**McKinley Mine Permit No. NM-0001K**
**Vegetation Management Units 2, 3, and 5**
**Application for a Permanent Program Final Bond Release and**
**Initial Program Reclamation Liability Release & Termination of Jurisdiction**

**Submitted to:** The Office of Surface Mining Reclamation and Enforcement
Western Region Office
P.O. Box 25065
Denver, Colorado 80225-0065

**Submitted by:** Chevron Environmental Management Company
On behalf of Chevron Mining Inc.
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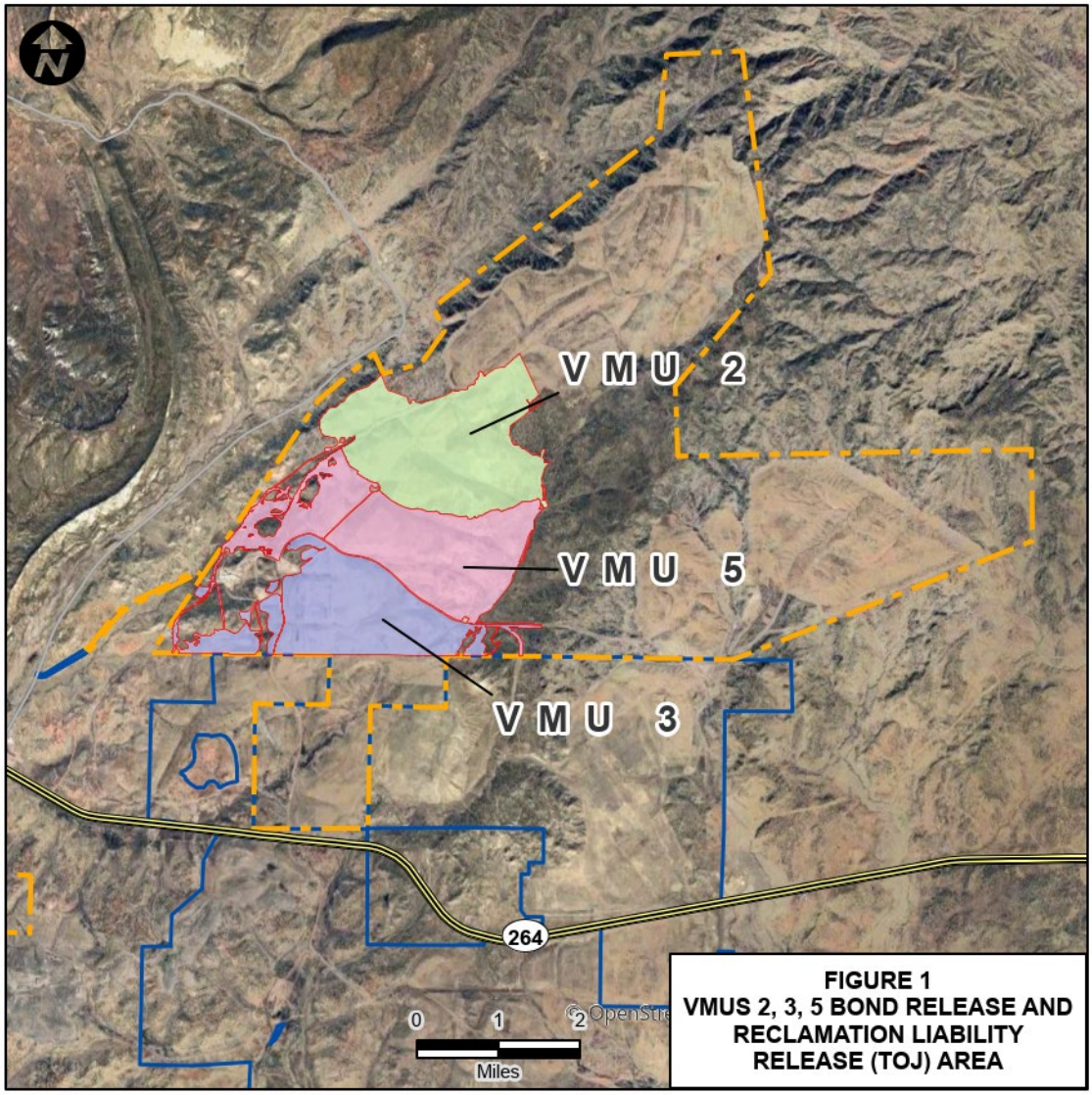
**Date:** October 24, 2025

## 1.0 Overview

On behalf of Chevron Mining Inc. (CMI), the Chevron Environmental Management Company (CEMC) hereby submits this Application for a Phase III bond release of Permanent Program Lands (PPL), and a reclamation liability release and Termination Of Jurisdiction (TOJ) of Initial Program Lands (IPL) and Prelaw Lands (PLL) for reclaimed lands in Vegetation Management Units 2, 3, and 5 (VMU 2, VMU 3, and VMU 5). The application includes a request for Phase I, II, and III bond release on Nine Permanent Impoundments. The total associated performance bond reduction for VMU 2, 3, and 5 requested in this application is a total of $5,067,000 as discussed by VMU in Section 12 of this document.

The lands are generally located in former mining Areas 1, 2, 3, and 5 of the McKinley Mine. Figure 1 shows the general location of VMUs 2, 3, and 5. Section 3.0 references more detailed exhibits showing the configurations of the VMUs.

**Figure 1: General Location of VMUs 2, 3, and 5**




The McKinley Mine is permitted under Permit NM-0001K (the Permit). The McKinley Mine permittee is CMI (formerly the Pittsburg and Midway Coal Mining Co. [P&M]).

This Application addresses bond release requirements under 30 CFR 800.40 (c) (3) and the Office of Surface Mining, Reclamation, and Enforcement's (OSMRE's) Permanent Program Phase III bond release guidance provided in the document, "Guideline to Bond Release Procedures for Permanent Program Lands, Indian Programs Branch, Western Region" (OSMRE Bond Release Guideline) (OSMRE 2017).

The application demonstrates that the plant community has moved toward the desired successional trajectory to meet the intended postmining land use per 30 CFR 816.111

and the currently approved Permit. Reclamation was completed in conformance with the performance standards in 30 CFR 715 for IPL, and the standards in place at the time for PLL, and 30 CFR 816 and the PPL permit for PPL. The PPL reclamation also meets all applicable requirements of the performance standards in 30 CFR Part 810 through 828.

The lands in each VMU constitute a bond release block, as described in the OSMRE Bond Release Guideline. Each of the VMUs combine PPL, IPL, and PLL into one sampling unit in accordance with Section 6.5.1.2 of the Permit. All three land categories together as one logical unit must meet the Permit revegetation success standards, which they do, as discussed in this Application. The period of extended responsibility of ten years for the PPL has been met in accordance with 30 CFR 816.116 and the permit. Furthermore, this application contains information that demonstrates revegetation success has been met on PPL in any two years following Year 6 of the responsibility period, as required by the OSMRE Bond Release Guidance. The IPL has been revegetated for decades well beyond the minimum two growing seasons for cover called for in 30 CFR 715.20 (f). PLL has been revegetated for decades as well. In summary, each VMU has met revegetation success standards in 2023 and 2024.

This application has been organized to address both PPL, IPL, and PLL application requirements as much as possible. The application adheres to the following order of information: 2.0 Application Certification, 3.0 VMUs 2, 3, and 5 Location and Regulatory Acreages, 4.0 Brief History, 5.0 Access Roads, 6.0 Surface and Subsurface Water, 7.0 Erosion and Sediment Control, 8.0 Postmining Water-Containment Structures, 9.0 Postmining Land Use, 10. Revegetation, 11.0 Wildlife Habitat Enhancements, 12.0 Performance Bond, 13.0 Landowner Notification, 14.0 Newspaper Advertisement, and Section 15.0 Supplemental Information for Initial Program Lands and Prelaw Lands. This Section includes information to make the reclamation liability release and TOJ for the IPL and PLL application complete.

## 2.0 Application Certification

An executed Application Certification is contained in Appendix A1, which certifies that all applicable reclamation activities have been completed in VMUs 2, 3, and 5 that are necessary for a Phase I, II, and III for the included impoundments, a Phase III bond release of the rest of the PPL, and a full reclamation liability release and TOJ of IPL and PLL. The document also states that these activities were done in accordance with applicable mine permits, reclamation requirements and regulations, and consistent with the intent of the Surface Mining Control and Reclamation Act of 1977. The Application Certification includes a statement that there are no outstanding violations or cessation orders for the lands contained in this Application.

## 3.0 VMUs 2, 3, and 5 Location and Regulatory Acreages

This Section contains information that characterizes the VMUs and their location. Table T1 summarizes the acreages for each VMU by regulatory category, number of impoundments, and latitude and longitude of the approximate centroid of each VMU. Exhibit E1 shows the location of VMUs 2, 3, and 5 relative to all the other McKinley Mine VMUs.

Exhibit E2 shows the relative location of the three VMUs to each other and depicts the PPL, IPL, and PLL within each VMU. Minor adjustments were made to the initial VMU vegetation sampling configurations to establish logical release boundaries based on Phase I and II approved land configurations and disturbance limits. Appendix A2 illustrates the locations of four minor areas that were included in this Application that had Phase I and II approved, but were not in the sampled VMUs; these areas have vegetation at a level comparable to the rest of the VMU. The appendix includes photographs showing typical vegetation in the added areas. Two track accesses within these VMUs that are part of this Application are discussed in Section 5.0.

**Table T1: VMUs 2, 3, and 5 Regulatory Categories and Summary Table**

| Category | VMU 2 | VMU 3 | VMU 5 | Total |
|---|---|---|---|---|
| PLL (acres) | 0 | 178 | 24 | 202 |
| IPL (acres) | 302 | 230 | 196 | 728 |
| PPL (acres) | 771 | 450 | 829 | 2050 |
| Total (acres) | 1073 | 858 | 1049 | 2980 |
| Impoundments | 2 | 0 | 7 | 9 |
| Latitude | 35.686335 | 35.665164 | 35.6746 | |
| Longitude | -108.961588 | -108.976841 | -108.967807 | |

A USGS 7.5 Minute Quadrangle map (from the Window Rock and Tse Bonita School Quadrangle) with the location and boundaries of VMUs 2, 3, and 5 is provided on Exhibit E3-1 through E3-3.

## 4.0 Brief History

The VMU 2, 3, and 5 configurations overlap parts of previous Phase I and II bond release applications on the PPL. The first application was the Areas 3 and 5 Phase I and Phase II Bond Release Application, which was approved January 29, 2020. The second application was the Area 2 Phase I and Phase II Bond Release Application, which was approved September 13, 2022. There have been no previous applications for reclamation liability release and TOJ on the IPL and PLL.

Exhibits E4-1 through E4-3 show the VMUs 2, 3, and 5 boundary superimposed over previous Phase I and II bond-released areas on PPL. Exhibit E4-1 through E4-3 also show the impoundments included in this Application for Phase I, II, and III bond release.

Lands in VMUs 2, 3, and 5 were mined by draglines and truck/loader/shovel operations. Mining started in the late 1970s during the prelaw period up until 1977, proceeded from 1977 through 1986 under the initial program regulations, and under the permanent program regulations and associated permit from 1986 through 2009. Mining activities generally proceeded from west to east (towards Tse Bonita Wash) with final pits along the east edge of the VMUs.

The various reclamation phases through seeding were conducted contemporaneously with mining activities. Initial seeding on PLL, IPL and PPL generally spans a period from 1975 through 2013. More details on the timing of seeding may be found in the revegetation section below.

**5.0 Access Roads**

The Navajo Nation requested that two-track trails be the primary access for the postmining land users. Section 5.1.5 and 5.6.3.7 in the Permit contain details regarding configurations for the postmining road system in accordance with the Navajo Nation request. Annual updates to the currently active road system shown on Permit Exhibit 5.1-4 are submitted to OSMRE for incorporation into the Permit. Permit Exhibit 5.1-4, dated March 27, 2024, was used as the source of the road locations for the final postmining primary road system provided in this Application. Exhibits E5-1 through E5-3 show the final postmining primary road network in VMUs 2, 3, and 5. The location of the primary road network within the VMUs has been certified by a Professional Engineer.

**6.0 Surface and Subsurface Water**

This Section provides information regarding impacts to surface and subsurface water by lands in VMUs 2, 3, and 5. The VMU lands are reclaimed and revegetated such that they are not contributing total suspended solids to streamflow or runoff outside the permit area. A detailed analysis is provided in Appendix A3, which also includes information on ground water. The data will also show that there is no alkaline or acid drainage coming from the reclaimed land.

Sedimentology and NPDES Outfalls

As stated in Section 5.7.4.3 of the Permit, extensive sediment-yield analyses were performed throughout the mine through paired watershed sampling and modeling that demonstrated acceptable sediment yields for various reclaimed-land scenarios.

All outfalls at McKinley Mine are categorized under the EPA NPDES Western Alkaline Coal Mining (reclamation areas) standards, which focus on a sediment control plan (SCP) supported by modeling built around attaining sediment discharge levels that do not exceed pre-mining conditions. The primary attainment mechanism is monitoring of and compliance with Best Management Practices (BMPs). The BMPs for the reclaimed areas include the reconstructed landforms, the hydrologic structures (including terraces and down-drains, drainages, and armored channels), seeding and mulching, and revegetation. These BMPs are further augmented by the application of rock mulch in zones prone to higher levels of sheet erosion. Compliance is verified through collection of water monitoring data from outfall discharges and field inspections of the BMPs.

There are thirteen NPDES outfalls associated with VMUs 2, 3, and 5, which include: Outfall 009 (DC-25), Outfall 010 (DC-1), Outfall 014 (SP-3-5), Outfall 017 (CB-2-21), Outfall 018 (CH-2-14), Outfall 024 (DC 2), Outfall 058 (DC-10), Outfall 059 (DC-11), Outfall 060 (DC-12), Outfall 061 (DC-13), Outfall 063 (DC-15), Outfall 080 (DC-27), and Outfall 091 (CH-2-11). The outfall locations are shown on Exhibit 6.1-1 in Appendix A4 and on Figure 2-1 In Appendix A3.

## 7.0 Erosion Control and Maintenance

Maintenance of structures and erosion has been conducted regularly during the liability period. Disturbance associated with the maintenance work was seeded and mulched.

## 8.0 Postmining Water-Containment Structures

This Section contains support information for the design and function of Permanent Impoundments. There are no Reclamation Channel Pools (RCPS) or Small Depressions (SDs) in VMUs 2, 3, and 5 that had been identified specifically for wildlife, although there are likely some SDs. Information regarding wildlife enhancements for these structures is provided in the Wildlife Habitat Enhancements Section of this Application.

Permanent Impoundments

The Navajo Nation requested that as many impoundments as possible be retained for the postmining land use (See Permit Appendix 5.6-B). To that end, a total of nine permanent impoundments are included in this Application, as shown in Table T2. These impoundments have been approved for retention by OSMRE and meet the requirements of 30 CFR 816.49 and the Permit.

**Table T2: Permanent Impoundments in VMUs 2, 3, and 5**

| | VMU 2 | VMU 3 | VMU 5 |
|---|---|---|---|
| Quantity | 2 | 0 | 7 |
| Structure No. | 2-3 & 3-5 | | 2-8, 2-9, 2-10, 2-11, 2-12, 2-13 & 2-21 |

The impoundments were not included in Phase I or II applications since they were still temporary impoundments at the time. They are included in this Application for Phase I, II, and III bond release. The locations of these impoundments may be found in Exhibit E6-1 through E6-3.

Impoundment Design and Construction

The Permanent Impoundments were designed to be adequate for their intended use, and the water level will be sufficiently stable and capable of supporting grazing and wildlife, as discussed in Permit Section 5.7.3.4. Professional Engineer certified as-built drawings of the impoundments were submitted to OSMRE for incorporation into Permit Appendix 5.7-B.

The impoundments were last inspected on May 16, 2025, and an impoundment report for each structure was certified on June 20, 2025. The volumes measured on May 16, 2025, are provided in Table T3, which includes the average annual 10-year annual capacity loss from sedimentation.

As previously discussed, after the regraded area was returned to the required contour a sediment yield analysis was completed. This analysis demonstrated that the average annual sediment yield of reclaimed lands was less than the sediment yield levels from pre-mined undisturbed conditions, meaning the impoundment would no longer be required for sediment control. Over time, the impoundments will continue to accumulate sediment and may even silt in completely.

A minimum impoundment capacity is no longer required, because the annual average sediment yield is less than the sediment yield levels from pre-mined undisturbed

conditions. The Permanent Impoundment As-Built Designs assume a worst-case scenario in which the structure is silted into the spillway crest to demonstrate the spillway is still able to safely pass the 25-year, 6-hour discharge event. This discharge event was selected for this watershed since this impoundment does not meet size requirements of Class B or C criteria for dams in the U.S. Department of Agriculture Soil Conservation Service (SCS) Technical Release Number 60 (TR-60) or meet or exceed the size or other criteria of 30 CFR 77.216(a).

The permanent impoundments provide a water resource for livestock and wildlife in their current condition, and at minimum will function in the post-mining landscape as a wildlife enhancement feature to complement the approved wildlife habitat post-mining land use. After the watershed area is reclaimed and released, it is recognized that cleanout of sediment and organic material is no longer necessary; the postmining land user; however, may continue maintenance, so the structure provides long-term livestock watering.

**Table T3: Permanent Impoundment Summary**

| VMU | Impoundment | Volume (Ac-Ft) | Average Annual Capacity Loss (Ac-Ft) |
|---|---|---|---|
| 2 | 2-3 | 0.53 | 0.06 |
| 5 | 2-8 | 1.56 | 0.18 |
| 5 | 2-9 | 3.82 | 0.13 |
| 5 | 2-10 | 2.34 | 0.07 |
| 5 | 2-11 | 0.67 | 0.02 |
| 5 | 2-12 | 0.57 | 0.18 |
| 5 | 2-13 | 2.07 | 0.09 |
| 5 | 2-21 | 74.38 | 0.41 |
| 2 | 3-5 | 3.48 | 0.21 |

Impoundment Water Quality

The requirements for impoundment water quality may be found under 30 CFR 816.49 (b)(2). As discussed in Permit Section 5.6.3.4.3 Permanent Impoundment Water Quality, it was demonstrated that the water quality in these impoundments met the applicable water-quality standards for livestock watering.

Impoundment Riparian PATFM

Permit Section 5.3.5.12 requires that Permanent Impoundments built on spoil have the spoil tested to confirm the soil materials are not detrimental to riparian plant establishment. Permit Modification 25-02 was submitted to OSMRE (currently pending

approval) making that demonstration that the spoil material was suitable for planting, which includes the Permanent Impoundments in this Package. Permanent impoundments 2-3 and 3-5 are not located on spoil material and were not necessary to include in this demonstration. The permit modification included a Technical Report with the demonstration entitled Riparian PATFM Assessment, dated 6/4/25. The narrative from that Report in support of this demonstration has been included in Appendix A5.

## 9.0 Postmining Land Use

The IPL were reclaimed to rangeland for grazing, and the PPL were reclaimed to a grazing and wildlife habitat postmining land use. PLL revegetation is also consistent with a rangeland postmining land use. As discussed below, PLL, IPL, and PPL together as one unit meet the revegetation success standards and together are suitable for grazing and wildlife habitat.

## 10.0 Revegetation

Standard revegetation practices were followed as part of final reclamation. The seedbed was prepared by plowing, scarifying, or ripping the soil. Seeding was done using various implements that drilled and/or broadcast the seed. After the seeding, hay, or straw mulch, was applied at a rate of about two tons per acre. The mulch was anchored into the cover with a tractor-drawn straight coulter disc. The approved seed mixes used at McKinley have varied over time but included both introduced and native warm-season grasses, cool-season grasses, forbs, and shrubs. More detail by regulatory category (IPL, PL, or PPL) follows in the next two subsections.

PPL Revegetation

Most PPL lands in VMU 2, 3, and 5 were initially seeded during the periods shown on Table T4, with some parcels done in later years. These initial seeding activities by polygon and year are shown on Exhibit E7-1 through E7-3. The exhibits also show other reseeding or interseeding activity for areas that required erosion repair or that had low vegetation establishment.

**Table T4: Summary of General Start and End of Initial Seedings (by Year)**

| | PPL | | IPL | | PLL | |
|---|---|---|---|---|---|---|
| | Start | End | Start | End | Start | End |
| VMU 2 | 1992 | 2011 | 1981 | 1986 | NA | NA |
| VMU 3 | 1986 | 2013 | 1980 | 1988 | 1975 | 1980 |
| VMU 5 | 1993 | 2013 | 1981 | 1992 | 1975 | 1977 |

The permanent seed mix shown in Table T5 (Table 5.5-3 of the Permit) was the primary seed mix used based on the availability of the species listed. CMI worked with the seed supplier to substitute comparable species for unavailable seeds.

**Table T5: Permanent Program Seed Mix**

| Common Name - Scientific Name | Bulk Total Mix % by WT | Bulk SubMix % by WT | Bulk Appl Rate Lbs/Ac | # Total Seeds/Lb | Bulk Appl Rate Seeds/Ac | % Purity | % Germination | Appl Rate PLS/Sq-Ft | Mix % by PLS/Sq-Ft | Application Rates & Mix% by PLS/sq-ft | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Warm Season Grasses | | Cool Season Grasses | | Brush & Shrub | | Forb/Legume Native | | Forb/Legume Introduced | |
| DRILL SUBMIX | | | | | | | | | | | | | | | | | | | |
| Western wheatgrass - Agropyron smithii | 1.9% | 3.7% | 0.37 | 110,000 | 40,810 | 0.91 | 0.92 | 0.8 | 2.1% | | | 0.8 | 2.1% | | | | | | |
| Thickspike wheatgrass - Agropyron dasystachyum | 1.3% | 2.6% | 0.26 | 154,000 | 39,270 | 0.97 | 0.87 | 0.8 | 2.0% | | | 0.8 | 2.0% | | | | | | |
| Streambank wheatgrass - Agropyron riparium | 1.5% | 3.0% | 0.30 | 156,000 | 46,800 | 0.92 | 0.77 | 0.8 | 2.0% | | | 0.8 | 2.0% | | | | | | |
| Mountain brome - Bromus marginatus | 2.1% | 4.2% | 0.42 | 90,000 | 37,800 | 0.91 | 0.99 | 0.8 | 2.1% | | | 0.8 | 2.1% | | | | | | |
| Arizona fescue - Fstuca arizonica | 0.4% | 0.8% | 0.08 | 550,000 | 41,250 | 0.84 | 0.95 | 0.8 | 2.0% | | | 0.8 | 2.0% | | | | | | |
| Indian ricegrass - Oryzopsis hymenoides | 2.6% | 5.3% | 0.53 | 141,000 | 74,025 | 0.96 | 1.00 | 1.6 | 4.3% | | | 1.6 | 4.3% | | | | | | |
| Sandberg bluegrass - Poa sandbergii | 0.2% | 0.4% | 0.04 | 925,000 | 37,000 | 0.84 | 0.97 | 0.7 | 1.8% | | | 0.7 | 1.8% | | | | | | |
| Needle and Thread - Stipa comata | 3.4% | 6.8% | 0.68 | 115,000 | 77,625 | 0.95 | 0.96 | 1.6 | 4.3% | | | 1.6 | 4.3% | | | | | | |
| Fourwing saltbush - Atriplex canescens | 4.8% | 9.5% | 0.95 | 52,000 | 49,400 | 0.59 | 0.96 | 0.7 | 1.7% | | | | | 0.7 | 1.7% | | | | |
| Shadscale - Atriplex confertifolia | 4.3% | 8.7% | 0.87 | 65,000 | 56,225 | 0.80 | 0.97 | 1.0 | 2.6% | | | | | 1.0 | 2.6% | | | | |
| Mat saltbush - Atriplex corrugata | 4.2% | 8.4% | 0.84 | 60,000 | 50,400 | 0.60 | 0.94 | 0.7 | 1.7% | | | | | 0.7 | 1.7% | | | | |
| Trident saltbush - Atriplex tridentata | 2.7% | 5.3% | 0.53 | 111,500 | 59,541 | 0.50 | 0.96 | 0.7 | 1.7% | | | | | 0.7 | 1.7% | | | | |
| Antelope bitterbrush - Purshia tridentata | 19.7% | 39.5% | 3.95 | 15,000 | 59,175 | 0.93 | 1.00 | 1.3 | 3.3% | | | | | 1.3 | 3.3% | | | | |
| Blueflax - Linum lewisii | 0.5% | 1.0% | 0.10 | 293,000 | 29,300 | 0.88 | 1.00 | 0.6 | 1.6% | | | | | | | 0.6 | 1.6% | | |
| Palmers penstemon - Penstemon palmeri | 0.2% | 0.4% | 0.04 | 610,000 | 24,400 | 0.99 | 0.85 | 0.5 | 1.2% | | | | | | | 0.5 | 1.2% | | |
| Rocky Mtn. penstemon - Penstemon strictus | 0.3% | 0.5% | 0.05 | 592,000 | 29,600 | 0.87 | 0.97 | 0.6 | 1.5% | | | | | | | 0.6 | 1.5% | | |
| Black-eyed susan - Rudbeckia hirta | 0.1% | 0.2% | 0.02 | 1,710,000 | 25,650 | 0.94 | 1.00 | 0.6 | 1.5% | | | | | | | 0.6 | 1.5% | | |
| SUBMIX TOTAL | 50.0% | 100.0% | | | 778,271 | | | 14.2 | 37.6% | 0.0 | 0.0% | 7.8 | 20.7% | 4.2 | 11.2% | 2.2 | 5.8% | 0.0 | 0.0% |
| BROADCAST SUBMIX | | | | | | | | | | | | | | | | | | | |
| Big bluestem - Andropogon gerardi | 1.8% | 3.7% | 0.41 | 130,000 | 52,650 | 0.94 | 0.95 | 1.1 | 2.9% | 1.1 | 2.9% | | | | | | | | |
| Blue grama - Bouteloua gracilis | 0.9% | 1.8% | 0.20 | 825,000 | 165,000 | 0.93 | 0.67 | 2.4 | 6.2% | 2.4 | 6.2% | | | | | | | | |
| Buffalograss - Buchloe dactyloides | 4.2% | 8.4% | 0.93 | 56,000 | 51,800 | 0.92 | 0.99 | 1.1 | 2.9% | 1.1 | 2.9% | | | | | | | | |
| Switchgrass - Panicum virgatum | 0.7% | 1.4% | 0.15 | 389,000 | 58,350 | 0.92 | 0.99 | 1.2 | 3.2% | 1.2 | 3.2% | | | | | | | | |
| Inland saltgrass - Distichlis stricta | 0.6% | 1.3% | 0.14 | 520,000 | 72,800 | 0.84 | 0.82 | 1.1 | 3.0% | 1.1 | 3.0% | | | | | | | | |
| Galleta - Hilaria jamesii | 5.9% | 11.8% | 1.30 | 159,000 | 206,541 | 0.89 | 0.56 | 2.4 | 6.3% | 2.4 | 6.3% | | | | | | | | |
| Alkali sacaton - Sporobolus airoides | 0.3% | 0.7% | 0.08 | 1,758,000 | 131,850 | 0.91 | 1.00 | 2.8 | 7.3% | 2.8 | 7.3% | | | | | | | | |
| Silver sagebrush - Artemisia cana | 2.1% | 4.3% | 0.47 | 850,000 | 399,500 | 0.79 | 0.12 | 0.9 | 2.3% | | | | | 0.9 | 2.3% | | | | |
| Fringed sagebrush - Artemisia frigida | 0.1% | 0.1% | 0.01 | 4,536,000 | 49,896 | 0.78 | 0.95 | 0.9 | 2.3% | | | | | 0.9 | 2.3% | | | | |
| Black sagebrush - Artemisia nova | 2.6% | 5.2% | 0.58 | 907,200 | 521,640 | 0.74 | 0.10 | 0.9 | 2.4% | | | | | 0.9 | 2.4% | | | | |
| Winterfat - Ceratoides lanata | 12.6% | 25.3% | 2.77 | 56,700 | 157,116 | 0.60 | 0.80 | 1.7 | 4.6% | | | | | 1.7 | 4.6% | | | | |
| Cliffrose - Cowania mexicana | 11.6% | 23.2% | 2.54 | 64,800 | 164,084 | 0.50 | 0.50 | 0.9 | 2.5% | | | | | 0.9 | 2.5% | | | | |
| White yarrow - Achellea millefolium | 0.1% | 0.2% | 0.02 | 2,770,000 | 47,090 | 0.93 | 0.97 | 1.0 | 2.6% | | | | | | | 1.0 | 2.6% | | |
| Blanket flower - Gaillardia aristata | 2.1% | 4.2% | 0.46 | 132,000 | 60,720 | 0.73 | 0.92 | 0.9 | 2.5% | | | | | | | 0.9 | 2.5% | | |
| Alfalfa - Medicago sativa | 0.9% | 1.8% | 0.19 | 210,000 | 40,320 | 0.94 | 1.00 | 0.9 | 2.3% | | | | | | | | | 0.9 | 2.3% |
| Sainfoin - Onobychis viciaefolia | 1.5% | 3.0% | 0.33 | 30,000 | 9,900 | 0.87 | 1.00 | 0.2 | 0.5% | | | | | | | | | 0.2 | 0.5% |
| Prairie coneflower - Ratibida columnarias | 0.2% | 0.3% | 0.04 | 1,230,000 | 43,050 | 0.83 | 0.96 | 0.8 | 2.1% | | | | | | | 0.8 | 2.1% | | |
| Globemallow - Sphaeralcea parvifolium | 0.3% | 0.7% | 0.08 | 500,000 | 37,500 | 0.95 | 0.99 | 0.8 | 2.2% | | | | | | | 0.8 | 2.2% | | |
| Purple prairie clover - Petalostemum purpureum | 0.8% | 1.6% | 0.18 | 210,000 | 36,750 | 0.95 | 1.00 | 0.8 | 2.1% | | | | | | | 0.8 | 2.1% | | |
| Strawberry clover - Trifolium fragiferum | 0.6% | 1.1% | 0.13 | 300,000 | 37,500 | 0.96 | 1.00 | 0.8 | 2.2% | | | | | | | 0.8 | 2.2% | | |
| SUBMIX TOTAL | 50.0% | 100.0% | 10.970 | | 2,344,057 | | | 23.5 | 62.4% | 12.0 | 31.8% | 0.0 | 0.0% | 5.3 | 14.1% | 5.1 | 13.6% | 1.1 | 2.8% |
| MIX TOTAL | 100.0% | | | | 3,122,328 | | | 37.7 | 100.0% | 12.0 | 31.8% | 7.8 | 20.7% | 9.5 | 25.3% | 7.3 | 19.5% | 1.1 | 2.8% |

IPL and PLL Revegetation

IPL lands and PPL in VMU 2, 3, and 5 were mostly seeded between the years shown on Table T6 as represented on the drawings in Appendix A6. Subsequent interseeding or seeding of repair areas are shown on Exhibits E7-1 through E7-3 .

The seed mixes utilized on PPL and IPL varied over the years. While definitive records are not available for what was planted where, the Settlement Agreement B.8 Report-Volume I Revegetation report developed by the Pittsburg & Midway Coal Mining Co. (P&M (now CMI)) (SA B.8 Report) (P&M 1994) contained in Appendix 5.5-A of the Permit No. NM-0001K, has a table that summarizes the mixes that were used during the PLL and IPL time period, which is provided in Table T6. PLL was likely seeded with the mixes shown in the mid-1970s. Most of the IPL would have been initially seeded with the mixes shown during the late1980s and early 1990s. Interseeding and seeding of

repaired areas in the more recent years were planted with mixes like those shown for the early 1990s. More recent interseeding and seeding of repair areas would have been done with the permanent seed mix in Table T5.

