SECTION 37

POST-RECLAMATION VEGETATION

TABLE OF CONTENTS

SECTION	SECTION TITLE	PAGE NUMBER

SECTION 37

POST-RECLAMATION VEGETATION

LIST OF TABLES

SECTION 37

POST-RECLAMATION VEGETATION

LIST OF EXHIBITS

SECTION 37

POST-RECLAMATION VEGETATION

LIST OF APPENDICES

37. POST-RECLAMATION VEGETATION

37.1. Revegetation Plan

Navajo Transitional Energy Company (NTEC) has developed a comprehensive revegetation plan to be implemented within its permit area. This revegetation plan is specific to the areas that fall under the proposed No Name Permit Application Package (PAP); however, it has been created to match other permits that cover the entire Navajo Mine lease area including the Navajo Mine NM-0003I (NTEC 2024) and Pinabete Mine (NM-0042B) permit areas. There are only minor differences between the reclamation plans in these three permits and these are detailed in Section 37.1.1 below.

This revegetation plan will establish a diverse, stable, and self-sustaining vegetation community that will satisfy the following criteria:

- Adequate cover capable of stabilizing the soil surface from erosion,
- Adequate forage to sustain the post-mining land uses of livestock grazing and wildlife habitat, and
- Suitable species composition for enhancement of wildlife forage and cover.

NTEC will implement a geomorphic approach to reclamation, as discussed in Section 34 (Post-Reclamation Topography) by creating landforms with compatible topography and comparable erosional stability to the surrounding undisturbed landscape whenever possible. Geomorphic reclamation is accomplished by integrating variations in slopes and aspects in uplands, while conveying both run-on and run-off in appropriately designed channels that tie in, both upstream and downstream, with native channels. Geomorphic reclamation implementation, surface stabilization, and post-reclamation sediment control are discussed in Section 38 (Post-Reclamation Surface Stabilization and Sediment Control). The post-reclamation vegetation resource will be influenced by the topographic variability. With the application of a standard revegetation plan outlining the revegetation procedures and processes, NTEC anticipates that the revegetation communities may exhibit signs of succession during the life of the operation. Revegetation species may show preference for certain topographic conditions such as slope, aspect, or location within the landscape. This will ultimately help to meet the revegetation goals by creating diverse, stable, and self-sustaining vegetation communities.

This revegetation plan describes the procedures and methods NTEC will implement to revegetate disturbed areas within the permit boundary. These disturbed areas include, but are not limited to, mining pits, transportation facilities, coal stockpiles and preparation facilities, utility corridors, and other support facilities New revegetated areas will be submitted to the Office of Surface Mining Reclamation and Enforcement (OSMRE) each year as part of the annual reporting requirements. NTEC will update the permit exhibits at permit renewal (e.g., every five years).

37.1.1. Differences Between the Three Navajo Mine Lease Area Permits

The Navajo Mine lease area is over 25 miles from north to south and is permitted under three separate permits.

- Navajo Mine (NM-0003I): Northern two thirds of the lease area, split into Resource Areas 1, 2, 3, and 4 North (overlapping the Pinabete Permit)
- Pinabete Mine (NM-0042B): a portion of Resource Area 4 North (overlapping the Navajo Mine Permit) and a portion of Resource Area 4 South
- No Name Mine (Application Pending): Southern quarter of the lease area, starting at the southern boundary of the Pinabete Mine

37.2. Revegetation Methods

Revegetation is initiated on areas that have been graded and topdressed (or graded only if suitable overburden exists) during the first normal period for planting following the completion of grading and topdressing activities. Seeding and mulching applications may may occur at any time during the year. This is possible because Navajo Mine has an irrigation program (Section 37.2.3) that provides the necessary water requirements needed to establish a sustainable plant community during growing season. Late fall planting generally doesn't happen unless of some unique situation because plants can germinate but not achieve enough growth to withstand the freezing conditions in the winter. However, winter seeding can be ideal when temperatures are below germination requirements and can take advantage of some unique environmental conditions to advance revegetation efforts such as:

- Utilization of winter moisture to set up an optimal seed bed for seeding (Section 37.2.1.1),
- Preparation of more areas of seedbed as soils retain moisture for an extended period (low evaporation rates),
- Minimal irrigation preparation as low temperatures prevent germination,
- Utilization of winter moisture for spring germination therefore reducing irrigation quantities and costs,
- Allow plants to have the full advantage of the growing season.

Some husbandry practices (reseeding/interseeding) may occur in areas that need ecological uplift to promote more plant diversity and/or plant composition. These areas may not receive irrigation, but the timing of seeding will focus on targeting favorable weather patterns and seasons where natural precipitation has a good chance of providing positive assistance such as winter season. Seed mix species for these areas will be selected from the approved species list, but the makeup and quantities will vary depending on what is necessary to achieve diversity or composition with the target release standard.

Revegetation activities will be conducted on logical operational areas, or blocks. Revegetation blocks will be sized for safe and efficient equipment operations and to minimize disturbance of previously revegetated blocks. Upon completion of the revegetation activities, a v-ditch may be installed around the revegetation block to delineate the area and protect it from erosion and vehicle access.

NTEC will not conduct topdressing or revegetation activities in areas of active coal spoil fires. If a coal spoil fire ignites beneath a previously revegetated area, it will be monitored until it extinguishes itself. The area will then be assessed and, if necessary, revegetated.

37.2.1. Seeding and Planting

37.2.1.1. Seedbed Preparation

An essential component of a successful revegetation program is a properly prepared seedbed. NTEC will either replace topdressing material, discussed in Section 36 (Post-Reclamation Soil), or prepare the existing surface material to create an effective seedbed.

During reclamation, certain areas can become heavily compacted. This generally occurs in areas where rock trucks and scrapers are utilized with the heaviest compaction typically occurring in areas of repeated traffic such as roads. These heavily compacted areas are ripped with a dozer, blade, and/or disk depending on the severity of compaction. Once the spoil/rootzone materials are loosened, the area is smoothed by a blade to prepare for topdressing placement.

Topdressing materials are only moved/placed during dry conditions due to the compaction potential with wet soils. Topdressing material on regraded areas will be mechanically prepared to achieve the following benefits:

- Reduce soil compaction caused by heavy equipment used in regrading and redistribution of topdressing,
- Provide a transition at the interface between spoil material and the topdressing to enhance root penetration,
- Promote water infiltration,
- Help control wind and water erosion,
- Provide a firm and smooth surface for proper seed placement, and
- Improve seed to soil contact for enhanced germination.

Shortly after topdressing is placed on final-graded rootzone areas and the appropriate depths have been verified (Section 36), the seedbed preparation process begins. The first phase of seedbed preparation is to mechanically work the topdressing utilizing a chisel and/or disk pulled behind a farm tractor. This eliminates any compaction that may have occurred during the placement of the topdressing and also breaks the interface between the topdressing and the regraded spoil/rootzone. This phase leaves the topdressing surface very rough and loose with sizable furrows. This rough state is beneficial for controlling wind and water erosion while waiting for a precipitation event sizable enough to wet the entire topdressing profile before seeding.

The rough state also improves water infiltration when a precipitation event does occur while minimizing runoff and soil erosion. Rock picking will occur during this waiting period to remove any large rocks to prevent damage to seeding equipment.

Moisture is key for preparing the final seedbed. The topdressing materials used at Navajo Mine are sodium affected, sandy materials with little to no organic matter. When moved/placed, the structural component in the topdressing is destroyed, leaving the topdressing in a loose fluffy state. In this state, the topdressing is unable to support the drilling units used to place the seeds at the prescribed depths for optimal seed establishment. The replaced topdressing requires an adequate amount of moisture as a catalyst to allow the cohesion and adhesion forces to re-establish and the topdressing to regain adequate structure to support the drilling units.

The second phase of seedbed preparation consists of either a smaller disk and/or roller harrow to smooth (break large clods if present) and firm the surface of the topdressing/seedbed while it is moist. This process is completed as quickly as possible before the topdressing dries out. Once this second phase of seedbed preparation is complete, seeding can commence, even after the soils have dried. After drying, the topdressing will generally have a crusty surface due to the sodium presence. The crusting is generally not thick enough or hard enough to affect the drilling units from penetrating the surface to obtain the optimum depths for proper seed placement. However, if the crusting does impede proper seed placement, then a “no-till” setup will be used. The “no-till” setup consists of straight wavy edge disk blades designed to provide a light soil shuffle that slightly breaks the crust in front of the drilling units, allowing for a better penetration of the seeding units to assure optimum seed placement.

37.2.1.2. Seed Mixture

Since 1975, the revegetation seed mixtures used at Navajo Mine have been the subject of extensive research. Generally, the number of species seeded have increased, while the seeding rates (pounds of pure live seed planted) have decreased. The seeding rate has been the subject of continued investigation to determine its impact on revegetation success. Numerous revegetation research studies were conducted at Navajo Mine, directly adjacent to the permit area, and at San Juan Mine, approximately 19 miles north of the permit area between 1975 and 1999. The goal of these research studies was to identify optimal plant species and seeding application rates for revegetation in the arid Southwest. In 2025, NTEC updated the seed mixture (Table 37-1) utilizing that research and experience gained from revegetation programs at Navajo Mine and San Juan Mine. NTEC will utilize the seed mixture in Table 37-1 for all three permit areas within the Navajo Mine lease area and will continue to evaluate the seed mixtures to ensure the established revegetation communities meet reclamation goals.

The seed mixture utilizes a menu approach, so that the species selected can be varied based on the time of year when seeding occurs, localized variability in soils or topography, annual climatic variation, and species availability. Additionally, a number or suitable substitute species have been identified for approved use, if the standard species in Table 37-1 are unavailable for seeding due to seed availability or cost (Table 37-2). These substitute species may replace any of the standard species, as needed. Should other native or introduced species indicate suitability for revegetation and compatibility with the post-mining land use objectives, they may be added to the revegetation species list with the approval of OSMRE. Additionally, the quantities of pure live seed (PLS) used per acre and corresponding numbers of seeds per square foot may be adjusted subject to seed availability. To ensure the best germination results, NTEC will utilize quality seed from reputable dealers using standards outlined under the Federal Seed Act (1983).

The seed mixture may also be modified using these approved substitutes based on soil temperature, planting season, or topography of a particular revegetation block. Soil depth and texture may also influence seed species selection or specific seeding rates. The geomorphic approach to reclamation will assist NTEC in creating diverse revegetation communities due to different species expression on varied aspects and slopes based on available soil moisture and sun exposure. The undulating topography will also create the opportunity for variable topdressing depths. Studies have shown that variable topdressing depths enhance the final revegetation communities' species diversity and life form composition (Bowen et.al. 2005 and Buchanan et.al. 2005). Cultural practices, including irrigation, will continue to be investigated with the intent to enhance cover, production, and diversity of vegetation. When such trials involve altering the approved seed mixtures, OSMRE will be consulted.

