	2.00	--	--
Sporobolus contractus	Spike dropseed	P	N	SPCO4	1.33	--	--
Bothriochloa ischaemum	Yellow bluestem	P	I	BOIS	0.67	--	--
Bouteloua curtipendula	Sideoats grama	P	N	BOCU	--	10.67	--
Forbs							
Chamaesyce albomarginata	Rattlesnake weed	P	N	CHAL11	1.33	--	0.67
Tribulus terrestris	Puncturevine	A	I	TRTE	--	--	--
Tidestromia lanuginosa	Woolly tidestromia	A	N	TILA2	0.67	--	1.33
Dimorphocarpa wislizeni	Spectaclepod	A	N	DIWI2	--	0.67	2.00
Baileya multiradiata	Desert marigold	A	N	BAMU	--	1.33	--
Amaranthus acanthochiton	Green str. amaranth	A	N	AMAC	--	--	4.00
Boerhavia coulteri	Coulter's spiderling	A	N	BOCO2	--	--	10.00
Chamaesyce prostrata	Spurge	A	N	CHPR	--	--	1.33
Shrubs							
Gutierrezia sarothrae	Broom snakeweed	P	N	GUSA	2.00	1.33	--
Psorothamnus scoparius	Broom dalea	P	N	PSSC	--	4.67	--
Chilopsis linearis	Desert Willow	P	N	CHLI2	--	1.33	--
Atriplex canescens	Fourwing saltbush	P	N	ATCA	--	--	0.67
Yucca elata	Soaptree yucca	P	N	YUEL	--	--	0.67
Ephedra trifurca	Longleaf jointfir	P	N	EPTR	--	--	0.67

*-- Indicates that plant was not observed during belt transect

3.2 Basal Cover

3.2.1 Tailing Impoundment basal cover

The tailings mean basal cover was 8.0% ± 6.5%, which is significantly larger than 70% of the basal coverage of the reference site. The relative basal cover consists primarily of two perennial grasses, 66.67% of which are sideoats grama and 16.67% of which are purple threeawn. Total perennial basal cover at the tailings site was 6.7% ± 7.3%.Needle grama (*Bouteloua aristidoides*), an annual grass, had a relative basal cover of 16.67%.

3.2.2 Borrow Pit basal cover

The mean basal cover at the borrow pit site was 3.3% ± 5.4%. The perennial grasses purple three-awn and sand dropseed accounted for 60% of the relative total basal cover on the borrow pit site. The total perennial basal cover at the tailings site was 2.0% ± 4.3%. The remaining 40% of the relative total basal cover consisted entirely of the annual grass six-weeks grama (*Bouteloua barbata*).

3.2.3 Reference basal cover

The basal cover mean percentage for the reference site was 4.0% ± 4.4%. The relative basal cover is primarily needle grama (*Bouteloua aristidoides*) 66.67% which is an annual grass. The rest of the relative basal coverage consists of forbs. Spectacle pod had a relative basal coverage of 16.67% and green stripe amaranth had 16.67% coverage. No perennial basal coverage was recorded on the reference site.

Table 4 - Basal Cover Percentages by Species for Sites at Deming Mill Property for 2019 Vegetation Monitoring

Scientific Name	Common Name	Duration	Native Status	Code	Borrow Pit Site	Tailings Site	Reference Site
Grasses							
Dasyochloa pulchella	Low woollygrass	P	N	DAPU7	--	--	--
Aristida purpurea	Purple threeawn	P	N	ARPU	0.67	1.33	--
Bouteloua aristidoides	Needle grama	A	N	BOAR	--	1.33	2.67
Bouteloua barbata	Six-weeks grama	A	N	BOBA2	1.33	--	--
Sporobolus cryptandrus	Sand dropseed	P	N	SPCR	1.33	--	--
Sporobolus contractus	Spike dropseed	P	N	SPCO4	--	--	--
Bothriochloa ischaemum	Yellow bluestem	P	I	BOIS	--	--	--
Bouteloua curtipendula	Sideoats grama	P	N	BOCU	--	5.33	--
Forbs							
Chamaesyce albomarginata	Rattlesnake weed	P	N	CHAL11	--	--	--
Tribulus terrestris	Puncturevine	A	I	TRTE	--	--	--
Tidestromia lanuginosa	Woolly tidestromia	A	N	TILA2	--	--	--
Dimorphocarpa wislizeni	Spectaclepod	A	N	DIWI2	--	--	0.67
Baileya multiradiata	Desert marigold	A	N	BAMU	--	--	--
Amaranthus acanthochiton	Green str. amaranth	A	N	AMAC	--	--	0.67
Boerhavia coulteri	Coulter's spiderling	A	N	BOCO2	--	--	--
Chamaesyce prostrata	Spurge	A	N	CHPR	--	--	--
Shrubs							
Gutierrezia sarothrae	Broom snakeweed	P	N	GUSA	--	--	--
Psorothamnus scoparius	Broom dalea	P	N	PSSC	--	--	--
Chilopsis linearis	Desert Willow	P	N	CHLI2	--	--	--
Atriplex canescens	Fourwing saltbush	P	N	ATCA	--	--	--
Yucca elata	Soaptree yucca	P	N	YUEL	--	--	--
Ephedra trifurca	Longleaf jointfir	P	N	EPTR	--	--	--

*-- Indicates that plant was not observed during belt transect

3.3 Shrub Density

3.3.1 Tailing Impoundment Shrub Density

The mean number of shrubs/acre is 1436 ± 1343 for the Tailings Site. Only two shrub species were recorded during the belt transects at the tailings site. Broom snakeweed was the most prevalent shrub during the transects, as it was observed 110 times at the tailings site. The next most common shrub present during the transects was broom dalea which was recorded 32 times.

3.3.2 Borrow Pit Shrub Density

For the Borrow Pit Site, the shrub density mean was 4300 ± 3012 shrubs/acre. Four shrub species were observed at the Borrow Pit Site. The most prevalent species at the site was *Gutierrezia sarothrae* at 419 observations. Other species of shrubs observed on the site were *Ephedra trifurca*, *Yucca elata,* and *Psorothamnus scoparius.*

3.3.3 Reference Shrub Density

For the Reference Site, the shrub density mean was 435 ± 420 shrubs/acre. Forty-three individual shrubs were observed at the Reference Site during the belt transects. The most prevalent species was Broom dalea at 37 observations. Two other species of shrubs were observed on the site. The two other shrubs observed were *Ephedra trifurca*, and *Gutierrezia sarothrae.*

Table 5 - Shrub Density by Species as Shrubs per Acre for Sites at Deming Mill Property for 2019 Vegetation Monitoring

Scientific Name	Common Name	Native Status	Code	Borrow Pit Individual Shrubs	Tailing Impoundment Individual Shrubs	Reference Area Individual Shrubs	Borrow Pit Density (Stems/Acre)	Tailing Impoundment Density (Stems/Acre)	Reference Area Density (Stems/Acre)
Gutierrezia sarothrae	Broom snakeweed	N	GUSA2	419	110	1	4239.08	1112.89	10.12
Yucca elata	Soaptree yucca	N	YUEL	1	--	--	10.12	--	--
Psorothamnus scoparius	Broom dalea	N	PSSC6	4	32	37	40.47	323.75	374.33
Ephedra trifurca	Longleaf jointfir	N	EPTR	1	--	5	10.12	--	50.59

*-- Indicates that plant was not observed during belt transect

3.4 Diversity

The Simpson's Diversity Index (C) was also computed for the revegetation and Reference Sites. This formula was outlined in the vegetation monitoring standards provided by the MMD.

The Simpson's Index value C decreases as diversity increases. This value is usually reported as its complement 1-C. In this report the original Simpsons Index value C and the compliment 1-C is reported. The complement to the Simpson's Index 1-C rises as diversity and evenness rises (Simpson 1949, Magurran 2004).