## Table T6: Expected Seed Mixtures for IPL and PL

| | SPECIES<br>Common Name - *Scientific Name* | MIX APPROVED BY YEAR | | | MIX PLANTED BY YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | spoil<br>73<br>75 | topsoil<br>73<br>75 | 80 | 75 | 77 | 79 | 80-84 | 85 | 86-87 | 88 & 90 | 91 | 92 |
| | Alkali sacaton - *Sporobolus airoides* | | | | | | | | ● | ● | ● | ● | ● |
| | Sandberg bluegrass - *Poa sandbergii* | | | | | | | | ● | ● | ● | ● | ● |
| | Mountain brome - *Bromus marginatus* | | | | | | | | ● | ● | ● | ● | ● |
| | Smooth brome - *Bromus inermis* | | | | ● | ● | | | | | | | |
| | Arizona fescue - *Festuca arizonica* | | | | | | | | ● | ● | ● | | ● |
| | Sheeps fescue - *Festuca ovina* | | | | | | | | | | | ● | |
| | Galleta - *Hilaria jamesii* | | ● | ● | | | | ● | | ● | ● | ● | ● |
| G | Blue grama - *Bouteloua gracilis* | | | | | | | | | | ● | ● | ● |
| R | Sideoats grama - *Bouteloua curtipendula* | | | ● | | | ● | ● | ● | ● | ● | ● | ● |
| A | Indian ricegrass - *Oryzopsis hymenoides* | | | ● | | | ● | ● | ● | ● | ● | ● | ● |
| S | Mountain muhly - *Muhlenbergia montana* | | | | | ● | | | | | | | |
| S | Spike muhly - *Muhlenbergia wrightii* | | | | | ● | | | ● | ● | ● | ● | ● |
| E | Sand dropseed - *Sporobolus cryptandrus* | | | | | ● | ● | | | | | ● | ● |
| S | Crested wheatgrass - *Agropyron cristatum* | ● | ● | | ● | ● | | | | | | | |
| | Intermediate wheatgrass - *Agropyron intermedium* | | | ● | | | | ● | | | | | |
| | Pubescent wheatgrass - *Agropyron trichophorum* | ● | ● | ● | | ● | | ● | | | | | |
| | Siberian wheatgrass - *Agropyron sibericum* | ● | ● | | ● | ● | | | | | | | |
| | Slender wheatgrass - *Agropyron trichycautum* | | | | ● | ● | | | | | | ● | |
| | Streambank wheatgrass - *Agropyron riparium* | | | | | ● | ● | | | | | | |
| | Tall wheatgrass - *Agropyron elongatum* | | | ● | ● | ● | | ● | | | | | |
| | Thickspike wheatgrass - *Agropyron dasystachyum* | | | | | | ● | | ● | ● | | | |
| | Western wheatgrass - *Agropyron smithii* | | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| S | Fourwing saltbush - *Atriplex canescens* | | ● | ● | | | ● | ● | ● | ● | ● | ● | ● |
| H | Shadscale - *Atriplex confertifolia* | | | | | | | | ● | ● | ● | ● | ● |
| R | Winterfat - *Ceratoides lanata* | | | ● | | | | ● | ● | ● | ● | ● | ● |
| U | Cliffrose - *Cowania mexicana* | | | | | | | | | | | ● | ● |
| B | Utah servicaberry - *Amelanchier utahiis* | | | | | | | | | | | ● | ● |
| S | Skunkbush sumac - *Rhus trilobata* | | | | | | | | | | | ● | ● |
| | Alfalfa - *Medicago sativa* | | | | | | | | ● | ● | ● | ● | ● |
| | Black-eyed Susan - *Rudbecka hirta* | | | | | | | | | ● | ● | ● | ● |
| | Blanket flower - *Gaillardia aristata* | | | | | | | | | ● | ● | ● | ● |
| | Blueflax - *Linum Lewisii* | | | | | | | | | ● | ● | ● | ● |
| F | Purple prairie clover - *Petalostemum purpureum* | | | | | | | | | | | ● | |
| O | Red prairie coneflower - *Ratibida columnaris* | | | | | | | | | | | ● | ● |
| R | Globemallow - *Sphaeralcea coccinea* | | | | | | | | ● | ● | ● | | ● |
| B | Globemallow - *Sphaeralcea parvifolia* | | | | | | | | | | | ● | |
| S | Rocky Mtn. penstemon - *Penstemon strictus* | | | | | | | | ● | ● | ● | ● | ● |
| | Hooker evening primrose - *Oenothera hookeri* | | | | | | | | | | | ● | |
| | Sainfoin - *Onobrychis viciaefolia* | | | | | | | | ● | | | | |
| | Sulphur Flower - *Eriogonum umbellatum* | | | | | | | | | ● | | | |
| | Yellow sweet clover - *Melilotus officinalis* | | | | ● | ● | | | | | | | |
| | White yarrow - *Achillea millefolium* | | | | | | | | | ● | ● | ● | ● |

Source: Settlement Agreement B.8 Report – Volume I: Revegetation

## Revegetation Success Standards

Revegetation success standards are those provided in Table T7 (Table 5.5-1 of the Permit). The standards are applicable to PPL, IPL and PL, which are sampled as one unit in the VMU. There was a change to the revegetation success standards in 2023 through OSMRE-approved Permit Modification 23-03. The change in standards allowed for an improved and more accurate assessment of revegetation success. More information regarding and supporting this modification may be found in the Permit. Table T7 shows the revegetation success criteria applicable for the 2023 and 2024 sample results.

**Table T7: Permanent Program Revegetation Success Standards**

| **Table 5.5-1: Revegetation Standards for McKinley Mine** | | | |
|---|---|---|---|
| **Ground Cover** | Total Ground Cover (Live Vegetation and Litter) | | ≥ 52% |
| | Perennial Vegetation Cover | | ≥ 24% |
| **Diversity "Lifeform Statement"** | Perennial Grasses | All grasses | ≥ 7% cover |
| | | Cool season | ≥ 2 species, 1st species ≥ 5% relative perennial cover, 2nd species ≥ 2.5% relative perennial cover |
| | | Warm season | ≥ 2 species, 1st species ≥ 5% relative perennial cover, all other species combined ≥ 1.5% relative perennial cover |
| | Perennial Forbs | | ≥ 3 species, combining for ≥ 1% relative cover |
| | Shrubs | All shrubs | ≥ 6% relative total perennial cover |
| | | Any single species | ≤ 70% relative total shrub density |
| | Any single species | | ≤ 40% relative total vegetative cover |
| **Production** | Pounds/acre (air dry) | | ≥ 550 lbs/ac |
| **Woody Plant Density** | | | ≥ 400/acre |

**Notes:**
1) Success for cover, production, and stocking shall be ≥ 90% of the standard in accordance with 30 CFR 816.116 (a)(2).
2) Total ground cover does not include noxious weeds.
3) Perennial vegetation cover is foliar cover from LPI, not including annuals and noxious weeds.
4) Relative cover is the percent cover of a species or functional group divided by the total vegetation cover.
5) Relative perennial cover is the total cover of a perennial species or perennial functional group divided by the total perennial cover (see below).
6) Total perennial cover includes shrubs, cactus, trees, perennial grasses and perennial forbs not including noxious species.
7) Relative total shrub density is the density of each woody species divided by the total woody plant density not including noxious weeds.
8) Production is above-ground biomass of forage species.

## Revegetation Sampling

Sampling methodologies were also updated in 2023, which were approved by OSMRE as part of Permit Modification 23-03. The change in methodology allowed for better capture of data more representative of the revegetation conditions on the reclaimed land. More information regarding this change may be found in the Permit in Section 5.5 and 6.5. The revegetation success sampling reports in Appendix A7 detail what methodologies were used for the respective years of sampling.

Vegetation sampling for bond release of VMUs 2, 3, and 5 was conducted in 2019 through 2024. The revegetation success standards were all met in 2023 and 2024. Table T8 summarizes all the parameters that were met.

**Table T8: Yearly Vegetation Standards Were Met by VMU**

| Veg Parameter | Components | | Standard[1] (2023) | O-VMU-2 | | O-VMU-3 | | O-VMU-5 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 2023 | 2024 | 2023 | 2024 | 2023 | 2024 |
| Cover | Total Ground Cover [2] | | ≥ 52% | P | P | P | P | P | P |
| | Perennial Vegetation Cover[3] | | ≥ 24% | P | P | P | P | P | P |
| Diversity "Lifeform Statement" | Perennial Grasses | All Grasses | ≥ 7% absolute cover | P | P | P | P | P | P |
| | | Cool-season | ≥ 2 species, 1st species ≥ 5% relative perennial cover, 2nd species ≥ 2.5% relative perennial cover | P | P | P | P | P | P |
| | | Warm-season | ≥ 2 species, 1st species ≥ 5% relative perennial cover, all other species combined ≥ 1.5% relative perennial cover | P | P | P | P | P | P |
| | Perennial Forbs[4] | | ≥ 3 species, combining for ≥ 1% relative perennial cover | P | P | P | P | P | P |
| | Shrubs[4] | All Shrubs | ≥ 6% relative total perennial cover | P | P | P | P | P | P |
| | | Any single species | ≤ 70% relative total shrub density | P | P | P | P | P | P |
| | Any single species[4,5] | | ≤ 40% relative total vegetative cover | P | P | P | P | P | P |
| Production | Annual Forage[6] | | ≥ 550 lbs/ac | P | P | P | P | P | P |
| Woody Plant Density | Density by Belt Transet | | ≥ 400/acre | P | P | P | P | P | P |
| **All Parameters** | | | | P | P | P | P | P | P |
| **# Years All Parameters Met** | | | | 2 | | 2 | | 2 | |

Notes:
P = Parameter passes

Moreover, the longevity of the revegetation on the IPL and PL that goes back 40 years shows the long-term resiliency of the vegetation. Vegetation sampling sites were selected that included PPL. IPL and PL lands as called for in the Permit. The locations sampled, methodologies, and results may be found in the Vegetation Success Monitoring Reports for the various VMUs in Appendix A7.

## Carrying Capacity

While there has been no formal grazing for carrying capacity demonstrations, this Section contains information on the livestock carrying capacity for VMUs 2, 3, and 5. The calculations were based on an average of 30 days per month with a 50% utilization of the vegetation production values. Carrying capacity is in terms of the Animal-Unit-Month (AUM), which is the amount of dry forage required by one animal unit for one month based on a forage allowance of twenty-six (26) pounds per day for a 1,000-pound cow either dry or with calf up to 6 months of age, or four (4) sheep or goats (MMD 2000).

Table T9 summarizes the carrying capacities calculated from VMU 2, 3, and 5 forage production data collected in 2023 and 2024. The calculations were performed on both mean and median forage production values. The utility of these calculations can be assessed by comparing them to an acceptable range condition. To that end, the mine reclaimed soils best fit the NRCS range site description (RSD) for Shallow Savannah, and the carrying capacity for this RSD for a good range condition is 0.20 AUM/Ac (See SA B.8 Report in the Permit Appendix 5.5-A). The 2023 and 2024 forage production data for all three VMUs significantly exceed 0.20 AUM/AC, which supports that the intended postmining land use of grazing is met by the level of vegetation on the reclamation.

**Table T9: VMU 2, 3, and 5 Carrying Capacity Calculations for 2023 and 2024 Forage Production**

| VMU | Year | Mean/ Median | Total Forage | Production - 50% Utilization | Forage Production | |
|---|---|---|---|---|---|---|
| | | | lb/ac | lb/ac | days/ac | AUM/ac |
| 2 | 2023 | Mean | 768 | 384 | 14.8 | 0.49 |
| 2 | 2023 | Median | 631 | 316 | 12.1 | 0.40 |
| 2 | 2024 | Mean | 881 | 441 | 16.9 | 0.56 |
| 2 | 2024 | Median | 835 | 418 | 16.1 | 0.54 |
| 3 | 2023 | Mean | 816 | 408 | 15.7 | 0.52 |
| 3 | 2023 | Median | 708 | 354 | 13.6 | 0.45 |
| 3 | 2024 | Mean | 845 | 423 | 16.3 | 0.54 |
| 3 | 2024 | Median | 671 | 336 | 12.9 | 0.43 |
| 5 | 2023 | Mean | 848 | 424 | 16.3 | 0.54 |
| 5 | 2023 | Median | 701 | 351 | 13.5 | 0.45 |
| 5 | 2024 | Mean | 855 | 428 | 16.4 | 0.55 |
| 5 | 2024 | Median | 839 | 420 | 16.1 | 0.54 |

Note: AUM - Animal Unit Month
Assumptions: 1 Cow will utilize 26 lbs/day in forage
30 Days/month

Weed Management

Because the proposed Phase III bond release area plant community is moving toward a desired successional trajectory, as per 30 CFR 816.111, and the currently approved Permit to meet the intended post-mine land use, continued ecologically based invasive plant management practices have been employed. Various options for weed control are contained in the McKinley Mine Integrated Weed Management Plan (HMI 2018). The most effective tools from the weed management plan have been appropriately timed herbicides and mechanical treatments, complemented with interseeding. The revegetation monitoring reports have not indicated that weeds have been problematic

toward revegetation meeting revegetation success or the postmining land uses. Weeds are not included in measurements for revegetation success.

## 11.0 Wildlife Habitat Enhancements

Wildlife enhancements were completed in VMUs 2, 3, and 5 that included: application of the permanent seed mix (which contains species important for wildlife), creation of rock piles, enhanced shrub plantings in wildlife corridors, planting of materials beneficial to mule deer, creation of permanent impoundments, riparian plantings, and wildlife fencing. Each of these categories is discussed below:

Permanent Seed Mix

The permanent seed mix contains species beneficial to wildlife for browse and cover. The mix includes important browse species, including shrubs such as Cliff rose or Antelope bitter brush, or a forb such as Sainfoin. Shrubs such as Fourwing saltbush are also utilized for cover by small mammals, and even mule deer have been observed using it as cover.

Rock Piles

Rock piles to support wildlife habitat were constructed on the PPL, IPL, and PLL. Rock piles were created from stones and boulders that became available during grading operations. The availability of suitably sized materials partially determined the number and distribution of these features. The rock features were generally constructed in piles or in elliptical shapes along the contour to maximize the surface area of each pile and facilitate topsoil replacement and revegetation operations. In some areas, rock was placed along the top or base of the slopes to simulate escarpment outcrops or ledge features. Shrub and/or tree plantings were conducted at rock piles to compliment and augment the utility of the rock piles in some areas.

The rock piles range from about 20-to-400 square feet and from two to twelve feet high. The rock piles were constructed at an average density mine wide of about one per twenty acres of reclaimed land.

Permit Section 5.7.3.3 contains more details regarding rock piles. Exhibits E8-1 through E8-3 show the rock pile locations.

Enhanced Shrub Planting in Wildlife Corridor

A wildlife corridor on permanent program lands was developed that extended from the north end of Area 6, south to Area 10 near State Highway 264; a part of that corridor extends through VMUs 2 and 5. The corridor was established as a zone in which many of the supplemental plantings were done. Exhibits E8-1 through E8-3 detail this wildlife corridor.

The corridor has a permit requirement of 100 shrubs/acre comprising of at least four shrub species. The 100 shrubs/acre were to include plants established from the permanent seed mix, supplemental plantings, ad-mixes, and volunteer growth. As documented in Permit Section 5.7.3.2.1, this standard was met.

Mule deer plantings

Permit Section 5.7.3.2.3 contains a commitment to plant additional browse species beneficial to mule deer throughout the mine, which included sites in VMUs 2, 3, and 5. Table T10 (Table 5.5-1A from the Permit) shows the standard for the supplemental wildlife enhancement plantings.

This commitment was successfully completed and documented in the 2021 Annual Report. The report is entitled McKinley Mine: Mule Deer Additional Browse Species Planting Success (Golder 2022). Note that supplemental mule deer plantings also occurred as part of riparian plantings, as discussed in the next subsection.

**Table T10: Permanent Program Requirements for Supplemental Wildlife and Pond/Riparian Plantings and Enhancements**

| Table 5.5-1a: Supplemental Wildlife and Pond/Riparian Plantings and Enhancements | | |
|---|---|---|
| **Supplemental Wildlife Enhancement Plantings** | Supplemental perennial shrubs in proposed wildlife enhancement areas in accordance with Section 5.8. | ≥ 4 target shrubs combining for ≥ 100 stems/acre; any single species ≤ 50%. Target species include Cliffrose, Antelope bitterbrush, Winterfat, Ephedra, ≤ 5% Rubber rabbitbrush, and other species approved by OSMRE. |
| **Supplemental Pond/Riparian Enhancements** | Enhancements at each pond/riparian area (i.e., fencing and riparian plantings), and weed control in accordance with Section 5.8. | Success will be based on detailed documentation demonstrating execution of planned enhancements, and documentation of the results of those efforts. |

Permanent Impoundments and Riparian Plantings

This Section provides information on postmining water resources and associated riparian habitat enhancements. As stated earlier, the VMUs contain the Permanent Impoundments show in Table T11 (repeated here for easier review).

**Table T11: Permanent Impoundments in VMUs 2, 3, and 5**

| | VMU 2 | VMU 3 | VMU 5 |
|---|---|---|---|
| Quantity | 2 | 0 | 7 |
| Structure No. | 2-3 & 3-5 | | 2-8, 2-9, 2-10, 2-11, 2-12, 2-13 & 2-21 |

Wildlife Enhancements Exhibits E8-1 through E8-3 show the locations of these impoundments. These impoundments are also part of a greater mine-wide network for access to water by wildlife (See Permit Section 5.8.3.4).

Impoundments not only promote reclaimed-land diversity but also have conditions for riparian-habitat establishment. To that end, a combination of riparian plantings was done that included live plantings and special seeding. The Permit (Appendix 5.8-B, Table 5.8-B1) lists the riparian species proposed for the plantings and the locations to be planted. Plantings were also done at other locations when there was an opportunity to do so. Table T12 lists the expectations around supplemental impoundment/riparian enhancements.

Table T12 in this Application lists the kinds of plantings that were done at the ponds to demonstrate execution of the plan. This information was extrapolated from the 2019 through 2023 annual reports, which contain more details. This table was augmented with information from field inspections conducted in 2024 and 2025.

**Table T12: Permanent Program Wildlife Enhancements Plan and Results**

| | | Coyote | | | | | | | Woody Seed Mix | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cottonwood | Willow | Woods Rose | Licorice | Bulrush | Sedge | Pond AdMix | Riparian Mix | Mule Deer Mix | Wildlife Fence | Cattle Ramp |
| | Live Poles | Live Whips | Seedlings | Seedlings | (From Seed) | (From Seed) | (Seed) | (Seed) | (Seed) | | |
| | | | | | | | | | | | |
| PI 2-3 | | y | y | | | | | | P-y | y | y |
| PI 2-8 | P-y | P-y | P-y | y | y | y | P-y | | P-y | P-y | P-y |
| PI 2-9 | P-y | P-y | P-y | y | y | y | P-y | | P-y | P-y | P-y |
| PI 2-10 | P-y | P-y | P-y | y | y | y | P-y | | P-y | P-y | P-y |
| PI 2-11 | P-y | P-y | P-y | y | y | y | P-y | | P-y | P-y | P-y |
| PI 2-12 | y | y | y | | y | y | y | | y | y | y |
| PI 2-13 | P-y | P-y | P-y | | y | y | P-y | | P-y | P-y | P-y |
| PI 2-21 | P-y | P-y | P-y | y | P-y | P-y | P-y | y | P-y | P-y | P-y |
| PI 3-5 | y | P-y | P-y | y | y | P-y | P-y | | | P-y | P-y |
| | | | | | | | | | | | |
| Notes: | | | | | | | | | | | |
| Letter "P" indicates that the activity was proposed for the structure in the permit. | | | | | | | | | | | |
| Letter "y" indicates that the activity occurred at a structure | | | | | | | | | | | |
| Green pattern indicates activity or element from this activity observed at structure. | | | | | | | | | | | |
| Mule Deer Shrub Enhancement Mix: Permit Table 5.5-10 | | | | | | | | | | | |
| Pond admix and Riparian Seed Mix: Permit Table 5.5-5 | | | | | | | | | | | |
| Bulrush and Sedge in the Pond Admix | | | | | | | | | | | |

The results of the planting efforts are also shown in Table T12. The table identifies in a green pattern where live plantings were observed that survived, where there was expression of species from the various special seed mixes, or where there were occurrences of more mature target species that came from the permanent seed mix.

Additional documentation regarding riparian plantings is provided in Appendix A8 that includes a more-detailed table, a list of observed species, key planting information from the annual reports, and photographs from each of the ponds.

IPL and PL Plantings

There were no specific IPL or PLL plantings in VMU 2, 3, and 5 beyond those done as part of the enhanced shrub planting in the wildlife corridor discussed above.

Wildlife fencing

To promote the longevity of the riparian plantings and the utility of the impoundments by wildlife, the Permit (Appendix 5.8-B, Table 5.8-B1) identified impoundments to be fenced with wildlife-friendly fences (See Permit Section 5.8.3.4.2). In addition, to allow for controlled access to water by livestock, cattle ramps were installed in the impoundments. Table T12 identifies which impoundments had fences installed and which had cattle ramps constructed. Exhibits E8-1 through E8-3 show these fenced structures and the acreage within the fenced areas.

**12.0 Performance Bond**

The current performance bond amount is shown on Table T13 for the remaining permanent program reclamation liability. There are two final costs to be deducted from the performance bond for VMUs 2, 3, and 5 at this last phase. The first bond reduction is for the cost to revegetate the reclaimed lands, which includes the acreage for the nine impoundments. The other bond reduction is for the cost reserved in the bond to reclaim the impoundments.

The methodology for deducting the revegetation costs required factoring in that the performance bond is set up primarily by mining area. VMUs 2, 3, and 5 contain lands from different mining areas, and while prorating and tracking costs from each area could be done, it would be complex and difficult to follow in this Application and in future applications for other Phase III bond releases.

Subsequently, the clearest and most supportable method to calculate the Phase III bond reduction is to multiply the number of PPL acres in VMUs 2, 3, and 5 by the unit cost/acre to revegetate disturbed land from the bond assumptions as was done in past applications. In a similar manner, the bond reduction for reclamation of the impoundments was calculated by multiplying the number of impoundments by the unit

cost to remove each impoundment. The unit cost for impoundment reclamation included dewatering, backfilling, and grading.

The calculations for the bond reduction related to Phase III revegetation costs and impoundment reclamation are provided in Appendix A9. The amount of bond to be released in this Application and the remaining total bond are shown in Table T13. Approximately $373,000 of the total bond reduction (direct and indirect costs) is associated with Phase I and II costs for the impoundment removals.

**Table T13: Performance Bond Summary**

| | | VMU 2 | VMU3 | VMU5 | Total |
|---|---|---|---|---|---|
| Current Total Bond | $53,925,545 | | | | $53,925,545 |
| Bond Reduction | | $1,860,000 | $1,039,000 | $2,168,000 | $5,067,000 |
| New Bond | | $52,065,545 | $52,886,545 | $51,757,545 | $48,858,545 |

New Bond calculation: Current Total Bond minus Bond Reduction for each VMU.

## 13.0 Landowner Notification

The list of property owners and entities adjacent to the reclamation liability release area affected by this Application is provided in Appendix A10. The appendix includes a typical copy of the notification letter with a map to be sent along with a list of recipients.

A copy of this Application will be available for public inspection at the following locations:

Mr. Jacob Mulinix and Ms. Christy Luciani
Western Region Office
Office of Surface Mining Reclamation and Enforcement
One Denver Federal Center, Building 41
Western Region Mine Plan Library
Lakewood, CO 80225-0065
Advance call required: WR Permitting Information Line 1-866-847-7362

The Navajo Nation Minerals Department – Office of Surface Mining Program
P.O. Box 9000
Window Rock, AZ 86515

County Clerk's Office
McKinley County Courthouse
201 W. Hill Ave.
Gallup, NM 87301

## 14.0 Newspaper Advertisement

The reclamation liability release notice (and associated map) to be published in the local newspapers is provided in Appendix A11. The announcement will be published in both the Gallup Independent and Navajo Times for four consecutive weeks. Affidavits of publication from these newspapers will be sent to OSMRE.

## 15.0 Supplemental Information for Initial Program Lands and Prelaw Lands

Backfilling and Grading

Backfilling and grading were conducted in a manner that promoted stability, eliminated spoil piles, and blended into unmined land. A proposed postmining topographical map was not available for this Application. Spoil was generally graded to at least a 3H:1V slope in accordance with the IP regulations or PL guidance at the time. A topographical map showing the final configuration may be found on Exhibits E9-1 through E9-3; the exhibits also show cross section locations of the topography. Cross sections of the final topography are provided on Exhibits E10-1 through E10-3.

Exhibits E11-1 through E11-3 are isograms with a gradient analysis for the slopes throughout the reclaimed area. Slopes depicted as greater than 30 percent are typically affiliated with drainages.

Potentially Acid and Toxic Forming Materials (PATFM)

The level of PATFM monitoring on the IPL and PLL is unknown, although the reclaimed land today does not show evidence of poor soil conditions or vegetation that might not be growing because of poor spoil quality.

Topdressing

IPL
Topsoil replacement would have been done in conformance with 30 CFR 715.16 (b) Topsoil Redistribution. Regraded land would have been scarified prior to the placement of topdressing. Topsoil would have been redistributed in a uniform thickness (typically a minimum of six inches) and in a manner that minimized the potential for compaction.

To that end, topsoil depth checks were conducted at eight locations on IPL. The locations included a diversity of locations representative of the IPL. Topsoil was found to be at least six inches at the locations tested, which supports that at least a six-inch

topdressing was applied at the time as required. Successful revegetation after 40 years, as discussed below, also supports that there is good soil medium for vegetation throughout the area. The locations of topsoil depth checks and the depths recorded are shown on Exhibit E12-1 through E12-3.

PLL

These lands were not required to be topdressed. The soil materials used as a planting medium, however, appear to have been suitable as a topsoil substitute since they have supported revegetation since the 1970s. As stated earlier, these PLL were included in the vegetation sampling program for the VMU they were located in.

## Drainage Control

Drainage control technologies were instituted to create a stable landform and to safely route the design storm runoff through the reclaimed areas and into adjacent undisturbed lands. While terraces and downdrains were constructed on the PPL and on some later IPL to promote controlled drainage of runoff from the reclaimed land, such structures were not built on the early IPL or PLL. Other hydrologic structures, however, were constructed to control runoff on IPL and PLL.

Drainage channels that concentrate flow were armored with riprap to control runoff and to promote a smooth transition into undisturbed drainages. Exhibits E6-1 through E6-3 show the locations of primary hydrologic structures installed to control runoff and minimize erosion in IPL and PLL.

## Sedimentology and Surface Water

This Section provides information regarding impacts to surface water by IPL and PLL in VMUs 2, 3, and 5. The section also covers sedimentology since that is directly related to surface water quality.

Sediment yields from VMU 2, 3, and 5 IPL and PL are expected to be below pre-mining levels based on the reclaimed landform, mine-wide sediment-yield analysis, and the EPA watershed status. Regarding the reclaimed landform, VMU 2, 3, and 5 IPL and PLL were reconstructed in a manner consistent with stable landforms, hydrologic structures that were constructed were built in accordance with standard practice on the rest of the mine, and the land has been seeded, mulched, and revegetated.

As stated in Section 5.7.4.3 in PP Permit No. NM-0001K, extensive sediment-yield analyses have been done throughout the mine through paired watershed sampling and modeling that all demonstrated acceptable sediment yields for various reclaimed-land scenarios.

## 16.0 Bibliography

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WSP USA Inc. 2025. Vegetation Management Unit 2, Vegetation Success Monitoring, 2024.

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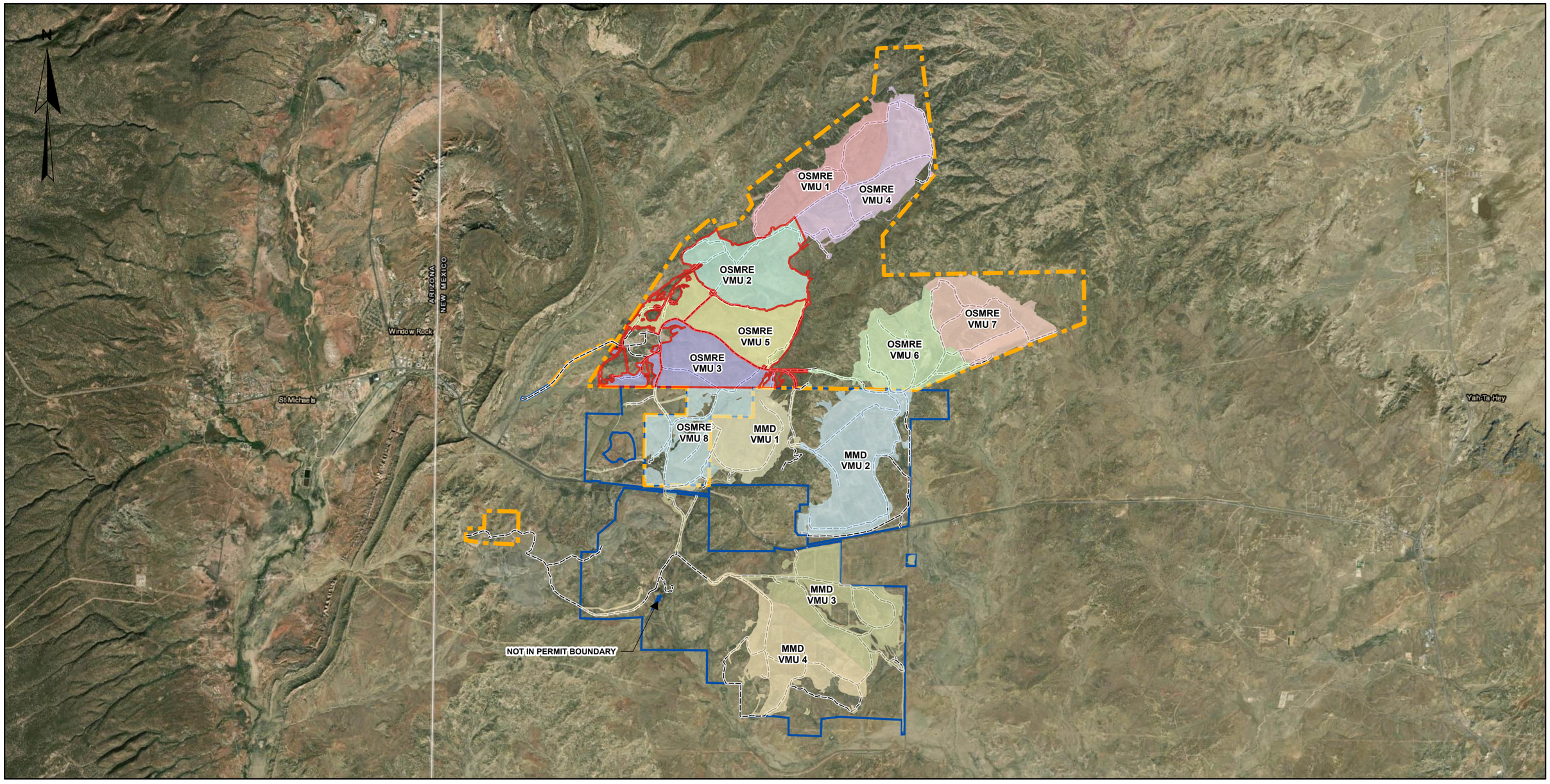
WSP USA Inc. 2025. Vegetation Management Unit 3, Vegetation Success Monitoring, 2024.

WSP USA Inc. 2024. Vegetation Management Unit 5, Vegetation Success Monitoring, 2023.

WSP USA Inc. 2025. Vegetation Management Unit 5, Vegetation Success Monitoring, 2024.

Trihydro Associates. 2025. Vegetation Management Unit 2, 3, and 5 Final Bond Release and Liability Release & Termination of Jurisdiction Application, Groundwater and Surface Water Evaluation.