The seed mixture species are all native to the San Juan Basin and were selected for their ability to survive the soil and climatic conditions within the permit area. The herbaceous species provide nutrition for livestock and wildlife during the growing season, and the palatable shrubs, such as fourwing saltbush (*Atriplex canescens*), shadscale (*Atriplex confertifolia*), and winterfat (*Krascheninnikovia lanata*), provide nutrition throughout the year. Three native shrub species with minimal palatability, Mormon tea (*Ephedra viridis*), greasewood (*Sarcobatus vermiculatus*), and rubber rabbitbrush (*Ericameria nauseosa*), were included to provide cover for small mammals and passerine birds.

37.2.1.3. Seeding Methods

Following seedbed preparation, seeding is accomplished by either broadcasting or rangeland seed drilling. These seeding methods are designed to place each species at their optimum planting depths. Optimum planting depths for each seeded species are provided in Table 37-1. These depths have been determined using documentation prepared by the United States Department of Agriculture Natural Resources Conservation Service's Plant Materials Centers (USDA 2025) and through field observation of site-specific conditions at Navajo Mine.

Seeded species are separated into three groups to improve distribution and ensure that each species is planted at its optimal depth:

- Broadcast group – small seeds that germinate best on the surface or less than 0.25 inches deep.
- Fluffy group – seeds with hairy or bristly appendages on the seed coat drilled to a targeted depth of 0.25 to 0.50 inches.
- Large smooth group – large seeds that are less likely to bind or clog within the seed drill drilled to a targeted depth of 0.5 to 1.0 inches.

The seed drill is equipped with depth bands to ensure proper seeding depth and packer wheels to improve seed to soil contact. When the topdressing is dry and powdery the area may be pre-irrigated to improve the tilth of the soil. With consideration to the safety of operators and equipment, all seeding will be done on the contour whenever possible. Hand seeding will occasionally be implemented when slopes are considered too steep for the safe operation of equipment or in small areas such as around rock habitat structures or localized spot-seeding.

37.2.1.4. Special Seedings and Plantings

NTEC may undertake special native species seeding and planting projects on a limited basis. The purpose of special projects would be to create habitat niches or augment the standard seeding practices. Examples of these projects include, but are not limited to, establishing native species that may not be included in the standard seed mixes (e.g., Navajo Nation culturally significant species or riparian species within drainage microclimates) or site-specific planting of live native species stock (e.g., bare-root or containerized native plants). Planting live rootstock is cost prohibitive over large areas and thus may only be utilized within small areas. Techniques used for these special plantings may include, but are not limited to, hand-planting seedlings or other small containerized materials, mechanical transplanting of larger containerized materials or locally harvested plants, pole planting of cottonwoods or willows, or deep pots. Seedlings and small containers are planted primarily by hand using dibbles, planting bars, or planting hoes. Hand planting allows for better microsite selection, provides a more random pattern of planting, and improves handling and placement of seedlings. Mechanical planting may be utilized using a skid steer mounted tree planter or small excavator that has the capability to handle both bare root stock and containerized materials. Pole plantings and deep pots will be installed using an equipment-mounted auger to ensure the materials are placed within the water table or capillary fringe. Proper handling and planting procedures for plantings include proper storage and handling of materials to avoid desiccation, proper planting depths, firming the soil around roots and removal of air pockets, proper positioning of the plants to minimize the potential for burial or root exposure, and maximum use of available microsites. Special seedings and plantings may be conducted anytime from November through February depending on weather and soil conditions. The location and species used in any special seeding or planting projects will be submitted to OSMRE in the annual report.

37.2.2. Mulching Techniques

Native grass mulch will be applied after seeding, primarily to control wind and water erosion while the plants establish. The mulch is procured in large round bales that yield non-crushed stems and leaves for ease of application and for optimum tacking to the topdressing. A round bale Haybuster is used to apply 2.0 to 2.5 tons of mulch per acre. Once the mulch is applied, it is mechanically crimped into the soil using a tractor-pulled crimper. All crimping is done on the contour when practical.

In actual field operation, the mulching and crimping program has proved to be far superior in controlling erosion than contour trenching and contour furrowing. A good quality mulch, crimped properly on the contour, will anchor topdressing far beyond plant establishment. Under an irrigation program, plant establishment is much faster than mulch decomposition. Contour ditching and contour furrowing have led to erosional problems which required repeated repair efforts with little long-term success. For these reasons, the prescribed mulching operation will be utilized to limit contributions of sediment to stream flow outside the permit area. Other advantages of mulch are:

- Slows evaporation at the soil surface,
- Promotes water infiltration,
- Conserves soil moisture,
- Lowers surface temperature,
- Decreases surface wind velocity and soil crusting, and
- Provides an organic base (carbon) for reestablishing a beneficial microbial population and promoting nutrient cycling.

37.2.3. Irrigation

Research and experience at Navajo Mine demonstrate that irrigation is needed to promote germination and produce self-sustaining stands of vegetation in a reasonable period of time. Navajo Mine has conducted numerous research studies and trial programs to answer many questions about how irrigation application rates, scheduling, and application systems aid the establishment of the revegetation communities. NTEC will utilize this experience to develop and implement an irrigation program for the NNP.

Research on methods for reducing water use has been, and will continue to be, an important aspect of Navajo Mine revegetation programs. Water is a vital resource in the region and finding methods to reduce water consumption, without adversely affecting the quality of revegetation communities, is one of the main goals of NTEC's revegetation program at Navajo Mine. Recently, Navajo Mine began utilizing soil moisture probes to better understand water movement and availability (e.g., saturation, field capacity, available water and wilting point) in reconstructed mined land soils and how it relates to native plant species establishment and sustainability. The probes give real-time data, helping avoid overwatering or underwatering, prevent erosion and minimize plant stress optimizing establishment. The probes help optimize irrigation therefore supporting the need to conserve our limited water resource in the desert Southwest. Navajo Mine is also gaining a better understanding of how evapotranspiration rates affect soil moisture conditions throughout the day and growing season to again to better understand and manage plant establishment and irrigation management.

The type of irrigation system used for the permit area consists of a solid-set aluminum system, which uses various sizes of aluminum pipe to cover the revegetation block and/or a solid set irripod system comprised of polypipe and plastic irripods. These systems work well to irrigate and conform to the various landform surfaces that are recreated with the geomorphic reclamation process. These systems also allow for optimum timing and scheduling and have led to more efficient water use without adverse effects on seed germination and vegetation establishment.

Newly seeded plots in the NNP area will be irrigated for approximately two growing seasons. Irrigation will be applied to the revegetation areas from March to mid to late October. Navajo Mine may extend the irrigation past October if unusual warm weather persists late into the growing season therefore the need for additional irrigation. Once it has been determined the irrigation season is complete the irrigation pipe and equipment will be drained to prevent freeze damage. The first season irrigation pipe and equipment will remain in place to complete the second season of irrigation. The second season irrigation pipes and equipment will be removed to be placed on new planned first year plots.

Some husbandry practices (reseeding/interseeding) may occur in areas that need a little ecological uplift to promote more plant diversity and/or plant composition. These areas may not receive irrigation, but the timing of seeding will focus on targeting favorable weather patterns and season where natural precipitation has a good chance of providing positive assistance.

The irrigation schedule for the first growing season is divided into a germination cycle and support cycle. The goal of the germination cycle is to first achieve field capacity throughout the entire depth of the topdressing material, assuring adequate moisture for initiating germination and assuring adequate moisture capacity to allow for a fast and easy development of new root systems into the lower topdressing profile. Some plant species will germinate immediately so adequate moisture throughout the topdressing profile is important. During the first irrigation application, depending on the texture of the topdressing materials (infiltration potential) it may take several applications due to slow infiltration rates to achieve the first field capacity of the entire profile of the topdressing material. If the infiltration rate is less than the application rate, then runoff/erosion will occur therefore requiring several applications. As for the rootzone, there is no need for water at this time. Water will eventually start moving into the rootzone as the irrigation application continues, advancing a wetting front deeper into the rootzone to promote root development deeper into the profile. Once a wetting front has moved through the entire topdressing profile subsequent irrigation will move much quicker, infiltrating faster since the water has helped initiate the restructuring of the topdressing. Generally, it will take 1.5 to 2 inches of initial irrigation application to get a wetting front through a 6 to 10 inch thick freshly placed topdressing material. Shortly after the initial application has been successfully applied steady ½ inch application will continue for 4 to 6 weeks through the germination cycle. The frequency of applications will range from ½ inch every other day during the hottest period of the year to ½ inch every 3rd or 4th day during early spring when it is cooler, less evaporation. The soil moisture probes will also play a role in helping to determine frequency of irrigation.

The support cycle will begin immediately after the germination cycle and will continue through the remainder of the first season. The objective of the support cycle is to continue to promote growth and root development to ensure plants are adequately established to survive the first winter season. The application rate will generally be a 1inch application, once every week. This may vary depending on temperatures, wind, natural rainfall, evapotranspiration rates and what the moisture probes are indicating.

Second year irrigation objective is to promote root development, driving the root system deep into the profile generating a sizable mass that will provide the plants with the uptake and storage capacities needed to weather the droughts and harsh conditions that exist naturally in this desert region. Therefore, irrigation will be applied in heavier applications (2.5 to 3 inches at a time) and less frequent (every couple of weeks or more) to promote this objective. The less frequent irrigation will also stress the plants somewhat and begin weaning the plants away from irrigation and back to natural conditions. This rate and timing may be influenced or adjusted due to natural rainfall or what the moisture probes are showing. After the end of the second season the irrigation will cease.

37.2.4. Pest and Disease Control

Currently pest or disease controls are not implemented on revegetation blocks at Navajo Mine. Pest and disease control plans are not anticipated for the permit area. If such plans become necessary, NTEC will notify OSMRE prior to their development and implementation.

37.2.5. Noxious and Invasive Weed Control

Native plant communities in New Mexico experience challenges from the presence of noxious and invasive weeds. These plant species specialize in colonizing disturbed areas and quickly out-compete native species. Competition from noxious and invasive weeds is a problem in some native plant communities surrounding the permit area and in some previously reclaimed areas within the lease boundary. Absent the complete eradication from the region, it is likely these species will continue to colonize the permit area due to the seed sources outside of the permit area. Therefore, it is likely the revegetation areas will have a similar distribution of noxious and invasive species as the off-lease areas.

NTEC is committed to preventing the introduction and spread of noxious and invasive weeds. The Bureau of Indian Affairs (BIA) and the Navajo Nation have developed regional weed control plans (BIA 2022 and BIA 2024). NTEC will implement its own weed control management plan for the permit area (Appendix 37-A) that complies with the agencies' regional weed management plans.

The introduction of noxious weeds is reduced by using revegetation seeds from reputable vendors which are not contaminated with weed seeds. NTEC also utilizes grass mulch from credible producers to minimize introduction of noxious and invasive weeds into revegetated areas. Seed vendors and mulch producers may be inspected by NTEC to audit their quality control procedures and ensure their products are free of noxious and invasive weeds.

Prior to the weed management season, the current applicable weed management lists for potential species of concern at Navajo Mine will be reviewed. The New Mexico Department of Agriculture's (NMDA) New Mexico Noxious Weed List (NMDA 2020) and the BIA Navajo Region Noxious/Invasive Weed List (BIA 2024) will be reviewed. Where there are conflicts in the recommendations or prioritizations on species of concern between the two lists, the NMDA's list will take precedence. Below are the noxious weed classifications compiled by the NMDA, this classification system will be used as a guidance in the management of noxious weeds:

- Class A: Species that are not currently present in New Mexico, or that have limited distribution.
- Class B: Species that are limited to portions of the State.
- Class C: Species that are wide-spread and well-established. The control effort for these species is costly, and management is limited to awareness.