3.4.1 Tailing Impoundment Diversity

At the tailings site, 10 plant species were present during both surveys.The Simpson's index for the site was C= 0.259, and the compliment 1-C=0.741 which indicated that the tailings site had greater species diversity than the reference site. The tailings site met the success standard requirements for individual cover percentages for shrubs and also for non-weedy native forbs. Three species of perennial shrubs were recorded during the line-point intercept survey and each species met the individual canopy cover requirements and each exceeded the 0.5% coverage requirement. Both species of non-weedy native forbs exceeded the success criteria individual canopy cover percentages. Spectacle pod had an individual cover percentage of 0.67% and desert marigold had a cover percentage of 1.34% which both exceed the 0.1% requirement. However, it did not exceed the requirements for individual warm perennial grass cover even though three species were observed due to one of the species (low woollygrass) had 0.67% individual cover which is below the 1% cover requirement. The other two grass species had individual cover percentages of 10.67% (sideoats grama) and 2.67% (purple threeawn).

3.4.2 Borrow Pit Diversity

A total of 14 plant species were recorded at the borrow pit site; 11 were observed while conducting the line-point intercept survey and 3 additional species were observed during the belt transects. Using the Simpson's Diversity index, the greatest species diversity was observed at the borrow pit site. The borrow pit site met the success criteria for individual cover percentages for warm-season perennial grasses with four different species each having greater than 1% cover. The success criteria for non-weedy native forbs was also met at the Borrow Pit site with two species each with cover that exceeded 0.1%. The Borrow Pit did not exceed the requirements for individual shrub cover since only one species of shrub was recorded during the surveys. Two shrub species are required and their individual overall cover must each exceed 0.5%. However, the one species that was observed had a percent cover of 2.0% which far exceeded the 0.5% performance standard.

3.4.3 Reference Diversity

Twelve plant species were recorded at the reference site during the surveys. Ten (10) were recorded during the line-point intercept transects and two additional species were observed during the belt transects that were not in the line-point intercept. The C index for the reference site was calculated and is 0.326, with the complement 1-C = 0.674. The Simpson Diversity Index indicated that the reference site was the least diverse of the sites. The reference site did not exceed the vegetation success standard for individual cover percentages for the class type warm perennial grasses which requires that at least three species be present with an individual canopy cover of 1%. No perennial grasses were observed on the reference site. The reference site is supposed to be an undisturbed site that is used as a comparative site to the revegetated sites. The reference site did exceed the revegetation success criteria provided in the MMD guidance for having greater than two species of perennial shrubs at an individual cover percentage greater than 0.5%, and for having more than two species of native non-weedy forbs each at an individual cover percentage greater than 0.1%.

4.0 STATISTICAL ANALYSIS METHODS

Analysis of the Deming Mill monitoring data was performed according to the methods specified in New Mexico Energy, Minerals and Natural Resources Department Mining and Minerals Division 19.8 NMAC Attachment 1, Coal Mine Reclamation Program Vegetation Standards (MMD 1999). All statistical analyses were completed in Excel (Microsoft 2016). In the previous report for the 2019 Vegetation Success Monitoring dated January 20, 2020, statistical analyses were run utilizing the "R" software environment for statistical computing and graphics. Reanalysis of the data was deemed necessary to include the additional parameters of Perennial canopy and basal cover. In addition, the reanalysis will ensure continuity between the 2019 data and the 2020 data.

4.1 Sample Adequacy

The Cochran formula (1977) was applied to percent canopy cover data collected in 2019 at the Deming Mill Tailing impoundment site to determine *n*, an estimate of the number of transects to be collected. Cochran's was performed during the reanalysis of the data. Only 10 samples were taken at each site and it was determined during the reanalysis that sample adequacy was not met for the 2019 data sampling. The test yielded an estimate of 32 transects for the Tailings Site, 40 transects for the Borrow Pit Site, and 18 transects for the Reference Site. Statistical analysis was performed on the data despite the sample adequacy criteria not met.

4.2 Tests of Normality

Because the statistical procedures used to analyze the Deming Mill monitoring data are based on the assumption that the data follow a normal distribution, parameter estimates were visually inspected and the Shapiro-Wilk Expanded Test (1965) was performed to assess normality of canopy cover, perennial canopy cover, basal cover, perennial basal cover, and shrub density for each of the sites separately.

4.3 Hypothesis Tests

In order to evaluate the 2019 Deming Mill monitoring data against the revegetation success criteria required by MMD Permit LU008RE Mod 18-1 (Table 2), the one-sample, one-sided Student's *t*-test (Neter et al. 1985) was performed on normal data. The only parameter that was determined to be of a normal distribution was the shrub density data. The test compared whether shrub density at the Tailings Site and the Borrow Pit Site was equal to or greater than the 60% of the shrub density at the Reference Site. The parameters canopy cover, perennial canopy cover, basal cover, and perennial basal cover were not normally distributed. Transformations could not improve the data for the various cover parameters so the Wilcoxon non-parametric one-sample hypothesis test was used to evaluate if the multiple cover parameters measured at the Tailings Site and the Borrow Pit Site was equal to or greater than the 70% of the cover at the Reference Site. Formulae and assumptions are provided in Appendix C.

5.0 STATISTICAL ANALYSIS RESULTS

The summary statistics for vegetation success monitoring are presented in Table 6 below. Data analysis results are presented in the following section and in Appendix C.

Table 6 - 2019 Vegetation Monitoring Summary Statistics

Parameter	Reference Area	Borrow Pit	Tailings
Canopy Cover			
Mean	42.7	17.3	28.0
Standard Deviation	15.3	11.6	14.2
Number of Samples	10	10	10
p-value	--	0.005	0.459
Standard Met	--	No	No
Perennial Canopy Cover			
Mean	2.7	12.7	21.3
Standard Deviation	3.3	8.7	16.3
Number of Samples	10	10	10
p-value	--	0.003	0.003
Standard Met	--	Yes	Yes
Basal Cover			
Mean	4.0	3.3	8.0
Standard Deviation	4.4	5.4	6.5
Number of Samples	10	10	10
p-value	--	0.375	0.014
Standard Met	--	No	Yes
Perennial Basal Cover			
Mean	0	2.0	6.7
Standard Deviation	0	4.3	7.3
Number of Samples	10	10	10
p-value	--	0.910	0.002
Standard Met	--	No	Yes
Shrub Density (Shrubs/Acre)			
Mean	435	4300	1437
Standard Deviation	420	3012	1344
Number of Samples	10	10	10
p-value	--	0.001	0.011
Standard Met	--	Yes	Yes

5.1 Data Analysis Results

5.1.1 Sample Adequacy

More transects were needed to achieve 90% confidence that the sample means for percent canopy cover, percent perennial canopy cover, percent basal cover, percent perennial basal cover, and shrub density for both the Tailings Site and the Reference Site lie within 10% of the true population means (Appendix C, Table C-1).

5.1.2 Tests of Normality

The assessment indicated that shrub density was normally distributed for the Tailings Site, Borrow Pit Site, and the Reference Site. None of the other cover parameters were normally distributed and could not be improved through numerical transformation (Appendix C, Table C-2).

5.1.3 Hypothesis Tests

Table C-3 in Appendix C indicates that the shrub density at Tailings Site and Borrow Pit Site are significantly greater than 60% of shrub density at the Reference Site ($t_{calculated} > t_{critical}$, $d.f. = 9$, $p = 0.1$). Table C-4 in Appendix C details the findings of the Wilcoxon non-parametric tests and indicates that canopy cover at the Tailings Site (p=0.459) and Borrow Pit Site (p= 0.005) are not significantly greater than 70% of canopy cover at the Reference Site . However, it does indicate that perennial canopy cover at the Tailings Site perennial coverage (p=0.003) was greater than the Reference site. Additionally, the Borrow Pit perennial cover (p=0.003) was also significantly greater than 70% of the perennial canopy cover at the Reference Site. The basal cover percentage is also greater at the treatment sites than the Reference Site. The basal cover at the Tailings Site (p=0.014) is significantly greater than the Reference but the basal cover at the Borrow Pit (p=0.375) is greater but not significantly greater. However, it does exceed the reference standard. Tailings perennial basal cover (p=0.002) is significantly greater than the reference site. The Borrow Pit basal perennial cover was greater than the Reference Site, but not significantly greater (p=0.910)

6.0 DISCUSSION

The results of the surveys at the three monitoring sites seemed to suggest they were each unique thereby rendering difficult any legitimate conclusions about the relative success of revegetation efforts by comparison of the sites.