## Exhibits




LEGEND

- OSMRE Permit Boundary
- MMD Permit Boundary
- Post-Mining Two-Track Trails

Vegetation Management Unit

- OSMRE VMU 2
- OSMRE VMU 3
- OSMRE VMU 5
- OSMRE VMU 1
- OSMRE VMU 4
- OSMRE VMU 6
- OSMRE VMU 7
- OSMRE VMU 8
- MMD VMU 1
- MMD VMU 2
- MMD VMU 3
- MMD VMU 4

0 1 2
Miles

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET
2. SERVICE LAYER CREDITS: WORLD IMAGERY: EARTHSTAR GEOGRAPHICS
WORLD BOUNDARIES AND PLACES: ESRI, HERE, GARMIN

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McKINLEY MINE

CONSULTANT
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| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**MCKINLEY MINE OSMRE VEGETATION MANAGEMENT UNITS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E1** |

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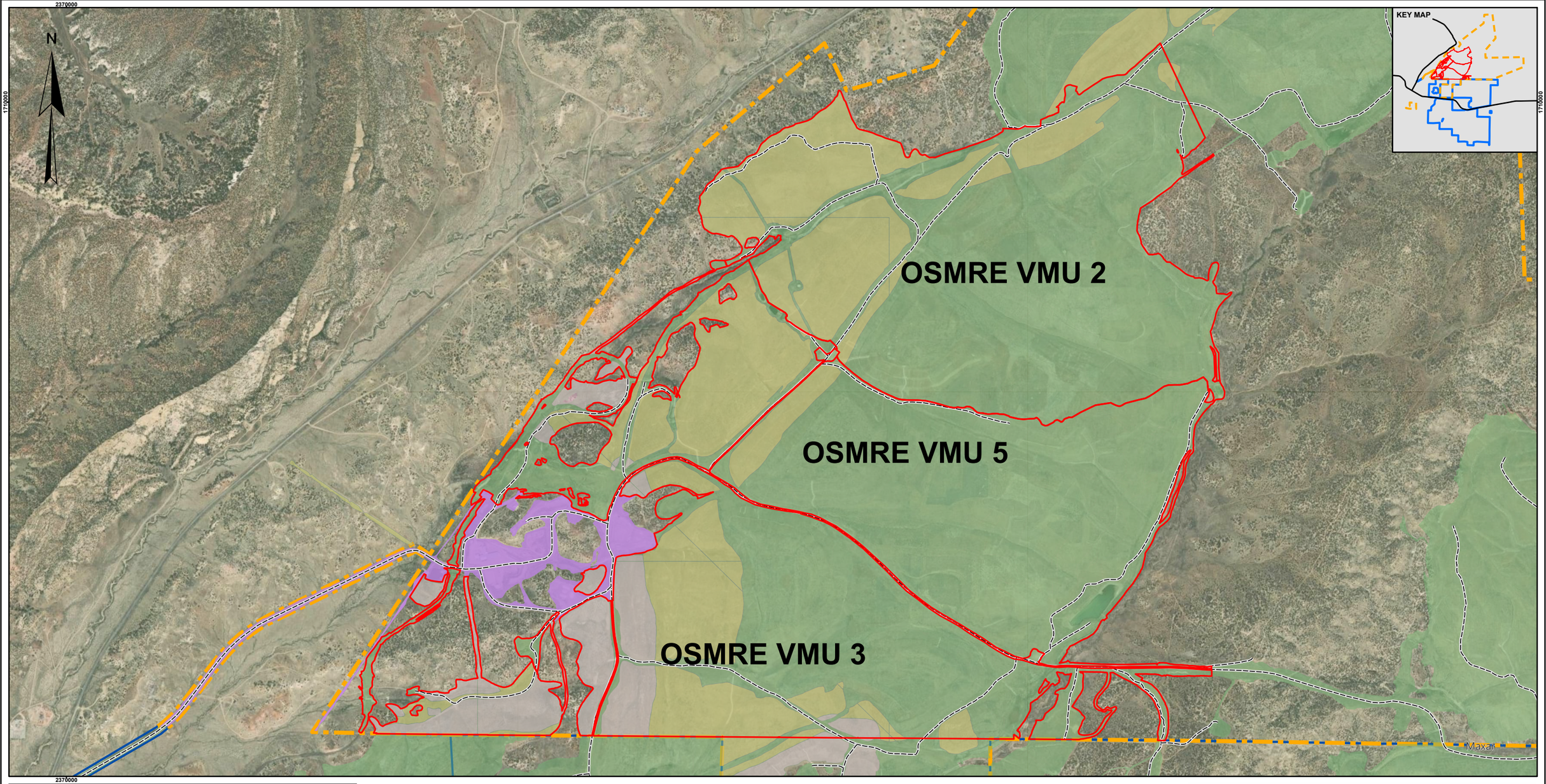


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- North Facilities Area
- Initial Program Lands
- Prelaw Lands
- Permanent Program Lands
- OSMRE Permit Boundary
- MMD Permit Boundary
- Post-Mining Two-Track Trails

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Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

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**McKINLEY MINE**

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PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**GENERAL LOCATION**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E2** |

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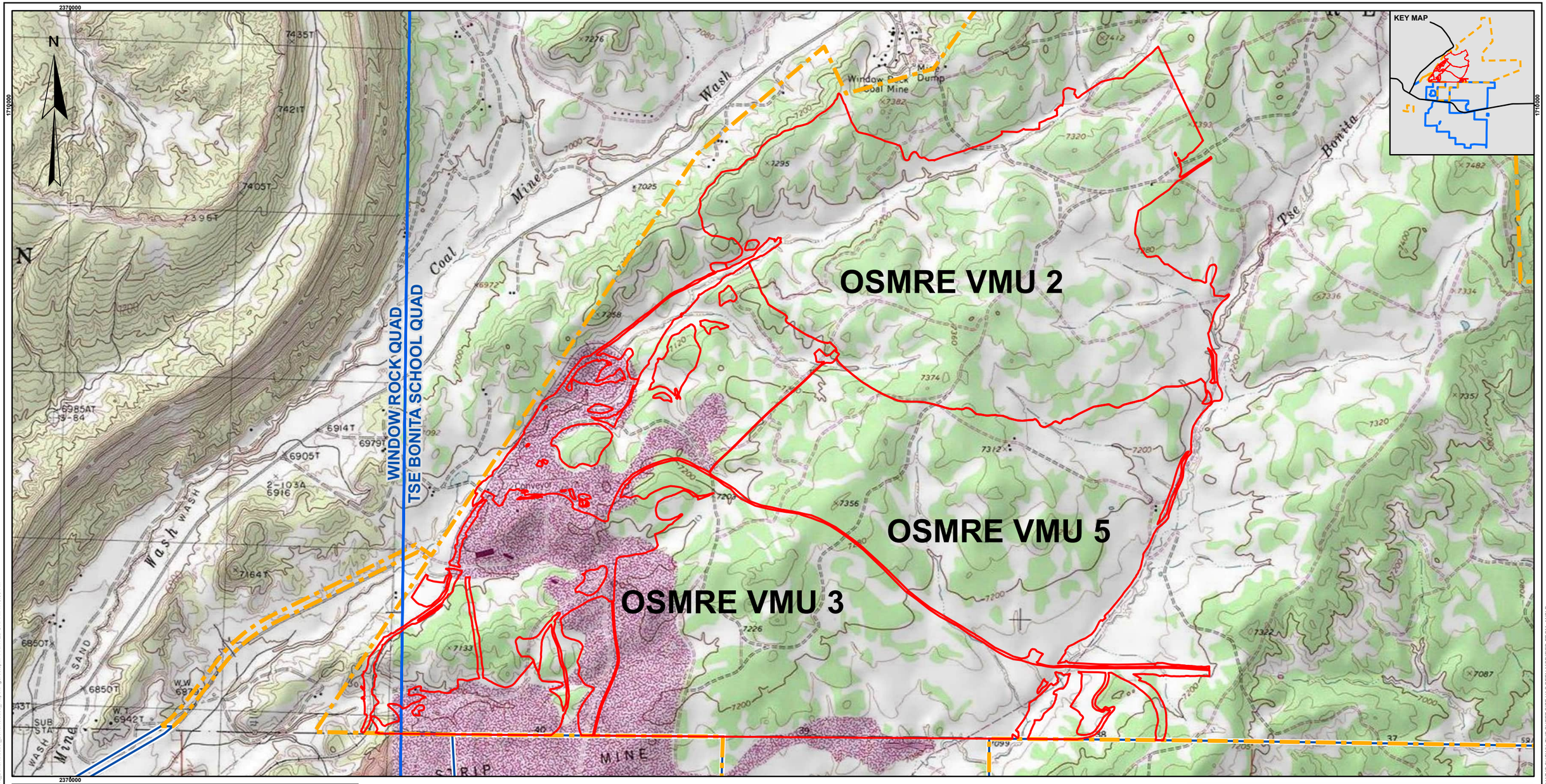


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- USGS 24k Topo Map Boundaries
- OSMRE Permit Boundary
- MMD Permit Boundary

0 2,000 4,000
Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET
2. SERVICE LAYER CREDITS: USGS TOPO MAPS (MAP SERVICE): COPYRIGHT:© 2013 NATIONAL GEOGRAPHIC SOCIETY, I-CUBED

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| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**USGS 7.5 MINUTE (24K) TOPOGRAPHIC MAP**
**TSE BONITA SCHOOL QUADRANGE**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E3** |

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KEY MAP

Undisturbed Area

OSMRE VMU 2

2-3
2-11
2-10
2-9
2-8
2-13
2-12
3-5

Maxar

## LEGEND

- Bond Release and Reclamation Liability Release (TOJ)
- Phase I and II Bond Release Area Previously Approved by OSMRE
- Phase I, II and III Bond Release of Impoundments
- North Facilities Area
- Post-Mining Two-Track Trails
- Initial Program Lands
- Prelaw Lands
- Permanent Program Lands
- OSMRE Permit Boundary

Note: Undisturbed areas include annotated small polygons, and larger polygons that were distinctly undisturbed and did not necessitate the annotation.

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**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

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**McKINLEY MINE**

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PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 2**
**BOND RELEASE AREAS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E4-1** |

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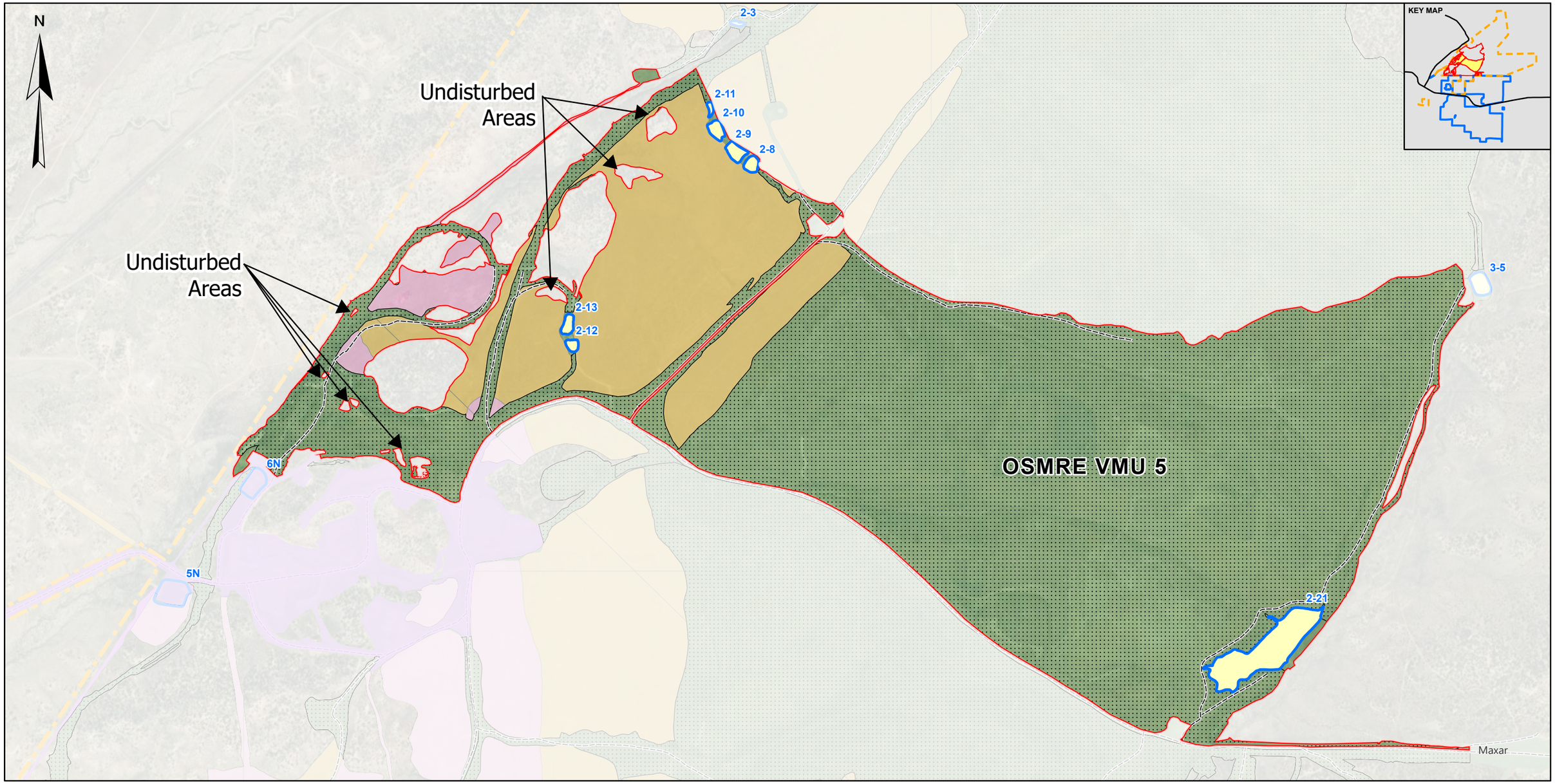


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Phase I and II Bond Release Area Previously Approved by OSMRE
- Phase I, II and III Bond Release of Impoundments
- North Facilities Area
- Post-Mining Two-Track Trails
- Initial Program Lands
- Prelaw Lands
- Permanent Program Lands
- OSMRE Permit Boundary

Note: Undisturbed areas include annotated small polygons, and larger polygons that were distinctly undisturbed and did not necessitate the annotation.

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**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

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PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 5**
**BOND RELEASE AREAS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E4-2** |

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KEY MAP

2-13

2-12

6N

5N

2-21

OSMRE VMU 3

Undisturbed Area

Maxar

**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Phase I and II Bond Release Area Previously Approved by OSMRE
- Phase I, II and III Bond Release of Impoundments
- North Facilities Area
- Post-Mining Two-Track Trails
- Impoundment
- Initial Program Lands
- Prelaw Lands
- Permanent Program Lands
- OSMRE Permit Boundary
- MMD Permit Boundary

Note: Undisturbed areas include annotated small polygons, and larger polygons that were distinctly undisturbed and did not necessitate the annotation.

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**NOTE(S)**
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**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

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PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 3**
**BOND RELEASE AREAS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E4-3** |

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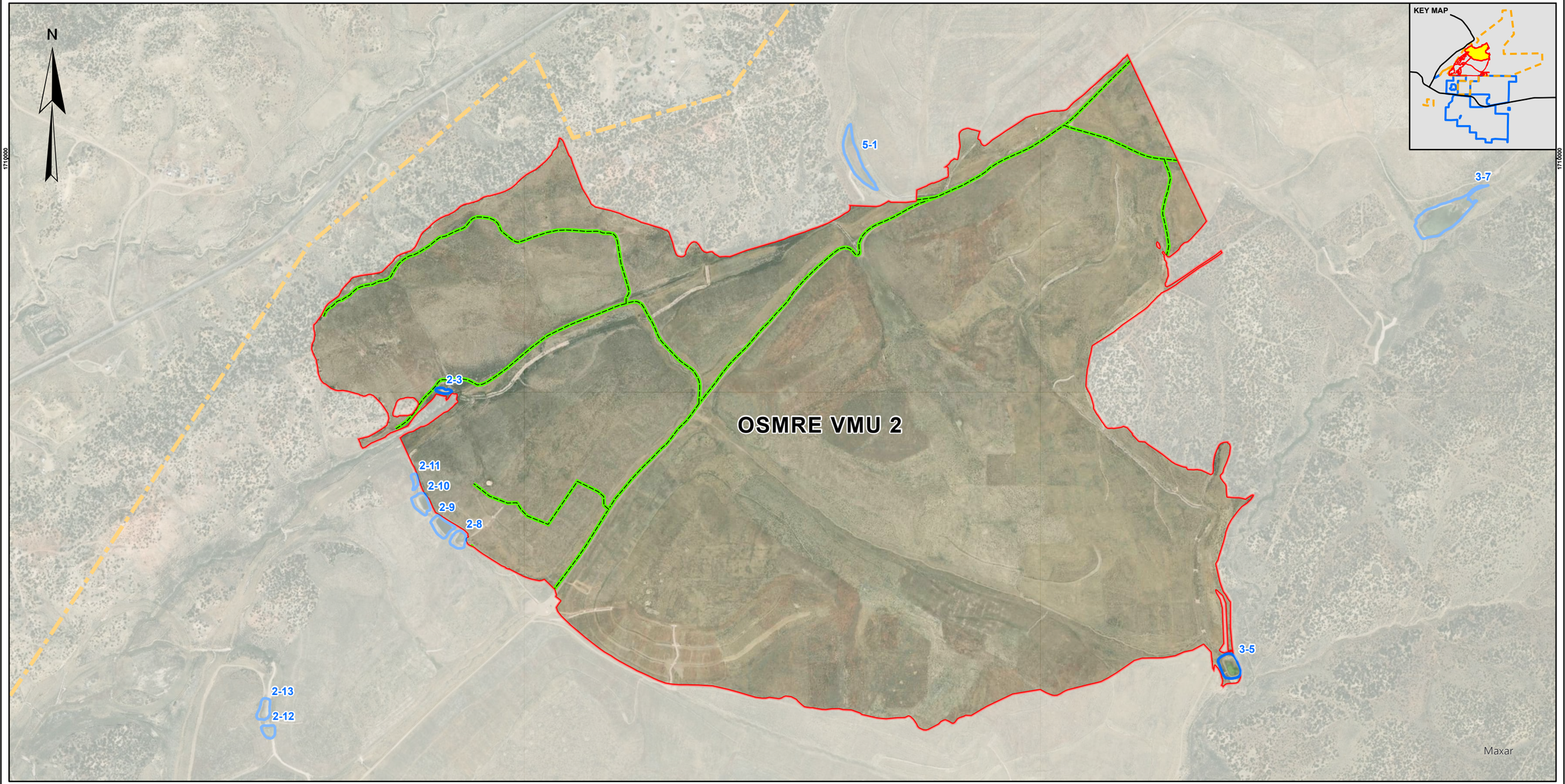


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Impoundment
- Primary Roads Included in this Application for Phase III Bond Release
- OSMRE Permit Boundary

SEAL

I certify that the primary road locations shown within the VMU 4 boundary are correct to the best of my knowledge and belief.

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**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

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**McKINLEY MINE**

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| REVIEWED | KK |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 2 PRIMARY ROADS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
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| 1338105302 | 0003 | A | **E5-1** |

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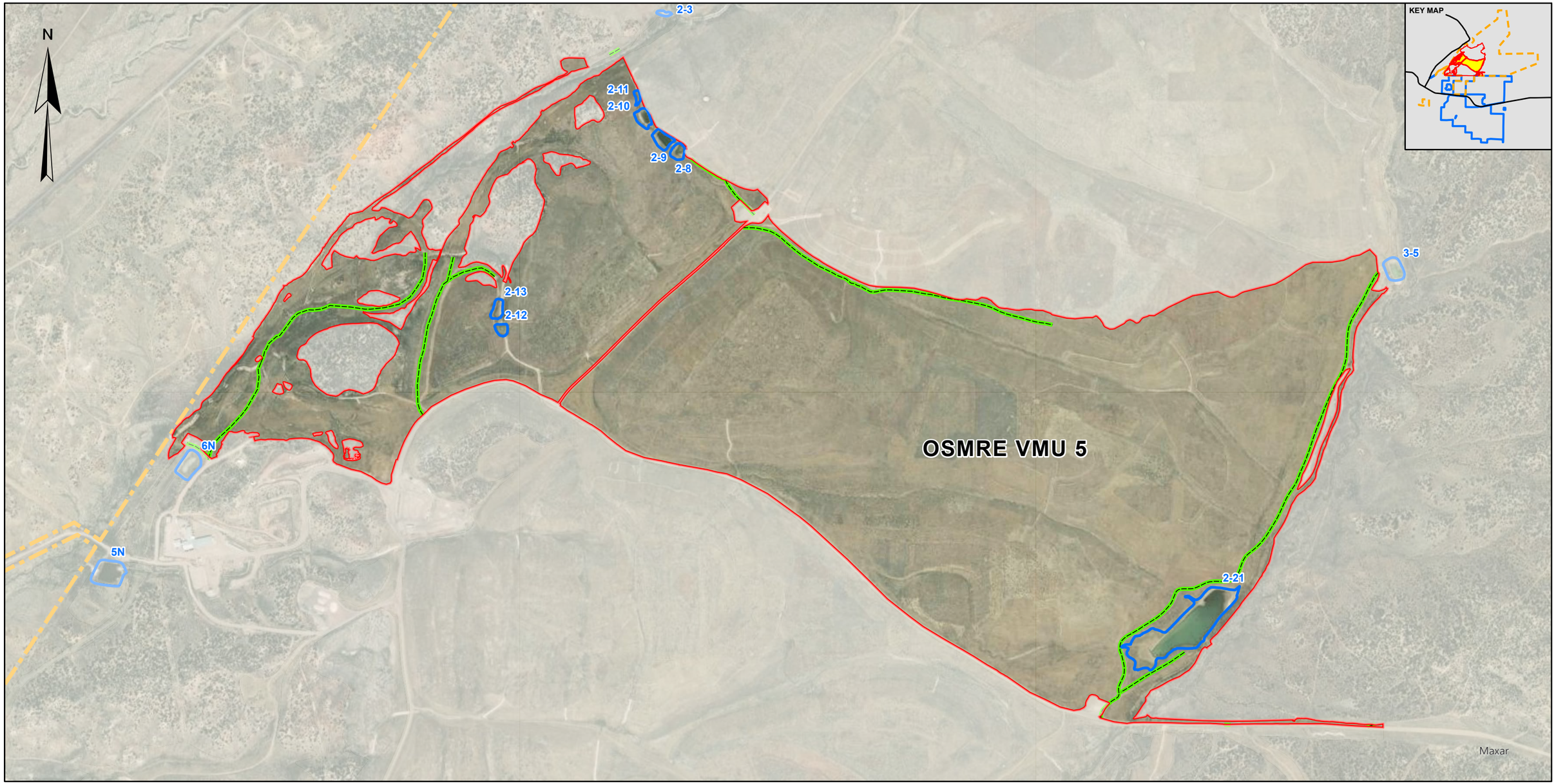


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Impoundment
- Primary Roads Included in this Application for Phase III Bond Release
- OSMRE Permit Boundary

SEAL

I certify that the primary road locations shown within the VMU 4 boundary are correct to the best of my knowledge and belief.

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**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

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| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 5 PRIMARY ROADS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E5-2** |

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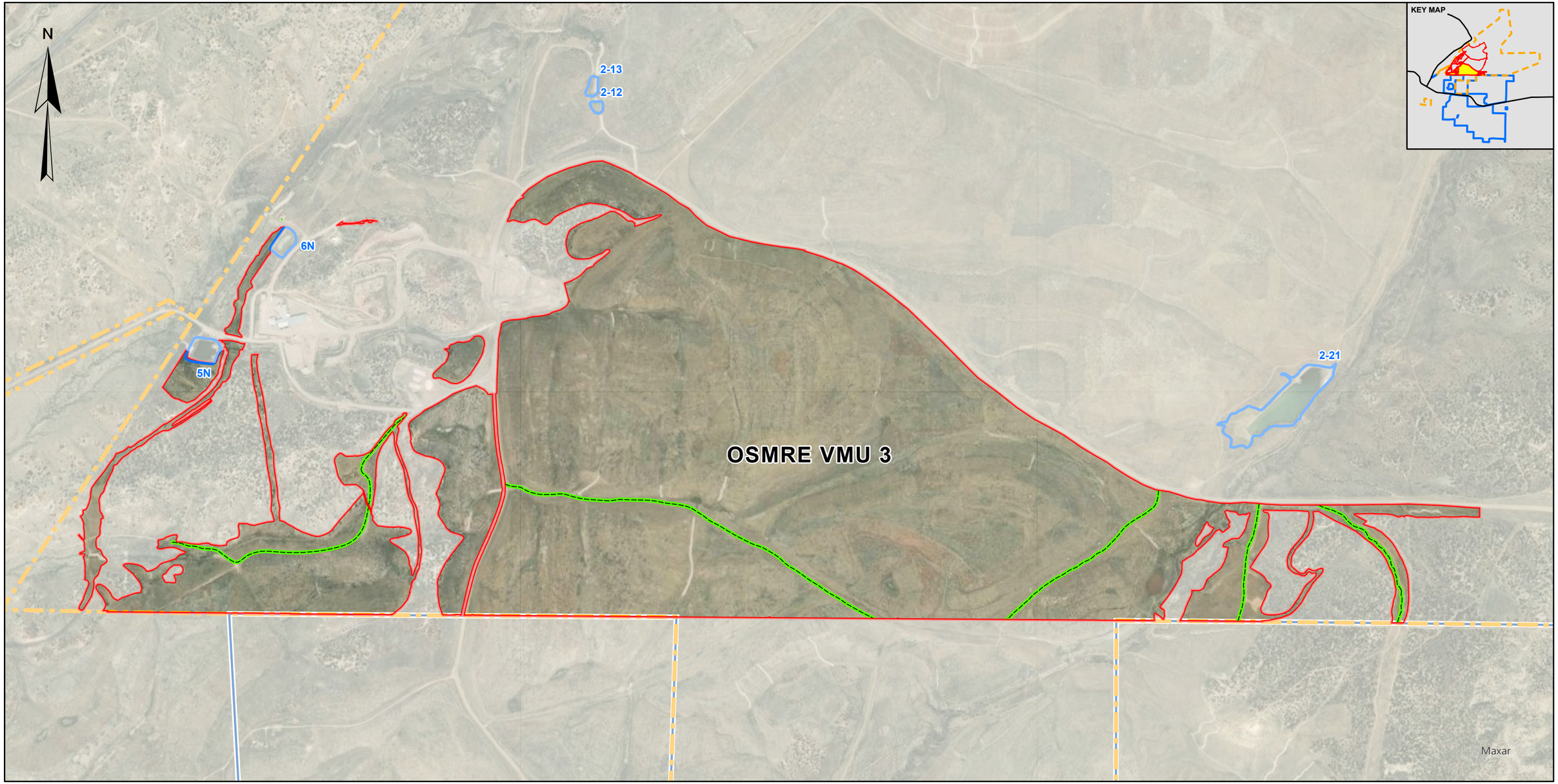


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Impoundment
- Primary Roads Included in this Application for Phase III Bond Release
- OSMRE Permit Boundary
- MMD Permit Boundary

SEAL

I certify that the primary road locations shown within the VMU 4 boundary are correct to the best of my knowledge and belief.

0 1,000 2,000
Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
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| YYYY-MM-DD | 2025-10-24 |
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| PREPARED | HJ |
| REVIEWED | KK |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 3 PRIMARY ROADS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E5-3** |

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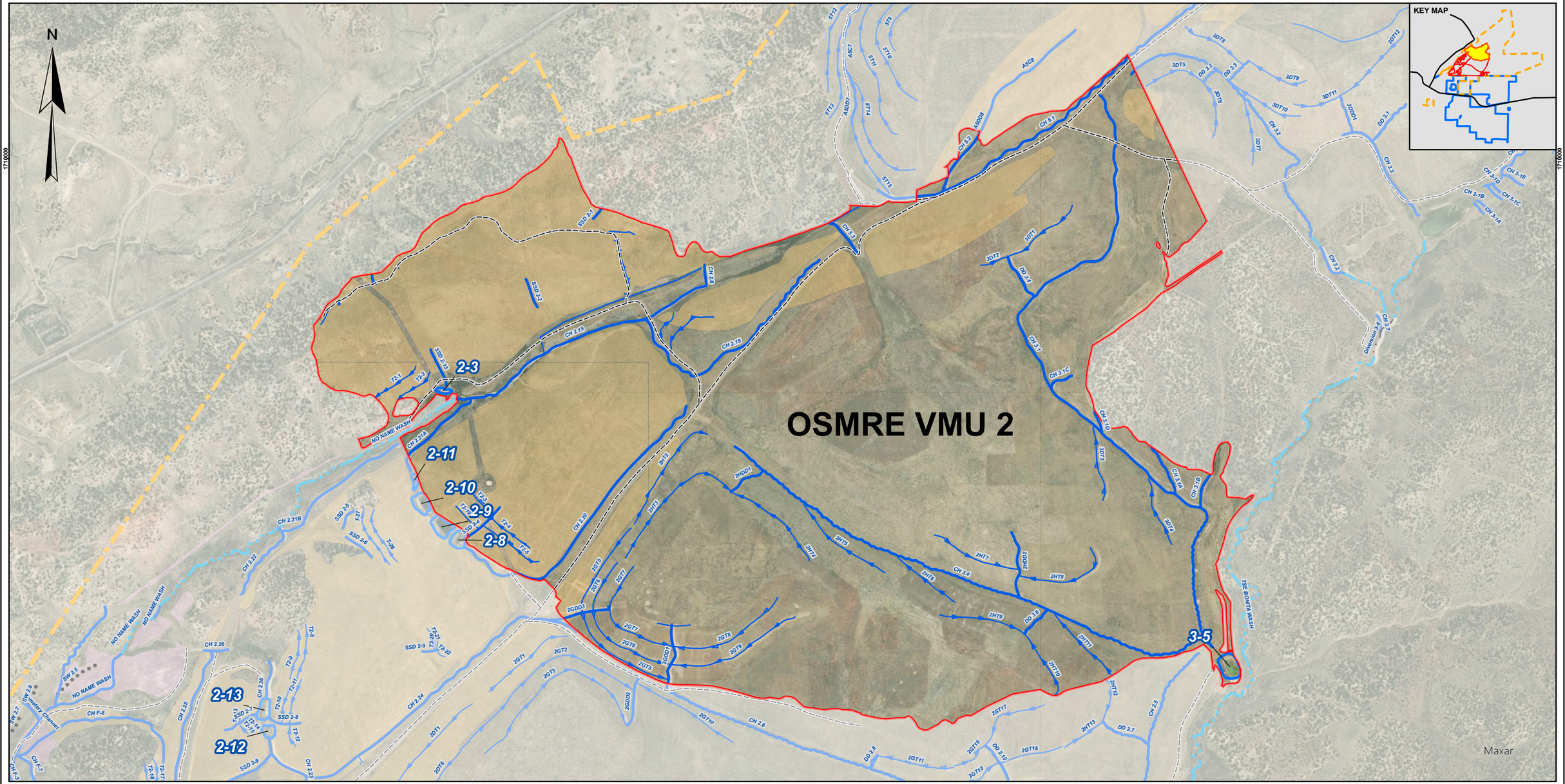


**LEGEND**

- Bond Release and Reclamation Liability Release
- Undisturbed Stream
- Swale
- "CH" represents Channels
  "DD" represents Downdrains
  "SC" represents Scallops
- Concentrated Flow Path and Terrace
- Diversion
- Impoundment
- Initial Program Lands
- Prelaw Lands
- Post-Mining Two-Track Trails
- OSMRE Permit Boundary

SEAL

I certify that the hydrologic structures shown within the VMU 4 boundary are correct to the best of my knowledge and belief.