In conjunction with the review of weed management lists, the type of weed control (chemical, mechanical, biological, etc.) will be determined on reclaimed areas at Navajo Mine. The most effective weed control on revegetated lands is a healthy, diverse community of native vegetation. In cases where the plant community of a revegetation block cannot resist the invasion of noxious weeds, control measures will be implemented.

At this time, monitoring will occur for any weed establishment on ungraded or recently graded spoil areas. Noxious weeds in these areas will only be controlled if they are impacting the revegetation. Weed eradication may occur at facility areas or along roads to prevent noxious weeds from spreading and impacting revegetation.

37.2.6. Grazing and Other Husbandry Practices

NTEC is not proposing any grazing or other husbandry practices at this time. This section will be revised prior to NTEC implementing any such practices on the permit area. Additional discussion on historic grazing practices at Navajo Mine can be found in Section 30 (Post-Reclamation Land Use).

37.3. Revegetation Success Determination

The primary goal of revegetation activities is to ensure that reclaimed areas are capable of supporting the post-mining land uses of livestock grazing and wildlife habitat. To meet this goal, NTEC conducts both periodic internal evaluations and bond release revegetation surveys. Evaluation surveys are conducted, as needed, during the responsibility period to identify trends in the revegetation and to evaluate the progress of the revegetation towards successful post-mining land use. Liability release surveys are conducted to evaluate whether the revegetated community has developed into a diverse, stable, and self-sustaining vegetation community by meeting the revegetation success standards. The revegetation success criteria for the permit area are presented in Table 37-3 and discussed further in Section 37.3.2.

All revegetation sampling will be conducted between April and October. This period was selected to provide the highest expression of revegetation species. Data collection will begin in the year following the termination of irrigation since the growth rate of many perennial species is such that they would be difficult to identify before this time. Additionally, seeded areas of the past year will be indicated on the reclamation status exhibits that accompany the annual report. Results of revegetation success surveys, if conducted, will be reported to OSMRE in the following year's annual report.

37.3.1. Reference Areas

To demonstrate revegetation success, NTEC will compare the post-mining revegetation blocks to reference areas that are managed similarly to the revegetation communities. The reference areas were primarily selected based on intact contiguous size, similarity in range sites to pre-mine vegetation communities, likelihood of no future impact, and the ability to control grazing similar to the revegetated areas. Reestablishing all pre-mining plant communities after mining is not practical. Consequently, revegetation efforts were designed to establish plant communities (or range sites) capable of meeting the approved post-mining land use requirements. The eight pre-mine range sites and percentages of area they covered are presented in Table 37-4. A post-mining comparison to these range sites will be used to demonstrate revegetation success. The reference areas and corresponding range sites within the permit area are presented in Exhibit 37-1 and described in Table 37-5. Refer to Exhibit 15-1 for the pre-mining vegetation community delineation not shown on Exhibit 37-1.

Baseline information contained in the PAP including geology, soils, slope, aspect, and vegetation demonstrate the reference areas are representative of the pre-mining landscape. Soil type, precipitation, slope and elevation are predominant factors in the development of vegetation communities at Navajo Mine. With Navajo Mine covering a relatively small geographical area and little change in elevation or precipitation, the soils play a leading role in determining the different vegetation communities. The reference areas have the same soil mapping units as the revegetated areas did before mining and consequently, the vegetation communities are the same for both areas. The reference areas were part of the initial baseline soils and vegetation mapping survey. More detailed information on geology, soils, and vegetation can be found in Part 2 Section 17, Section 14, and Section 15, respectively.

Six range sites were identified in the pre-mining landscape. However, only the Alkali Wash (Al/Wa, 37.7%), Arroyo Shrub (Ar/Sh, 3.9%), and All Sands (Sa, 36.3%) range sites will be used as comparison to determine revegetation success to be consistent with the previously approved Navajo Mine and Pinabete Mine permits. The All Sands range site is a combination of calcareous sands, sands, and saline sands vegetation communities and was combined into a single range site based on the similarity of baseline soils and vegetation information. These three range sites are dominated by soil series that are classified as coarse or fine loamy, mixed, mesic, Typic Haplargids formed from either eolian or alluvial material. Common soil series include the Bacobi and Monierco, Blancot, Redlands variant, Shiprock, Mayqueen-Shiprock, and Razito. The plant communities are dominated by the perennial grasses Alkali sacaton (*Sporobolus airoides*), Indian ricegrass (*Achnathyrum hymenoides*), and galleta (*Pleuraphis jamesii*) and perennial shrubs shadscale and broom snakeweed (*Gutierrezia sarothrae*). Because of the limited differences between the soils and plant communities on these range sites consolidation of these communities into one reference community is appropriate.

The Dunes (Du, 8.5%), Thin Breaks (Th, 6.8%), and Badlands (Ba, 6.8%) range communities were removed from the revegetation success comparisons because they are not representative of the desired post-reclamation landscape for use as rangeland. Soils within the Dune vegetation community are deep and composed of well-drained eolian sands that are not likely to be recreated in the post-reclamation soil profile. Similarly, the Thin Breaks exposed outcrops and the Badlands exposed, weathered shales are not suitable for the post-mining land use of rangeland and are expected to be recreated in the post-reclamation landscape.

There are 12 reference areas that have been previously identified within the NTEC lease area. Revegetation success comparisons for reclaimed areas within the No Name Mine permit boundary will be compared to only those six reference areas included in the Pinabete and No Name Mine permit boundaries (Table 37-6). All reference areas will be fenced with signage posted and managed similar to the revegetated areas to which they will be compared. In the event that future mining related activity impacts the reference areas, NTEC will identify potential replacement reference areas, in consultation with OSMRE, either within or outside of the permit or lease area. If necessary, NTEC will commence discussions with appropriate grazing and customary use area permittee(s) and agencies about obtaining right of entry to those sites. NTEC will obtain OSMRE's approval prior to final selection and use of any replacement reference areas.

37.3.2. Methods to Determine Revegetation Success

The primary goal of revegetation success is to ensure that revegetated areas are capable of supporting the post-mining land use of livestock grazing and wildlife habitat. Bond release surveys are conducted to evaluate whether the revegetated community has developed into a diverse, stable, and self-sustaining vegetation community. These surveys may be conducted six years after any augmented seeding, fertilizing, irrigation, or other similar activities have been completed, excluding approved grazing or husbandry practices. The revegetation community must meet the revegetation success criteria in any two of the final four years of the responsibility period. The revegetation success criteria will include annual success criteria compared to the reference areas for total vegetation cover and production and technical standards for shrub density and species diversity. The revegetation success criteria are presented in Table 37-3 and discussed in Section 37.3.3.

Depending on location and site conditions, revegetation blocks may not be sampled at the earliest opportunity. Revegetation blocks eligible for bond release sampling may be combined into a single sampling unit. Before conducting any bond release sampling, the areas to be combined for sampling will be discussed with OSMRE. The justification for combining revegetation areas may include, but is not limited to:

- Adequate sampling area,
- Seed-mix used,
- Proximity to one another,
- Availability of water in a proposed release area,
- Logical grazing blocks, and/or
- Similar appearance.

Before conducting any bond release surveys, the areas proposed for sampling will be discussed with OSMRE. The same sampling procedures will be used on the reference areas and revegetation blocks. Sample locations in each area will be selected using randomly generated grid coordinates overlain on a map, computer-generated stratified random point locations, or some other appropriate randomization method. Sampling will be conducted according to the procedures and criteria discussed in the following sections.

37.3.2.1. Sample Selection

Geographic information system (GIS) software will be used to generate 40 randomly located sample points in the revegetation unit. If multiple polygons are included in a revegetation unit, then a stratified random design (based on acreage) will be used to distribute the 40 points across the polygons. A stratified random design will also be used to place 40 random points across the various reference areas based on acreage and the pre-mining percentages of each range site community. The anticipated number of samples to be placed in each reference area plant community are shown in Table 37-5.

Shrub corridors are utilized to demonstrate the shrub density success standard required for 20% of the revegetation unit. Of the 40 random sample locations within a revegetation unit, eight samples (20% of the samples) are placed within shrub corridors that are held to a higher shrub density standard. Shrub corridors are initially mapped using aerial imagery and field verified during sampling. A total of 40 samples will be collected within each revegetation unit and the reference areas.

37.3.2.2. Sample Methods

37.3.2.2.1. Total Vegetation Cover

Point-intercept methods are used to collect vegetation and ground cover data. A 50 meter (m) transect is established for each point and represents a single sampling unit. One data point is recorded at each half-meter interval along each transect, 0.5 m to the left side of and at a right angle to the transect. A laser bar (or similar device) is used to determine intercepts, with the beam projected vertically to the ground surface. Each point-intercept represents an absolute cover value of 1%.

"First-hit" point-intercepts (the first item that the laser beam intercepts) are recorded as either: live vegetation (by plant species), litter, rock, or bare ground. Litter includes all dead plant material not living during the current growing season. Vegetation cover is reported in absolute and relative percentages from the point-intercept data using all 100 first-hit observations for each sample transect. Vegetation cover used in hypothesis testing for revegetation success includes both live vegetation and litter.

37.3.2.2.2. Shrub Density

Shrub density is estimated by counting the number of shrubs rooted within a 50 m by 1 m (50 m^2) belt transect located within 1 m on the right side of the cover transect. Densities are reported as stems per acre.

37.3.2.2.3. Species Diversity

Diversity is determined by calculating the number of grass, forb, or shrub species having at least a specified amount of cover or density as determined by the revegetation success standards (Table 37-4. Grass and forb diversity will be calculated from the point-intercept transect cover data. However, in periods of drought (years when cumulative total precipitation for January through April is less than or equal to 0.85 inches) forb species diversity is based on forb observations within the shrub density belt transect. Shrub species diversity will be calculated from the shrub density belt transect

37.3.2.2.4. Annual Production

The current year's growth of herbaceous and shrub species will be clipped from a 10 centimeter by 10 m plot (1 square meter (m^2)) located between the 5-m mark and the 15-m mark on the left side of the cover transect. All collected material is bagged separately by species. The bags containing the clipped material are oven dried at 30 degrees Celsius until weights stabilized to within 0.1 grams. Production is reported in pounds per acre (lbs/ac). Production of noxious weed species listed on the A or B lists produced by the Navajo Nation (BIA 2024) or the State of New Mexico (NMDA 2020) will not to be included in the determination of revegetation production success.

37.3.3. Revegetation Success Comparisons

Vegetative cover and production will be considered successful when the reclaimed area averages are not less than 90 percent of the of the reference area averages based on hypothesis testing. Shrub density and species diversity will be considered successful when they meet or exceed the set technical standards in f.

Statistical hypothesis testing will be completed for vegetation cover, production, and shrub density using the formulas and flow charts in Appendix37-B. Diversity standards are not subject to hypothesis testing.