When analyzed closely, the canopy cover at both the Tailings site and Borrow Pit site was primarily composed of perennial grasses, which was expressed again in terms of the significantly higher percentages of basal coverage found on the Tailings site. The surveys at the reference site also revealed a species composition of primarily shrubs and forbs, and no perennial grasses, which is evidence of severe past disturbance and may be relatively unstable. By contrast, the treatment sites, particularly the tailings site, were found to have greater species richness with a diverse array of grasses, as a result of seeding efforts, which overtime will prove to be more stable for the proposed PMLU for wildlife. According to the USDA: *"Basal cover is simply the area covered by plant bases. It is generally a more reliable long-term indicator than canopy cover because it is less affected by growing season, drought, grazing or other short-term disturbances. Changes in total basal cover should be interpreted in the context of changes in species composition. In areas with the potential to support perennial grassland, an increase in basal cover due to a change in species composition usually (but not always) indicates an improvement in biotic integrity. This is because perennial grasses tend to have higher basal cover than shrubs."* (Herrick, 2005).

Shrub densities at the treatment sites were also quantified and both sites were found to meet the revegetation success criteria and to have a significantly higher shrub density than the reference site. The borrow pit site had nearly 10 times the shrub density as the reference site and the tailing site exceeded shrub density of the reference site more than threefold. The species composition partly explains this dramatic difference. Broom snakeweed, which was by far the most prevalent shrub in the borrow pit, is a native perennial shrub that is often found growing in colonies that quickly spread during the early successional stages of a disturbed site with poor soils, such as that of the borrow pit. By contrast, the abundance of broom snakeweed was dramatically lower at the reference site, which is representative of later-succession, shrub-invasion vegetation type found at the reference site.

Diversity amongst the sites was also compared. Although the total number of species observed each site during the surveys were 14 species at the borrow pit site, 10 species at the tailings site, and 12 at the reference site, the Simpson’s diversity index indicated that the borrow pit site had the highest diversity followed by the tailings site, with the lowest diversity present on the reference site. The Simpson’s diversity index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. Therefore, sites with more individuals of more species will rank higher in the index calculation. Again, the relative diversity of grasses resulting from the seeding efforts, combined with the abundance of broom snakeweed at the borrow pit site provided an advantage in terms of species diversity. Overall the revegetation sites have higher diversity than the reference site.

The MMD also provided plant class cover criteria as a measure of diversity. Plant species diversity on the tailings and borrow pit sites was also quantified by different plant classes meeting minimum species abundance and coverage criteria. None of the revegetation sites nor the reference site met all of the requirements imposed by the MMD standards. The borrow pit site met the success standard requirements for 2 out of the 3 criteria. The tailings site also met 2 out of the 3 success standard requirements, and the reference site also met 2 of the 3 criteria. The same two sets of criteria were not met for any pair of sites, suggesting that all three sites were basically unique.

It stands to reason that the comparison of the single variable of canopy cover of the treatment sites to the reference site was perhaps irrelevant and should not be the singular criteria that determines the effectiveness (*i.e.* “success”) of revegetation efforts. Basal coverage and perennial coverage should be given equal weight in the judgement of performance of the revegetation effort. This being the case with regard to the Deming Mill Tailings Impoundment and Borrow Pit revegetation sites, it is believed that although these treatment sites do not exceed the performance standards *sensu stricto*, the revegetation efforts at these sites are indeed successful in terms of improving the overall biotic integrity of the sites and improving the sites abilities to withstand erosion, drought, and other short-term disturbances that might be expected with a PMLU of wildlife use.

7.0 RECOMMENDATIONS

MMD requires a minimum of two years of revegetation success monitoring to show that revegetation success criteria have been met and to determine if the site can be considered a self-sustaining ecosystem as stated by the PMLU wildlife description. It is recommended that the second round of monitoring be conducted in the fall of 2020 and that the same analytical testing regime be repeated. It is also recommended that more samples be obtained during the 2020 round of monitoring in order to provide stronger statistical validation to the observations. Finally, the relevance of additional success criteria measures (*e.g.* basal cover) should be taken into consideration to be used in the judgement of revegetation success. An alternative approach to determining vegetation success could be development of performance standards utilizing a technical standard derived from a literature search.

While the field survey methods would basically remain the same, the development of a technical standard through literature review could result in equally unclear performance standards due to the widely variable nature of ecological restoration and interpretation of restoration objectives.

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APPENDIX A - MAPS

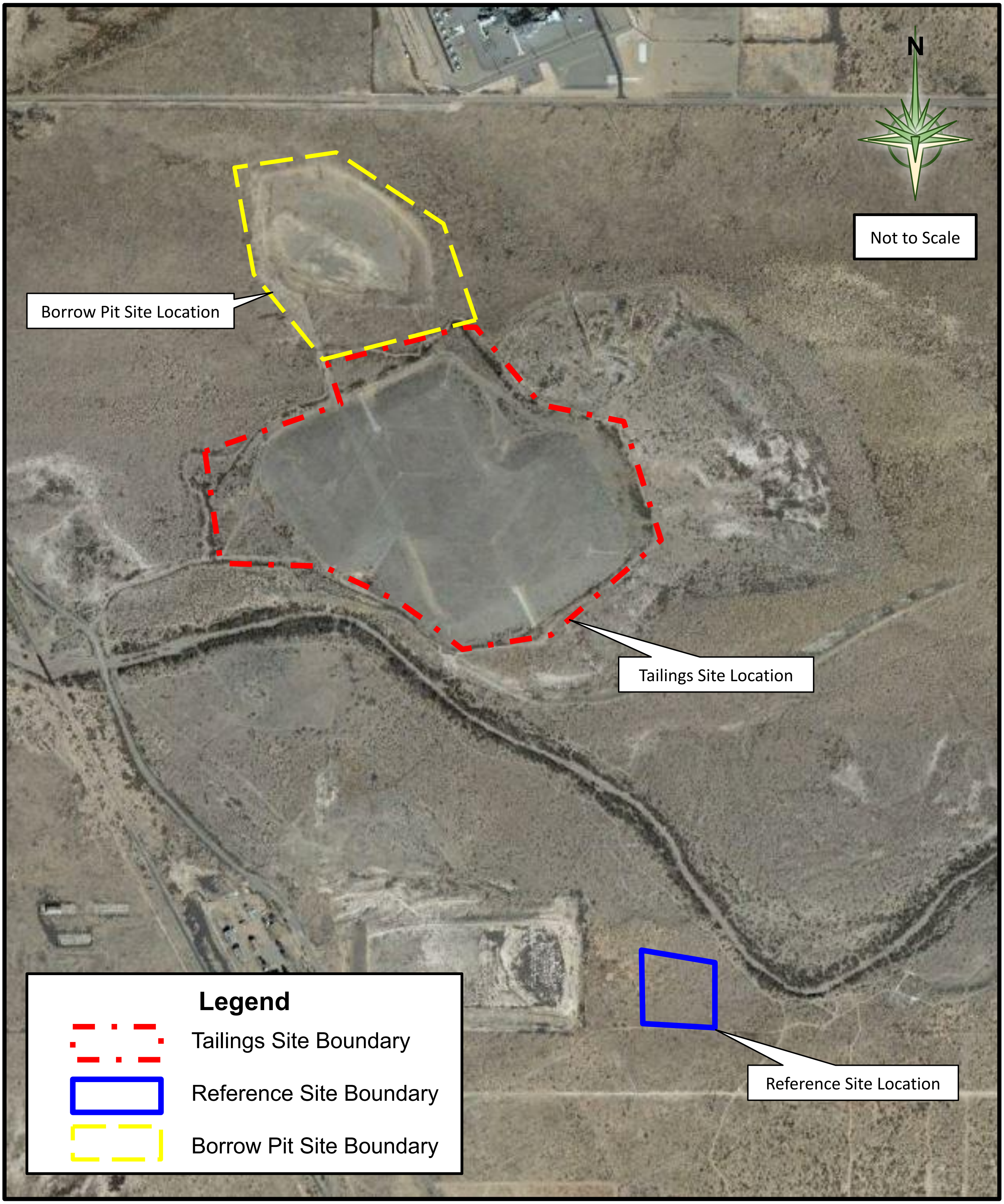

FIGURE 1 Aerial Photograph © Google Earth 2011	DEMING MILL TAILING VEGETATION SUCCESS MONITORING - 2019 SITE LOCATIONS Deming, New Mexico	High Desert NATIVE PLANTS LLC 5404 FLEETWOOD RD EL PASO, TX 79932 HIGHDESERTNATIVEPLANTS.COM