0 1,000 2,000 Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
**Chevron Mining Inc.**
**McKINLEY MINE**

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| YYYY-MM-DD | 2025-10-24 |
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| PREPARED | HJ |
| REVIEWED | KK |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 2 HYDROLOGIC FEATURES**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E6-1** |

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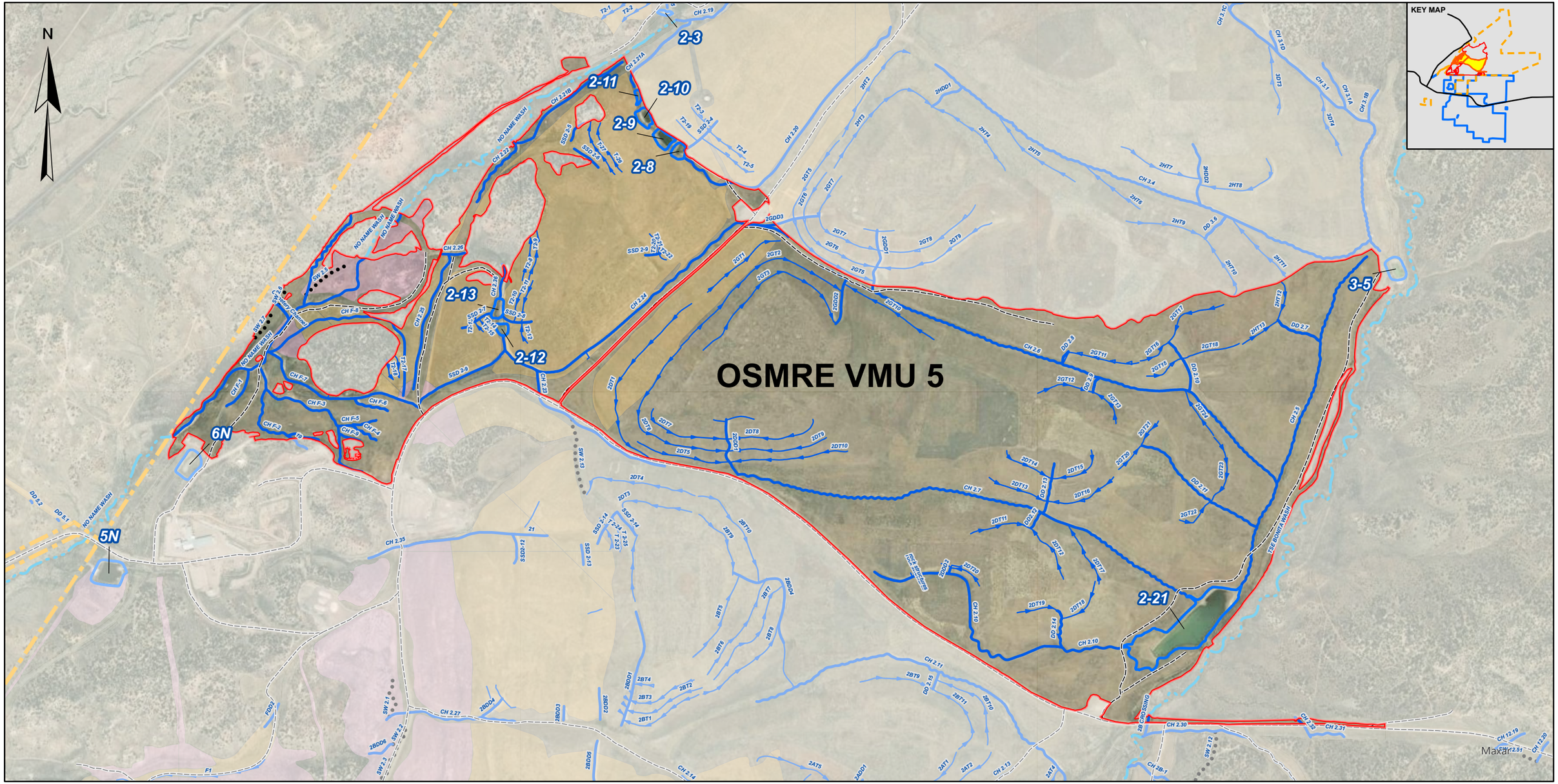


**LEGEND**

- Bond Release and Reclamation Liability Release
- Undisturbed Stream
- Swale
- "CH" represents Channels
  "DD" represents Downdrains
  "SC" represents Scallops
- Concentrated Flow Path and Terrace
- Impoundment
- Initial Program Lands
- Prelaw Lands
- Post-Mining Two-Track Trails
- OSMRE Permit Boundary

SEAL

I certify that the hydrologic structures shown within the VMU 4 boundary are correct to the best of my knowledge and belief.

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Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
Chevron Mining Inc.
McKINLEY MINE

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| PREPARED | HJ |
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| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 5 HYDROLOGIC FEATURES**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E6-2** |

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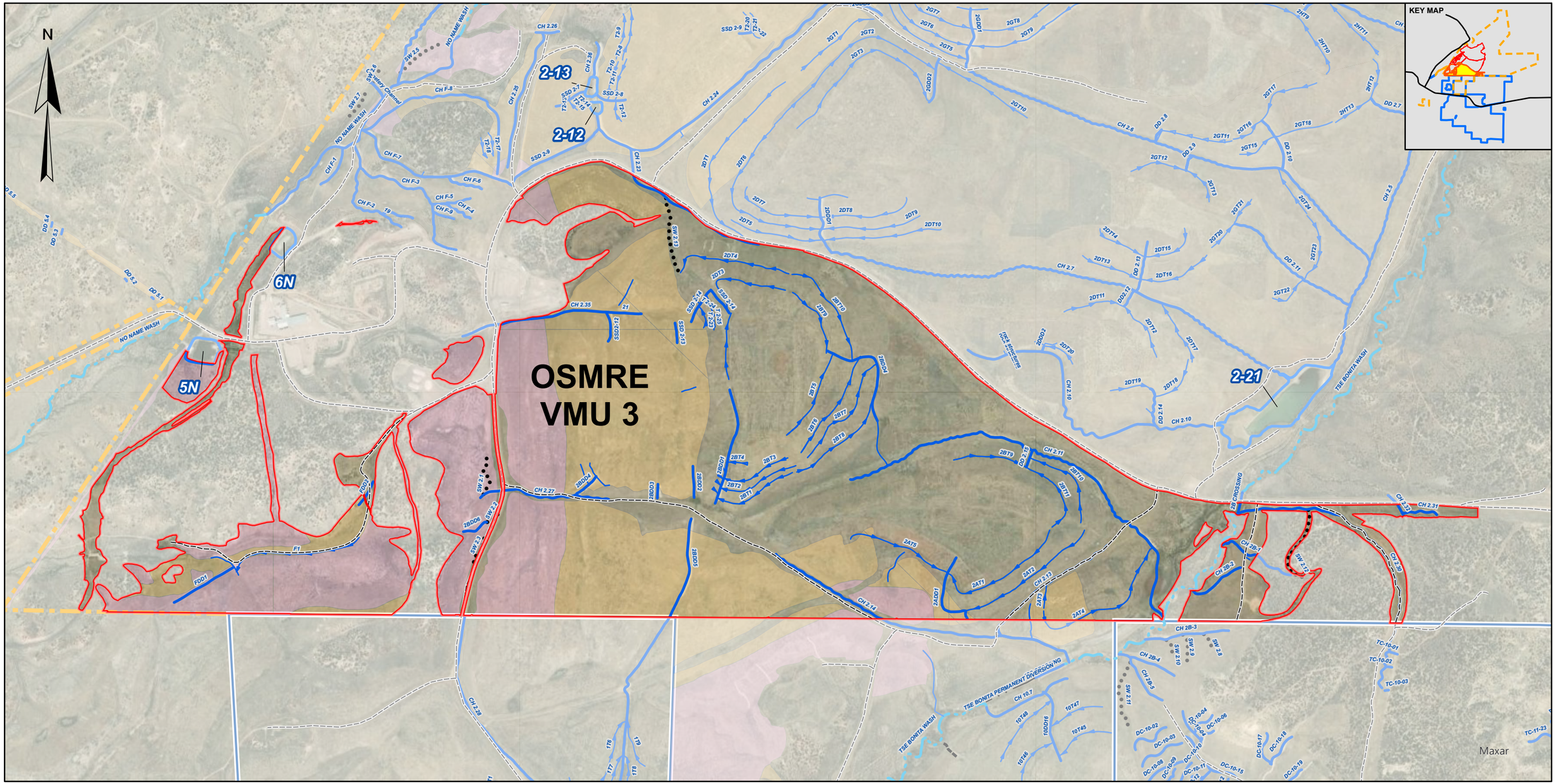


**LEGEND**

- Bond Release and Reclamation Liability Release
- Undisturbed Stream
- Swale
- "CH" represents Channels
  "DD" represents Downdrains
  "SC" represents Scallops
- Concentrated Flow Path and Terrace
- Step Drain
- Diversion
- Impoundment
- Initial Program Lands
- Prelaw Lands
- Post-Mining Two-Track Trails
- OSMRE Permit Boundary
- MMD Permit Boundary

SEAL

I certify that the hydrologic structures shown within the VMU 4 boundary are correct to the best of my knowledge and belief.

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Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT Chevron Mining Inc.
McKINLEY MINE

CONSULTANT WSP

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PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 3 HYDROLOGIC FEATURES**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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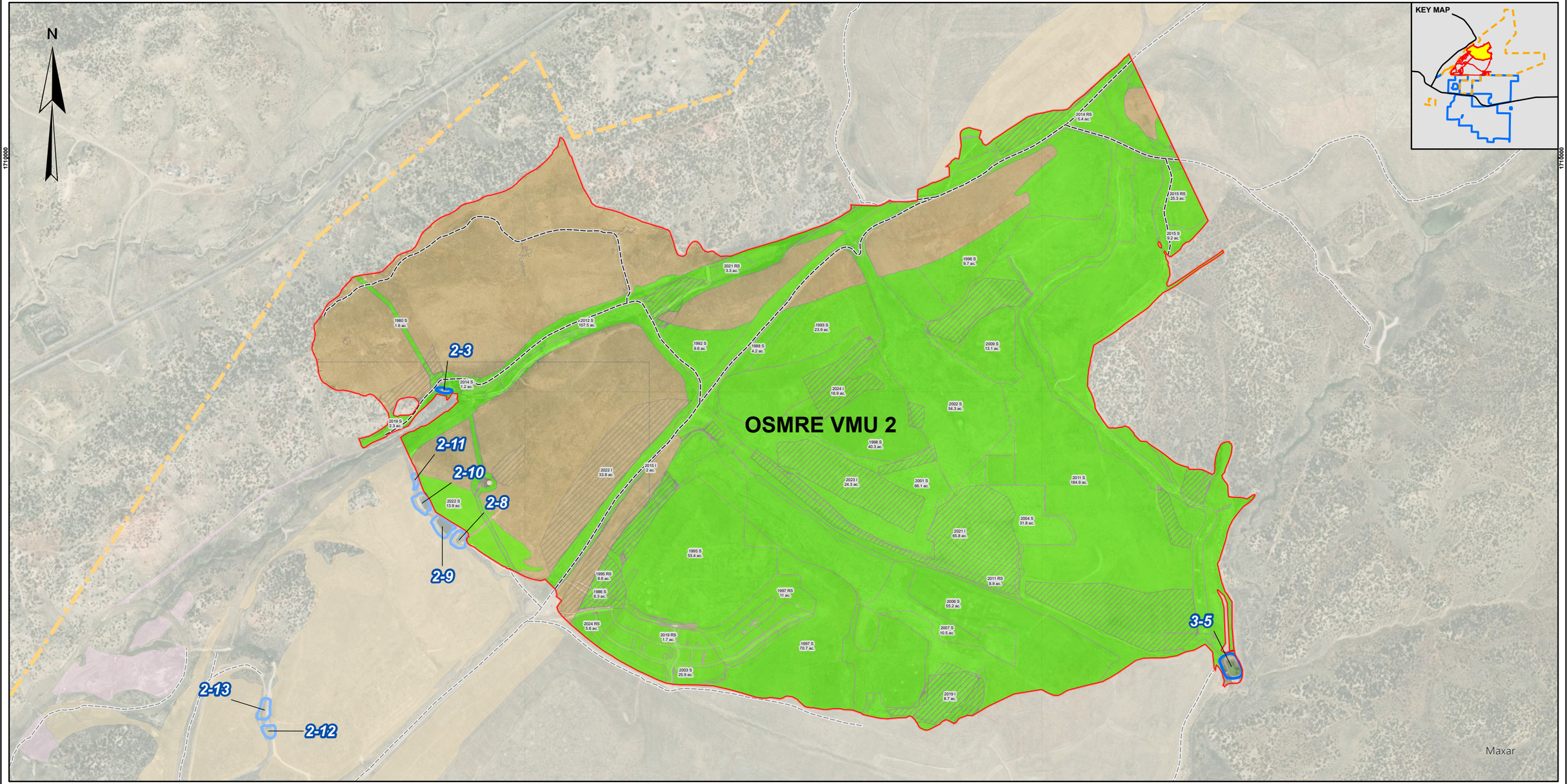



**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Seeding Year Seeded ("S") or Reseeded ("R") and acreage
- Interseeded ("I")
- Initial Program Lands
- Prelaw Lands
- Post-Mining Two-Track Trails
- Impoundment
- OSMRE Permit Boundary

0 1,000 2,000 Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT Chevron Mining Inc.
McKINLEY MINE

CONSULTANT wsp

| | |
|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

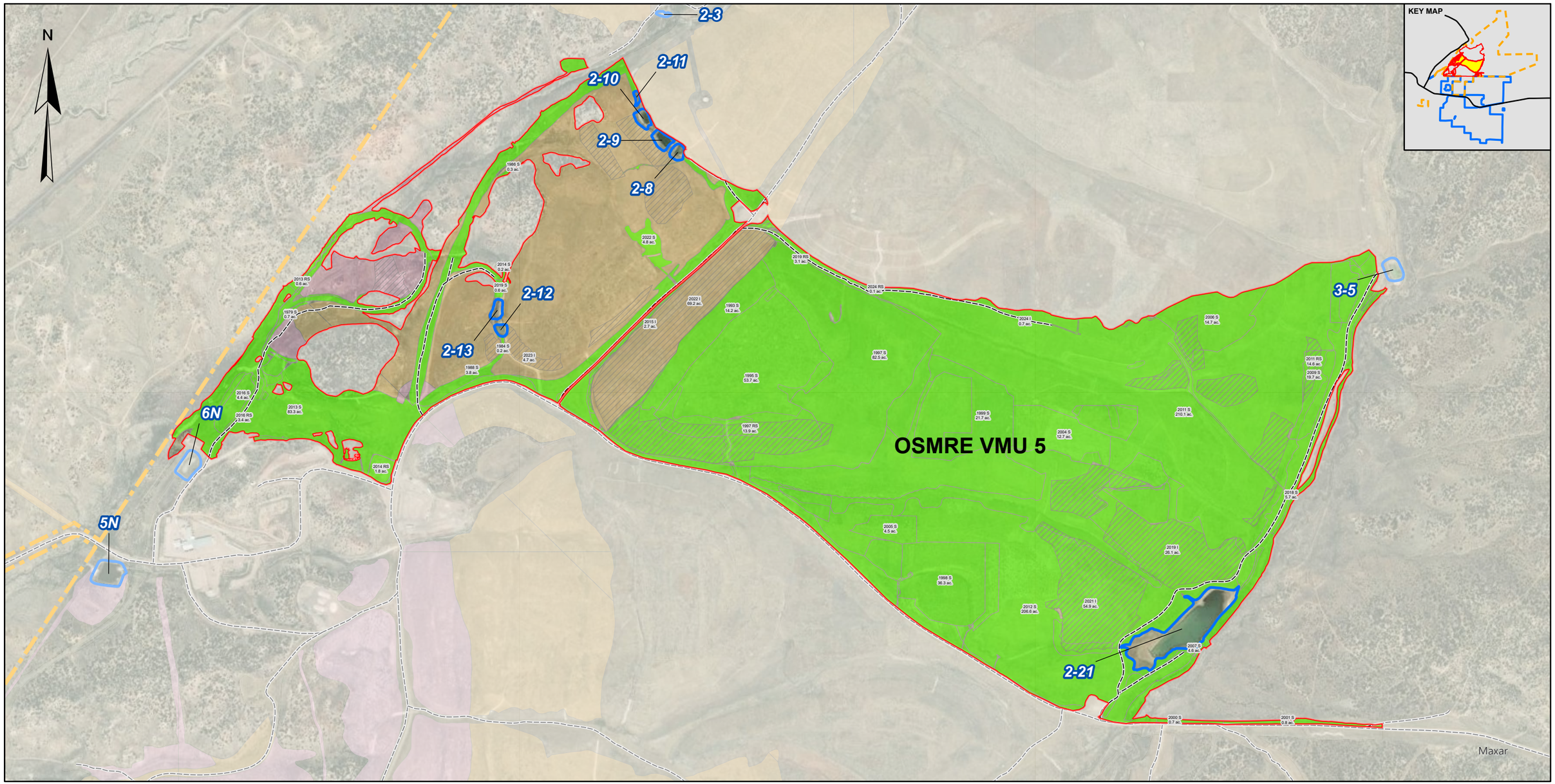
PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 2 SEEDING**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E7-1** |

PATH: P:\Projects\Chevron\McKinley Mine\99_PROJECTS\1338105207_McKinley_Mine\0016_BondRelease_BondRelease_ReportFigures.aprx PRINTED ON: AT: 1:14:00 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B




**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Seeding Year Seeded ("S") or Reseeded ("R") and acreage
- Interseeded ("I")
- Initial Program Lands
- Prelaw Lands
- Post-Mining Two-Track Trails
- Impoundment
- OSMRE Permit Boundary

0 1,000 2,000
Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT Chevron Mining Inc.
McKINLEY MINE

CONSULTANT wsp

| | |
|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 5 SEEDING**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E7-2** |

PATH: P:\Projects\Chevron\McKinley_Mine\69. PROJECTS\1338105207 McKinley_Mine\0016 BondRelease\ BondRelease_ReportFigures.aprx, PRINTED ON: AT: 1:14:03 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
1 in
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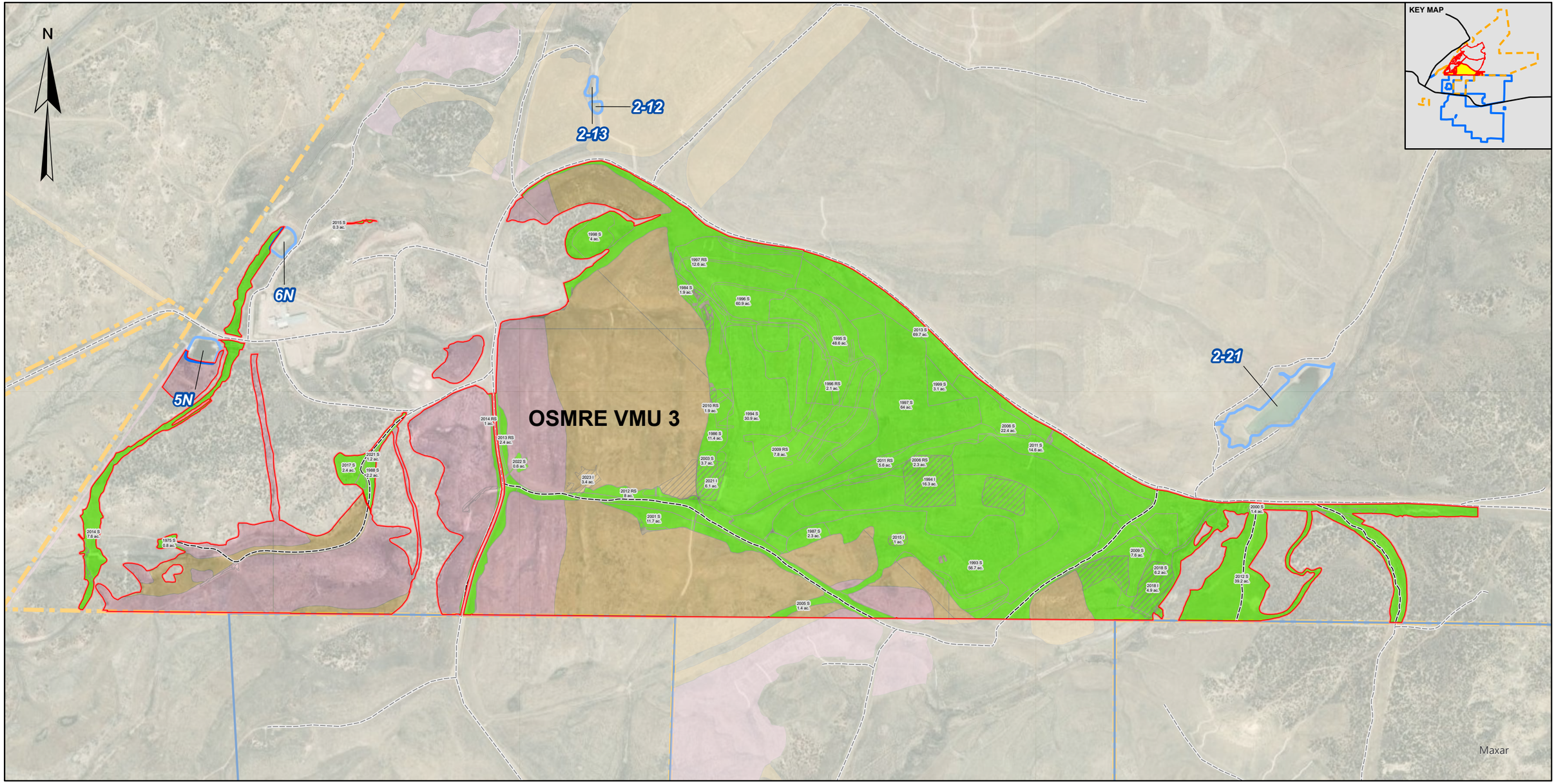


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Seeding Year Seeded ("S") or Reseeded ("R") and acreage
- Interseeded ("I")
- Initial Program Lands
- Prelaw Lands
- Post-Mining Two-Track Trails
- Impoundment
- OSMRE Permit Boundary
- MMD Permit Boundary

0 1,000 2,000
Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
**Chevron Mining Inc.**
**McKINLEY MINE**

CONSULTANT
wsp

| | |
|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 3 SEEDING**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E7-3** |

PATH: P:\Projects\Chevron\McKinley Mine\99_PROJECTS\1338105207_McKinley_Mine\0016_BondRelease_BondRelease_ReportFigures.aprx PRINTED ON: AT: 1:14:06 PM

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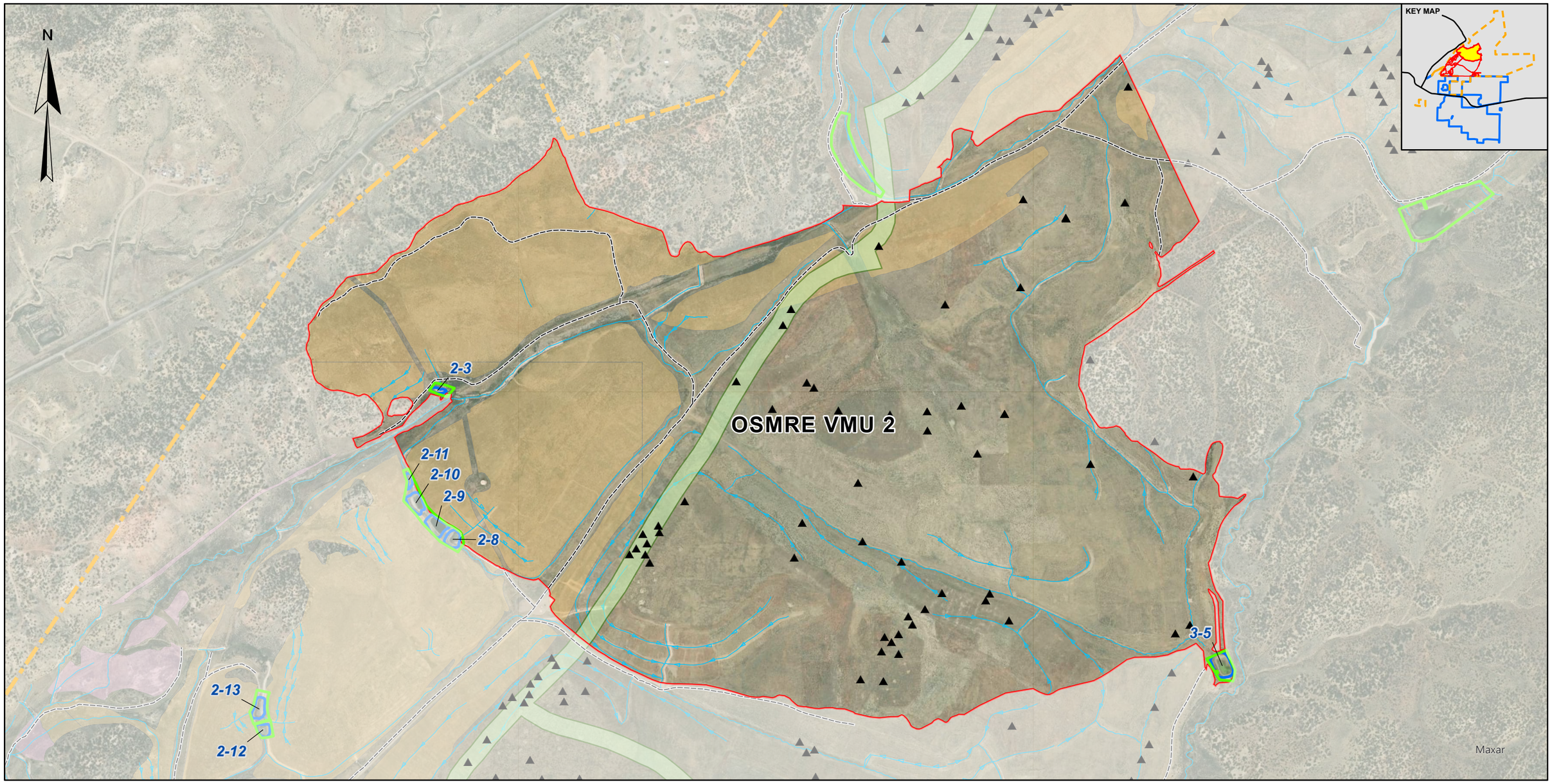


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Wildlife Rock Pile
- Pre-2018 Planted Wildlife Corridors
- Installed Wildlife Fence
- Drainage Features
- Impoundment
- Initial Program Lands
- Prelaw Lands
- OSMRE Permit Boundary
- Post-Mining Two-Track Trails

0 1,000 2,000
Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
Chevron Mining Inc.
McKINLEY MINE

CONSULTANT
WSP

| | |
|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 2 WILDLIFE ENHANCEMENTS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E8-1** |

PATH: P:\Projects\Chevron\McKinley_Mine\09_PROJECTS\1338105207_McKinley_Mine\0016_BondRelease_BondRelease_ReportFigures.aprx PRINTED ON: AT: 1:14:40 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
1 in
0

N

KEY MAP

2-3
2-11
2-10
2-9
2-8
2-13
2-12
3-5
6N
5N
OSMRE VMU 5
2-21
Maxar

**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Wildlife Rock Pile
- Pre-2018 Planted Wildlife Corridors
- Installed Wildlife Fence
- Drainage Features
- Impoundment
- Initial Program Lands
- Prelaw Lands
- OSMRE Permit Boundary
- Post-Mining Two-Track Trails

0 1,000 2,000
Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT Chevron Mining Inc.
McKINLEY MINE

CONSULTANT wsp

| | |
|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 5 WILDLIFE ENHANCEMENTS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E8-2** |

PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207 McKinley_Mine\0016_BondRelease_BondRelease_ReportFigures.aprx, PRINTED ON: AT 11:14:42 PM

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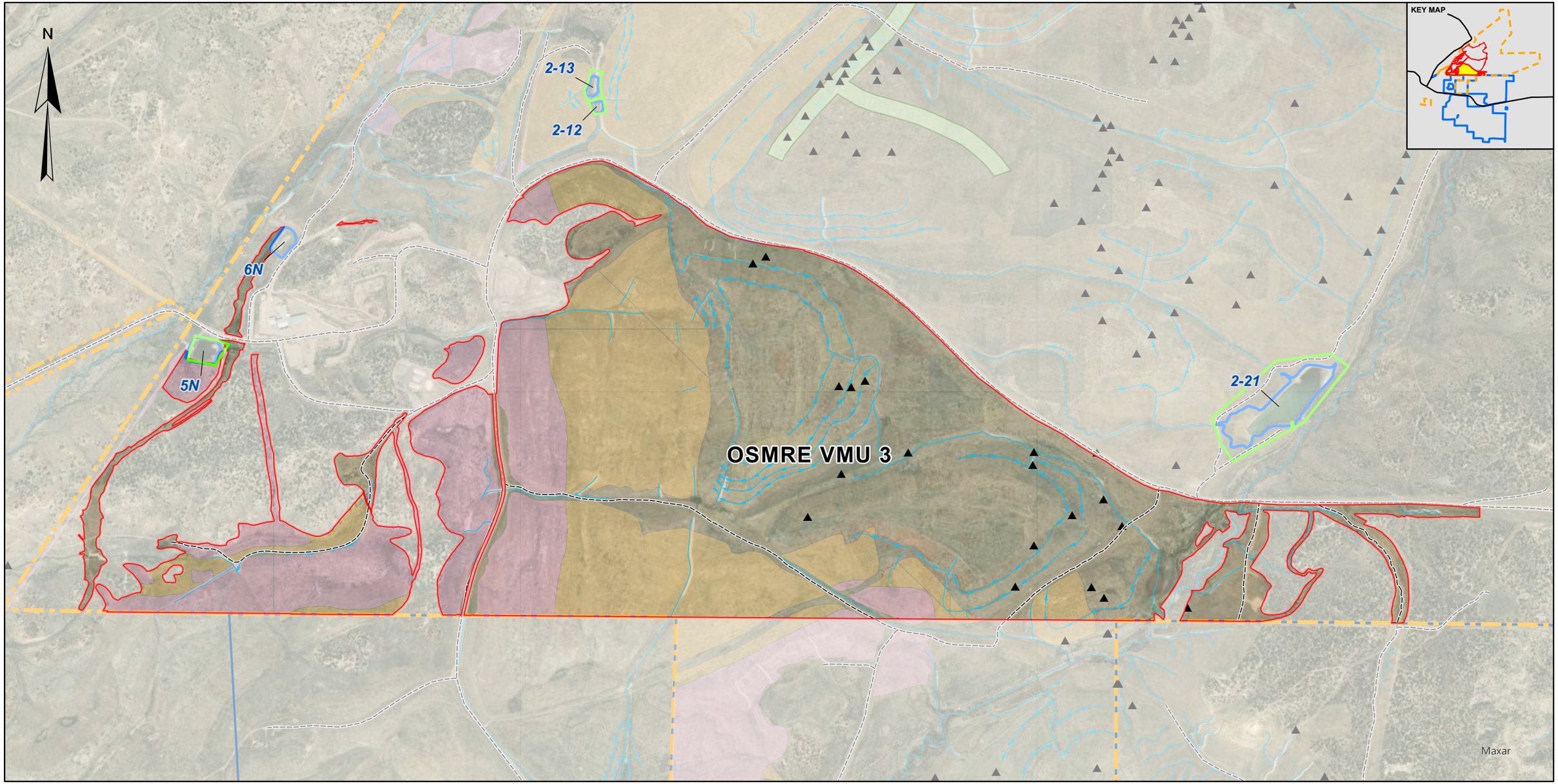


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Wildlife Rock Pile
- Pre-2018 Planted Wildlife Corridors
- Installed Wildlife Fence
- Drainage Features
- Impoundment
- Initial Program Lands
- Prelaw Lands
- OSMRE Permit Boundary
- MMD Permit Boundary
- Post-Mining Two-Track Trails

0 1,000 2,000 Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT Chevron Mining Inc.
McKINLEY MINE

CONSULTANT WSP

| | |
|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**OSMRE VMU 3 WILDLIFE ENHANCEMENTS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E8-3** |

PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0016_BondRelease_BondRelease_ReportFigures.aprx PRINTED ON: AT: 1:14:45 PM

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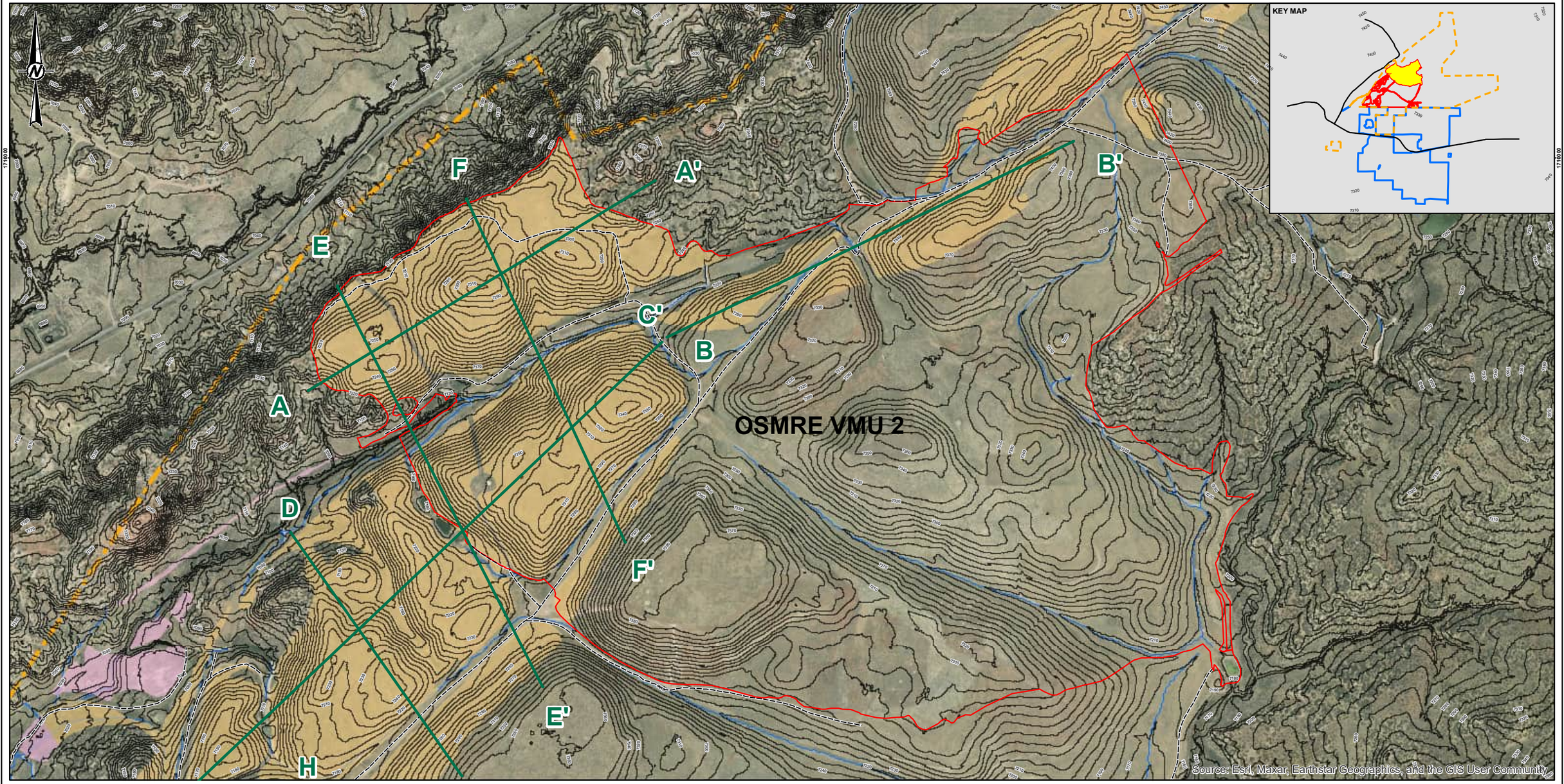