37.4. Prime Farmlands Revegetation Plan

There are no areas identified as prime farmlands within the permit area. The negative results of the prime farmland investigation are presented in Section 14 (Soil).

37.5. References

Aldon, E. F. 1975. Reclamation of Coal-Mined Land in the Southwest. Journal of Soil and Water Conservation, Volume 33, No. 2.

Navajo Transitional Energy Company (NTEC). 2024. Navajo Mine Permit Application Package. OSM Permit No. NM-0003I. On file at Office of Surface Mining Reclamation and Enforcement- Western Region Technical Office. Denver, Colorado.

Bowen, C.K., G. Schuman, and R.A. Olson. 2005. Long-Term Plant Community Development In Response to Topsoil Replacement Depth On Mined Land In Wyoming. Proc. Raising Reclamation to New Heights. 22nd meeting. June 18-25, 2005. Breckenridge, Colorado. American Society of Mining and Reclamation, Lexington, Kentucky.

Buchanan. B, M. Owens, J. Mexal, T. Ramsey, and B. Musslewhite. 2005. Long-Term Effects of Cover Soil Depth on Plant Community Development for Reclaimed Mined Lands in New Mexico. Proc. Raising Reclamation to New Heights. 22nd meeting. June 18-25, 2005. Breckenridge, Colorado. American Society of Mining and Reclamation, Lexington, Kentucky.

Bureau of Indian Affairs (BIA) Navajo Region. 2022. *Final Navajo Nation Integrated Weed Management Plan*.https://www.bia.gov/sites/default/files/dup/inline-files/appendix_a._navajo_nation_integrated_weed_management_plan_full.pdf.

Bureau of Indian Affairs (BIA) Navajo Region. 2024. *BIA Navajo Region Noxious Weed Information* https://www.bia.gov/regional-offices/navajo/navajo-nation-integrated-weed-management-plan/noxious-weed-information.

Federal Seed Act. 1983. 7 U.S.C. Ch. 37: Seeds.

New Mexico Department of Agriculture (NMDA). 2020. *Noxious and troublesome weeds of New Mexico.* https://pubs.nmsu.edu/_circulars/CR698/.

United States Department of Agriculture Plants Database (USDA). 2025. USDA Plants Database, plants.usda.gov/. Accessed 5 June 2025.

United States Department of Agriculture (USDA). 2024. *Plant Materials Centers*. Natural Resources Conservation Service. https://www.nrcs.usda.gov/plant-materials/pmc.

Table 37-1: Reclamation Seed Mixture

Scientific Name	Common Name	Method[1]/ Group[2]	Seed Depth	Seeds/ Lb	%	Lb/Ac	PLS/ SF	Standard %	Standard Lb/Ac	Standard PLS/SF
Warm Season Grasses										
Minimum of 4 species					***15-45%***		***7.5-22.5***	***39%***	***1.9***	***19.5***
Aristida purpurea	purple threeawn	B/B	<1/4"	300,000	0-5%	0-0.4	0-2.5			
Bouteloua curtipendula	sideoats grama	D/F	1/4"-1/2"	191,000	0-5%	0-0.6	0-2.5			
Bouteloua dactyloides	buffalograss	D/F	1/4"-1/2"	56,000	0-5%	0-2.0	0-2.5			
Bouteloua eriopoda	black grama	D/F	1/4"-1/2"	1,335,000	0-5%	0-0.08	0-2.5			
Bouteloua gracilis	blue grama	D/F	1/4"-1/2"	825,000	5-15%	0.1-0.4	2.5-7.5	12%	0.3	6.0
Pleuraphis jamesii	James' galleta	D/LS	1/2"-1"	159,000	5-15%	0.7-2.1	2.5-7.5	10%	1.4	5.0
Sporobolus airoides	alkali sacaton	B/B	<1/4"	1,758,000	5-15%	0.1-0.2	2.5-7.5	10%	0.1	5.0
Sporobolus compositus	composite dropseed	B/B	<1/4"	759,362	0-5%	0-0.1	0-2.5	2%	0.1	1.0
Sporobolus contractus	spike dropseed	B/B	<1/4"	3,107,000	0-5%	0-0.1	0-2.5			
Sporobolus cryptandrus	sand dropseed	B/B	<1/4"	5,298,000	0-10%	0-0.1	0-5	5%	0.0	2.5
Sporobolus giganteus	giant dropseed	B/B	<1/4"	1,723,000	0-10%	0-0.1	0-5			
Cool Season Grasses										
Minimum of 2 species					***5-25%***		***2.5-12.5***	***14%***	***2.1***	***7.0***
Achnatherum hymenoides	Indian ricegrass	D/LS	1/2"-3"	141,000	0-15%	0-2.3	0-7.5	0.05	0.8	2.5
Elymus elymoides	squirreltail	D/LS	1/2"-1"	192,000	0-10%	0-1.1	0-5			
Elymus lanceolatus	thickspike wheatgrass	D/LS	1/2"-1"	155,000	0-10%	0-1.4	0-5	5%	0.7	2.5
Elymus trachycaulus	slender wheatgrass	D/LS	1/2"-1"	159,000	0-10%	0-1.4	0-5	2%	0.3	1.0
Hesperostipa comata	needle and thread	D/F	1/4"-1/2"	137,000	0-5%	0-0.8	0-2.5	2%	0.3	1.0
Koeleria macrantha	prairie Junegrass	B/B	<1/4"	2,300,000	0-5%	0-0.1	0-2.5			
Pascopyrum smithii	western wheatgrass	D/LS	1/2"-1"	110,000	0-10%	0-2.0	0-5			
Pseudoroegneria spicata	bluebunch wheatgrass	D/LS	1/2"-1"	135,000	0-5%	0-0.8	0-2.5			
Total Grasses					***35-65%***		***17.5-32.5***	***53%***	***4.0***	***26.5***
Perennial Forbs										
Minimum of 2 species					***10-20%***		***5-10***	***13%***	***1.2***	***6.5***
Abronia fragrans	snowball sand verbena	B/B	<1/4"	72,000	0-2%	0-0.6	0-1	0.02	0.6	1
Chaenactis douglasii	Douglas' dustymaiden	B/B	<1/4"	342,500	0-2%	0-0.1	0-1			
Gaillardia pinnatifida	red dome blanketflower	B/B	<1/4"	136,200	0-2%	0-0.3	0-1	1%	0.2	0.5
Hymenopappus filifolius	fineleaf hymenopappus	B/B	<1/4"	220,000	0-2%	0-0.2	0-1			
Penstemon palmeri	Palmer's penstemon	B/B	<1/4"	610,000	0-10%	0-0.4	0-5	5%	0.2	2.5
Sphaeralcea coccinea	scarlet globemallow	D/F	1/4"-1/2"	500,000	0-5%	0-0.2	0-2.5			
Sphaeralcea grossulariifolia	gooseberryleaf globemallow	D/F	1/4"-1/2"	500,000	0-5%	0-0.2	0-2.5	5%	0.2	2.5
Sphaeralcea parvifolia	small-leaf globemallow	D/F	1/4"-1/2"	500,000	0-5%	0-0.2	0-2.5			
Annual/Biennial Forbs										
Maximum of 2 species					***0-10%***		***0-5***	***2%***	***0.1***	***1.0***
Cleome lutea	yellow spiderflower	B/B	<1/4"	101,000	0-5%	0-1.1	0-2.5			
Machaeranthera tanacetifolia	tanseyleaf tansyaster	B/B	<1/4"	408,000	0-2%	0-0.1	0-1	0.02	0.1	1
Oenothera pallida	pale evening primrose	D/LS	1/2"-1"	512,000	0-5%	0-0.2	0-2.5			
Phacelia crenulata	desert bluebells	D/F	1/4"-1/2"	800,000	0-2%	0-0.1	0-1			
Total Forbs					***10-30%***		***5-15***	***15%***	***1.3***	***7.5***
Subshrubs										
Minimum of 1 species					***5-15%***		***2.5-7.5***	***10%***	***0.9***	***5.0***
Artemisia ludoviciana	white sagebrush	B/B	<1/4"	4,500,000	0-10%	0-0.05	0-5	0.05	0.02	2.5
Artemisia frigida	fringed sagebrush	B/B	<1/4"	4,536,000	0-10%	0-0.05	0-5			
Eriogonum umbellatum	sulphur-flower buckwheat	B/B	<1/4"	210,000	0-5%	0-0.5	0-2.5			
Krascheninnikovia lanata	winterfat	B/B	<1/4"	123,000	5-10%	0.9-1.8	2.5-5	5%	0.9	2.5
Senecio flaccidus	threadleaf ragwort	B/B	<1/4"	750,000	0-5%	0-0.1	0-2.5			
Shrubs										
Minimum of 3 species					***15-35%***		***7.5-17.5***	***22%***	***4.5***	***11.0***
Artemisia filifolia	sand sagebrush	B/B	<1/4"	2,000,000	0-5%	0-0.1	0-2.5			
Atriplex canescens	fourwing saltbush	D/LS	1/2"-1"	52,000	5-10%	2.1-4.2	2.5-5	0.05	2.1	2.5
Atriplex confertifolia	shadscale saltbush	D/LS	1/2"-1"	65,000	0-10%	0-3.4	0-5	2%	0.7	1
Atriplex gardneri	Gardner's saltbush	D/LS	1/2"-1"	111,000	0-5%	0-1	0-2.5	5%	1.0	2.5
Atriplex corrugata	mat saltbush	D/LS	1/2"-1"	60,000	0-5%	0-1.8	0-2.5			
Atriplex obovata	mound saltbush	D/LS	1/2"-1"	207,600	0-5%	0-0.5	0-2.5			
Ephedra viridis	mormon tea	D/LS	1/2"-1"	23,545	0-5%	0-4.6	0-2.5			
Ericameria nauseosa	rubber rabbitbrush	D/F	1/4"-1/2"	400,000	0-10%	0-0.5	0-5	5%	0.3	2.5
Sarcobatus vermiculatus	greasewood	D/LS	1/2"-1"	245,000	0-10%	0-0.9	0-5	5%	0.4	2.5
Total Subshrubs/Shrubs					***20-45%***		***10-22.5***	***32%***	***5.4***	***16.0***
Total Seed Mixture							**50**	**100%**	**10.6**	**50.0**

* Species included on menu are based on historic seed mixtures, species observed during monitoring of surrounding native areas, and plant availability.