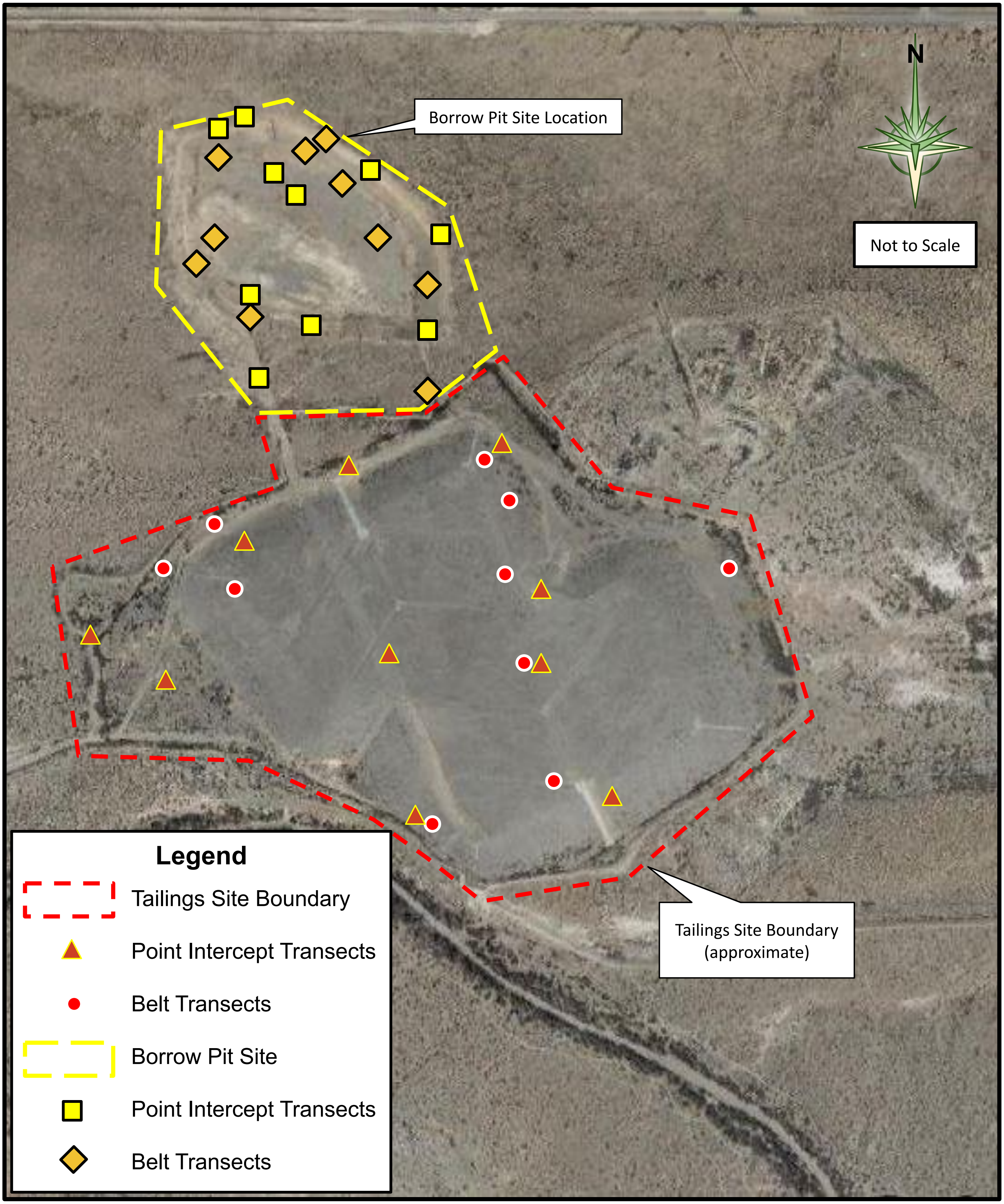

FIGURE 2 Aerial Photograph © Google Earth 2011	DEMING MILL TAILING VEGETATION SUCCESS MONITORING - 2019 TAILINGS & BORROW PIT SITE TRANSECT LOCATIONS Deming, New Mexico	High Desert NATIVE PLANTS LLC 5404 FLEETWOOD RD EL PASO, TX 79932 HIGHDESERTNATIVEPLANTS.COM