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Cross section
- Contour (ft)
- Channel
- Initial Program Lands
- Prelaw Lands
- OSMRE Permit Boundary
- Post-Mining Two-Track Trails

0 1,000 2,000
Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
**Chevron Mining Inc.**
**McKINLEY MINE**

CONSULTANT
wsp

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|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**IPL TOPOGRAPHY AND CROSS SECTION LOCATIONS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E9-1** |

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PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0016_BondRelease\OSM_VMUs2_3_5\09_OSM_VMUs 2_3_5_CrossSections.mxd PRINTED ON: 2025-10-23 AT 2:17:51 PM

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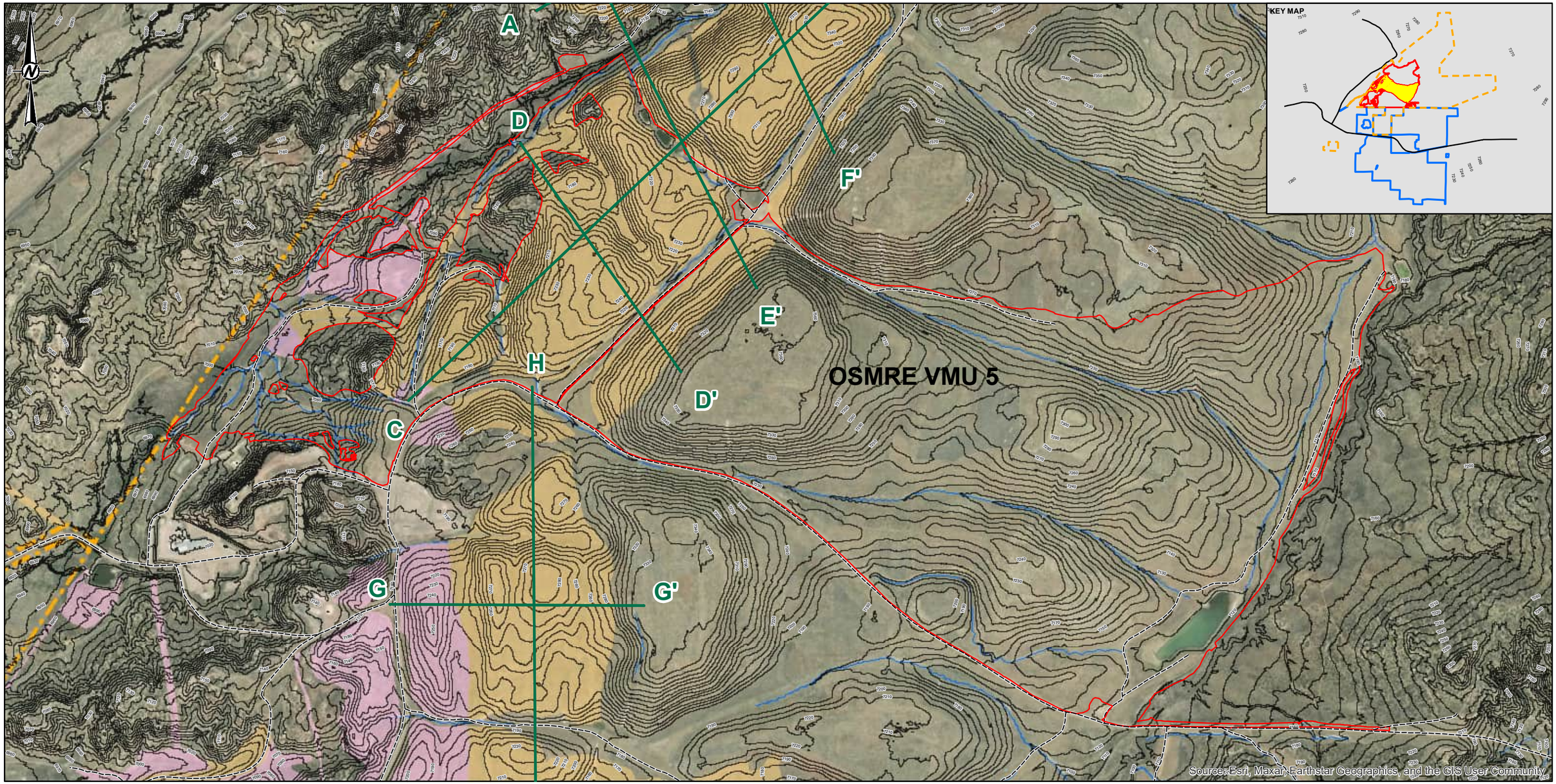


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Cross section
- Contour (ft)
- Channel
- Initial Program Lands
- Prelaw Lands
- OSMRE Permit Boundary
- Post-Mining Two-Track Trails

0 1,000 2,000
Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
Chevron Mining Inc.
McKINLEY MINE

CONSULTANT
wsp

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|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**IPL TOPOGRAPHY AND CROSS SECTION LOCATIONS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E9-2** |

PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0016_BondRelease\OSM_VMUs2_3_5\F09_OSM_VMUs_2_3_5_CrossSections.mxd PRINTED ON: 20:25-10:23 AT: 2:18:04 PM

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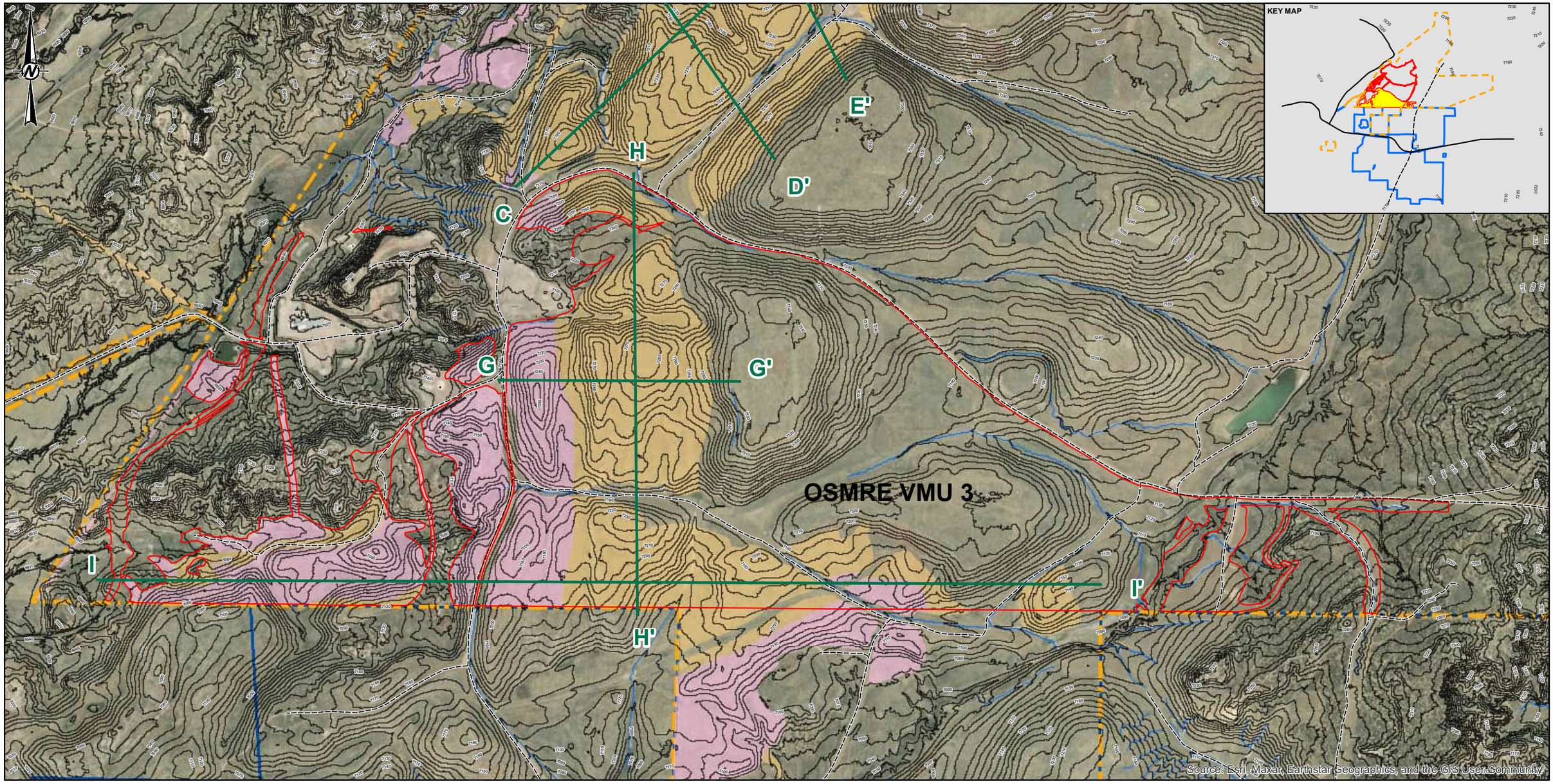


**LEGEND**

- Bond Release and Reclamation Liability Release (TOJ)
- Cross section
- Contour (ft)
- Channel
- Initial Program Lands
- Prelaw Lands
- OSMRE Permit Boundary
- MMD Permit Boundary
- Post-Mining Two-Track Trails

0 1,000 2,000
Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
Chevron Mining Inc.
McKINLEY MINE

CONSULTANT
wsp

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|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

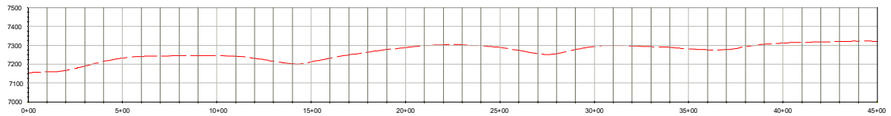
TITLE
**IPL TOPOGRAPHY AND CROSS SECTION LOCATIONS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E9-3** |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0016_BondRelease\OSM_VMUs\2_3_5_OSM_VMUs 2_3_5_CrossSections.mxd PRINTED ON: 2025-10-23 AT: 2:18:19 PM

## PROFILE A - A'

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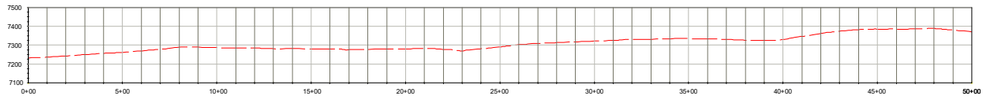


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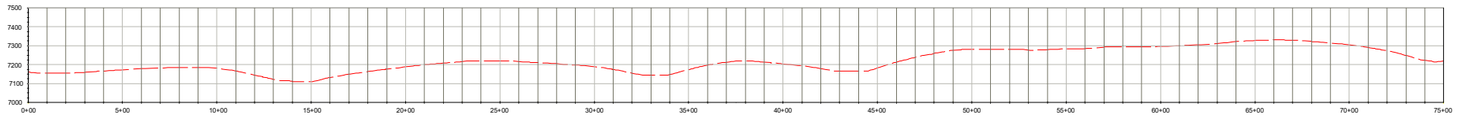
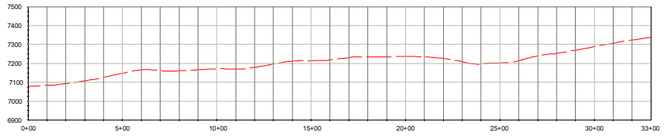
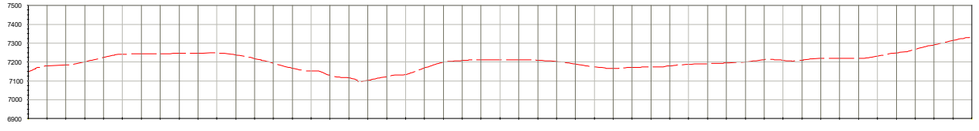



## PROFILE D - D'




## PROFILE E - E'

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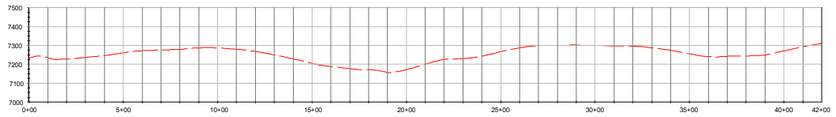


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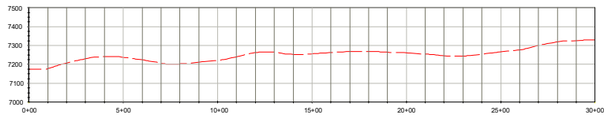
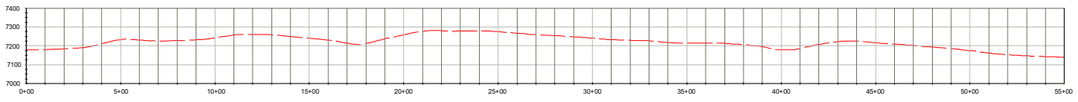
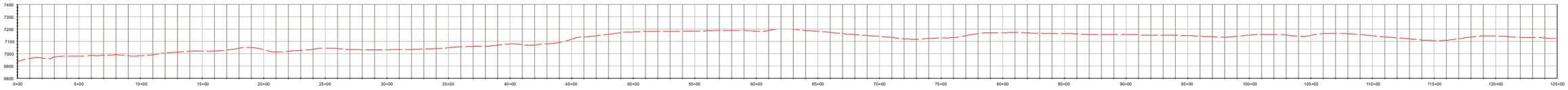



## PROFILE H - H'




## PROFILE I - I'




CLIENT
Chevron Mining Inc.
McKINLEY MINE

CONSULTANT
wsp

| | |
|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | KK |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**IPL CROSS SECTION PROFILES**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E10** |

PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0016_BondRelease\OSM_VMUs2_3_5\F10_OSM_VMUs_2_3_5_CrossSectionProfiles.mxd PRINTED ON: 2025-10-23 AT: 2:24:29 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

1 in
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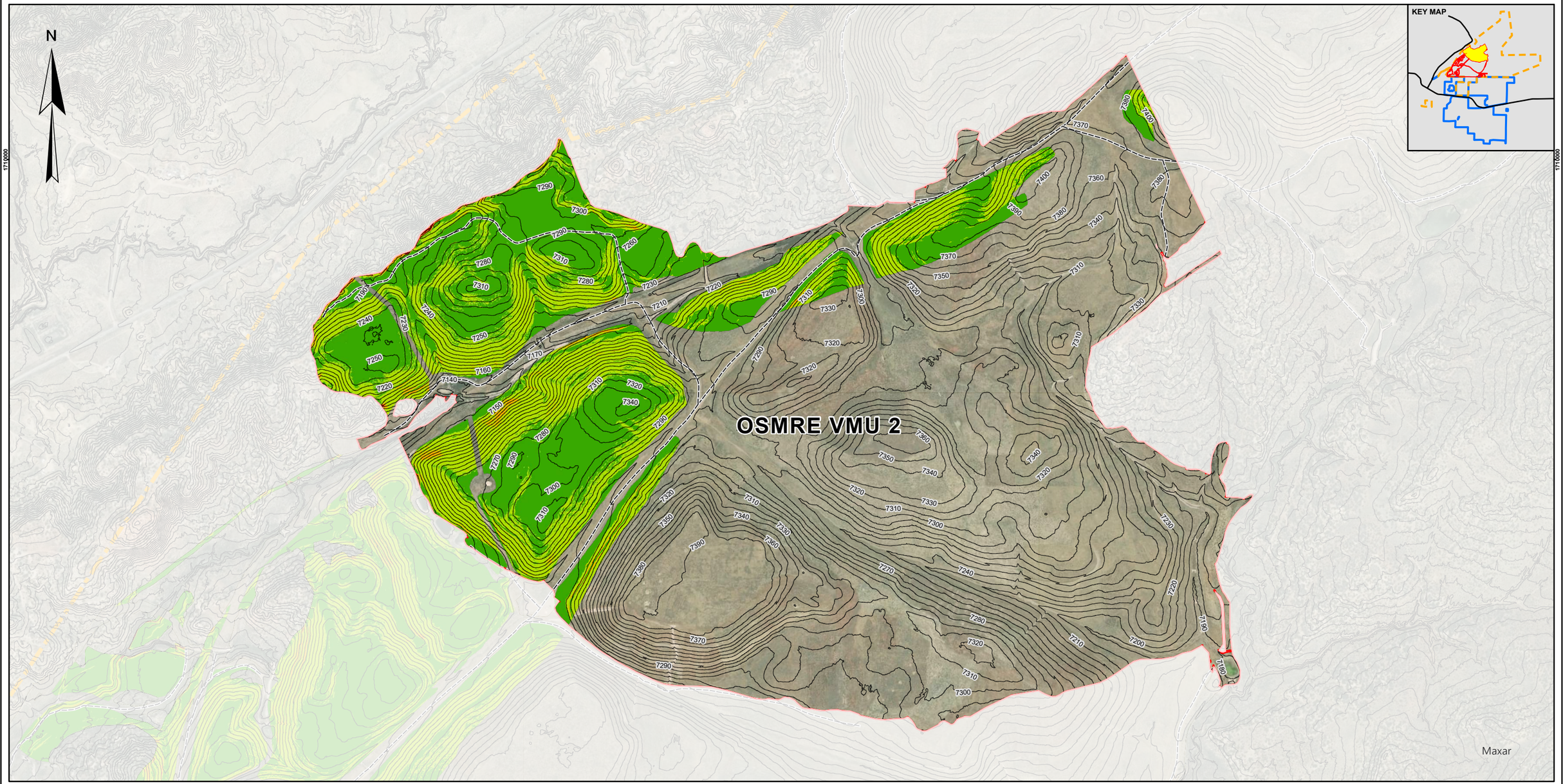


## LEGEND

Percent Slope

- 0 - 10%
- 11 - 20%
- 21 - 30%
- > 30%

- Bond Release and Reclamation Liability Release (TOJ)
- Post-Mining Two-Track Trails
- OSMRE Permit Boundary
- MMD Permit Boundary

0 2,000 4,000 Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT **Chevron Mining Inc.**
**McKINLEY MINE**

CONSULTANT wsp

| | |
|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**IPL SLOPE GRADIENT ANALYSIS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E11-1** |

PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0016_BondRelease_BondRelease_ReportFigures.aprx PRINTED ON: AT: 11:15:44 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B




## LEGEND

Percent Slope

- 0 - 10%
- 11 - 20%
- 21 - 30%
- > 30%

- Bond Release and Reclamation Liability Release (TOJ)
- Post-Mining Two-Track Trails
- OSMRE Permit Boundary
- MMD Permit Boundary

0 2,000 4,000 Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
Chevron Mining Inc.
McKINLEY MINE

CONSULTANT
WSP

| | |
|---|---|
| YYYY-MM-DD | 2025-10-24 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**IPL SLOPE GRADIENT ANALYSIS**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
|---|---|---|---|
| 1338105302 | 0003 | A | **E11-2** |

PATH: P:\Projects\Chevron\McKinley_Mine\69 PROJECTS\1338105207 McKinley_Mine\0016 BondRelease\ BondRelease_ReportFigures.aprx PRINTED ON: AT: 1:16:08 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
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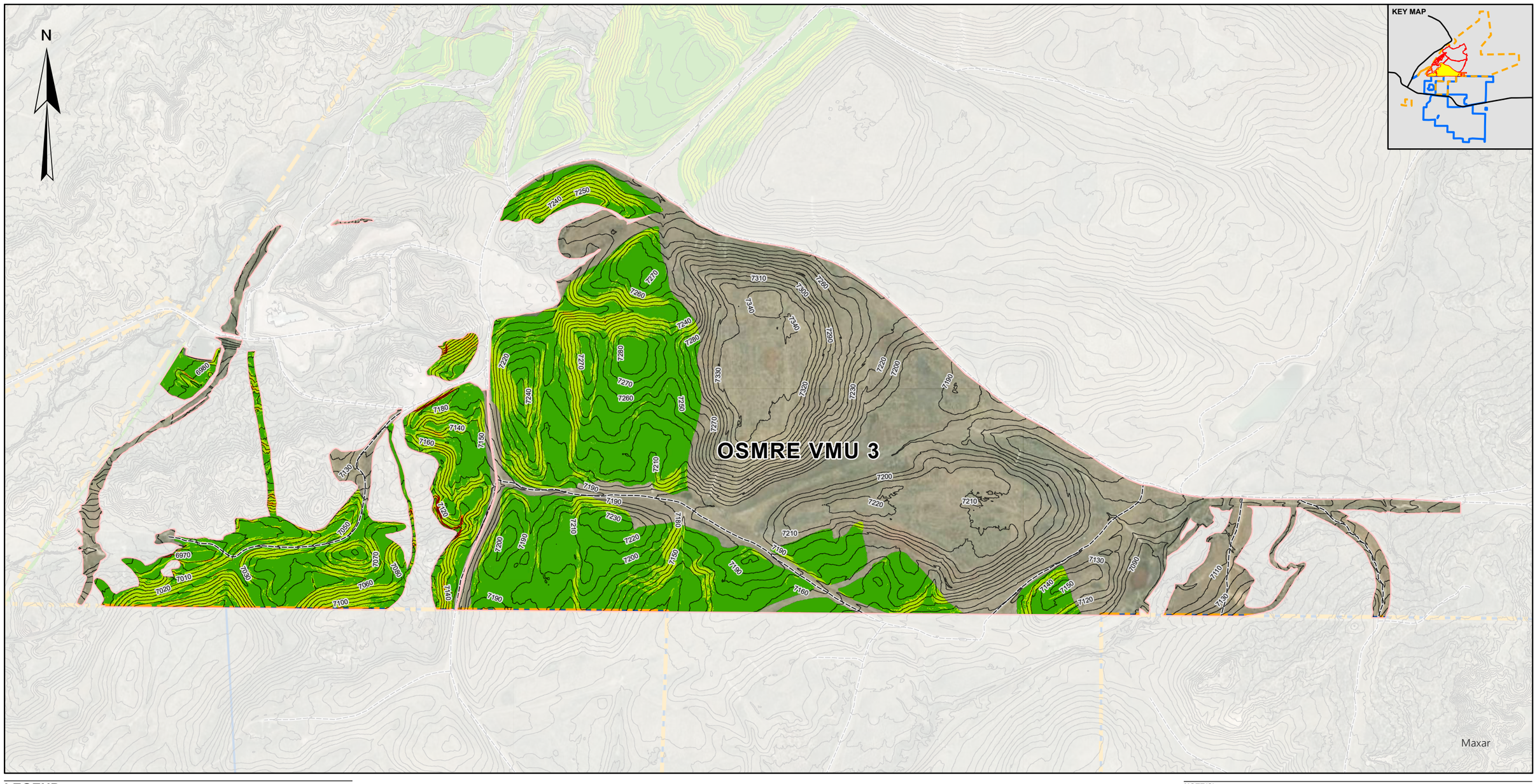


## LEGEND

Percent Slope

- 0 - 10%
- 11 - 20%
- 21 - 30%
- > 30%

- Bond Release and Reclamation Liability Release (TOJ)
- Post-Mining Two-Track Trails
- OSMRE Permit Boundary
- MMD Permit Boundary

0 2,000 4,000
Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
Chevron Mining Inc.
McKINLEY MINE

CONSULTANT
wsp

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| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**IPL SLOPE GRADIENT ANALYSIS**

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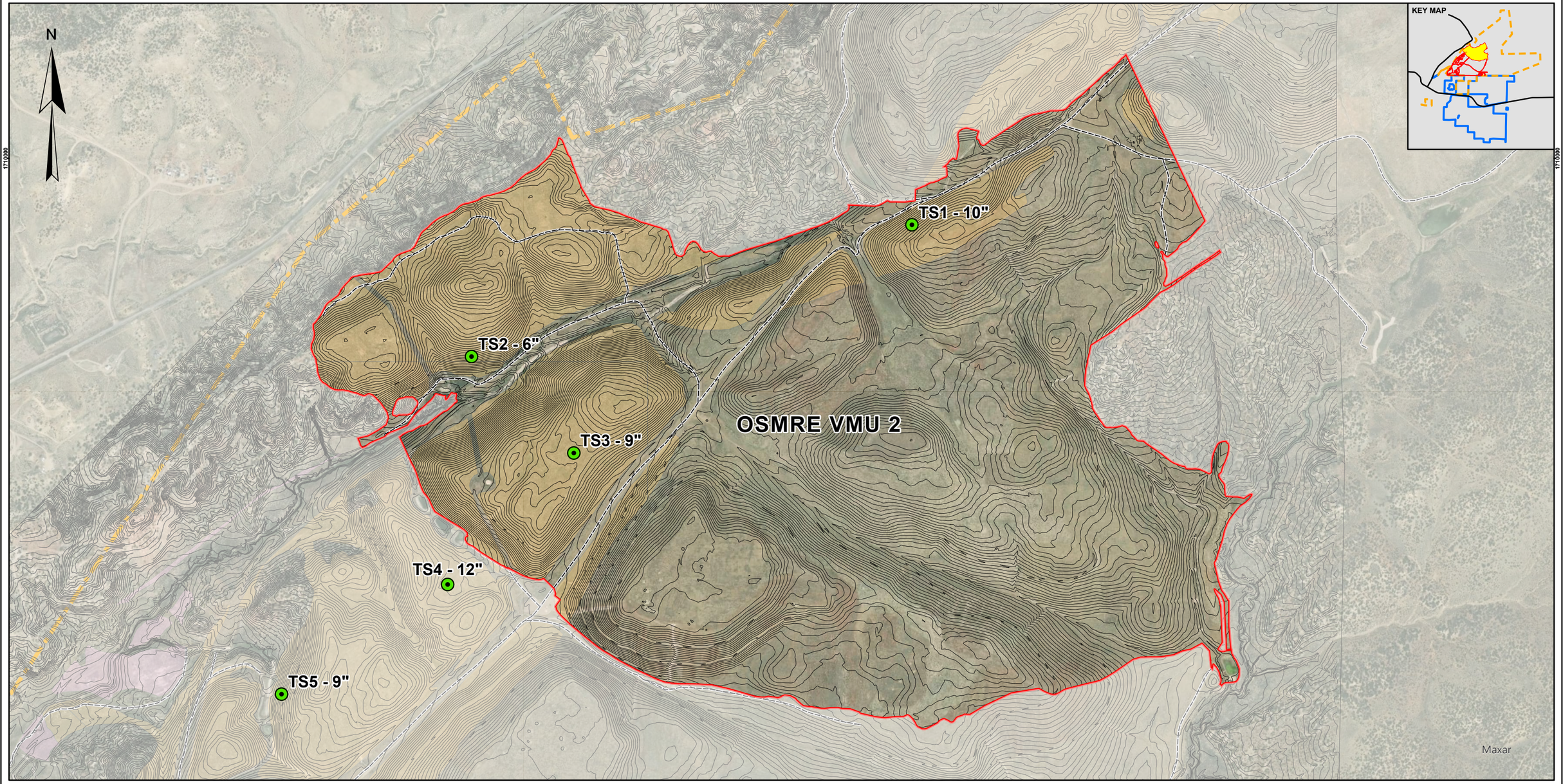


**LEGEND**

- Topsoil Depth Verification Location
- Bond Release and Reclamation Liability Release (TOJ)
- Post-Mining Two-Track Trails
- Contour
- Initial Program Lands
- Prelaw Lands
- OSMRE Permit Boundary
- MMD Permit Boundary

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**NOTE(S)**
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**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
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**McKINLEY MINE**

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PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**IPL TOPSOIL DEPTH - VERIFICATION LOCATION**

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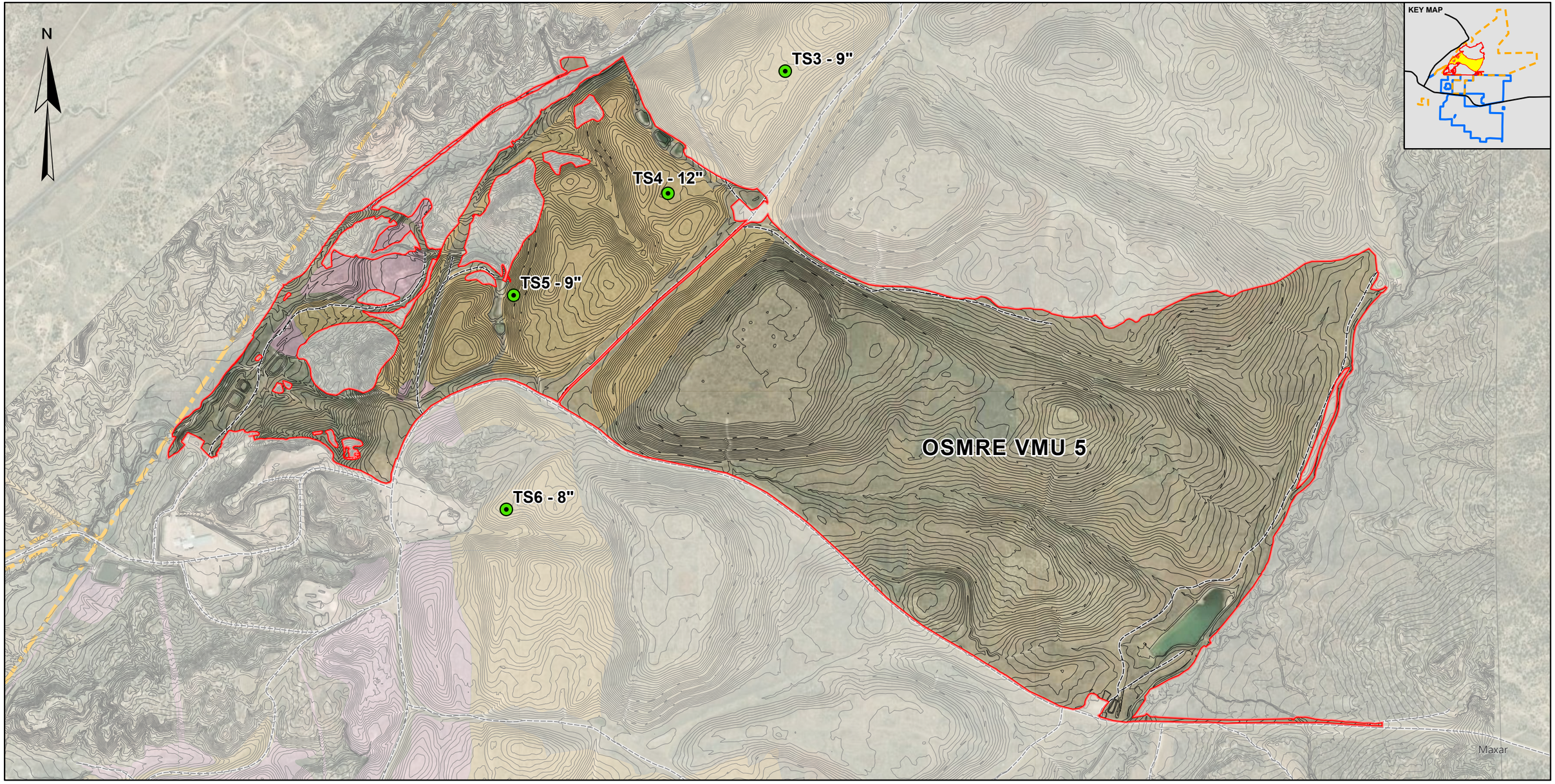