[1] Seeding method: B = broadcast, D = drilled

[2] Seed group: B = broadcast group, F = fluffy seed, LS = large smooth seed

Table 37-2: Alternate Seed Mixture Species

Scientific Name	Common Name	Availability
Warm Season Grasses		
Distichlis spicata	saltgrass	Usually
Muhlenbergia pungens	sandhill muhly	Rarely
Muhlenbergia wrightii	spike muhly	Sometimes
Schedonnardus paniculatus	tumblegrass	Rarely
Schizachyrium scoparium	little bluestem	Sometimes

Scientific Name	Common Name	Availability
Cool Season Grasses		
Achnatherum lettermanii	Letterman's needlegrass	Sometimes
Achnatherum speciosum	desert needlegrass	Sometimes
Hesperostipa neomexicana	New Mexico feathergrass	Usually
Hordeum jubatum	foxtail barley	Sometimes
Leymus salinus	saline wildrye	Sometimes
Nassella viridula	green needlegrass	Sometimes
Poa fendleriana	muttongrass	Sometimes
Poa secunda	Sandberg bluegrass	Sometimes
Psathyrostachys juncea	Russian wildrye	Usually

Perennial Forbs		
Abronia elliptica	fragrant white sand verbena	Rarely
Agoseris glauca	pale agoseris	Rarely
Aletes macdougalii	MacDougal's Indian parsley	Rarely
Allium macropetalum	largeflower onion	Rarely
Artemisia dracunculus	tarragon	Rarely
Asclepias sanjuanensis	San Juan milkweed	Rarely
Astragalus mollissimus	woolly locoweed	Rarely
Astragalus sabulonum	gravel milkvetch	Rarely
Chaetopappa ericoides	rose heath	Rarely
Chamaesaracha coronopus	greenleaf five eyes	Rarely
Chamaesyce fendleri	Fendler's sandmat	Rarely
Cryptantha cinerea	James' cryptantha	Rarely
Cymopterus acaulis	plains springparsley	Rarely
Cymopterus bulbosus	bulbous springparsley	Sometimes
Cymopterus purpurascens	widewing springparsley	Rarely
Cymopterus purpureus	purple springparsley	Rarely
Dalea lanata	woolly prairie clover	Rarely
Eriogonum jamesii	James' buckwheat	Sometimes
Evolvulus nuttallianus	shaggy dwarf morning-glory	Rarely
Evolvulus nuttallianus	shaggy dwarf morning-glory	Rarely
Glycyrrhiza lepidota	American licorice	Sometimes
Ipomopsis multiflora	manyflowered ipomopsis	Rarely
Linum lewisii	Lewis flax	Usually
Picradeniopsis woodhousei	Woodhouse's bahia	Rarely
Pomaria jamesii	James' holdback	Rarely
Psoralidium lanceolatum	lemon scurfpea	Sometimes
Rumex hymenosepalus	canaigre dock	Rarely
Senecio spartioides	broom-like ragwort	Rarely
Sphaeralcea munroana	Munro's globemallow	Usually
Streptanthus cordatus	heartleaf twistflower	Rarely
Suaeda calceoliformis	Pursh seepweed	Rarely

Annual/Biennial Forbs		
Aliciella leptomeria	sand gilia	Rarely
Atriplex powellii	Powell's saltweed	Rarely
Chaenactis stevioides	Esteve's pincushion	Rarely
Cryptantha crassisepala	thicksepal cryptantha	Rarely
Cryptantha minima	little cryptantha	Rarely
Erigeron bellidiastrum	western daisy fleabane	Rarely
Erigeron divergens	spreading fleabane	Rarely
Eriogonum cernuum	nodding buckwheat	Rarely
Eriogonum wetherillii	Wetherill's buckwheat	Rarely
Ipomopsis longiflora	flaxflowered ipomopsis	Sometimes
Ipomopsis pumila	dwarf ipomopsis	Rarely
Linum puberulum	plains flax	Sometimes
Lupinus pusillus	rusty lupine	Sometimes
Machaeranthera canescens	hoary tansyaster	Rarely
Mentzelia albicaulis	whitestem blazingstar	Rarely
Mentzelia pumila	dwarf mentzelia	Rarely
Monolepis nuttalliana	Nuttall's povertyweed	Rarely
Oenothera albicaulis	whitest evening primrose	Sometimes
Phacelia integrifolia	gypsum phacelia	Rarely
Phacelia ivesiana	Ives' phacelia	Rarely
Plantago patagonica	woolly plantain	Rarely
Townsendia annua	annual Townsend daisy	Rarely
Townsendia fendleri	Fendler's Townsend daisy	Rarely
Verbesina encelioides	golden crownbeard	Sometimes

Subshrubs		
Brickellia microphylla	littleleaf brickellbush	Rarely
Brickellia oblongifolia	Mojave brickellbush	Rarely
Eriogonum leptocladon	sand buckwheat	Rarely
Eriogonum leptophyllum	slenderleaf buckwheat	Rarely
Eriogonum lonchophyllum	spearleaf buckwheat	Rarely
Eriogonum microthecum	slender buckwheat	Rarely
Suaeda moquinii	Mojave seablite	Rarely

Shrubs		
Artemisia bigelovii	Bigelow sage	Rarely
Atriplex cuneata	valley saltbush	Sometimes
Baccharis salicifolia	mule-fat	Usually
Celtis reticulata	netleaf hackberry	Usually
Chrysothamnus greenei	Greene's rabbitbrush	Rarely
Chrysothamnus linifolius	spearleaf rabbitbrush	Rarely
Chrysothamnus viscidiflorus	yellow rabbitbrush	Usually
Ephedra cutleri	Cutler's jointfir	Rarely
Ephedra torreyana	Torrey's jointfir	Rarely
Forestiera pubescens	desert olive	Usually
Lycium pallidum	pale desert-thorn	Rarely
Parryella filifolia	common dunebroom	Rarely
Ribes aureum	golden currant	Usually
Salix exigua[1]	coyote willow	Usually
Symphoricarpos albus	common snowberry	Usually

Trees		
Chilopsis linearis	desert willow	Usually
Populus fremontii[1]	Fremont cottonwood	Usually
Salix amygdaloides[1]	peachleaf willow	Usually
Salix gooddingii[1]	Goodding's willow	Usually

* Species included on menu are based on historic seed mixtures, species observed during monitoring of surrounding native areas, and plant availability.

[1] Species is a riparian species only suitable for use in appropriate microclimate during special project.

Table 37-4: Revegetation Success Criteria

Vegetation Cover	Total vegetation cover (live vegetation + litter) ≥ 90% reference areas
Shrub Density	80% of area ≥ 190 stems/acre
	20% of area ≥ 500 stems/acre
Grass Diversity	1 perennial grass species ≥ 5% relative perennial herbaceous cover
	2nd perennial grass species ≥ 3% relative perennial herbaceous cover
	No one species ≥ 85% relative perennial herbaceous cover
Forb Diversity	Combined perennial forbs ≥ 0.5% relative herbaceous cover *IF above fails AND the January-April precipitation is < 0.85 inches then 1 forb present within the shrub density belt
Shrub Diversity	Non-dominant shrub species combined density ≥ 20 stems/acre
Production	Total vegetation production ≥ 90% reference areas

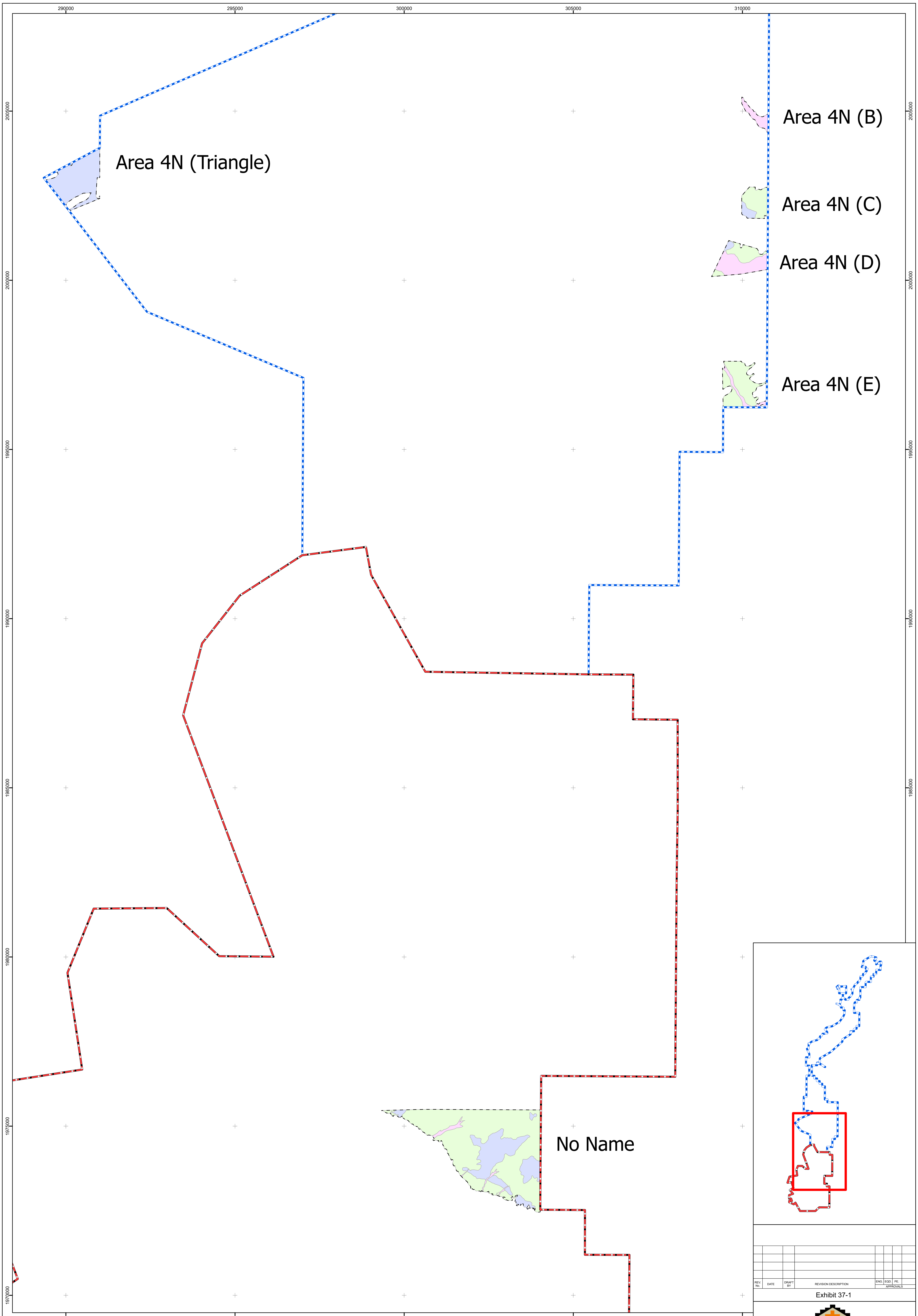
Table 37-5: Range Site-Community Identification & Associated Reference Areas

Navajo Mine	Bureau of Indian Affairs (BIA)	Natural Resources Conservation Service (NRCS)	Percent of Pre-mining Communities [1]	Percent of Reference Area Communities	Reference Area
Alkali Wash (Al/Wa)	Badlands	Sodic Slopes, Loamy	37.7 %	48.4 %	Alkali Wash (ALWA)
All Sands (Sa) [2]	Sandy, Sands	Limy	36.3 %	46.5 %	All Sands (ALSAN)
Dunes (Du)	Choppy Sands	Deep Sands	8.5 %	N/A[2]	N/A[2]
Badlands (Ba)	Shaley Saline, Badlands	Sodic Slopes	6.8 %	N/A[2]	N/A[2]
Thinbreaks (Th)	Thinbreaks	Shallow	6.8 %	N/A[2]	N/A[2]
Arroyo Shrub (Ar/Sh)	Saline Lowlands	Loamy	3.9 %	5.1 %	Arroyo Shrub (ARSH)