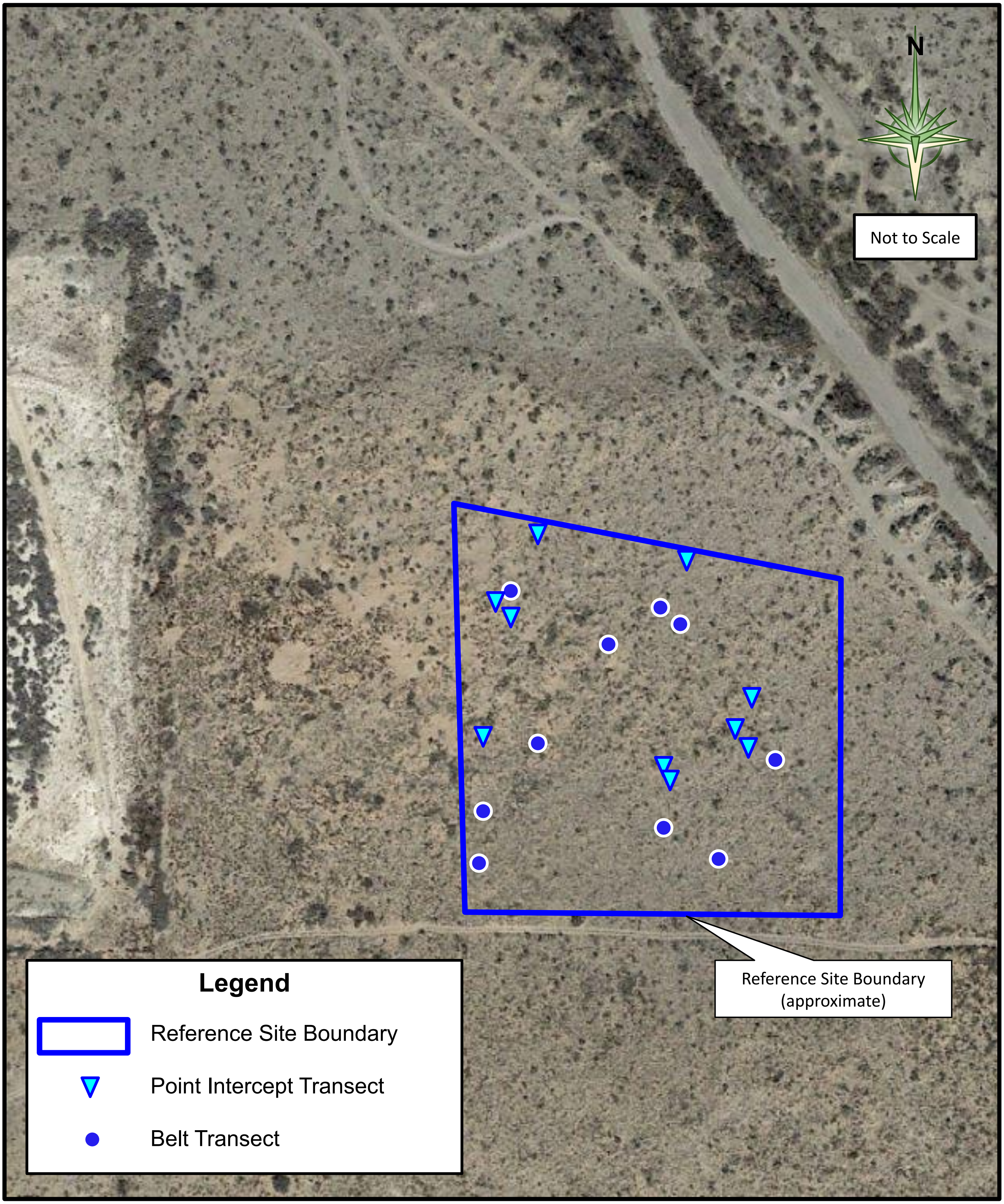

FIGURE 3 Aerial Photograph © Google Earth 2011	DEMING MILL TAILING VEGETATION SUCCESS MONITORING - 2019 REFERENCE SITE TRANSECT LOCATIONS Deming, New Mexico	High Desert NATIVE PLANTS LLC 5404 FLEETWOOD RD EL PASO, TX 79932 HIGHDESERTNATIVEPLANTS.COM

APPENDIX B - DATA SHEETS

LINE POINT INTERCEPT

Line-point Intercept Data Form

Page 1 of 30
Plot:Borrow Pit Line #: 1 Direction: W to E Observer: Lara Date: Recorder:Lara Intercept (Point) Spacing = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None				S	26					
2	None				R	27					
3	None				R	28					
4	None				S	29					
5	None				S	30					
6	DAPU7				S	31					
7	None				R	32					
8	None				S	33					
9	CHAL11				S	34					
10	None				S	35					
11	None				S	36					
12	None				S	37					
13	None				S	38					
14	None	L			S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 2 of 30
Plot:Borrow Pit Line #: 2 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None				S	26					
2	None				S	27					
3	DAPU7				R	28					
4	None				S	29					
5	None	WL			S	30					
6	None				S	31					
7	None	L			S	32					
8	GUSA	L			S	33					
9	None				R	34					
10	None				S	35					
11	None				S	36					
12	None				S	37					
13	None				S	38					
14	None	L			S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 3 of 30
Plot:Borrow Pit Line #: 3 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
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2	None				S	27					
3	DAPU7				S	28					
4	None				S	29					
5	DAPU7				S	30					
6	None				S	31					
7	None				S	32					
8	None				S	33					
9	None				S	34					
10	None				S	35					
11	None				S	36					
12	None				S	37					
13	None				S	38					
14	None				S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 4 of 30
Plot:Borrow Pit Line #: 4 Direction: W to E Observer: Lara Date: Recorder:Lara Intercept (Point) Spacing Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
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1	None				R	26					
2	None				S	27					
3	None				S	28					
4	None				S	29					
5	None	L			S	30					
6	DAPU7	TRTE			S	31					
7	None				S	32					
8	None				S	33					
9	None				R	34					
10	None				S	35					
11	None				S	36					
12	None				S	37					
13	None				S	38					
14	None				R	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 5 of 30
Plot:Borrow Pit Line #: 5 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

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2	None	WL	L		S	27					
3	None	WL	L		S	28					
4	ARPU	WL	L		S	29					
5	None				S	30					
6	ARPU	WL			S	31					
7	None				S	32					
8	None				S	33					
9	BOAR	L			S	34					
10	TILA2				S	35					
11	None	L			S	36					
12	None				S	37					
13	None				S	38					
14	BOBA2				BOBA2	39					
15	None	WL			S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 6 of 30

Plot:Borrow Pit | Line #: 6 | Direction: W to E | Observer: Lara | Date: | Recorder:Lara | Intercept (Point) Spacing Interval = 100cm (in)

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		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
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2	None	L			S	27					
3	None	L			S	28					
4	SCPR				SCPR	29					
5	None	L			S	30					
6	SCPR	SCPO4	L		S	31					
7	SCPR				SCPR	32					
8	None				S	33					
9	None				S	34					
10	None	WL			S	35					
11	None	L			S	36					
12	SCPO4				S	37					
13	SCPO4				S	38					
14	None				S	39					
15	None	L			S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 7 of 30
Plot:Borrow Pit Line #: 7 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

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2	None				S	27					
3	None				S	28					
4	None				S	29					
5	None	L			S	30					
6	None				S	31					
7	None				S	32					
8	None	L			R	33					
9	None				S	34					
10	None				R	35					
11	None				S	36					
12	BOIS				R	37					
13	None				S	38					
14	None				S	39					
15	None				R	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 8 of 30
Plot:Borrow Pit | Line #: 8 | Observer: Lara | Recorder:Lara
Direction: W to E | Date: | Intercept (Point) Spacing
Interval = 100cm (in)

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2	CHAL11				S	27					
3	None				S	28					
4	None				S	29					
5	GUSA	L			S	30					
6	None				S	31					
7	None				S	32					
8	None				S	33					
9	None				S	34					
10	None				S	35					
11	None				S	36					
12	None				S	37					
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16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 9 of 30
Plot:Borrow Pit Line #: 9 Direction: W to E Observer: Lara Date: Recorder:Lara Intercept (Point) Spacing Interval = 100cm (in)

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2	GUSA	L			S	27					
3	None				S	28					
4	None				R	29					
5	None				R	30					
6	None				R	31					
7	None				R	32					
8	BOBA2				BOBA2	33					
9	None				S	34					
10	None				S	35					
11	None				S	36					
12	None				R	37					
13	None				S	38					
14	None				S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 10 of 30
Plot:Borrow Pit | Line #: 10 | Observer: Lara | Recorder:Lara
Direction: W to E | Date: | Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None				S	26					
2	None				R	27					
3	None				R	28					
4	None				R	29					
5	None				S	30					
6	None				R	31					
7	None				S	32					
8	BOAR	L			S	33					
9	None				S	34					
10	BOAR	L			S	35					
11	None	L			S	36					
12	None				S	37					
13	None				S	38					
14	None	L			S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 11 of 30
Plot:Tailings Line #: 11 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	BOAR				BOAR	26					
2	None	L			S	27					
3	None	L			S	28					
4	None				S	29					
5	None	L			S	30					
6	GUSA	L			S	31					
7	None	L			S	32					
8	None				R	33					
9	None				R	34					
10	BOAR	L			S	35					
11	None				S	36					
12	BOAR				R	37					
13	None				S	38					
14	None				S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 12 of 30
Plot:Tailings Line #: 12 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None	L			S	26					
2	DAPU7	L			R	27					
3	None	L			S	28					
4	PSSC	WL			R	29					
5	PSSC	WL	L		S	30					
6	PSSC	WL	L		S	31					
7	PSSC	ARPU	L		S	32					
8	None				R	33					
9	None	L			R	34					
10	None	L			R	35					
11	BOCU				BOCU	36					
12	None				R	37					
13	BOCU				BOCU	38					
14	None				R	39					
15	None				R	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 13 of 30
Plot:Tailings Line #: 13 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None				S	26					
2	None				S	27					
3	None				S	28					
4	None				R	29					
5	None				S	30					
6	PSSC	L			S	31					
7	None				S	32					
8	None				S	33					
9	None				S	34					
10	None				R	35					
11	None				S	36					
12	None				S	37					
13	None				S	38					
14	None	L			S	39					
15	None				R	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 14 of 30
Plot:Tailings | Line #: 14 | Direction: W to E | Observer: Lara | Date: | Recorder:Lara | Intercept (Point) Spacing Interval = 100cm (in)