**LEGEND**

- Topsoil Depth Verification Location
- Bond Release and Reclamation Liability Release (TOJ)
- Post-Mining Two-Track Trails
- Contour
- Initial Program Lands
- Prelaw Lands
- OSMRE Permit Boundary
- MMD Permit Boundary

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Feet

**NOTE(S)**
1.

**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

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Chevron Mining Inc.
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| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**IPL TOPSOIL DEPTH - VERIFICATION LOCATION**

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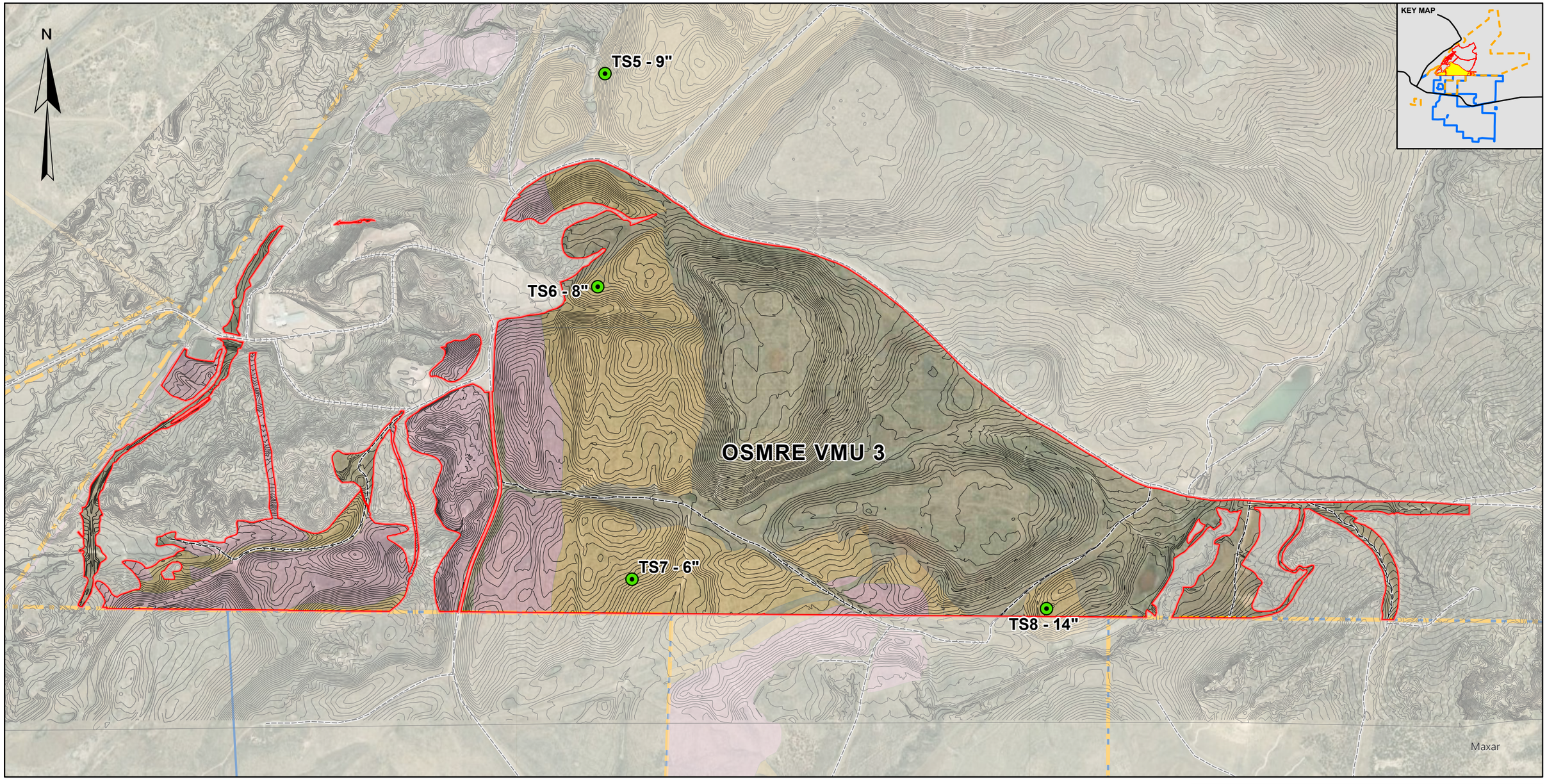


**LEGEND**

- Topsoil Depth Verification Location
- Bond Release and Reclamation Liability Release (TOJ)
- Post-Mining Two-Track Trails
- Contour
- Initial Program Lands
- Prelaw Lands
- OSMRE Permit Boundary
- MMD Permit Boundary

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**NOTE(S)**
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**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

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Chevron Mining Inc.
McKINLEY MINE

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| APPROVED | MS |

PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**IPL TOPSOIL DEPTH - VERIFICATION LOCATION**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
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## Appendix A1: Application Certification

**McKinley Mine**

**Vegetation Management Unit 2, 3 & 5**

**Permanent Program Final Bond Release**

**and**

**Initial Program Reclamation Liability Release and Termination of Jurisdiction Application**

## CERTIFICATION

Chevron Mining Inc. (CMI) certifies that all applicable reclamation activities have been accomplished in this application that are necessary for final bond release of Permanent Program lands and for a reclamation liability release and termination of jurisdiction of Initial Program lands in McKinley Mine Vegetation Management Units 2, 3 and 5 in accordance with the requirements of the Surface Mining Control and Reclamation Act, the regulatory program, and the approved reclamation plans.

There are no outstanding violations, cessation orders, or other Office of Surface Mining, Reclamation and Enforcement (OSMRE) enforcement actions on the lands subject to this release application.

Armando Martinez
Operations Manager
Chevron Environmental Management Company (CEMC)

Date: 10/22/25

State of New Mexico )
) SS
County of Taos )

Subscribed and sworn to before me, in my presence, this 22nd day of October, 2025, a Notary Public in and for the State of New Mexico.

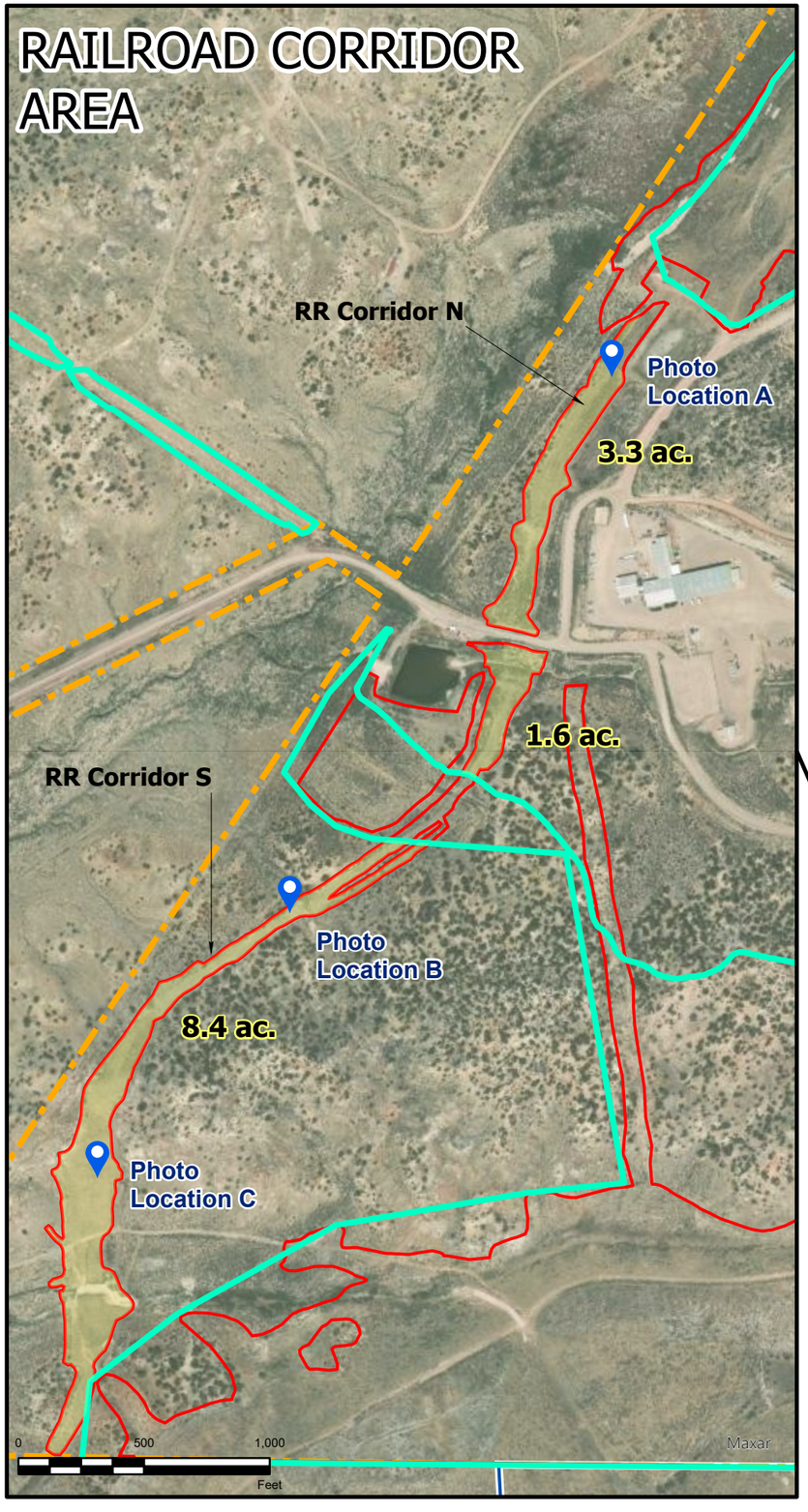
Anna C. Martinez

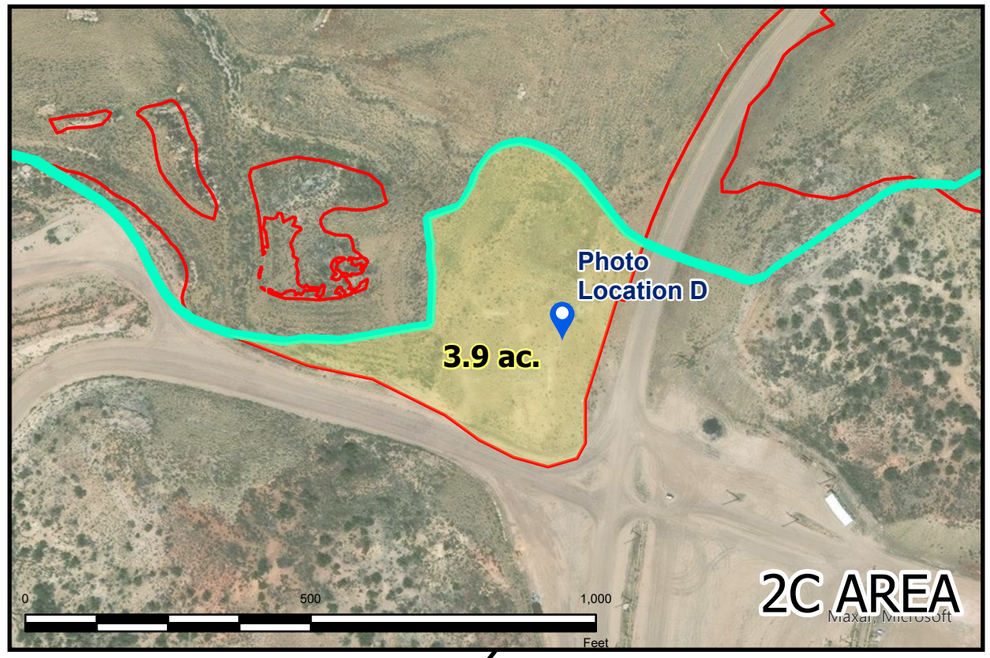
Notary Public

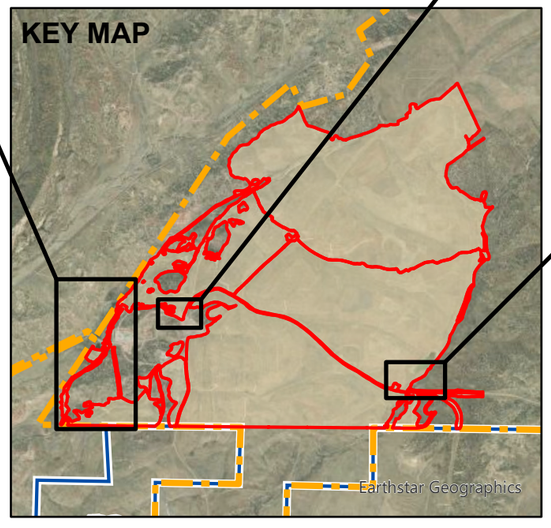
ANNA C. MARTINEZ
Notary Public - State of New Mexico
Commission # 1058122
My Comm. Expires Jul 24, 2026

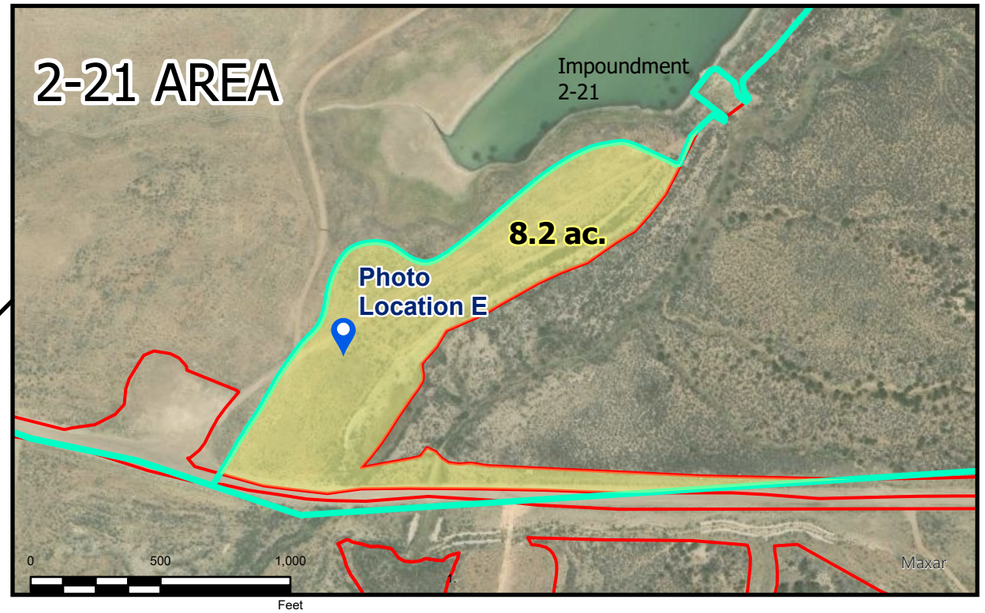
My Commission expires: July 24, 2026

## Appendix A2: Supplemental Bond Release Areas




**LEGEND**

- General Photo Location
- Original VMU Sampling Boundary
- Bond Release and Reclamation Liability Release (TOJ)
- Supplemental Bond Release Areas
- OSMRE Permit Boundary
- MMD Permit Boundary

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**REFERENCE(S)**
1. COORDINATE SYSTEM: NAD 1983 STATEPLANE NEW MEXICO WEST FIPS 3003 FEET

CLIENT
**Chevron Mining Inc.**
**McKINLEY MINE**

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PROJECT
VEGETATION MANAGEMENT UNITS 2, 3, AND 5
BOND RELEASE

TITLE
**SUPPLEMENTAL BOND RELEASE AREAS**
**APPENDIX A2**

| PROJECT NO. | PHASE | REV. | EXHIBIT |
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Railroad.Corridor.South.Photo.C8



8C.Area.Photo.D7



8C.Area.Photo.D8



8_87.Area.Photo.E7



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## Appendix A3: Groundwater and Surface Water Evaluation (Trihydro)

# VEGETATION MANAGEMENT UNITS 2, 3, AND 5
# FINAL BOND RELEASE AND
# LIABILITY RELEASE & TERMINATION OF JURISDICTION APPLICATION
# GROUNDWATER AND SURFACE WATER EVALUATION
# CHEVRON MINING INC. – MCKINLEY MINE, NEAR GALLUP, NEW MEXICO

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**October 24, 2025**

**Project #: CHEVR-025-0034**

**SUBMITTED BY:** Trihydro Corporation

1252 Commerce Drive, Laramie, WY 82070

---

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# 1.0 INTRODUCTION

This report contains a surface water and groundwater assessment in support of the Phase III bond release application for Vegetation Management Units 2, 3, and 5 (VMU 2, VMU 3 and VMU5). VMUs 2, 3, and 5 are located on reclaimed land near the North Facilities Area of the McKinley Mine (Mine) permitted under Office of Surface Mining Reclamation and Enforcement (OSMRE) Permit No. NM-0001K. This report was prepared in accordance with the OSMRE Guideline to Bond Release Procedures for Permanent Program Lands as well as the 30 CFR 800.40 Requirement to Release Performance Bonds. Information regarding the Probable Hydrologic Consequences (PHC) and the Cumulative Hydrologic Impact Assessment (CHIA) is discussed in OSMRE Permit NM-0001K, Section 3.4, and included in Appendix A of this report.

The Mine is located approximately 24 miles northwest of Gallup, New Mexico. The Mine began operations in the early 1960s and ceased operations in 2009. Since that time, the Mine has been in various phases of reclamation including grading to post-mine topography, placement of topsoil, and revegetation. VMUs 2, 3, and 5 surface and groundwater sources have been monitored through a network of surface water monitoring stations and wells. Figure 2-1 shows the location of these monitoring facilities. The map also shows National Pollutant Discharge Elimination System (NPDES) Permit No. NN0029386 outfalls affiliated with the proposed bond-release area and other nearby areas within the larger watershed containing VMUs 2, 3, and 5, since information from the outfalls is discussed in this report.

Trihydro Corporation (Trihydro) began collecting water quality data in October 2012 and managing water quality data in January 2013. This report provides an evaluation of water data from 2013 through 2024 as data during this time period are representative of post-mining conditions and are the most complete dataset available. The data analysis includes comparisons to baseline information, effluent standards, and the PHC.

A summary of the hydrologic setting and protection requirements for the Mine are included in this report in Section 2.0. Section 3.0 reviews the -long-term chemical and physical characteristics of surface water associated with the NPDES outfalls 003, 009, 010, 014, 017, 018, 024, 058, 059, 060, 061, 063, 080, and 091, as well as surface water monitoring sites Tse Bonita Wash (TBW) and Coal Mine Wash Tributary (CMWT) that receive waters from the VMU 2, 3, and 5 area. Section 4.0 provides a review of the long-term chemical and physical characteristics of the five groundwater wells (Well TB3D, Well 2, Well 3A, Well MBR2, and Well 2G2) located nearest to VMUs 2, 3, and 5.

# 2.0 HYDROLOGIC SETTING AND PROTECTION

## 2.1 GEOLOGIC SETTING AND CLIMATE

The Mine is located in the southwest corner of the San Juan Basin in a structural sub-basin known as the Gallup Sag. The San Juan Basin, which is roughly circular in shape, occupies much of northwestern New Mexico, a narrow strip of northeastern Arizona, and a small portion of southwestern Colorado. The basin is bordered on the north by the San Juan Mountains, on the east by the Nacimiento Uplift, on the south by several uplifts including the Lucero Uplift and Zuni Uplift, and on the west by the Defiance Monocline, which separates it from the Black Mesa Basin.

The sedimentary rocks in the San Juan Basin are predominantly of Mesozoic age with some Tertiary rocks outcropping in the central basin and some Paleozoic and Pre-Cambrian rocks upturned along the basin margins. The sediments increase in thickness toward the basin's center. The geology in the vicinity of Gallup and McKinley County is comprised of Middle to Upper Jurassic (175-145 million years old) and Quaternary (less than 1-million years old) rocks. Older rocks, the Triassic River deposits of the Chinle Group, are exposed in the plains to the south and Cretaceous rocks form the high ridges. The rock formations include sandstone, shale, limestone, coal, and mudstone.

The San Juan Basin is characterized by low surface relief. Most of the basin is a relatively featureless plain with wide shallow valleys and some low mesas and cuestas. Elevations in the area range from 5,000 feet above mean sea level (ft amsl) in the north to 7,000 ft amsl in the south. A prominent north-south trending range, the Chuska Mountains, occurs along the western part of the basin with elevations exceeding 9,500 ft amsl. The Mt. Taylor volcanic area, with elevations up to 10,000 ft amsl, occurs within the southeast corner of the basin. The margins of the basin are characterized by hogback ridges, which are associated with the tectonic uplifts defining the basin boundaries.

The majority of the Mine is located in the Puerco River Drainage Basin with a small portion of the Mine located in the San Juan River Drainage. The main drainages or watersheds in the Mine are the headwaters of Defiance Draw (DD) and its tributary, Defiance Draw Tributary (DDT), TBW, Coal Mine Wash (CMW) and its tributary, CMWT, and an unnamed tributary to Black Creek. A small portion of the Mine lease area is in the headwaters of Deer Springs Wash and Black Springs Wash (both in the San Juan River Drainage Basin). Of the drainage basins listed above, DD is the largest drainage basin with an area of 27.5 square miles. TBW is the drainage basin that encompasses the highest percentage within the Mine boundary at 35.0%. The watersheds encompassing VMUs 2, 3, and 5 discharge surface water run-off to TBW and CMWT; the sampling locations for those drainages are shown on Figure 2-1.

As presented in Mine Permit No. NM-0001K, Section 3.4, groundwater resources within the Mine fall into three main types: alluvial, bedrock, and aquifer. Alluvial and bedrock groundwater resources are discontinuous, of poor physical and chemical quality, and of limited extent. The first major deep aquifer is the Gallup Sandstone Aquifer (GSA). The GSA lies well below the zone of mining impact and is overlain by several impermeable shale members. Most recharge to the Gallup Sandstone comes from the Chuska Mountains to the northwest of the Mine. In addition to these three types, groundwater may also be found in spoil material above bedrock. The groundwater monitoring wells nearest VMUs 2, 3, and 5 are alluvial monitoring well TB3D, bed rock monitoring well MBR2, GSA wells 2 and 3A, and spoil monitoring well 2G2. The locations of these wells are shown on Figure 2-1.

The Mine climate is semi-arid with an average annual precipitation of approximately 11 inches (in.) per year. More than half of the annual precipitation typically falls during the months of July through October. Precipitation often occurs as rainfall from intense, localized thunderstorms that occur sporadically in the region. This can result in high suspended solids levels in the runoff. In addition, soil chemistry and geomorphology contribute to the high levels of dissolved solids, salinity, and alkalinity. Within the general area of the Mine, runoff due to precipitation events occurs in the form of surface runoff. Natural drainages or watersheds convey or temporarily store the runoff as it is routed to the Puerco River or San Juan River.

Precipitation data nearest to VMUs 2, 3, and 5 is reported from the precipitation monitoring stations at the Mine, Rain 2, Rain 12, and Bluff, as shown on Figure 2-1. The Rain 2 and Rain 12 precipitation stations operate between mid-April and mid-November and are shut down annually during the winter months. The Bluff precipitation station operates all year round.

Table 2-1 provides the monthly and annual precipitation data from the three precipitation stations for the 2013-2024 period. Average monthly precipitation between April and November at the three precipitation stations ranged from 0.27 in. in April to 1.67 in. in August during the 12-year evaluation period. On average, most of the precipitation is received between July and September. The month with the highest one--month precipitation total was August 2022 with 4.66 in. at Bluff. Precipitation data are referenced throughout the report to help explain some of the observations presented for surface and groundwater stations.

## 2.2 HISTORICAL WATER QUALITY DATA

The Mine began operations in the early 1960s, before the passage of the Surface Mine Control and Reclamation Act and other regulations governing coal mining on Indian lands. At that time, baseline surface and groundwater quality

and quantity data were not required before mining. As a result, comparisons cannot be made with pre-mining watershed conditions of the Mine as a single unit.

The original 1980 Geohydrology Associates Inc. (GAI) baseline groundwater report, incorporated into the Mine permits, provides surface and groundwater quality and quantity data that can be referenced for evaluating trends since that time. There are no baseline groundwater data applicable to the Mine site. Groundwater monitoring is reported annually as required by OSMRE Permit Number NM 0001K. The monitoring requirements were recently changed so all wells are sampled annually through Permit Modification Mod 23-04, which was approved by OSMRE on February 21, 2024. Groundwater resources within the Mine include alluvial, bedrock, Gallup Sandstone Aquifer, and spoil.

Alluvial groundwater is present in some fill and low-lying soils at the Mine. Wells penetrating the alluvial groundwater are designed to monitor the quality and quantity of shallow groundwater in alluvial valley-fill sediments. Valley-fill sediments in the Mine area serve as a reservoir for meteoric water to reside. Because the area is semi-arid and annual precipitation is limited, the presence of alluvial groundwater is generally dependent on rainfall and, to a lesser extent, snowfall quantities.

In 1980, five bedrock wells (MBR1, MBR2, MBR3, MBR4, and MBR5) were installed approximately 50 feet (ft) below the Green Coal Seam to monitor groundwater below this unit. The Green Coal Seam was the lower-most recoverable coal seam at the Mine. These monitoring wells, referred to as McKinley bedrock wells, were located in and around the major drainage watersheds throughout the Mine. Three of the original five wells (MBR1, MBR3, and MBR4) were mined through and not replaced. The active bedrock monitoring wells include MBR2 and MBR5, with MBR2 being in the vicinity of VMUs 2, 3, and 5. Well MBR2 lies at the northeastern edge of VMU 2, as shown on Figure 2-1.

The original 1980 GAI baseline groundwater report concluded that bedrock wells had little potential as a meaningful groundwater resource. The transmissivity of the bedrock deposits was less than 6 square feet per day ($ft^2$/day) and not capable of maintaining a sustained yield of 1 gallon per minute (gpm). Even though groundwater was present, none of the strata had sufficient continuity to be considered an aquifer.

Five water wells (1, 2, 3, 3A, and 4) have been completed in the Gallup Sandstone Aquifer throughout the Mine area. These wells were used as primary water sources for mine activities and reclamation. The wells now provide domestic water, dust-control water, and are also used as monitoring wells. Because of the relatively low permeability of the shale units overlying the Gallup Sandstone Aquifer and the geologic structure in the area, the Gallup Sandstone Aquifer

can be under artesian conditions. Moreover, due to the presence of the overlying shales, there is no hydraulic connection between the underlying Gallup Sandstone and the mined strata. Gallup Sandstone Aquifer Well 2 is located outside of and between VMUs 5 and 3, near the North Facilities Area. Well 3A is located within VMU 2 on the southwestern edge, just outside of VMU 5, as shown on Figure 2-1.

Five spoil recharge wells (2G2, 4A, 9A, 9S, and 11) were constructed in the Mine area. Two spoil wells 4A and 9A on New Mexico Mining and Minerals Division (MMD) regulated lands were installed in 1990; of these two wells, only 9A remains. Well 4A was not monitored after 2015 following approval by MMD to discontinue monitoring this well because the land at the well location had a full reclamation liability release. Well 4A was abandoned on October 29, 2018.

In April 2013, three additional spoil recharge wells were constructed and designated as wells 2G2 (on OSMRE lands), 11 (on MMD lands), and 9S (on MMD lands). Spoil recharge wells were installed throughout the Mine in reclaimed areas to determine chemical presence and groundwater properties. These wells were terminated at bedrock and their screens encompassed the spoil interval immediately above bedrock. Spoil Well 2G2 is the only spoil recharge well in the vicinity of VMUs 2, 3, and 5. Well 2G2 has had insufficient volume to sample since being installed in 2013 and has been dry since the third quarter of 2022.

Surface water has been monitored since the early 1980s through active and passive surface water monitoring stations, although the number and locations of stations have evolved over time. The currently monitored active, mine permit related surface water stations for large watersheds are located in and around the major drainage watersheds throughout the Mine and include the DD, TBW, DDT6, CMW, and CMWT stations. In the annual hydrology report, Station CMW is used to monitor flow and water quality from a relatively undisturbed large watershed drainage; the data from this station are used as background information and to contrast against other station data from large, disturbed watersheds.

## 2.3 APPLICABLE PROTECTION STANDARDS

### 2.3.1 SURFACE WATER COMPARISON

Stormwater runoff from the Mine drains through impoundments and/or hydraulic control structures (e.g., check dams, lined channels, etc.) before discharging into Defiance Draw, a tributary to the Puerco River segment from the Arizona border to the Gallup wastewater treatment plant in McKinley County. Data collected from the disturbed stations in the large watersheds are compared to data collected at the undisturbed CMW station, which are considered background

data. The comparison is used to determine impacts from mining activities. This comparison is provided in the annual hydrology report, which is an appendix to the annual reclamation report that is submitted to OSMRE (Trihydro 2025).

### 2.3.2 NPDES REQUIREMENTS

The Mine operates under NPDES Permit No. NN0029386 which was last renewed on July 1, 2017. A renewal application was submitted to the United States Environmental Protection Agency (USEPA) on December 27, 2021, and the Mine is currently operating under the current permit pending approval of the renewal application. As required under NPDES Permit No. NN0029386, the Mine submitted an updated Sediment Control Plan on September 5, 2017, and is currently awaiting approval from USEPA. Until then, the Mine is operating under the current Sediment Control Plan dated March 15, 2013. All watersheds within the Mine are classified as Western Alkaline, and in accordance with NPDES Permit No. NN0029386, reclamation inspections are conducted quarterly within the drainage basins associated with the Sediment Control Plan and inspection findings are summarized in quarterly reports.

Additionally, discharge sampling is conducted at NPDES outfalls per Table 1 of Permit No. NN0029386. All outfalls are subject to the Effluent Limitation Guidelines as specified in 40 CFR §434.80-81, water quality-based effluent limitations (WQBELs) in 40 CFR §122.44 (applicable to State NPDES programs), and Navajo Nation Water Quality Standards for outfalls located on Navajo Nation lands. There are 12 watersheds and NPDES outfalls located in the vicinity of VMUs 2, 3, and 5. Outfalls associated with VMUs 2, 3, and 5 and their associated watersheds are shown on Figure 2-1. The Mine will continue conducting quarterly reclamation inspections and sampling discharges through final bond release and subsequent removal of the outfalls from the NPDES permit.

### 2.3.3 GROUNDWATER PROTECTION STANDARDS

The Mine permit contains a list of parameters to analyze but there are no groundwater standards included with them since the intent of the permit is to monitor the change in water quality over time and to use that information to identify possible impacts to water quality during and after mining. While the permit has no standards, it may be useful to include in this report how the quality of the groundwater compares to known standards.

The Navajo Nation Environmental Protection Agency (NNEPA) exercises jurisdiction on Navajo Nation lands but does not have general groundwater protection standards. The New Mexico Administrative Code (NMAC), however, contains groundwater standards for the State of New Mexico, which will be reviewed in this report to provide a possible picture around utility of groundwater at the Mine. The table below contains a list of parameters with NMAC groundwater standards that would correlate to various parameters analyzed at the Mine.

| Analyte | Upper Limit (unless otherwise indicated) |
|---|---|
| pH | 6.0-9.0 s.u. |
| Fluoride | 1.6 mg/L |
| Nitrate as N | 10 mg/L |
| Selenium | 0.05 mg/L |
| Chloride | 250 mg/L |
| Dissolved Iron | 1 mg/L |
| Dissolved Manganese | 0.2 mg/L |
| Sulfate | 600 mg/L |
| TDS | 1,000 mg/L |
| Zinc | 10 mg/L |

Criteria listed for chloride, iron, manganese, sulfate, TDS, zinc, and pH represent the maximum concentration for domestic water supply. The NMAC also has an existing total dissolved solids (TDS) concentration of 10,000 milligrams per liter (mg/l) or less (also the case for the NNEPA standards), for present and potential future use as domestic and agricultural water supply (NMAC 20. 6.2.3103).