[1] See Section 15 (Vegetation).
[2] Not suitable for post-mining land use of rangeland

Table 37-6: Reference Area Range Sites

Reference Area	Resource Area	All Sands (ALSAN)	Alkali Wash (ALWA)	Arroyo Shrubs (ARSH)	Reference Acres
Area 4 N (B)	4 North			5.3	5.3
Area 4 N (C)	4 North	2.8	11.9		14.7
Area 4 N (D)	4 North	1.1	9.4	15.4	25.9
Area 4 N (E)	4 North		23.5	3.6	27.1
Area 4 N (Triangle)	4 North	35.2			35.2
Area 5	5	41.1	132.5	3.3	176.9
Total Acres		**80.2**	**177.3**	**27.6**	**285.1**
% of Reference Areas		28.1%	62.2%	9.7%	100.0%
% of Baseline		46.5%	48.4%	5.1%	100.0%
Reference Sample Size		19	19	2	40



Coordinate System:
NAD 1927 StatePlane New Mexico West FIPS 3003 Feet
Datum: North American 1927
Units US Feet

Feet 0 500 1,000 2,000 3,000
1:14,400
1 inch equals 1,200 feet

No Name Permit Boundary
NTEC Lease Boundary
Reference Area Boundary

Range Community
Alkali Wash (ALWA)
All-Sands (ALSAN)
Arroyo-Shrub (ARSH)

REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	EQD.	PE.
				APPROVALS		

Exhibit 37-1

Navajo Transitional Energy Company

No Name Permit Application Package

Reference Areas

PREPARED BY: RFB	DRAWN BY: RFB	PAPER SIZE: ARCH D
APPROVED BY:	DATE: 07/25/2025	

Appendix 37-A

No Name Permit

Noxious Weed Management Plan

Table of Contents

1 INTRODUCTION

Invasive weeds pose a serious threat to many native plants in New Mexico. They specialize in colonizing highly disturbed ground with their ability to establish quickly and grow faster on disturbed areas than other plants. Noxious weeds are invasive weeds that are subject to regulatory oversight by the local, State, federal, or tribal governments. The Navajo Transitional Energy Company (NTEC) is required to manage all noxious weeds regulated by the State of New Mexico (NMDA 2020) and by the Navajo Nation (BIA 2022) within its leasehold. Both these agencies use a classification system of A, B, and C species with Class A species being the highest priority for control and Class C having the lowest priority.

As a surface coal mining operation, NTEC has numerous acres of disturbed land within their lease holdings that fall under the continuous Navajo Mine, Pinabete Mine, and No Name Mine permits. Land disturbances associated with mining can provide a habitat conducive to the spread of noxious weeds. This weed management plan has been established to assist with NTEC's reclamation goal of establishing diverse, stable, and self-sustaining vegetation that will satisfy the following criteria:

- Adequate cover capable of stabilizing the soil surface from erosion,
- Adequate forage to sustain the post-mining land uses (i.e., livestock grazing and wildlife forage), and
- Suitable species composition for enhancement of wildlife habitat and cover.

2 OBJECTIVES

One of the reclamation objectives is to establish a diverse, effective, and self-sustaining vegetation cover of the same seasonal variety as the native vegetation. In addition, NTEC's Health, Safety, Environmental, and Community Policy strives for long-lasting benefits to the local environment from mining operations. Noxious weeds must be addressed to adhere to both of these goals.

The objectives of NTEC's weed management plan are prevention, early detection, and control of noxious weeds to assist in achieving successful reclamation.

2.1 Prevention

The best weed management action is to prevent noxious weeds from becoming established in the first place. Preventing weeds from invading a site is the most effective and least costly method for control.

Reclamation activities provide a venue for the introduction of noxious weeds. The introduction of noxious weeds can be reduced by purchasing seeds and mulch from reputable dealers with certified weed-free products. Routine inspections of seeds and mulch and familiarization with the dealers that provide them will be conducted to ensure no new weed seeds or vegetative parts enter the site through contaminated sources.

Areas will be seeded using native species or carefully chosen non-invasive introduced species as soon as possible after mining has ceased. Quickly establishing a good stand of desirable vegetation will minimize the opportunity for noxious weed establishment.

2.2 Early Detection

Detection of new infestations on the mine site is crucial for controlling noxious weeds. The NTEC environmental department will remain up to date on noxious weeds present on the mine site and those that have the potential to invade from surrounding areas. NTEC environmental specialists will perform periodic inspections of the reclamation to detect and identify infestations of noxious weeds. Detecting the infestations of noxious weeds is a high priority to minimizing their potential spread and colonization of reclamation areas.

2.3 Control

Control of noxious weeds on the permit area primarily consists of informally monitoring the disturbed and reclaimed areas, via regulatory inspections, irrigation pipeline checks, and general field inspections by NTEC environmental specialists. If an infestation is detected where control is needed, mechanical and/or chemical control, by a licensed operator, will be implemented. Control measures will be implemented which are suitable for each noxious weed on a species basis.

2.3.1 Mechanical Control

Mechanical control of noxious weeds can be an effective tool to physically disrupt noxious weed growth and seed development. A combination of mechanical methods may be used including hand-pulling, mowing, disking, and hand-held weed trimmers and saws. Mechanical weed control practices must be applied with correct timing to maximize their effectiveness in preventing vegetation development or seed production.

- **Hand pulling** should generally be used in sensitive vegetation communities where herbicide use is not appropriate or when conditions prevent its use such as high winds or high temperatures.
- **Mowing** of large-scale herbaceous infestations is most effective when implemented before seed set and can be implemented in conjunction with inter-seeding or over-seeding treatments. Mowing of weedy shrubs/trees such as saltcedar (*Tamarix* spp.) is most effective if completed in conjunction with herbicide application to the freshly cut stems.
- **Disking or harrowing** can be used in similar situations to mowing but will more often be used as a part of cultural controls to alleviate soil compaction prior to seeding. Large-scale infestations may be sprayed with a glyphosate herbicide or mowed to prevent seed set, then disked to prepare a seed bed, then seeded.
- **Gas-powered weed whackers** can be used for small-scale herbaceous infestations. This technique is most effective when implemented before seed set and can be implemented in conjunction with inter-seeding or over-seeding treatments. Weed whacking of weedy shrubs such as small saltcedar

sprouts on steep slopes not accessible by tractors is most effective if completed in conjunction with herbicide application to the freshly cut stems.

- **Chainsaws** can be used to cut larger noxious tree species such as saltcedar followed by treating stumps with herbicide.

Annual weedy species may be readily controlled with mowing or physical removal, but perennial species have extensive root systems with significant carbohydrate reserves. For perennial species, mowing may only control seed production without seriously affecting the plant's survival and mowing after seed production may increase the infestation. Disking or tilling areas containing perennial noxious species may also increase the area of infestation due to root sprouting. In most cases mechanical control methods used alone are not effective against hardy perennial weed species.

2.3.2 Chemical Control

Chemical control of noxious and nuisance weeds can be an effective tool to disrupt plant growth and seed development. Herbicides must be applied at the appropriate time to maximize their effectiveness in preventing seed production, for disrupting plant establishment and growth, or achieving kill of noxious species. Herbicide treatments are generally initiated in the spring after plant growth has commenced, but before flower bud set and again in fall before seed set. However, treatments will be scheduled on a site-specific basis and timed to maximize their effectiveness based on weed physiology and growth characteristics.

For large infestations, a boom sprayer attached to a truck or UTV can be used, but in many cases a more targeted spot-application of herbicide using a truck, UTV, or backpack sprayers will be preferable. Selectively treating individual weeds can minimize impacts to the surrounding vegetation in sensitive native areas or revegetated sites which are held to rigorous standards for vegetation cover and diversity. Broadleaf selective herbicides can further protect desirable grass species.

To avoid development of resistance to a particular herbicide through repeated use over prolonged periods of time, herbicides and plant growth regulators with varying modes of action should be used. Herbicides will be applied according to the manufacturer's label recommendations (i.e., application rate, method, and timing) to prevent development of plant resistance.

Due to the high level of seed and shoot production of noxious species, multiple herbicide applications will likely be necessary to treat plants growing at various times throughout the season. It is anticipated that the site will be treated multiple times during the growing season to treat new plants emerging from the seed bank and underground roots. It is also expected that multiple years of treatment will be required to reduce weed infestations on the site due to a well-developed seed bank and infestations on adjacent properties.

2.3.3 Herbicide Selection & Safety

Successful noxious weed management begins with an understanding of the target plant species and the environment within which it grows. Next, the physiological effects of an herbicide on plant growth and development must be understood. Understanding a pesticide's chemical nature is also important in minimizing impacts to non-target species, the applicator, endangered species, and pollinators, as well as surface water runoff hazards and leaching into groundwater.

All pesticides will be handled with care and applied by qualified personnel. Product labels will be read before use, and handling and application directions followed. Properly identifying the weed problem and the most effective chemical control method for use during the plant growth cycle is critical to effective weed control. Equipment will be properly calibrated before herbicides are applied and appropriate Personal Protective Equipment (PPE) will be used. Empty containers will be disposed of promptly, safely, and in accordance with product labeling.

3 INVENTORY OF NOXIOUS WEED SPECIES

The areas of concern for noxious weeds are on the disturbed and revegetated plots and along roads, constructed waterways, or impoundments. NTEC will monitor revegetation plots undergoing irrigation for noxious weeds. However, noxious weeds will not be managed unless the weeds consistently persist after irrigation has ceased. These irrigated plots commonly have a high initial density of annual noxious weeds with reduced densities once the area is no longer irrigated. There are five common noxious weed species known to be present in the lease area that are designated for control by the State of New Mexico and the Navajo Nation (Table 1).

Table 1 Common Noxious Weed Species Found in the Navajo Mine Permit Area

Common Name	Scientific Name	New Mexico Class	Navajo Nation Class
cheatgrass	*Bromus tectorum*	C	C
halogeton	*Halogeton glomeratus*	B	B
kochia	*Bassia scoparia*	-	C
Russian thistle	*Salsola tragus*	-	C
saltcedar	*Tamarix sp.*	C	A

4 COMMON NOXIOUS WEEDS

4.1 Cheatgrass

Cheatgrass (*Bromus tectorum*), also known as downy brome, is a winter annual grass introduced from Europe and Asia widely distributed throughout North America (NMDA 2020). Cheatgrass infestations can be found in both native and disturbed areas (NMDA 2020). Plants geminate in late fall or early spring. This early spring growth habit helps cheatgrass out compete native plants for water and nutrients (NMDA 2020). Cheatgrass is a Class C listed weed in New Mexico and the Navajo Nation meaning it is widespread, difficult to contain, with the management goal of preventing the further spread of infestations (BIA 2022).

Cheatgrass infestations are widespread and well established throughout the lease area. NTEC will manage cheatgrass infestations by purchasing native seeds and mulch from reputable dealers and establishing diverse, self-sustaining vegetation communities.