Pt.	Top layer	Lower layers Code 1	Lower layers Code 2	Lower layers Code 3	Soil surface	Pt.	Top layer	Lower layers Code 1	Lower layers Code 2	Lower layers Code 3	Soil surface
1	None				R	26					
2	None				R	27					
3	None				R	28					
4	None				R	29					
5	None				R	30					
6	None				R	31					
7	None				R	32					
8	None				R	33					
9	None				R	34					
10	CHLI2				R	35					
11	None				R	36					
12	None				R	37					
13	None				R	38					
14	None				R	39					
15	GUSA	BOCU	L		R	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 15 of 30
Plot:Tailings Line #: 15 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None				S	26					
2	None	L			S	27					
3	None				S	28					
4	None				S	29					
5	None				S	30					
6	None				S	31					
7	DIWI2				S	32					
8	BOAR				BOAR	33					
9	BOAR	L			S	34					
10	None				S	35					
11	None	L			S	36					
12	None				S	37					
13	None				S	38					
14	None				S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 16 of 30
Plot:Tailings Line #: 16 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	BOCU	L			R	26					
2	None				S	27					
3	BOCU				BOCU	28					
4	None				R	29					
5	BOCU	L			R	30					
6	None				R	31					
7	None				R	32					
8	BOCU	L			R	33					
9	None	L			R	34					
10	BOCU	L			R	35					
11	None	L			R	36					
12	None				R	37					
13	None	L			R	38					
14	BOCU	L			R	39					
15	BOCU	L			R	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 17 of 30

Plot:Tailings | Line #: 17 | Direction: W to E | Observer: Lara | Date: | Recorder:Lara | Intercept (Point) Spacing Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	BAMU	L			R	26					
2	ARPU	L			R	27					
3	None				R	28					
4	BOCU				BOCU	29					
5	BAMU	L			R	30					
6	None				R	31					
7	ARPU				R	32					
8	None				S	33					
9	None				R	34					
10	None	L			S	35					
11	None				R	36					
12	None				R	37					
13	ARPU				ARPU	38					
14	ARPU				ARPU	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 18 of 30
Plot:Tailings Line #: 18 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None				R	26					
2	None	L			S	27					
3	None				R	28					
4	None				R	29					
5	None				R	30					
6	None				R	31					
7	None	L			S	32					
8	BOCU				BOCU	33					
9	None	L			S	34					
10	CHLI2	BOCU			BOCU	35					
11	None				R	36					
12	None				R	37					
13	None				R	38					
14	None	L			R	39					
15	None				R	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 19 of 30
Plot:Tailings Line #: 19 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None				R	26					
2	PSSC	L			R	27					
3	BOBA2	L			R	28					
4	None				R	29					
5	None				S	30					
6	None	L			R	31					
7	BOBA2	L			S	32					
8	None				R	33					
9	PSSC	L			R	34					
10	None	L			R	35					
11	None				R	36					
12	None				R	37					
13	None	L			R	38					
14	None				R	39					
15	None				R	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 20 of 30
Plot:Tailings Line #: 20 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None	L			R	26					
2	BOCU	L			R	27					
3	None				R	28					
4	BOCU	L			R	29					
5	None	L			R	30					
6	BOCU				BOCU	31					
7	None				R	32					
8	None				S	33					
9	None				R	34					
10	BOCU	L			R	35					
11	None				R	36					
12	None				R	37					
13	None	L			R	38					
14	BOCU	L			BOCU	39					
15	None	L			R	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 21 of 30
Plot:Reference Line #: 21 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None				S	26					
2	None	L			S	27					
3	None				S	28					
4	None	WL	L		S	29					
5	None				S	30					
6	None				S	31					
7	None				S	32					
8	ATCA	WL			S	33					
9	None				S	34					
10	None				S	35					
11	None				S	36					
12	None				AMAC	37					
13	AMAC				S	38					
14	None				S	39					
15	None	L			S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 22 of 30
Plot:Reference
Line #: 22
Direction: W to E
Observer: Lara
Date:
Recorder:Lara
Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers Code 1	Code 2	Code 3	Soil surface	Pt.	Top layer	Lower layers Code 1	Code 2	Code 3	Soil surface
1	BOCO2	L			S	26					
2	None	L			S	27					
3	None	L			S	28					
4	AMAC				S	29					
5	AMAC				S	30					
6	None				S	31					
7	CHAL11				S	32					
8	CHPR				S	33					
9	AMAC				S	34					
10	None				S	35					
11	AMAC				S	36					
12	None				S	37					
13	None				S	38					
14	None				S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 23 of 30
Plot:Reference Line #: 23 Direction: W to E Observer: Lara Date: Recorder:Lara Intercept (Point) Spacing Interval = 100cm (in)

Pt.	Top layer	Lower layers Code 1	Code 2	Code 3	Soil surface	Pt.	Top layer	Lower layers Code 1	Code 2	Code 3	Soil surface
1	None	L			S	26					
2	YUEL				S	27					
3	BOCO2				S	28					
4	None	L			S	29					
5	None				S	30					
6	None				S	31					
7	BOCO2	WL			S	32					
8	None				S	33					
9	BOAR				S	34					
10	None				S	35					
11	CHPR	L			S	36					
12	BOAR				S	37					
13	DIWI2				S	38					
14	BOCO2				S	39					
15	None	L			S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 24 of 30
Plot:Reference Line #: 24 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None	L			S	26					
2	BOAR	L			S	27					
3	BOAR	L			S	28					
4	None				S	29					
5	None	WL			S	30					
6	None	WL	L		S	31					
7	None				S	32					
8	BOAR				S	33					
9	None	L			S	34					
10	BOAR				BOAR	35					
11	BOAR	L			S	36					
12	None				S	37					
13	BOAR	L			S	38					
14	None	L			S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 25 of 30
Plot:Reference Line #: 25 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None				S	26					
2	BOAR	L			S	27					
3	DIWI2				DIWI2	28					
4	None				S	29					
5	None				S	30					
6	None				S	31					
7	BOAR				S	32					
8	BOAR	L			S	33					
9	BOAR				BOAR	34					
10	None				S	35					
11	BOAR				S	36					
12	BOCO2	L			S	37					
13	None				S	38					
14	TILA2	L			S	39					
15	None	L			S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 26 of 30
Plot:Reference Line #: 26 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	BOAR	L			S	26					
2	BOAR				S	27					
3	BOAR	L			S	28					
4	None	L			S	29					
5	BOAR	L			S	30					
6	BOAR	L			S	31					
7	BOAR	L			S	32					
8	BOAR	L			S	33					
9	None	L			S	34					
10	BOAR	L			S	35					
11	None	L			S	36					
12	None	L			S	37					
13	None	L			S	38					
14	BOAR	L			S	39					
15	BOAR				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form
Page 27 of 30
Shaded cells for calculations
Plot:Reference
Line #: 27
Direction: W to E
Observer: Lara
Date:
Recorder:Lara
Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None	L			S	26					
2	None				S	27					
3	None	L			S	28					
4	BOCO2	L			S	29					
5	None				S	30					
6	None	L			S	31					
7	None				S	32					
8	None				S	33					
9	BOCO2	L			S	34					
10	None				S	35					
11	BOCO2	L			S	36					
12	None				S	37					
13	BOCO2	L			S	38					
14	None				S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 28 of 30
Plot:Reference Line #: 28 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	BOAR				S	26					
2	None				S	27					
3	BOCO2	L			S	28					
4	BOCO2	L			S	29					
5	None	L			S	30					
6	None				S	31					
7	DIWI2				S	32					
8	None	L			S	33					
9	BOAR	L			S	34					
10	None	L			S	35					
11	BOCO2				S	36					
12	None				S	37					
13	BOCO2	L			S	38					
14	BOAR				BOAR	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 29 of 30
Plot:Reference | Line #: 29 | Direction: W to E | Observer: Lara | Date: | Recorder:Lara | Intercept (Point) Spacing Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	None				S	26					
2	BOAR	L			S	27					
3	None	L			S	28					
4	BOAR	L			S	29					
5	None	L			S	30					
6	None				S	31					
7	None	L			S	32					
8	None				S	33					
9	None	L			S	34					
10	None	L			S	35					
11	None	L			S	36					
12	None				S	37					
13	EPTR				S	38					
14	BOAR				S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