### 2.3.4 IMPOUNDMENT WATER QUALITY

There are nine permanent impoundments in VMUs 2, 3, and 5. VMU 2 includes two impoundments: 2-3 and 3-5. VMU 3 has no impoundments. VMU 5 includes seven impoundments: 2-8, 2-9, 2-10, 2-11, 2-12, 2-13, and 2-21. These impoundments meet the required livestock watering standards as discussed in the McKinley Mine OSMRE Permit Section 5.7.3.4.3 Permanent Impoundment Water Quality. A water quality demonstration with data showing the Mine permanent impoundments met livestock watering standards is also provided in the McKinley Mine OSMRE Permit Section 5.7.3.4.3.

## 2.4 PROTECTION OF HYDROLOGICAL BALANCE

The Mine permit includes preventative and remedial measures for any potential adverse hydrologic consequences identified in the PHC determination. The Permit includes sections on the PHC determination, groundwater and surface water monitoring plans, general plans to address possible hydrologic consequences, and a CHIA, as provided by the MMD/OSMRE. These items can be found in Section 3.4 of the Mine permit. Related permit sections are summarized below. A copy of the active and approved Permit Section 3.4 is provided as Appendix A.

### 2.4.1 PHC DETERMINATION

The PHC first reviews the possible impacts of the impoundments on other surface waters, which are reviewed here for the purposes of a PHC update. Assumptions for, and analysis of runoff to the impoundments and consumptive losses from the impoundments are provided. The impoundments have no negative impacts on regional water quantity and should enhance local property use for livestock and wildlife. The PHC also acknowledges and evaluates the possible impact from impoundment stormwater discharge on downstream water chemistry. Review of available data indicated identifiable impact as related to pre- and post-mine monitoring stations along Defiance Draw and its tributaries. Lastly, the PHC considers the possible impacts of the groundwater, located in the alluvial, bedrock, and Gallup Sandstone Aquifer. This last item will be further discussed in report Section 4.5.3.

### 2.4.2 CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT (CHIA)

A CHIA was prepared by Radian Corporation for OSMRE and MMD in 1995 for the Mine. The CHIA follows the PHC language in Appendix A. Sections 3.0 and 4.0 of this report summarize possible surface and groundwater impacts/material damages concluded by the CHIA.

### 2.4.3 SURFACE AND GROUNDWATER MONITORING PLANS

Per Section 6.3.2.1 of the OSMRE Mine Permit, surface-water monitoring in large watersheds is conducted at five stations identified as DD, TBW, DDT6, CMW, and CMWT. Groundwater monitoring is conducted on the following sources: alluvial groundwater, bedrock groundwater, Gallup Sandstone Aquifer, and spoil recharge groundwater. McKinley Mine OSMRE Permit required analytes vary by water source, which are provided in Table 2-2.

# 3.0 SURFACE WATER MONITORING

VMUs 2, 3, and 5 are located in the Puerco River Drainage Basin, with possible influence on ephemeral and perennial streams. Surface water quality is monitored at 14 points downstream from VMUs 2, 3, and 5. Of the 14, 13 stormwater discharge locations have been monitored since 2013, including: Outfall 003 (SP 5), Outfall 009 (DC-25), Outfall 010 (DC-1), Outfall 014 (SP-3-5), and Outfall 017 (CB-2-21), Outfall 018 (CH-2-14), Outfall 024 (DC-2), Outfall 058 (DC-10), Outfall 059 (DC-11), Outfall 060 (DC-12), Outfall 061 (DC-13), Outfall 063 (DC-15), Outfall 080 (DC-27), and Outfall 091 (CH-2-11). Additionally, two stream monitoring locations along Coal Mine Wash Tributary and Tse Bonita Wash have been monitored since 2013.

Temporal plots were developed for a graphical representation of surface water monitoring data. The surface water temporal plots are found in Appendices B-1 and B-2. A statistical analysis was performed on the data as the temporal plots were developed. Outliers noted during the statistical analysis are depicted as a red dot on the temporal plots. As these are relatively small datasets (less than 30 observations for each given parameter), outliers are detected using Dixon's Test. The test focuses on the most extreme observation in a given data set and determines if the observation is an outlier by assessing the gap between the extreme values and its nearest neighbor relative to the overall range of the data. Dixon's Test is a standardized test and was used to identify outliers on both the discharge data sets and the stream water quality data sets.

## 3.1 SURFACE WATER DATA

### 3.1.1 DISCHARGE DATA

USEPA conducted a reasonable potential analysis based on comparisons with applicable water quality standards and found no basis for incorporating WQBELs in Permit No. NN0029386. If available data or other information showed that discharges had reasonable potential to contain levels of a pollutant in excess of a standard, this would demonstrate the reasonable potential to cause or contribute to future exceedances and a limit for that pollutant would be incorporated into Permit No. NN0029386. Limits for pH (Table 1, NN0029386) are established based on the Navajo Nation water quality standards and State of New Mexico water quality standards, based on the location of the outfall.

There are 12 stream discharge sampling locations affiliated with watersheds in VMUs 2, 3, and 5; Outfall 003, Outfall 009, Outfall 010, Outfall 014, Outfall 017, Outfall 018, Outfall 024, Outfall 058, Outfall 059, Outfall 060, Outfall 061, Outfall 063, Outfall 080, and Outfall 091 (see Figure 2-1). Historical discharge data have been recorded since July 2018 at Outfall 009, Outfall 018, and Outfall 024, since September 2018 at Outfall 014, since March 2019 at Outfall 010, since August 2021 at Outfall 060, Outfall 080, and Outfall 091, and since July 2022 at Outfall 017. No

discharge data have been recorded from Outfalls 058, 059, 061, and 063 during the reporting period due to insufficient flow. Therefore, Outfalls 058, 059, 061, and 063 are not represented on the discharge data tables or temporal plots. Outfalls 017 and 060 each only have one instance of sampling in August of 2022 and August 2021, respectively. Outfall 080 has sampling data from August, September, and October of 2021. Outfall 091 has sampling data from August 2021, August 2022, and March 2023. Outfall 018, 014, and 009 have sampling data from 2018 to 2024. Outfall 010 has sampling data from 2019 to 2024. Sample data for Outfalls 003, 009, 010, 014, 017, 018, 024, 060, 080, and 091 are presented in Tables 3-1, 3-2, 3-3, 3-4, 3--5, 3-6, 3-7, 3-8, 3-9, and 3-10, respectively. Appendix B-1 presents temporal plots including Outfalls 009, 010, 014, 017, 018, 024, 060, 080, and 091. The temporal plots are based on available 2018 to 2024 data. There were generally fewer data points at the outfalls prior to 2022. A discussion concerning the data for each analyte follows.

- Aluminum concentrations fluctuated over time for Outfalls 010 and 024. Aluminum concentrations in Outfalls 003, 009, 014, 018, and 091 were lower and generally less variable, but consistent with the fluctuations of Outfall 010 and Outfall 024. Outfall 080 had highly variable concentrations across the three sampling events at that location in 2021. The aluminum concentration spiked for Outfall 010 in August 2021, for Outfall 024 in July 2021 and July 2022, and for Outfall 080 in October 2021.
- Conductance is similar across the included outfalls and fluctuates between approximately 50-450 microsiemens per centimeter (µS/cm) with one high outlier at Outfall 014 in October 2022. Outfall 003 has generally higher conductance than the other outfalls ranging from 250-500 µS/cm.
- Cyanide was typically not detected above the laboratory limit of quantification for most sampling events at most outfalls. Outfall 014 had a high outlier in September 2024, and Outfall 080 had one high detectable sample that, given the overall body of data, would likely be an outlier if Outfall 080 had more data. Outfall 003 has been stable below detection limit except for one outlier in June 2024.
- Gross alpha was highly variable across most outfalls, with Outfall 024 having the widest range from 9.49 picocuries per liter (pCi/L) to 809 pCi/L in June 2024, excluding a high outlier in July 2021. Outfall 003 was the least variable of the reported outfalls. There are no significant impacts to Puerco River because of the ephemeral storm response and small loads by extension.
- Related to the concentration of metals and biotoxicity is hardness. Discharge hardness has typically stayed below 500 mg/L CaCO3, and has almost always stayed below 1,000 mg/L CaCO3. Discharge hardness at Outfall 080 reached 1,300 mg/L $CaCO_3$ In October 2021, and Outfall 024 reached 1,000 mg/L CaCO3 in July 2021. Even with elevated concentrations of iron and selenium, hardness will reduce toxicity for aquatic life.
- Iron concentrations fluctuated over time for Outfall 010 and Outfall 024. Iron concentrations in Outfalls 009, 014, 018, and 091 were lower, less variable, and generally consistent with the fluctuations of Outfall 010 and

Outfall 024. Iron concentrations typically stayed well below 200 mg/L with a few exceptions. Outfall 080 had highly variable concentrations across the three sampling events at that location in 2021. The iron concentration spiked for Outfall 010 to 230 mg/L in August 2021, for Outfall 024 to 260 mg/L in July 2021, and for Outfall 080 to 610 mg/L in October 2021. Outfall 024 had another notable spike in iron concentration to 370 mg/L in July 2022.

- Oil & grease were not detected above the laboratory limit of quantification except for one instance at Outfall 009 with 2.4 mg/L in August 2019, once for Outfall 003 with 2.3 mg/l in August 2019, and one outlier each from Outfalls 010 and 018, both detected in July 2022.
- Across all outfalls, field pH fluctuated between 7 and 9 s.u., and lab pH fluctuated between 7.33 and 8.23 s.u.
- Selenium concentrations were generally stable and stayed below 0.015 mg/L. One high outlier was recorded at Outfall 10 in August 2021, and Outfall 080 had one high sample in October 2021 that, given the overall body of data, would likely be an outlier if Outfall 080 had more data. Outfall 024 had two notable spikes; one with a selenium concentration of 0.28 mg/L in July 2021, and one with a selenium concentration of 0.31 mg/L in July 2022. Selenium concentrations increased slightly in 2024 for Outfall 010 and Outfall 024 but have remained comparatively stable for all other outfalls.
- Total dissolved solids generally remained below 1,500 mg/L over the reporting period with some elevated points from 2021 on and four notable spikes. In 2018, the total dissolved solids in Outfall 009 spiked to 2,850 mg/L. In August 2021, Outfall 010 and Outfall 080 spiked. The Outfall 010 spike was classified as an outlier, and the Outfall 080 spike reached 3,150 mg/L. In June 2024, Outfall 010 and Outfall 024 spiked. The Outfall 024 spike was classified as an outlier and the total dissolved solids in Outfall 010 spiked to 2,800 mg/L.
- Total suspended solids stayed below 5,000 mg/L, excepting Outfall 009, Outfall 010, Outfall 024, and Outfall 080. Outfall 009 fluctuated from near 0 mg/L to 9,540 mg/L in August 2019. Outfall 003 is most consistent ranging from 22 mg/L to 223mg/L with one outlier at 1200 mg/l noted in August 2021. Total suspended solids fluctuated over the reporting period at Outfall 010, reaching a maximum of 25,000 mg/L in June 2024. The total suspended solids at Outfall 024 fluctuated over the reporting period, reaching a maximum of 18,000 mg/L in July 2021. In October 2021, Outfall 080 reached 8,700 mg/L total suspended solids.

Permanent impoundments are not suspected to significantly impact surface water quality or regional hydrology. Of the nine impoundments located in VMUs 2, 3, and 5, seven are upstream from Outfall 010, one is upstream from Outfall 014, and one is upstream from Outfall 017. Small depressions do not pose any additional impacts to the PHC assessment in the Permit. These structures provide opportunistic water for livestock and wildlife and add diversity to

Examination of the previously discussed analytical trends suggests that discharge water quality outcomes have remained relatively consistent, sometimes with a great degree of variability in the data ranges. Many analyte concentrations were anomalous in 2021 and 2024 for much of the surface water data available in the vicinity of VMUs 2, 3, and 5. Notable anomalies were also present in 2019 and 2022. As for unstable analytes, the data examined in Section 3.1.2 indicate significant attenuation within the Mine boundary or just downstream in the case of CMWT. Overall, these trends support the presumption that there are no significant impacts from mining and reclamation operations on surface waters.

### 3.1.2 STREAM WATER QUALITY DATA

There are two large watershed stream monitoring stations downstream of VMUs 2, 3, and 5: CMWT along Coal Mine Wash Tributary and TBW along Tse Bonita Wash (Figure 2-1). Stream water quality data are available for both of these locations since July 2013. Water quality for CMWT and TBW may be further compared with the undisturbed watershed Coal Mine Wash (CMW) station as outlined in the McKinley Mine 2024 Annual Report - Hydrology Section (Trihydro 2025), Section 3.3. Required analyte data are presented in Tables 3-10 and 3-11. Appendix B-2 presents temporal plots for stream monitoring data at CMWT and TBW from 2013 to 2024.

- Even though alkalinity is not a reportable analyte specified in the permit, it is a useful parameter when discussing bicarbonate and carbonate, which are the two most important compounds that determine alkalinity. Alkalinity has generally remained steady during the reporting period for CMWT and TBW. The July 2018 concentration is an outlier for alkalinity in CMWT.
- Bicarbonate concentrations shown on the temporal plot mimic alkalinity trends for CMWT and TBW.
- Total calcium concentrations at CMWT have been variable for the reporting period while remaining comparatively stable at TBW from 2013 to 2022. Calcium concentrations have been similar in both streams since 2022. Concentrations for both sample locations were low in 2022, then increased significantly in the second quarter of 2024 before again decreasing in the third quarter of 2024. The high result in the second quarter of 2024 for TBW was identified as an outlier.
- Carbonate concentrations shown on the temporal plot are misleading as this analyte has historically been reported at or near the laboratory detection limit or the limit of quantification and is an insignificant component of total alkalinity at the historical pH levels. The carbonate concentrations were below detection limits during the reporting period except for an outlier value for CMWT detected in July 2018.
- The calculated cation-anion balance at both CMWT and TBW has been variable during the reporting period, and values for both streams have been similar during the reporting period.

- CMWT had a spike in its Chloride concentration in August 2013. A similar spike at TBW was determined to be an outlier. Chloride concentrations have been relatively stable at both streams during the reporting period. The 2024 data collected at CMWT potentially indicates the beginning of an increasing trend.
- Field conductance is similar for both CMWT and TBW and slightly decreased from 2013 to 2019 then has slightly increased from 2019 to 2024.
- Total hardness at CMWT has been variable for the reporting period while increasing slightly at TBW from 2015 to 2024. Concentrations for both sample locations were low in 2022, then increased significantly in the second quarter of 2024 before again decreasing in the third quarter of 2024.
- Dissolved iron concentrations have generally decreased CMWT during the reporting period except for elevated values during July and August of 2019 with one of those values noted as an outlier. Dissolved iron concentrations at TBW typically stayed near 0 mg/L with a flat trend.
- Total iron concentrations at CMWT and TBW have been variable during the reporting period, with concentrations in TBW generally lower than those in CMWT. Concentrations for both sample locations were low in 2022, then increased significantly in the second quarter of 2024 before again decreasing in the third quarter of 2024.
- Total magnesium concentrations at CMWT and TBW have been variable during the reporting period, with concentrations in TBW generally lower than those in CMWT. Concentrations for both sample locations were low in 2022, then increased significantly in the second quarter of 2024 before again decreasing in the third quarter of 2024.
- Dissolved manganese concentrations have shown a relatively stable trend for TBW during the reporting period. Concentrations in CMWT were elevated from 2019 to 2021 but have since decreased to values similar to TBW.
- Total manganese concentrations at CMWT and TBW have been variable during the reporting period, with concentrations in TBW generally lower than those in CMWT. Concentrations for both sample locations were lowest in 2022, then increased significantly in the second quarter of 2024 before again decreasing in the third quarter of 2024. Analytical results indicate that a greater concentration of suspended manganese was present than dissolved manganese for all of the sampling events in TBW and most of the sampling events for CMWT.
- The total mercury concentration spiked at CMWT to 0.0028 mg/L in July 2019. Total mercury concentrations were below the limit of quantification for CMWT and TBW post-2019 with the exception of an increase in concentrations for CMWT in August 2022 and July 2024 and for TBW in July 2024.
- Nitrogen, expressed as nitrate, concentrations have remained relatively stable for CMWT during the reporting period. Concentrations in TBW have been relatively stable since an outlier value in July of 2017 with many samples below the laboratory limit of quantification.

- Field pH values have been variable during the reporting period but have ranged between 7.7 and 8.9 s.u. for both CMWT and TBW, with the exception of two elevated values, 9.5 and 9.6 s.u., for TBW in July 2015.
- Lab pH values have been variable during the reporting period with values at TBW ranging from 7.5 to 8.1 excluding one outlier and those at CMWT ranging from 7.8 to 8.2.
- Phosphate levels have not been detected above the laboratory limit of quantification for both CMWT and TBW since 2021. Prior to 2021, phosphate levels at TBW were stable. Phosphate levels at CMWT were generally higher and more variable than those at TBW prior to 2021.
- Total phosphorous concentrations have shown an increasing trend in CMWT over the reporting period while concentrations have been comparatively stable in TBW. Concentrations for both sample locations were lowest in 2022, then increased significantly in the second quarter of 2024 before again decreasing in the third quarter of 2024. The high result in the second quarter of 2024 for TBW was identified as an outlier.
- Total potassium concentrations have been variable in CMWT over the reporting period while concentrations have been comparatively stable in TBW. Concentrations for both sample locations were lowest in 2022, then increased significantly in the second quarter of 2024 before again decreasing in the third quarter of 2024.
- Total selenium concentrations were generally below the laboratory limit of quantification for both CMWT and TBW prior to 2021. Concentrations for both sample locations were lowest in 2022, then increased significantly in the second quarter of 2024 before again decreasing in the third quarter of 2024.
- The sodium adsorption ratio for both CMWT and TBW has been relatively stable over the reporting period with the exception of an outlier value at TBW in September 2014.
- Total sodium concentrations at CMWT have been variable during the reporting period. Concentrations at TBW have been generally stable and lower than those of CMWT with the exception of elevated values reported in September 2014 and June 2024.
- Sulfate concentrations have been stable at CMWT over the reporting period with an outlier value reported in August 2013. Concentrations at TBW have generally decreased and remained stable after a high point in 2014 and decrease to approximate current levels in 2017. An increased concentration was reported at TBW in June 2024 before returning to levels consistent with prior concentrations.
- Settleable solids concentrations have fluctuated throughout the reporting period at CMWT and concentrations at TBW have been comparatively stable since the second half of 2019. Both streams had high outlier values reported in July 2018.

- Total dissolved solids concentrations at CMWT have been variable over the reporting period, with peaks in 2021 and 2024. Concentrations at TBW have been comparatively stable during the reporting period. The second quarter of 2024 concentration was not detected due to an elevated detection limit as a result of a laboratory error.
- Total suspended solids concentrations at CMWT have been variable over the reporting period. Concentrations at TBW have been comparatively stable during the reporting period with a high outlier value in the second quarter of 2024. The majority of the cations found in surface water exist in the suspended phase relative to the dissolved phase.

Examination of the previously discussed analytical trends suggests that stream water quality has improved or remained consistent since 2013 in both Coal Mine Wash Tributary and Tse Bonita Wash. Lower constituent concentrations over time were expected as vegetation established in the area. Water quality is comparable between the two streams. There are anomalies within decreasing trends for samples taken in 2018 and 2021. Increased values for numerous analytes were reported in the second quarter of 2024 before decreasing in the third quarter of 2024. Along with comparisons to the undisturbed Coal Mine Wash discussed in the McKinley Mine 2024 Annual Report (Trihydro 2025), these trends support the presumption that impacts from mining and reclamation operations on surface water are limited or insignificant. Geochemical parameters such as pH, alkalinity, and hardness also indicate stream water is resistant to such impacts.

The McKinley Mine 2024 Annual Report – Hydrology Section (Trihydro 2025), Section 3.3, compared analyte concentrations between disturbed watersheds, such as CMWT and TBW, with the relatively undisturbed watershed CMW. This report found that, after accounting for year-to-year variability associated with naturally occurring climatic factors, most analytes were similar to or higher in samples from CMW than in samples from the disturbed watersheds. Based on the comparison of water quality in the disturbed watersheds versus the undisturbed watershed, the data indicate that mining and reclamation have not adversely impacted water quality in the disturbed watersheds. For more details and further watershed comparison discussion, please refer to the McKinley Mine 2024 Annual Report (Trihydro 2025).

## 3.2 ASSESSMENT OF SURFACE WATER DATA

### 3.2.1 COMPARISON TO BASELINE WATER QUALITY

There are no actual surface water data from pre-mining conditions available for comparison to current discharge or stream water quality data. Therefore, this comparison is not included in this report.

### 3.2.2 COMPARISON TO REGULATORY STANDARDS

There are 13 NPDES outfalls affiliated with VMUs 2, 3, and5: Outfall 003, Outfall 009, Outfall 010, Outfall 014, Outfall 017, Outfall 018, Outfall 024, Outfall 058, Outfall 059, Outfall 060, Outfall 061, Outfall 063, Outfall 080, and Outfall 091. USEPA conducted a reasonable potential analysis based on comparisons with applicable water quality standards and found no basis for incorporating WQBELs in the site NPDES Permit other than pH. Therefore, there are no regulatory standards to compare the outfall water quality results.

There are three stream monitoring stations downstream of the outfalls. CMWT is downstream of Outfalls 003, 009 and 010, CMW is downstream of Outfalls 058 and 059, and TBW is downstream of Outfalls 014, 017, 018, 024, 060, 061, 063, 080, and 091 (Figure 2-1). There is no discharge data available from Outfalls 058 and 059 to CMW. Discharge water quality analysis from the outfalls showed generally neutral trends, sometimes with a great degree of variability in the data range. Analytical trend analysis of surface water quality of CMWT and TBW indicates attenuation of impacts observed at Outfalls 003, 009, 010, 014, 017, 018, 024, 060, 080, and 091. The overall findings of this report, as well as the trends outlined in the 2024 Hydrology Report (Trihydro 2025), for the surface water monitoring sites, conclude there are limited or no impacts to surface waters after mining and reclamation operations and there are no impacts to the hydrologic balance.

### 3.2.3 COMPARISON TO PROBABLE HYDROLOGIC CONSEQUENCES

The PHC determination (Permit Section 3.4.4) acknowledges the possible consequence of stormwater on downstream water chemistry. Data show that there are no deleterious effects to watershed health of the Puerco River. Regional surface waters are also protected because of ephemeral flow patterns of the streams of interest and limited constituent loadings to downstream reaches as a result. Monitoring at NPDES outfalls and McKinley Mine surface water monitoring stations will cease upon final stages of bond release. NPDES outfalls will be removed from the stormwater permit subsequent to Phase III approval of permanent program lands and Termination of Jurisdiction on initial program lands. Full discussion of the surface water quality from each of the Mine watersheds is included in the 2024 Annual Hydrology Report (Trihydro 2025) Section 3.0.

# 4.0 GROUNDWATER MONITORING

Groundwater at the Mine is monitored at four sources: alluvial, bedrock, Gallup Sandstone Aquifer, and spoil. A summary of data for the four groundwater sources is provided below followed by a comparison of results to baseline water quality, regulatory standards, and the PHC, as applicable. Depth to water data for the groundwater sources are presented in Table 4-1. Tabulated water quality data for the groundwater sources are presented in Tables 4-2 and 4-3. Historical groundwater data tables include relevant groundwater protection standards for reference.

Temporal plots were developed for a graphical representation of the long-term groundwater monitoring data. The groundwater temporal plots are found in Appendices C-1 and C-2. A statistical analysis was performed on the data as the temporal plots were developed. Any outliers noted during the statistical analysis are depicted as a red dot on the temporal plots. As these are relatively small datasets (less than 30 observations for each given parameter), outliers are detected using Dixon's Test. The test focuses on the most extreme observation in a given data set and determines if the observation is an outlier by assessing the gap between the extreme values and its nearest neighbor relative to the overall range of the data. Dixon's Test is a standardized test and was used to identify outliers on both the GSA well data set and the bedrock well data set.

## 4.1 ALLUVIAL GROUNDWATER

Alluvial wells are located in and around major drainage watersheds throughout the Mine. Since water levels in these wells are dependent on direct precipitation, the depth to groundwater and the saturated thickness in wells vary to some degree based on rain and snowfall.

In 2016, OSMRE and MMD approved a permit modification to monitor only seven alluvial wells. Four of these wells have historically been considered recharging (DT2A, DT2B, TB2B2, and TB3D) whereas the remainder of the wells (CMC, D2C, and D3B2) have historically been dry. The alluvial wells being dry is consistent with the PHC. Only Well TB3D is in the vicinity of VMUs 2, 3, and 5. As shown on Table 4-1, water column thickness in Well TB3D has been less than 1 ft since 2015. Due to insufficient water depth, Well TB3D has not been sampled and therefore has no available sampling data for the 2013 to 2024 reporting period.

## 4.2 GALLUP SANDSTONE AQUIFER

Five water wells (1, 2, 3, 3A, and 4) have been completed in the Gallup Sandstone Aquifer throughout the Mine area. These wells were used as primary water sources for mine activities and reclamation. The wells now provide domestic water, dust-control water, or are only monitored. Because of the relatively low permeability of the shale units

overlying the Gallup Sandstone Aquifer and the geologic structure in the area, the Gallup Sandstone Aquifer can be under artesian conditions. Moreover, due to the presence of the overlying shales, there is no hydraulic connection between the underlying Gallup Sandstone and the mined strata. The nearest GSA wells to VMUs 2, 3, and 5, Well 2 and Well 3A, are located between VMUs 5 and 3 near the North Facilities Area and in the southwest portion of VMU 2 respectively (Figure 2-1).

### 4.2.1 WATER LEVELS

Water level and saturated thickness are presented in Table 4-1 for Well 2 and Well 3A. Depth to ground water in Well 2 has been generally increasing since depth measurement began in 2014 with corresponding decreases in saturated thickness. Depth to groundwater in Well 3A has been variable over a 25-foot range since measurement began in 2015 with corresponding increases and decreases in saturated thickness.

### 4.2.2 WATER QUALITY

Sampling of Well 2 has been conducted quarterly for multiple parameters since 2013. Significant chemical parameters are included in the Groundwater Quality Summary 2013-2024 (Table 4-2). Sampling of Well 3A has been conducted quarterly for multiple parameters since 2015. Significant chemical parameters are included in the Groundwater Quality Summary 2015-2024 (Table 4-3). Appendix C-1 presents temporal plots for Well 2 and Well 3A based on available 2013 to 2024 data.

Examination of the analytical data and temporal plots for the reporting period associated with Well 2 and Well 3A indicates the following.

- Alkalinity concentrations at Well 2 were variable with high and low outliers until early 2020. Since then, the Well 2 alkalinity concentrations have been relatively stable. Well 3A alkalinity concentrations have been relatively stable and slightly higher than Well 2 over the reporting period, except for a low outlier value reported in November 2024. Nearly all the alkalinity present in Gallup Sandstone groundwater is attributable to bicarbonate, as carbonate is a relatively minor component.
- Bicarbonate concentrations are identical to alkalinity trends for the reporting period.
- Dissolved calcium concentrations at Well 2 were variable with high and low outliers until early 2020 when the values stabilized. Dissolved calcium concentrations have been relatively stable at Well 3A over the reporting period except for a low outlier value reported in November 2024. The Well 2 concentrations have stabilized just over 40 mg/L, and the Well 3A concentrations have stabilized around 75 mg/L.

- Carbonate concentrations have consistently been reported below the laboratory limit of quantification over the reporting period for both Well 2 and Well 3A.
- Chloride concentrations in Well 2 were variable with high and low outliers until early 2020 when the values stabilized following a slightly decreasing trend with an uptick for the final value of 2024. Chloride concentrations in Well 3A have remained relatively stable with a flat to slightly decreasing trend during the reporting period, with high and low outliers reported throughout the reporting period. The Well 2 concentrations have stabilized roughly around 10 mg/L, and the Well 3A concentrations have stabilized under 5 mg/L.
- Flouride concentrations in Well 2 were somewhat variable with high and low outliers over the reporting period. Well 2 has had a generally neutral trend with concentrations typically just over 0.5 mg/L. Fluoride concentrations in Well 3A were mostly below laboratory limits of quantification for the reporting period.
- Total hardness concentrations, expressed as CaCO3, have been generally stable in both Well 2 and Well 3A. Well 2 has had a neutral trend around 150 mg/L CaCO3, and Well 3A has had a slightly decreasing trend with values around 250 mg/L CaCO3. Both wells have had some high and low outliers over the reporting period.
- Total iron concentrations were relatively stable at Well 2 and Well 3A during the reporting period with normal concentrations below 2 mg/L. High outliers were occasionally reported at both wells. Both reported values at Well 3A in 2024 were high outliers.
- Dissolved magnesium concentrations in Well 2 were variable with high and low outliers until early 2020 when the values stabilized following a slightly increasing trend with values up to 10 mg/L. Dissolved magnesium concentrations for Well 3A have been stable with a neutral trend, remaining close to 12 mg/L during the reporting period.
- Total manganese concentrations at Well 2 were variable but typically lower than concentrations in Well 3A with some high outliers; values have generally been below 0.05 mg/L over the reporting period. Total manganese concentrations have been relatively stable for Well 3A with values around 0.10 mg/L over the reporting period with both high and low outliers.
- Lab pH values remained relatively stable over the reporting period with normal values falling between 7.3 to 7.8 at Well 2, and 7.7 to 8.1 at Well 3A, excluding outliers.
- Phosphate was detected above the laboratory limit of quantification only once at Well 2 or Well 3A during the reporting period. This was determined to be an outlier.
- Potassium concentrations have slightly decreased in Well 2 and Well 3A over the reporting period, with the potassium concentrations in Well 2 higher than those in Well 3A.

- Dissolved sodium concentrations in Well 2 were variable with high and low outliers until early 2020 when the values stabilized following a neutral to slightly decreasing trend with values around 100 mg/L. Dissolved sodium concentrations at Well 3A have remained stable throughout the reporting period with values around 40 mg/L.
- Sulfate concentrations in Well 2 were variable with high and low outliers until early 2020 when the values generally stabilized with values around 120 mg/L. Sulfate concentrations remained relatively stable throughout the reporting period for Well 3A, fluctuating around 100 mg/L with both high and low outliers.
- Total dissolved solids concentrations in Well 2 were variable with high and low outliers until early 2020 when the values generally stabilized with values around 425 mg/L. Total dissolved solids concentrations have been relatively stable at Well 3A just under 400 mg/L since 2017 except for a low outlier value reported in November 2024.
- Turbidity values were relatively stable at Well 2 and Well 3A during the reporting period with normal values below 12 mg/L. The highest outliers were reported at Well 3A in August 2021 and November 2024.

Examination of the previously discussed analytical trends suggests that water quality concentration trends have been generally neutral since 2013 at Well 2, with a noticeable decrease in data variability starting in 2020. Water-quality concentrations have remained relatively consistent since 2015 at Well 3A. Anomalous high and low outlier values were reported at Well 3A for many analytes in the second half of 2024. Additional water quality data comparison with other GSA wells located at the McKinley Mine can be found in Section 2.3 of the 2024 Annual Hydrology Report (Trihydro 2025). Overall, these trends support the presumption that impacts from mining and reclamation operations on groundwater in the Gallup Sandstone Aquifer have not occurred.

## 4.3 BEDROCK AQUIFER

In 1980, five bedrock wells (MBR1, MBR2, MBR3, MBR4, and MBR5) were installed approximately 50 feet (ft) below the Green Coal Seam to monitor groundwater below this unit. The Green Coal Seam was the lower-most recoverable coal seam at the Mine. These monitoring wells, referred to as McKinley bedrock wells, were located in and around the major drainage watersheds throughout the Mine. Three of the original five wells (MBR1, MBR3, and MBR4) were mined through and not replaced. The active bedrock monitoring wells include MBR2 and MBR5, with MBR2 being within the northern portion of VMU 2. Upon the ultimate stages of bond release, MBR2 will be plugged and abandoned in accordance with Permit Section 6.3.2.2.1 and NMAC 19.27.4.30.C.1.

### 4.3.1 WATER LEVELS

Water level and saturated thickness data are presented in Table 4-1 for MBR2. Depth to groundwater in MBR2 had been gradually increasing since 2013 with corresponding gradual decreases in saturated thickness. Slight recoveries were noted in 2022 and 2024, however, 2022 and 2024 depths to water were still higher than pre-2020 levels.

### 4.3.2 WATER QUALITY

Sampling of MBR2 has been conducted annually for multiple parameters. Significant chemical parameters are included in Table 4-4. Appendix C-2 presents temporal plots for MBR2 based on available 2013 to 2024 data.

Examination of the analytical data and temporal plots for the reporting period associated with MBR2 indicate the following.