4.2 Halogeton

Halogeton (*Halogeton glomeratus*), also called saltlover, is an annual forb introduced from Russia that has been found to be toxic to grazing animals, especially sheep (NMDA 2020). It is adapted to alkaline soils and semi-arid environments. Halogeton is not extremely competitive with other plants because it does not grow a large root system early in the growing season (NMDA 2020). However, halogeton accumulates salt increasing soil salinity creating a less favorable environment for desirable species when an infestation occurs (BIA 2022). Halogeton is a Class B noxious weed in New Mexico and the Navajo Nation meaning the infestations are substantial but isolated and these species have caused harm to humans, wildlife, livestock, or property (BIA 2022). The management goals for these species are to contain and prevent the spread to unaffected areas (BIA 2022).

Areas of concern for halogeton within the lease area could be on older reclaimed plots where irrigation has ceased and halogeton continues to persist. If an infestation persists, halogeton will be mechanically or chemically controlled.

4.3 Kochia

Kochia (*Bassia scoparia*), also called burningbush, is an annual forb widely distributed throughout the United States and the Navajo Nation (BIA 2022). It grows on disturbed, alkaline soil areas like those created post-mining. Kochia is a Class C noxious weed on the Navajo Nation meaning it is widespread, difficult to contain, with the management goal of preventing the further spread of infestations (BIA 2022).

Kochia infestations are widespread throughout the lease area, and it is common that infestations arise from distribution from the surrounding area. These infestations are common in new reclamation areas under irrigation; however, once irrigation is removed it is typical that these infestations decrease or die out completely within three to five years. NTEC will monitor current infestations and new reclamation areas within the lease area. If management is needed a plan will be developed.

4.4 Russian thistle

Russian thistle (*Salsola tragus*) is a summer annual that grows on disturbed sites in sandy soils (BIA 2022). These infestations increase fire risk with their persistent skeletons and are toxic to livestock (BIA 2022). Russian thistle is a Class C noxious weed on the Navajo Nation meaning it is widespread, difficult to contain, with the management goal of preventing the further spread of infestations (BIA 2022).

Russian thistle infestations will be monitored and treated by NTEC. It has been shown to be resistant to herbicides, thus chemical control will be used sparingly and in appropriate situations. Mechanical control may be utilized on current infestations. Removal of Russian thistle skeletons will occur where accumulation is happening such as along fence lines, road ditches, and facilities to reduce fire risk.

4.5 Saltcedar

Saltcedar includes several species and hybrids in the genus *Tamarix* and is also known as tamarisk. It is a tall shrub or tree commonly found where water is present such as irrigation canals, springs, seeps, lakes, playas, arroyos, and dirt stock tanks (NMDA 2020). Saltcedar species can develop extensive taproots to access water sources deep below the surface lowering the water table and it excretes salts making for unfavorable conditions for desirable vegetation (BIA 2022).

Saltcedar is established along existing water sources within the lease area. In areas reclaimed by NTEC, if saltcedar becomes well established, appropriate mechanical and/or chemical treatments may be applied to remove the infestation.

5 REFERENCES

Bureau of Indian Affairs (BIA) Navajo Region. 2022. *Final Navajo Nation Integrated Weed Management Plan*.https://www.bia.gov/sites/default/files/dup/inline-files/appendix_a._navajo_nation_integrated_weed_management_plan_full.pdf.

New Mexico Department of Agriculture (NMDA). 2020. *Noxious and troublesome weeds of New Mexico.* https://pubs.NMDA.edu/_circulars/CR698/.

Appendix 37-B

No Name Permit

Hypothesis Testing Procedures

Table of Contents

1 INTRODUCTION

Formal sampling for bond release will follow the approved sampling methods and parameters detailed in Section 37 of the Permit Application Package (PAP). For Phase II release, only total vegetation cover data will undergo hypothesis testing. For Phase III release, total vegetation cover, annual production, and shrub density will be tested.

Comparisons to both reference areas and technical standards are used and hypothesis testing differs between the two. Total vegetation cover and annual production are compared to reference area data as detailed in Section 3. Shrub density is compared to a technical standard, detailed in Section 4. The procedures described below are consistent with other coal mines in the region and those described in Bilbrough and Howlin (2012). Critical values for all tests can be found in the tables included in Bilbrough and Howlin (2012).

The following tests will generally require field testing of sample data to ensure adequate sample size to support a revegetation success evaluation. Within the two groups of tests below (reference area comparisons and technical standard comparisons) the individual statistical tests are set forth in order of evaluation. In both, the use of parametric tests is prioritized over non-parametric tests if the dataset meets the applicable necessary characteristics regarding normality, sample adequacy, and equality of variance.

2 SAMPLE ADEQUACY

Sample adequacy is calculated for all datasets undergoing hypothesis testing (total vegetation cover in both Phase II and Phase III bond release evaluations as well as annual production and shrub density for Phase III evaluations). A minimum of 20 samples will be collected. If sample adequacy is not met, additional transects are sampled until sample adequacy is reached or the maximum of 40 samples are collected. Sample adequacy will be calculated using the following formula:

$$n_{min} \geq \frac{(ts)^2}{(d\bar{x})^2}$$

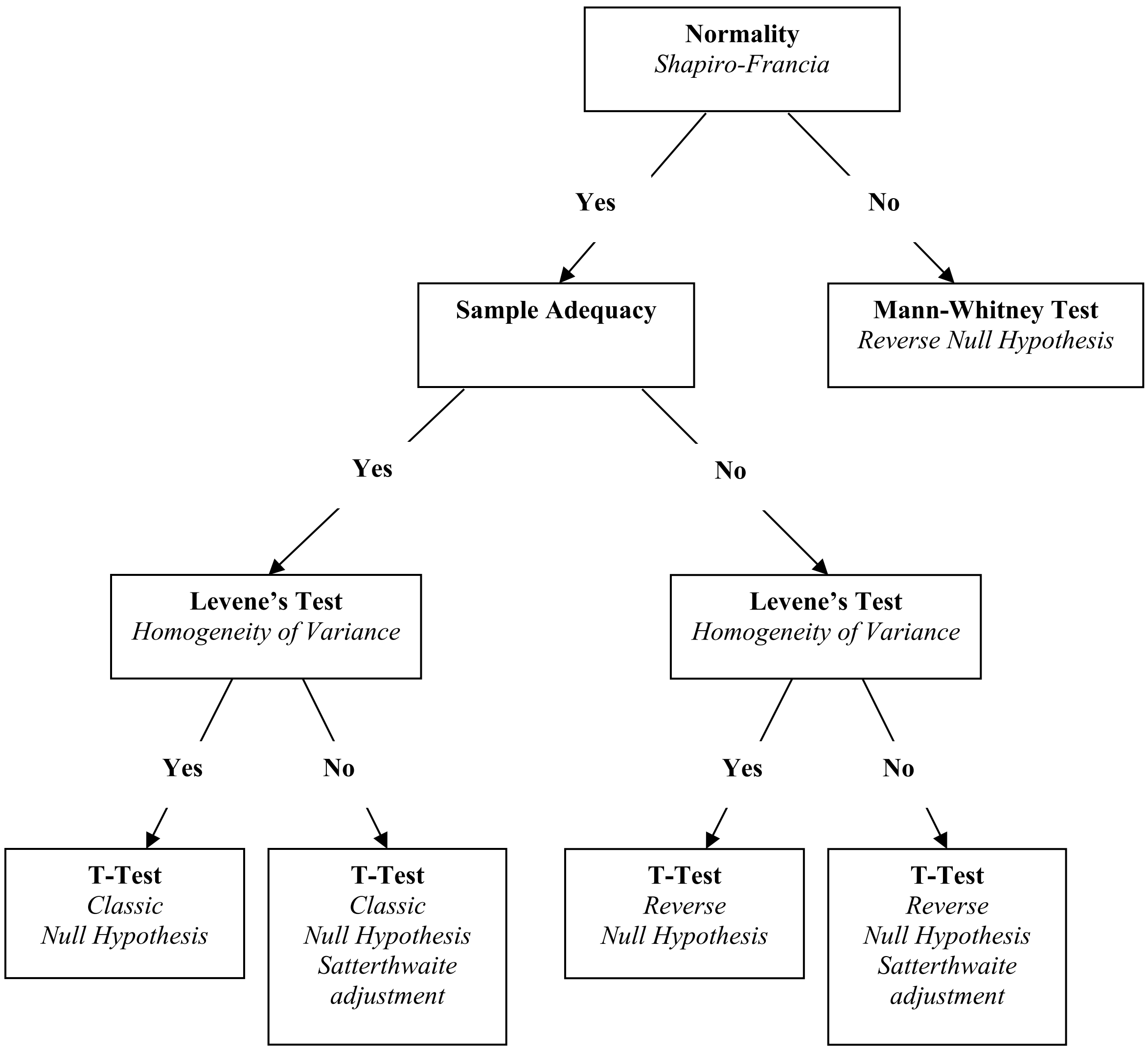
Where:

	$n_{\min}$ =	Number of samples (minimum sample size)
	t =	varies with sample size and confidence interval (1.685 for 90% confidence interval and 40 observations)
	s =	Sample standard deviation
	d =	Precision level for desired percentage of the sample mean (expressed as a decimal) (0.10 for 90% confidence interval)
	$\bar{x}$ =	Sample mean

3 REFERENCE AREA COMPARISONS

Total vegetation cover and annual production will be compared to reference area data collected at the same time as the revegetation data. Hypothesis testing will follow the statistical tests described below as illustrated in Figure 1.

Figure 1 Reference Area Comparison Flow Chart



3.1 Normality

Initially, an assessment of whether the data are normally distributed will be made using a Shapiro-Francia test with an alpha equal to 0.01 using the following formula:

$$W' = \frac{(\sum_{i-1}^{n} b_i\, y_i)^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2}$$

Where: y_i = sample data

$\bar{y}$ = sample mean

n = sample size

$b_i = \frac{z_i}{(\sum_{i=1}^{n} z_i^2)^{\frac{1}{2}}}$

z_i = order statistic corresponding to y_i

The null hypothesis states that the sample data are normally distributed. The null hypothesis is accepted, and the data are considered normally distributed, when W' $\geq$ critical value.

If there is indication that the data distribution is normal, then an assessment of sample adequacy will be made using the expression in Section 2. If the data are not normally distributed, then conduct the Mann Whitney Test as described in Section 3.6.

3.2 Homogeneity of Variance

After sample adequacy is calculated for the bond release area and the reference areas the data are tested for homogeneity of variance using Levene's Test with two-sided alpha equal to 0.01 (Bilbrough and Howlin 2012). The null hypothesis for Levene's test states that the variance of the revegetation sample data is equal to the variance of the reference area sample data. The test statistic is the two-sample t-statistic for the absolute deviations of every observation from the sample mean. For each sample, calculate the absolute deviations for each observation as:

$$Z_{br_i} = \left| y_{br_i} - \bar{y}_{br} \right|$$

$$Z_{ref_i} = \left| y_{ref_i} - \bar{y}_{ref} \right|$$

and test for differences between the mean Zbr and mean Zref using the two-sample t-test. The variances are unequal if the test statistic is less than $t_{(0.005, n_{br}+n_{ref}-2)}$ or greater than $t_{(0.995, n_{br}+n_{ref}-2)}$. If variances are unequal, then the Satterthwaite's adjustment must be used for the two-sample t-test.