Line-point Intercept Data Form

Page 30 of 30
Plot:Reference Line #: 30 Observer: Lara Recorder:Lara
Direction: W to E Date: Intercept (Point) Spacing
Interval = 100cm (in)

Pt.	Top layer	Lower layers			Soil surface	Pt.	Top layer	Lower layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1	DIWI2	L			S	26					
2	BOAR				S	27					
3	None				S	28					
4	AMAC				S	29					
5	None				S	30					
6	None				S	31					
7	None				S	32					
8	None	WL			S	33					
9	BOAR				S	34					
10	BOAR				BOAR	35					
11	BOCO2	L			S	36					
12	None	L			S	37					
13	BOAR	L			S	38					
14	None				S	39					
15	None				S	40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

BELT TRANSECTS

Belt Transect Data Form
Monitoring plot: Reference Line #1 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:1									
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
NONE									

Belt Transect Data Form
Monitoring plot: Reference Line #2 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:2									
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
PSSC	12								

Belt Transect Data Form
Monitoring plot: Reference Line #3 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:3									
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
PSSC	1								

Belt Transect Data Form
Monitoring plot: Reference Line #4 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:4- None				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density

Belt Transect Data Form
Monitoring plot: Reference Line #5 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:5						Direction:			
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
PSSC	3								
GUSA	1								

Belt Transect Data Form
Monitoring plot: Reference Line #6 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:6						Direction:			
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
PSSC	7								
EPTR	4								

Belt Transect Data Form
Monitoring plot: Reference Line #7 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:7				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
PSSC	5								

Belt Transect Data Form
Monitoring plot: Reference Line #8 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:8				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
EPTR	1								
PSSC	4								

Belt Transect Data Form
Monitoring plot: Reference Line #9 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:9- None				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density

Belt Transect Data Form
Monitoring plot: Reference Line #10 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:10				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
PSSC	5								

Belt Transect Data Form
Monitoring plot: Tailings Line #11 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:11				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	3								
PSSC	1								

Belt Transect Data Form
Monitoring plot: Tailings Line #12 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:12- None				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density

Belt Transect Data Form
Monitoring plot: Tailings Line #13
Date:
Reader: Lara
Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:13				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
PSSC	1								

Belt Transect Data Form
Monitoring plot: Tailings Line #14
Date:
Reader: Lara
Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:14				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	19								
PSSC	1								

Belt Transect Data Form
Monitoring plot: Tailings Line #15
Date:
Reader: Lara
Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:15				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	14								
PSSC	8								

Belt Transect Data Form
Monitoring plot: Tailings Line #16
Date:
Reader: Lara
Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:16				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	17								

Belt Transect Data Form
Monitoring plot: Tailings Line #17
Date:
Reader: Lara
Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:17				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	2								
PSSC	3								

Belt Transect Data Form
Monitoring plot: Tailings Line #18
Date:
Reader: Lara
Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:18				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	1								
PSSC	1								

Belt Transect Data Form
Monitoring plot: Tailings Line #19
Date:
Reader: Lara
Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:19				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	21								
PSSC	10								

Belt Transect Data Form
Monitoring plot: Tailings Line #20
Date:
Reader: Lara
Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:20				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
PSSC	7								
GUSA	33								

Belt Transect Data Form
Monitoring plot: Borrow Pit Line #21 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:21				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	29								

Belt Transect Data Form
Monitoring plot: Borrow Pit Line #22 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:22				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	106								
YUEL	1								

Belt Transect Data Form
Monitoring plot: Borrow Pit Line #23 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:23				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	45								
PSSC	1								

Belt Transect Data Form
Monitoring plot: Borrow Pit Line #24 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:24				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	42								

Belt Transect Data Form
Monitoring plot: Borrow Pit Line #25 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:25				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	13								

Belt Transect Data Form
Monitoring plot: Borrow Pit Line #26 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:26				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	13								

Belt Transect Data Form
Monitoring plot: Borrow Pit Line #27 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:27				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	11								

Belt Transect Data Form
Monitoring plot: Borrow Pit Line #28 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:28				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	72								

Belt Transect Data Form
Monitoring plot: Borrow Pit Line #29 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:29				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	24								
PSSC	1								

Belt Transect Data Form
Monitoring plot: Borrow Pit Line #30 Date:
Reader: Lara Recorder:Lara
Transect area =40m2 (line length)20m (belt width)2m

Line:30				Direction:					
	Size class								
Species	A (tally marks)	Total	Density	B (tally marks)	Total	Density	C (tally marks)	Total	Density
GUSA	64								
PSSC	2								
EPTR	1								

APPENDIX C - STATISTICAL ANALYSIS

Appendix C

Sample Adequacy

In order to collect enough data during 2019 to achieve 90% confidence that the sample means for total live cover and shrub density lie within 10% of the true population means, the Cochran (1977) formula was calculated to obtain the minimum number of samples (n_{min}) required to estimate a parameter with this level of precision, These values were calculated after fieldwork for 2019 was completed and sample adequacy was not met for the 2019 monitoring year. Analysis was performed despite sample adequacy requirements not being met.

$$n_{\min} = t^2 s^2 / (0.1\bar{x})^2$$

where:

- t is the tabular t value for a preliminary sample with n-1 degrees of freedom and a two-tailed significance level of α = 0.10,
- s is the standard deviation of a preliminary sample, and
- $\bar{x}$ is the sample mean of a preliminary sample.

Because the Cochran formula requires that the underlying data are normally distributed, basal percent cover and shrub density for both the Tailings Site and the Reference Site were transformed (see Data Analysis, Tests of Normality below).

Table C-1. Cochran's n_{min} for percent canopy cover for transects sampled in 2019 at the Tailings Site.

Sampling area	Parameter	Mean	Standard deviation	t	Cochran's n_{min}
Tailings Site (n = 10)	Canopy cover (%)	0.280	0.142	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	31.865*
	Perennial Canopy cover (%)	0.213	0.163	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	79.275*
	Basal cover (%)	0.080	0.065	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	29.506*
	Perennial Basal cover (%)	0.067	0.073	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	32.291*
	Shrub density (shrubs per acre)	1437	1344	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	293.865

*Indicates transformed data was used

Table C-2. Cochran's n_{min} for percent canopy cover for transects sampled in 2019 at the Borrow Pit Site

Sampling area	Parameter	Mean	Standard deviation	t	Cochran's n_{min}
Borrow Pit Site (n = 10)	Canopy cover (%)	0.173	0.116	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	39.946*
	Perennial Canopy cover (%)	0.127	0.087	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	31.295*
	Basal cover (%)	0.033	0.054	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	17.228*
	Perennial Basal cover (%)	0.020	0.043	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	10.505*
	Shrub density (shrubs per acre)	4300	3012	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	164.893

*Indicates transformed data was used

Table C-3. Cochran's n_{min} for percent canopy cover for transects sampled in 2019 at the Reference Site

Sampling area	Parameter	Mean	Standard deviation	t	Cochran's n_{min}
Reference Site (n = 10)	Canopy cover (%)	0.427	0.153	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	18.084*
	Perennial Canopy cover (%)	0.027	0.033	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	11.095*
	Basal cover (%)	0.040	0.044	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	16.386*
	Perennial Basal cover (%)	0.000	0.000	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	--
	Shrub density (shrubs per acre)	435	420	$1.833_{(df=9,\ p=0.1,\ \text{two-tailed})}$	312.730

*Indicates transformed data was used

Tests of Normality

Many of the statistical procedures including correlation, regression, t tests, and analysis of variance (i.e. parametric tests) are based on the assumption that sampled data follow a normal distribution; that is, it is assumed that the populations from which the samples are taken are normally distributed (Driscoll et al. 2000). Thus, the Deming Mill monitoring data were examined graphically and with the Shapiro-Wilk Expanded Test (1965) to assess normality. The Shapiro-Wilk test is based on the correlation (*W*) between the data and the corresponding normally distributed set of scores with the same mean and standard deviation. If the test is significant ($p < 0.05$), the distribution is non-normal.

Table C-4. Shapiro-Wilk test of normality. The correlation *W* and test statistic *p* are presented for canopy cover, perennial canopy cover, basal cover, perennial basal cover, and shrub density at the different sites.

Sampling area	Parameter	*W*	*p*	Assessment
Tailings Site (n = 10)	Canopy cover (%)*	0.915	0.321	normal
	Perennial Canopy cover (%)*	0.910	0.284	normal
	Basal cover (%)*	0.837	0.040	non-normal
	Perennial Basal cover (%)*	0.759	0.005	non-normal
	Shrub density (shrubs per acre)	0.887	0.157	normal
Borrow Pit Site (n = 10)	Canopy cover (%)*	0.720	0.002	non-normal
	Perennial Canopy cover (%)*	0.902	0.228	normal
	Basal cover (%)*	0.630	0.0001	non-normal
	Perennial Basal cover (%)*	0.539	0.00001	non-normal
	Shrub density (shrubs per acre)	0.897	0.202	normal
Reference Site (n = 10)	Canopy cover (%)*	0.931	0.455	normal
	Perennial Canopy cover (%)*	0.640	0.0002	non-normal
	Basal cover (%)*	0.756	0.004	non-normal
	Perennial Basal cover (%)*	0	0	--
	Shrub density (shrubs per acre)	0.852	0.061	normal

*Indicates transformed data was used

Hypothesis Tests

The one-sample, one-sided Student's *t*-test (Neter et al. 1985) was performed to evaluate the 2019 Deming Mill monitoring data against the revegetation success criteria required by MMD Permit LU008RE Mod 18-1. The shrub density data was the only parameter determined to be normal, therefore the Student's *t*-test was performed. The test compared whether shrub density at the Tailings Site was equal to or greater than the log of 60% of the shrub density at the Tailings Site. Specifically, the *t*-test evaluated the following mutually exclusive null (H_O) and alternative (H_A) hypotheses:

Shrub density: H_O: Tailings Site < 60% Reference Site
H_A: Tailings Site ≥ 60% Reference Site

The parameter estimates were compared to the performance standard using the one-sample, one-sided *t* test:

$$t^* = \frac{\bar{x} - [0.6]\,(Reference\ mean)}{s/\sqrt{n}}$$

Where:

t^* is the calculated t-statistic,
$\bar{x}$ is the sample mean,
s is the standard deviation of the sample, and
n is the sample size.

The α-level of the test is 0.10 by regulation, and the decision rules for testing the reverse null hypothesis are as follows:

if $t^* < t\,(1-\alpha;\, n-1)$, conclude failure to meet the performance standard, or
if $t^* \geq t\,(1-\alpha;\, n-1)$, conclude that the performance standard was met.

Table C-3. Results of one-sample Student's t-test.

Parameter	Tailings Site mean	Reference Site mean	s	n	$t_{critical}$	$t_{calculated}$	Standard met?
Shrub density (shrubs per acre)	1436.6	435	1343.6	10	$1.383_{(df=9,\ p=0.1)}$	2.77	yes

Parameter	Borrow Pit Site mean	Reference Site mean	s	n	$t_{critical}$	$t_{calculated}$	Standard met?
Shrub density (shrubs per acre)	4299.8	435	3012.2	10	$1.383_{(df=9,\ p=0.1)}$	4.24	yes

Table C-3 indicates that for both parameters, the calculated t-statistic is greater than the critical t-statistic. Thus, we can reject the null hypothesis that the shrub density at Tailings Site and Borrow Pit Site is less than the Reference and accept the alternative hypothesis. Therefore, the standard is met in both cases.

Non-parametric Hypothesis Tests

Wilcoxon non-parametric one-sample hypothesis test was performed to evaluate the 2019 Deming Mill monitoring data against the revegetation success criteria required by MMD Permit LU008RE Mod 18-1. The parameters for canopy over, perennial canopy cover, basal cover, and perennial basal cover could not be improved through numerical transformation. Therefore, non-parametric hypothesis testing was performed for these parameters. The tests compared whether canopy over, perennial canopy cover, basal cover, and perennial basal cover at the Tailings Site and the Borrow Pit Site was equal to or greater than the 70% of the coverage at the Reference Site. Specifically, the Wilcoxon non-parametric one-sample hypothesis test evaluated the following mutually exclusive null (H_O) and alternative (H_A) hypotheses:

Cover parameter:
H_O: Tailings Site < 70% Reference Site
H_A: Tailings Site ≥ 70% Reference Site

Cover parameter: H_O: Borrow Pit Site < 70% Reference Site
H_A: Borrow Pit Site ≥ 70% Reference Site

Table C-7. Results of Wilcoxon Non-parametric One-sample Test for the Tailings Site.

Sampling area	Parameter	W-	W+	*p-value*	Assessment
Tailings Site (*n* = 10)	Canopy cover (%)	29	26	0.459	Not Significantly Greater
	Perennial Canopy cover (%)	1	54	0.003	Significantly Greater
	Basal cover (%)	6	49	0.014	Significantly Greater
	Perennial Basal cover (%)	0	55	0.002	Significantly Greater

Table C-8. Results of Wilcoxon Non-parametric One-sample Test for the Borrow Pit Site.

Sampling area	Parameter	W-	W+	*p-value*	Assessment
Borrow Pit Site (*n* = 10)	Canopy cover (%)	52	23	0.005	Not Significantly Greater
	Perennial Canopy cover (%)	1	54	0.003	Significantly Greater
	Basal cover (%)	24.5	26	0.375	Not Significantly Greater
	Perennial Basal cover (%)	0	3	0.910	Not Significantly Greater

APPENDIX D - PHOTOGRAPHS

Site Photos from October 2019 Revegetation Success Monitoring Surveys

Photo 1 - Borrow Pit Site October 2019. Photo overlooking borrow pit facing northeast.

Photo 2 - Site conditions at Tailings Site October 2019. Photo taken looking southeast.

Site Photos from October 2019 Revegetation Success Monitoring Surveys

Photo 3 - Reference Site in October 2019. Photo taken looking towards the north.

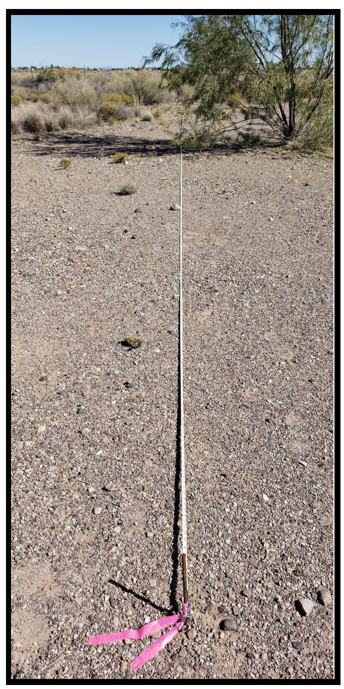

Photo 4 - Example photo of point-line intercept line (line 13, at tailings site). Photograph taken facing east.

Site Photos from October 2019 Revegetation Success Monitoring Surveys

Photo 5 - Example of point-line intercept pin drop (line 8, point 14, borrow pit). Photograph taken from the south side of measuring tape facing north.

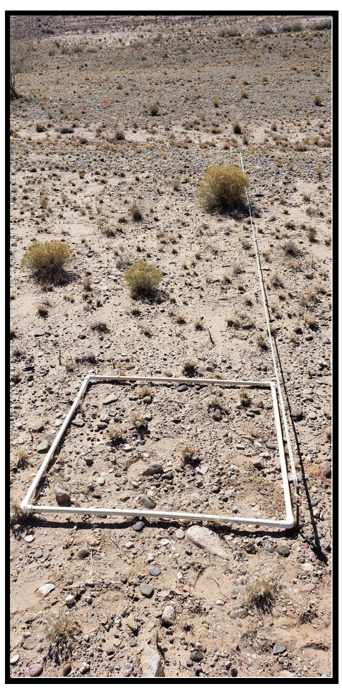

Photo 6 - Photo of belt transect methodology (transect 24, north to south portion of dogleg, borrow pit). Photograph taken facing south.