3.3 Two Sample T-Test (Classic Null Hypothesis)

If sample adequacy is indicated, a two-sample t-test with classic null hypothesis will be applied using the following formula:

$$t = \frac{\bar{x}_{br} - 0.9\bar{x}_{ref}}{\sqrt{\frac{(n_{br}-1)s_{br}^2 + (n_{ref}-1)s_{ref}^2}{n_{br}+n_{ref}-2}\left(\frac{1}{n_{br}}+\frac{1}{n_{ref}}\right)}}$$

Where: $\bar{x}$ = observed mean

n = number of samples

s = standard deviation

br = revegetation area

ref = reference area

The one-sided null hypothesis for the two-sample t-test is that the mean of a given vegetation parameter in the revegetation area (μ_{br}) is equal to or greater than the mean in the reference area (μ_{ref}).

H_o: br values – 0.9 x reference area values ≥ 0

H_a: br values – 0.9 x reference area values < 0

If homogeneity of variance is not indicated, the Satterthwaite adjustment should be utilized to correct the degrees of freedom prior to calculating the critical value as described in Section 3.5. Evidence in support of revegetation success is obtained when the null hypothesis is accepted, and the test statistic is greater than or equal to the critical value.

3.4 Two Sample T-Test (Reverse Null Hypothesis)

If sample adequacy is not indicated, a two-sample t-test with reverse null hypothesis will be applied. The one-sided reverse null hypothesis for the two-sample t-test is that the mean of a given vegetation parameter in the revegetation area (μ_{br}) is equal to or less than 90% of the mean in the reference area (μ_{ref}).

H_o: $\mu_{br} - 0.9 * \mu_{ref} \leq 0$

H_a: $\mu_{br} - 0.9 * \mu_{ref} > 0$

The t-test formula is:

$$t = \frac{\bar{x}_{br} - 0.9\bar{x}_{ref}}{\sqrt{\frac{(n_{br}-1)s_{br}^2 + (n_{ref}-1)s_{ref}^2}{n_{br}+n_{ref}-2}\left(\frac{1}{n_{br}} + \frac{1}{n_{ref}}\right)}}$$

Where: $\bar{x}$ = observed mean

n = number of samples

s = standard deviation

br = revegetation area

ref = reference area

Evidence in support of revegetation success is obtained when the null hypothesis is rejected, and the test statistic is less than the critical value. If homogeneity of variance is not indicated, the Satterthwaite adjustment should be utilized to correct the degrees of freedom prior to calculating the critical value as described in Section 3.5.

3.5 Satterthwaite's Adjustment

If sample adequacy is indicated and homogeneity of variance is not indicated, a two-sample t-test with classic null hypothesis will be used as shown above (Section 3.3) but with Satterthwaite adjustment utilized to correct the degrees of freedom. The Satterthwaite adjustment will be calculated as follows:

$$df_{sat} = \frac{SE_{sat}^4}{\left(\frac{SE_{br}^4}{n_{br}-1} + \frac{\left(0.9 * SE_{ref}\right)^4}{n_{ref}-1}\right)}$$

Where: SE = standard error of the mean

n = number of samples

br = revegetation area

ref = reference area

3.6 Mann-Whitney Test

If there is indication that the data distribution is not normal, then a non-parametric Mann-Whitney test with a reverse null hypothesis test will be utilized. The reverse null hypothesis for the Mann-Whitney test is that the revegetation values tend to be less than 90% of the reference area values.

Ho: br values – 0.9 x reference area values ≤ 0

Ha: br values – 0.9 x reference area values > 0

Evidence in support of revegetation success is obtained when the null hypothesis is rejected. There are no assumptions that need to be met for this test.

Because sample sizes will always be greater than 20, it is necessary to calculate the approximate Z statistic and compare the calculated value to the critical Z value. The approximate test statistic for Z is:

$$Z = \frac{\sum_{i=1}^{n} R(br_i) + \frac{1}{2} - n_{br}\frac{(n_{br} + n_{ref} + 1)}{2}}{\sqrt{\frac{n_{br}n_{ref}(n_{br} + n_{ref} + 1)}{12}}}$$

Where: $R(br_i)$ = the ranks of the observations in the revegetation sample

n_{br} = revegetation sample size

n_{ref} = reference sample size

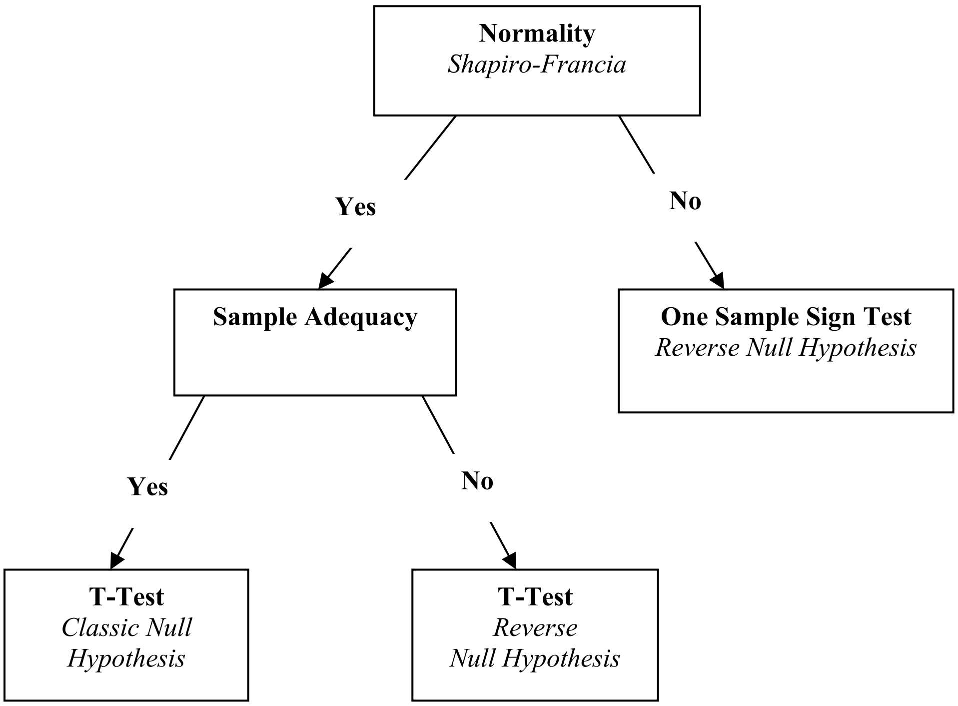
Before ranking the entire dataset, every observation in the reference sample is multiplied by 0.9. Ranks are determined by sorting the combined observations from both data sets from smallest to largest value. Ranks are then assigned starting with 1 and ending with the combined sample size ($n_{ref} + n_{br}$). Equal values are given equal ranks, determined by calculating the average of the summed rank values. For example, two equal values might be ranked 9 and 10, so each would be assigned a rank of 9.5. The ranks are then summed for the revegetation area ($R(br_i)$).

Revegetation is successful when the one-sided null hypothesis is rejected: the test statistic is greater than $Z_{1-\alpha}$. The conclusion is that the values from the revegetation distribution tend to be greater than 90% of the values from the reference distribution.

4 TECHNICAL STANDARD COMPARISONS

Shrub density will be compared to technical standards. Hypothesis testing will follow the statistical tests described below as illustrated in Figure 2.

Figure 2 Technical Standard Comparison Flow Chart



4.1 Normality

Initially, an assessment of whether the data are normally distributed will be made using a Shapiro-Francia test with an alpha equal to 0.01 using the following formula:

$$W' = \frac{(\sum_{i-1}^{n} b_i \, y_i)^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2}$$

Where: y_i = sample data

$\bar{y}$ = sample mean

n = sample size

$b_i = \frac{z_i}{(\sum_{i=1}^{n} z_i^2)^{\frac{1}{2}}}$

z_i = order statistic corresponding to y_i

The null hypothesis states that the sample data are normally distributed. The null hypothesis is accepted, and the data are considered normally distributed, when W' $\geq$ critical value.

If there is indication that the data distribution is normal, then an assessment of sample adequacy will be made using the expression in Section 2. If the data are not normally distributed, then conduct the one-sample sign test or Wilcoxan signed rank test as described in Section 4.2.

4.2 One Sample T-Test (Classic Null Hypothesis)

If sample adequacy is indicated a one-sample t-test with classic null hypothesis will be applied using the following formula:

$$t = \frac{\bar{x} - \ tech.std.}{s/\sqrt{n}}$$

Where: $\bar{x}$ = Sample mean
tech.std. = Technical standard
s = Sample standard deviation
n = number of samples

The null hypothesis for the classical one-sample t-test is that the revegetation mean is equal to or greater than 90% of the technical standard.

H_o: br values – 0.9 x technical standard ≥ 0
H_a: br values – 0.9 x technical standard < 0

Evidence in support of revegetation success is obtained when the null hypothesis is accepted, and the test statistic is greater than the critical value with alpha equal to 0.1 and n-1 degrees of freedom. When sample size is 40 (39 degrees of freedom), for example, the critical t-value is -1.304.

4.3 One Sample T-Test (Reverse Null Hypothesis)

If sample adequacy is not indicated a one-sample t-test with reverse null hypothesis will be utilized. The reverse null hypothesis for the one-sample t-test is that the revegetation mean is equal to or less than 90% of the technical standard.

H_o: br values – 0.9 x technical standard ≤ 0
H_a: br values – 0.9 x technical standard > 0

The test statistic will be calculated as follows:

$$t = \frac{\bar{x} - \ tech.std.}{s/\sqrt{n}}$$

Where: $\bar{x}$ = Sample mean

tech.std. = Technical standard

s = Sample standard deviation

n = number of samples

Evidence in support of revegetation success is obtained when the null hypothesis is rejected, and the test statistic is greater than the critical t-value (in the right tail) with 0.90 probability and n-1 degrees of freedom. When sample size is 40 (39 degrees of freedom), for example, the table t-value is 1.304.

4.4 One-Sample Sign Test

If the data are not normally distributed, then the non-parametric one-sample sign test with reverse null hypothesis will be used. The reverse null hypothesis for the one-sample sign test is that the revegetation values are equal to or less than 90% of the technical standard.

H_o: br values – 0.9 x technical standard ≤ 0

H_a: br values – 0.9 x technical standard > 0

Because the sample size is greater than 20, the test statistic (Z) will have to be approximated (Bilbrough and Howlin 2012) using the follow formula:

$$Z = \frac{M + 0.5 - 0.5n}{0.5\sqrt{n}}$$

Where: M = the number of minuses when 0.9 x the technical standard is subtracted from every observation

n = number of samples

The standard is met when the one-sided null hypothesis is rejected and the test statistic (Z) is less than a Zα value with a 0.10 probability ($Z_{0.10}$) in the left tail. For a probability of 0.10 to the left of the mean, the critical value of z = -1.28 (Table 1, Bilbrough and Howlin 2012). Hence the null hypothesis is rejected when the test statistic is less than -1.28.

5 REFERENCES

Bilbrough, C. and S. Howlin. 2012. Handbook of Approved Sampling and Statistical Methods for Evaluation of Revegetation Success on Wyoming Coal Mines. Wyoming Department of Environmental Quality, Land Quality Division. Cheyenne. 38 p.