- Alkalinity is a useful parameter when discussing bicarbonate and carbonate trends below. Alkalinity concentrations have been relatively stable at MBR2 and fluctuate around 550 mg/L $CaCO_3$. Nearly all the alkalinity present in bedrock groundwater is attributable to bicarbonate as carbonate, and is a relatively minor component
- Bicarbonate concentrations are identical to alkalinity trends for the reporting period.
- Total boron levels have fluctuated from 0.15 to 0.20 mg/L at MBR2, with the exception of an outlier of 0.27 mg/L reported in October 2024. Overall, boron levels show a slight increasing trend during the reporting period.
- Total calcium concentrations at MBR2 were generally stable over the reporting period, staying below 7.1 mg/L. A high outlier concentration of 120 mg/L was reported in October 2024.
- Carbonate concentrations have consistently been reported below the laboratory limit of quantification over the reporting period.
- The calculated cation-anion balance percentages at MBR2 have been consistently less than 6%, other than an outlier value in October 2014.
- Chloride concentrations at MBR2 have fluctuated since 2013 but indicate a generally neutral trend around 7.0 mg/L.
- Field conductance at MBR2 has been relatively stable around 2,250 µS/cm over the reporting period with the exception of a low outlier reported in October 2020.
- Fluoride concentrations at MBR2 have fluctuated since 2013 but indicate a generally neutral trend. Fluoride has consistently been around 5 mg/L after 2019, above the water quality standard of 1.6 mg/L.

- Total hardness at MBR2 has been generally stable over the reporting period, fluctuating between 20 to 45 mg/L with a slightly decreasing trend prior to a high outlier concentration of 370 mg/L in October 2024.
- Dissolved iron has not been detected above the laboratory limit of quantification for the majority of samples.
- Total iron concentrations have fluctuated over the reporting period but have decreased since 2021. Most of the iron exists in the suspended phase since dissolved iron has often been non-detect.
- Total magnesium concentrations at MBR2 have been generally stable over the reporting period, fluctuating between 1.5 and 3.9 mg/L. A high outlier concentration of 18 mg/L was reported in October 2024.
- Dissolved manganese concentrations at MBR2 have fluctuated since 2013 but indicate a generally neutral trend with the exception of a high outlier concentration reported in October 2021. Dissolved manganese has not been detected above the water quality standard of 0.2 mg/L during the reporting period.
- Total manganese concentrations at MBR2 have fluctuated over the reporting period but show a slightly decreasing trend. A high outlier concentration was reported in October 2021 corresponding to the increased dissolved manganese reported during the same period.
- Nitrogen, expressed as nitrate, concentrations have been below the laboratory limit of quantification except during September 2016 and October 2020. The laboratory limit of quantification has varied as a result of matrix interference.
- Field pH values at MBR2 have varied over the reporting period ranging from 7.3 to 8.0.
- Lab pH values at MBR2 have varied over the reporting period ranging from 7.5 to 8.1.
- Phosphate has consistently been reported below the laboratory limit of quantification during the reporting period. The variability shown on the temporal plot is a result of varying limits of quantification through the reporting period.
- Total phosphorous concentrations at MBR2 that were above the laboratory limit of quantification have exhibited a slight increasing trend over the reporting period.
- Total potassium concentrations at MBR2 were generally stable over the reporting period, fluctuating between 2.3 and 5.8 mg/L. A high outlier concentration of 25 mg/L was reported in October 2024.
- Total selenium concentrations were generally below the laboratory limit of quantification during the reporting period. The exceptions were detections reported in October 2014 and October 2024. The limit of quantification varies due to sample matrix interference.

- Total sodium concentrations have been relatively stable at MBR2 over the reporting period with the exception of a low outlier reported in October 2024.
- Sulfate concentrations at MBR2 have fluctuated since 2013, ranging from 540 mg/L to 600 mg/L, but indicate a generally neutral trend.
- Total dissolved solids concentrations at MBR2 have fluctuated since 2013 but indicate a generally neutral trend over the reporting period. Total dissolved solids concentrations routinely exceed the water quality standard of 1,000 mg/L.
- Total zinc concentrations at MBR2 that were above the laboratory limit of quantification have exhibited a slightly increasing trend over the reporting period, with the highest values reported in November 2015 and October 2024.

Examination of the previously discussed analytical trends suggests that water-quality concentrations have remained relatively consistent since 2013 at Well MBR2. Anomalous high and low outlier values were reported for several analytes in the second half of 2024. Overall, these trends support the presumption that impacts from mining and reclamation operations on groundwater have not occurred.

## 4.4 SPOIL GROUNDWATER

Five spoil recharge wells (2G2, 4A, 9A, 9S, and 11) were constructed in the Mine area. Two spoil wells (4A and 9A on MMD lands) were installed in 1990; of these two wells, only 9A remains. Well 4A was not monitored after 2015 following approval by MMD to discontinue monitoring this well because the land at the well location had a full bond and liability release. Well 4A was abandoned on October 29, 2018. In April 2013, three additional spoil recharge wells were constructed and designated as wells 2G2 (on OSMRE lands within VMU 5), 11 (on MMD lands), and 9S (on MMD lands). Spoil recharge wells were installed throughout the Mine in reclaimed areas to determine chemical presence and groundwater properties. These wells were terminated at bedrock and their screens encompassed the spoil interval immediately above bedrock. As shown on Table 4-1, water column thickness in Well 2G2 has been less than 1 ft since 2017. Due to insufficient water depth, Well 2G2 has not been sampled during the 2013 to 2024 reporting period.

## 4.5 ASSESSMENT OF GROUNDWATER DATA

### 4.5.1 COMPARISON TO BASELINE WATER QUALITY

There are no baseline groundwater data from pre-mining conditions available for comparison to current groundwater quality data. Therefore, this comparison is not included in this report.

### 4.5.2 COMPARISON TO REGULATORY STANDARDS

Though not required or necessary, water quality from the bedrock aquifer and Gallup Sandstone Aquifer were assessed against the regulatory standards established for the maximum allowable concentrations of groundwater of 10,000 mg/L TDS or less (NMAC 20.6.2.3103). Tables 4-2, 4-3, and 4-4 include these standards at the bottom, allowing for easy comparison to groundwater quality data, with bolded values indicating exceedances. Only the following monitored constituents are captured by the referenced standards: fluoride, nitrate as N, and selenium for human health standards and chloride, dissolved iron, dissolved manganese, sulfate, TDS, zinc, and pH for domestic water supply. As previously mentioned, Well 2 and Well 3A had fewer required analytes as Gallup Sandstone Aquifer wells. Well 2 and Well 3A had no observed exceedances (Tables 4-2 and 4-3). Fluoride and TDS were observed in exceedance of 1,000 mg/L for every sampling event at MBR2 (Table 4-4). MBR2 also has reported exceedances for dissolved iron (Q4 2013). Please see the McKinley Annual Hydrology Report (Trihydro 2025) for comparison between other GSA and MBR wells.

### 4.5.3 COMPARISON TO PROBABLE HYDROLOGIC CONSEQUENCES

Data establish that bedrock groundwaters are of poor quality that cannot be used for beneficial purposes. Data also show, however, that they have had no deleterious effect on established surface or groundwater uses. Upon the final stages of bond release, wells will be abandoned or transitioned to the Navajo Nation.

# 5.0 SURFACE AND GROUNDWATER ASSESSMENT SUMMARY

As required for bond release of long-term surface and groundwater monitoring, water quality and quantity data are provided in this report. Evaluation of the data was presented in two separate sections to confirm that mining activities at the McKinley Mine have not adversely disturbed the hydrologic balance in or around the site. Findings from the 1980 GAI Report, comparison with the undisturbed Coal Mine Wash watershed, comparison with regulatory standards, and the PHC determination indicate that mining and reclamation have had minimal impact on the quality and quantity of this resource. The following provides a brief summary of those findings.

## 5.1 SURFACE WATER ASSESSMENT SUMMARY

There are 12 NPDES outfalls affiliated with VMUs 2, 3, and 5: Outfall 003, Outfall 009, Outfall 010, Outfall 014, Outfall 017, Outfall 018, Outfall 024, Outfall 058, Outfall 059, Outfall 060, Outfall 061, Outfall 063, Outfall 080, and Outfall 091. There are three stream monitoring stations downstream of the outfalls. CMWT is downstream of Outfalls 009 and 010, CMW is downstream of Outfalls 058 and 059, and TBW is downstream of Outfalls 014, 017, 018, 024, 060, 061, 063, 080, and 091 (Figure 2-1). Discharge data was not available from Outfalls 058 and 059 for CMW. Discharge water quality analysis from the outfalls showed generally neutral trends, sometimes with a great degree of variability in the data range. Analytical trend analysis of surface water quality of CMWT and TBW indicates attenuation of impacts observed at the associated outfalls. The overall findings conclude there are limited or no impacts to surface waters after mining and reclamation operations and there are no impacts to the hydrologic balance.

The PHC determination (Permit Section 3.4.4) acknowledges the possible consequence of stormwater on downstream water chemistry. Data show that there are no deleterious effects to watershed health of the Puerco River. Regional surface waters are also protected because of ephemeral flow patterns of the streams of interest and limited constituent loadings to downstream reaches as a result.

## 5.2 GROUNDWATER ASSESSMENT

Near VMUs 2, 3, and 5, there is one alluvial well, Well TB3D, one bedrock well, Well MBR2, two Gallup Sandstone Aquifer wells, Well 2 and Well 3A, and one spoil well, Well 2G2. No water quality data was collected over the reporting period at either Well TB3D or Well 2G2. Analyte concentrations for wells 2, 3A, and MBR2 had generally neutral trends over the 2013 to 2024 reporting period. Comparison of groundwater quality data to NMAC standards indicates exceedances of various analytes had the standards been applicable. Well 2 and Well 3A had no observed exceedances over the reporting period. Meanwhile, MBR2 had one exceedance for dissolved iron over the period of

record, as well as excess concentrations of fluoride and TDS. Anomalous high and low outlier values were reported for many analytes in the second half of 2024 for both Well 3A and MBR2. Based on this water quality analysis, there are no impacts from mining on groundwater, which is consistent with the PHC.

# 6.0 REFERENCES


Geohydrology Associates, Inc. (GAI). 1980. Hydrology Study of the McKinley Mine.

McKinley Mine Permit No. NM-0001K. 2016.

30 CFR 800. Bond and Insurance Requirements for Surface Coal Mining and Reclamation Operations under Regulatory Programs. 1983 (as amended in 2017).

National Pollutant Discharge Elimination System (NPDES) Permit No. NN0029386. 2017. July 1.

New Mexico Administrative Code (NMAC). 2022. Title 20, Environmental Protection Chapter 6, Water Quality Part 4: Standards for Interstate and Intrastate Surface Waters. April 23.

New Mexico Administrative Code (NMAC). 2017. Title 19, Natural Resources and Wildlife Chapter 27, Underground Water Part 4: Well Driller Licensing; Construction, Repair, and Plugging of Wells. June 30.

New Mexico Administrative Code (NMAC). 2007. Title 20, Environmental Protection Chapter 6, Water Quality Part 2: Ground and Surface Water Protection. June 1.

Trihydro Corporation (Trihydro). 2025. McKinley Mine – 2024 Annual Report Hydrology Section. February 26.

# TABLES

**TABLE 2-1. PRECIPITATION DATA, RAIN 2, RAIN 12, AND BLUFF**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Month | 2013 | | | 2014 | | | 2015 | | | 2016 | | | 2017 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rain 2 (in) | Rain 12 (in) | Bluff (in) | Rain 2 (in) | Rain 12 (in) | Bluff (in) | Rain 2 (in) | Rain 12 (in) | Bluff (in) | Rain 2 (in) | Rain 12 (in) | Bluff (in) | Rain 2 (in) | Rain 12 (in) | Bluff (in) |
| January | -- | -- | 1.08 | -- | -- | 0.05 | -- | -- | 1.39 | -- | -- | 0.39 | -- | -- | 0.81 |
| February | -- | -- | 0.11 | -- | -- | 0.03 | -- | -- | 1.21 | -- | -- | 0.25 | -- | -- | 0.04 |
| March | 0.00 | 0.00 | 0.27 | -- | -- | 0.65 | -- | -- | 0.11 | -- | -- | 0.03 | -- | -- | 0.70 |
| April | 0.26 | 0.39 | 0.25 | 0.06 | 0.08 | 0.28 | 0.52 | 0.49 | 0.35 | 1.26 | 1.17 | 1.28 | 0.17 | 0.30 | 0.32 |
| May | 0.01 | 0.00 | 0.02 | 0.11 | 0.24 | 0.20 | 1.51 | 1.59 | 1.54 | 0.68 | 0.91 | 0.70 | 0.58 | 0.78 | 0.41 |
| June | 0.23 | 0.22 | 0.25 | 0.00 | 0.00 | 0.00 | 1.98 | 1.39 | 1.65 | 0.22 | 0.05 | 0.19 | 0.14 | 0.36 | 0.16 |
| July | 2.22 | 2.52 | 1.95 | 1.70 | 1.16 | 1.90 | 3.15 | 2.88 | 2.81 | 0.78 | 0.88 | 1.15 | 2.22 | 1.34 | 3.71 |
| August | 2.12 | 2.86 | 2.14 | 0.56 | 1.11 | 0.46 | 1.41 | 2.14 | 1.91 | 2.08 | 1.89 | 1.85 | 0.71 | 0.49 | 0.37 |
| September | 3.05 | 2.25 | 2.87 | 2.15 | 2.40 | 2.64 | 0.50 | 0.47 | 0.51 | 1.46 | 1.77 | 1.79 | 0.87 | 1.16 | 0.62 |
| October | 0.70 | 0.68 | 0.45 | 0.18 | 0.31 | 0.19 | 1.08 | 1.17 | 1.18 | 0.63 | 0.47 | 0.69 | 0.21 | 0.18 | 0.54 |
| November | 0.32 | 0.63 | 1.36 | 0.02 | 0.06 | 0.10 | 0.92 | 1.29 | 1.16 | 0.44 | 0.46 | 1.18 | 0.02 | 0.05 | 0.05 |
| December | -- | -- | 0.26 | -- | -- | 1.43 | -- | -- | 0.74 | -- | -- | 1.98 | -- | -- | 0.02 |

**Total Annual Precipitation**

| Year | 2013 | | | 2014 | | | 2015 | | | 2016 | | | 2017 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Apr-Nov (inches) | 8.91 | 9.55 | 9.56 | 4.78 | 5.36 | 5.77 | 11.07 | 11.42 | 11.11 | 7.55 | 7.60 | 8.83 | 4.92 | 4.66 | 6.18 |
| Jan-Dec (inches) | | | 11.01 | | | 7.93 | | | 14.56 | | | 11.48 | | | 7.75 |

Notes:
--_ precipitation station not operating due to freezing tem
--- - precipitation station data not collected
in - inches

Apr - April
Nov - November
Jan - January
Dec - December

**TABLE 2-1. PRECIPITATION DATA, RAIN 2, RAIN 12, AND BLUFF**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Month | 2018 | | | 2019 | | | 2020 | | | 2021 | | | 2022 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rain 2 (in) | Rain 12 (in) | Bluff (in) | Rain 2 (in) | Rain 12 (in) | Bluff (in) | Rain 2 (in) | Rain 12 (in) | Bluff (in) | Rain 2 (in) | Rain 12 (in) | Bluff (in) | Rain 2 (in) | Rain 12 (in) | Bluff (in) |
| January | -- | -- | 0.23 | -- | -- | 0.95 | -- | -- | 1.00 | -- | -- | 1.13 | -- | -- | --- |
| February | -- | -- | 0.48 | -- | -- | 0.98 | -- | -- | 1.35 | -- | -- | 0.21 | -- | -- | --- |
| March | -- | -- | 0.44 | -- | -- | 1.10 | -- | -- | 1.15 | -- | -- | 0.46 | -- | -- | 0.59 |
| April | 0.06 | 0.06 | 0.08 | 0.22 | 0.20 | 0.24 | 0.26 | 0.25 | 0.26 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.03 |
| May | 0.26 | 0.37 | 0.22 | 1.41 | 1.59 | 0.17 | 0.09 | 0.08 | 0.02 | 0.03 | 0.08 | 0.04 | 0.00 | 0.00 | 0.00 |
| June | 0.30 | 0.26 | 0.28 | 0.15 | 0.28 | 0.03 | 0.05 | 0.06 | 0.14 | 0.16 | 0.22 | 0.20 | 1.03 | 0.91 | 1.24 |
| July | 1.10 | 1.08 | 2.17 | 0.35 | 0.35 | 0.03 | 1.65 | 0.97 | 0.89 | 0.99 | 1.58 | 2.17 | 3.00 | 3.76 | 3.13 |
| August | 0.90 | 1.36 | 0.00 | 0.73 | 0.14 | 1.14 | 0.20 | 0.47 | 0.26 | 1.09 | 2.08 | 1.31 | 3.77 | 4.07 | 4.66 |
| September | 1.40 | 1.09 | 1.00 | 1.35 | 1.38 | 0.10 | 0.17 | 0.35 | 0.21 | 1.03 | 1.24 | 1.13 | 1.22 | 1.08 | 1.27 |
| October | 1.48 | 1.54 | --- | 0.04 | 0.07 | 0.04 | 0.31 | 0.29 | 0.33 | 0.94 | 1.01 | 0.86 | 1.14 | 1.57 | 1.40 |
| November | 0.00 | 0.00 | 0.14 | 0.05 | 0.04 | 1.15 | 0.16 | 0.28 | 0.28 | 0.00 | 0.00 | 0.20 | 0.39 | 0.52 | 0.48 |
| December | -- | -- | 0.43 | -- | -- | 0.97 | -- | -- | 0.32 | -- | -- | 0.92 | -- | -- | 0.58 |

**Total Annual Precipitation**

| Year | 2018 | | | 2019 | | | 2020 | | | 2021 | | | 2022 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Apr-Nov (inches) | 5.50 | 5.76 | 3.89 | 4.30 | 4.05 | 2.90 | 2.89 | 2.75 | 2.39 | 4.24 | 6.21 | 5.95 | 10.55 | 11.91 | 12.21 |
| Jan-Dec (inches) | | | 5.47 | | | 6.90 | | | 6.21 | | | 8.67 | | | 13.38 |

Notes:
--_ precipitation station not operating due to freezing tem
--- - precipitation station data not collected
in - inches

Apr - April
Nov - November
Jan - January
Dec - December

**TABLE 2-1. PRECIPITATION DATA, RAIN 2, RAIN 12, AND BLUFF**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Month | 2023 | | | 2024 | | |
|---|---|---|---|---|---|---|
| | Rain 2 (in) | Rain 12 (in) | Bluff (in) | Rain 2 (in) | Rain 12 (in) | Bluff (in) |
| January | -- | -- | 1.21 | -- | -- | 1.06 |
| February | -- | -- | 0.50 | -- | -- | 0.58 |
| March | -- | -- | 1.64 | -- | -- | 2.22 |
| April | 0.00 | 0.00 | 0.05 | 0.21 | 0.15 | 0.45 |
| May | 0.48 | 0.74 | 0.55 | 0.01 | 0.1 | 0.03 |
| June | 0.09 | 0.21 | 0.13 | 2.36 | 2.58 | 2.27 |
| July | 0.08 | 0.10 | 0.03 | 0.65 | 0.54 | 1.17 |
| August | 3.08 | 2.47 | 3.16 | 2.31 | 2.58 | 2.33 |
| September | 0.44 | 0.41 | 0.33 | 0.60 | 0.87 | 0.32 |
| October | 0.09 | 0.05 | 0.57 | 1.32 | 1.24 | 1.18 |
| November | 0.00 | 0.00 | 0.95 | 0.13 | 0.20 | 0.36 |
| December | -- | -- | 0.46 | -- | -- | 0.00 |

| Average (2013-2024) | Maximum (2013-2024) |
|---|---|
| (in) | (in) |
| 0.85 | 1.39 |
| 0.52 | 1.35 |
| 0.67 | 2.22 |
| 0.27 | 1.28 |
| 0.43 | 1.59 |
| 0.55 | 2.58 |
| 1.56 | 3.76 |
| 1.67 | 4.66 |
| 1.15 | 3.05 |
| 0.69 | 1.57 |
| 0.37 | 1.36 |
| 0.68 | 1.98 |

**Total Annual Precipitation**

| Year | 2023 | | | 2024 | | |
|---|---|---|---|---|---|---|
| Apr-Nov (inches) | 4.26 | 3.98 | 5.77 | 7.59 | 8.26 | 8.11 |
| Jan-Dec (inches) | | | 9.58 | | | 11.97 |

| Apr-Nov Average (2013-2024) | Rain 2 Average (in) |
|---|---|
| 6.69 | 6.38 |
| **Rain 12 Average (in)** | **Bluff Average (in)** |
| 6.79 | 6.89 |

Notes:
--_ precipitation station not operating due to freezing tem
--- - precipitation station data not collected
in - inches

Apr - April
Nov - November
Jan - January
Dec - December

**TABLE 2-2. McKINLEY MINE WATER ANALYSIS PARAMETERS**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Parameter | Sample Type | | |
|---|---|---|---|
| | Surface | Alluvial | Bedrock/Spoil |
| Bicarbonate | * | * | * |
| Boron | | | * |
| Calcium, Total | * | * | * |
| Carbonate | * | * | * |
| Cation-Anion Balance | * | * | * |
| Chloride | * | * | * |
| Conductance, Field | * | * | * |
| Fluoride | | | * |
| Hardness | * | * | * |
| Iron, Dissolved | *@ | *@ | *@ |
| Iron, Total | * | * | * |
| Magnesium, Total | * | * | * |
| Manganese, Dissolved | *@ | *@ | *@ |
| Mercury, Total | * | | |
| Manganese, Total | * | * | * |
| Nitrate | * | * | * |
| pH, Lab | * | * | * |
| pH, Field | * | * | * |
| Phosphate | * | * | * |
| Phosphorus, Total | * | * | * |
| Potassium, Total | * | * | * |
| SAR | * | | |
| Selenium, Total | * | * | * |
| Settleable Solids | * | | |
| Sodium, Total | * | * | * |
| Sulfate | * | * | * |
| Total Dissolved Solids | * | * | * |
| Total Suspended Solids | * | | |
| Zinc, Total | | | * |
| Depth to water | | * | * |

Notes: * indicates that sample is analyzed for this parameter.
@ indicates a 0.45 micron filter is utilized.

**TABLE 3-1. HISTORICAL DISCHARGE DATA - OUTFALL 003**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Location | Date Sampled | Aluminum, Total (mg/L) | Calcium, Total (mg/L) | Conductance (µS/cm) | Cyanide, Total (mg/L) | Gross Alpha (pCi/L) | Hardness [3] (mg/L CaCO ) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Oil & Grease (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) | Selenium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outfall 003/SP 5 | 7/14/2018 | 4.63 | NM | 507 | ND(0.01) | 9.91 | 108 | 4.38 | NM | ND(5) | 8.6 | 7.7 | 0.0012 | 335 | 223 |
| Outfall 003/SP 5 | 7/18/2018 | 1.26 | NM | 491 | ND(0.01) | 5.19 | 114 | 1.63 | NM | ND(5) | 7.8 | 7.6 | 0.001 | 319 | 22 |
| Outfall 003/SP 5 | 3/3/2019 | 2.49 | NM | 584 | ND(0.01) | 9.23 | 166 | 2.55 | NM | ND(5) | 8.3 | 8.1 | 0.0015 | 361 | 71 |
| Outfall 003/SP 5 | 8/6/2019 | 5.36 | NM | 547 | ND(0.01) | 15.2 | 153 | 5.54 | NM | 2.3 | 8.4 | 8.1 | 0.0012 | 403 | 224 |
| Outfall 003/SP 5 | 8/2/2021 | 29 | 48 | 403 | ND(0.005) | 47.1 | 180 | 31 | 15 | ND(9.89) | 8.3 | 7.92 | ND(0.01) | 1,100 | 1,200 |
| Outfall 003/SP 5 | 7/30/2022 | 22 | 30 | 322 | ND(0.005) | 15.4 | 110 | 9.1 | 7.4 | ND(9.9) | 8.4 | 7.87 | ND(0.005) | 695 | 94 |
| Outfall 003/SP 5 | 8/11/2022 | 13 | 25 | 319 | ND(0.005) | 7.46 | 87 | 5 | 5.7 | ND(9.65) | 7.9 | 7.85 | 0.0021 | 455 | 41 |
| Outfall 003/SP 5 | 8/16/2022 | 18 | 28 | 290 | ND(0.005) | 11.2 | 97 | 9.1 | 6.5 | ND(9.6) | 7.6 | 7.88 | 0.0016 | 670 | 230 |
| Outfall 003/SP 5 | 9/22/2022 | 11 | 31 | 318 | ND(0.005) | ND(22.9) | 120 | 14 | 9.7 | ND(9.78) | 7.8 | 7.85 | 0.0036 | 360 | 170 |
| Outfall 003/SP 5 | 10/17/2022 | 6.8 | 31 | 232 | ND(0.005) | ND(76.2) | 110 | 7.7 | 8.5 | ND(9.59) | 8.5 | 7.88 | 0.0072 | 328 | 78 |
| Outfall 003/SP 5 | 3/22/2023 | 7.2 | 45 | 580 | ND(0.005) | 9.07 | 160 | 6.8 | 12 | ND(9.96) | 8.4 | 8.07 | 0.0031 | 600 | 200 |
| Outfall 003/SP 5 | 8/24/2023 | 2.2 | 40 | 496 | ND(0.005) | 10.7 | 140 | 2.3 | 11 | ND(9.88) | 8 | 8.12 | 0.002 | 3,840 | 60 |
| Outfall 003/SP 5 | 6/28/2024 | 4.6 | 34 | 464 | 0.19 | 15.7 | 120 | 5.2 | 9.4 | ND(5.4) | 8.5 | 8 | 0.0025 | 500 | 80 |
| Outfall 003/SP 5 | 7/25/2024 | 5.3 | 44 | 501 | ND(0.005) | 8.93 | 160 | 6.7 | 11 | ND(5.1) | 8.1 | 7.7 | ND(0.005) | 460 | 190 |
| Outfall 003/SP 5 | 8/7/2024 | ND(2) | 41 | 449 | ND(0.005) | 3.81 | 140 | ND(5) | 9.9 | ND(5.2) | 7.9 | 7.9 | 0.001 | 340 | 45 |
| Outfall 003/SP 5 | 8/14/2024 | 3.7 | 38 | 375 | ND(0.005) | 7.41 | 130 | 4.1 | 8.5 | ND(5.3) | 7 | 7.8 | 0.0016 | 350 | 72 |
| Outfall 003/SP 5 | 8/26/2024 | 4.6 | 34 | 356 | ND(0.005) | 10.2 | 120 | 4.7 | 8.4 | ND(10) | 8.2 | 7.7 | 0.0015 | 410 | 72 |
| Outfall 003/SP 5 | 10/20/2024 | 3.8 | 30 | 355 | ND(0.005) | 6.23 | 110 | 3.7 | 7.9 | ND(5) | 8.9 | 8.2 | 0.0015 | 370 | 61 |
| Standard | | - | - | | 0.0052 | 15 | - | - | - | - | 6 - 9 | 6 - 9 | 0.005 | 1,000 | - |

Abbreviations:
mg/L - milligrams per liter
mg/L CaCO - milligrams per liter as calcium carbonate
µS/cm - microSiemens per centimeter
ND - non-detect (detection limit in parentheses)
NM - not measured
pCi/L - picocuries per liter, measure of radioactivity
s.u. - standard units

**TABLE 3-2. HISTORICAL DISCHARGE DATA - OUTFALL 009**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Location | Date Sampled | Aluminum, Total (mg/L) | Calcium, Total (mg/L) | Conductance (µS/cm) | Cyanide, Total (mg/L) | Gross Alpha (pCi/L) | Hardness [3] (mg/L CaCO ) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Oil & Grease (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) | Selenium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outfall 009/DC 25 | 7/18/2018 | 63.3 | NM | 247 | ND(0.01) | 186 | 325 | 55.1 | NM | ND(5) | 8.6 | 7.9 | 0.00094 | 2,850 | 5,530 |
| Outfall 009/DC 25 | 3/3/2019 | 9.33 | NM | 193 | ND(0.01) | 14.6 | 54.6 | 9.56 | NM | ND(5) | 8.4 | 8 | ND(0.002) | 183 | 297 |
| Outfall 009/DC 25 | 8/6/2019 | 164 | NM | 285 | ND(0.01) | 384 | ND(2000) | 150 | NM | 2.4 | 8.3 | 8 | 0.004 | 360 | 9,540 |
| Outfall 009/DC 25 | 2/23/2020 | 18.4 | NM | 325 | ND(0.01) | 11.8 | 47.7 | 16.3 | NM | ND(5) | 8.2 | 8 | 0.0016 | 569 | 296 |
| Outfall 009/DC 25 | 7/22/2021 | 81 | 47 | 215 | ND(0.005) | 359 | 220 | 83 | 24 | ND(10.7) | 8.06 | 7.8 | 0.012 | 1,110 | 5,400 |
| Outfall 009/DC 25 | 2/21/2023 | 9.2 | 47 | 131.6 | ND(0.01) | 99.2 | 160 | 14 | 11 | ND(9.69) | 8.38 | 7.84 | 0.0032 | 590 | 3,800 |
| Outfall 009/DC 25 | 7/25/2024 | 68 | 150 | 101.02 | ND(0.005) | 48.8 | 520 | 70 | 36 | ND(10) | 8.52 | 7.9 | 0.0094 | 1,100 | 9,500 |
| Standard | | - | - | | 0.0052 | 15 | - | - | - | - | 6 - 9 | 6 - 9 | 0.005 | 1,000 | - |

Abbreviations:
mg/L - milligrams per liter
mg/L CaCO - milligrams per liter as calcium carbonate
µS/cm - microSiemens per centimeter
ND - non-detect (detection limit in parentheses)
NM - not measured
pCi/L - picocuries per liter, measure of radioactivity
s.u. - standard units

**TABLE 3-3. HISTORICAL DISCHARGE DATA - OUTFALL 010**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Location | Date Sampled | Aluminum, Total (mg/L) | Calcium, Total (mg/L) | Conductance (µS/cm) | Cyanide, Total (mg/L) | Gross Alpha (pCi/L) | Hardness[3] (mg/L CaCO ) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Oil & Grease (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) | Selenium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outfall 010/DC 1 | 3/2/2019 | 6.35 | NM | 331 | ND(0.01) | 12.7 | 83.6 | 4.92 | NM | ND(5) | 8.9 | 7.9 | 0.00073 | 264 | 158 |
| Outfall 010/DC 1 | 8/2/2021 | 210 | 190 | 230 | ND(0.005) | 266 | 790 | 230 | 77 | ND(9.84) | 8.6 | 8 | 0.045 | 3,800 | 12,000 |
| Outfall 010/DC 1 | 7/30/2022 | 87 | 39 | 273 | ND(0.005) | 30.9 | 150 | 35 | 12 | 31.3 | 8.4 | 7.97 | 0.0071 | 785 | 240 |
| Outfall 010/DC 1 | 8/16/2022 | 19 | 36 | 317 | ND(0.005) | 11.5 | 130 | 8.3 | 8.5 | ND(9.73) | 7.81 | 8.2 | 0.0016 | 290 | 19 |
| Outfall 010/DC 1 | 9/22/2022 | 17 | 39 | 304 | ND(0.005) | ND(86) | 140 | 17 | 11 | ND(9.61) | 8.07 | 7.98 | 0.0024 | 535 | 270 |
| Outfall 010/DC 1 | 10/17/2022 | 5.5 | 38 | 332 | ND(0.005) | ND(75.6) | 130 | 5.7 | 9.3 | ND(10) | 8.5 | 8.1 | ND(0.005) | 274 | 38 |
| Outfall 010/DC 1 | 2/21/2023 | 3.2 | 22 | 227 | ND(0.01) | ND(84) | 79 | 1.7 | 5.7 | ND(9.83) | 9 | 7.59 | ND(0.001) | 345 | 100 |
| Outfall 010/DC 1 | 3/22/2023 | 15 | 29 | 451 | ND(0.005) | ND(95.2) | 110 | 10 | 9.3 | ND(9.95) | 8.55 | 8.06 | 0.0048 | 705 | 180 |
| Outfall 010/DC 1 | 8/15/2023 | 36 | 44 | 291 | ND(0.005) | 61 | 170 | 35 | 14 | ND(9.78) | 8.25 | 7.74 | 0.0022 | 1,180 | 1,000 |
| Outfall 010/DC 1 | 8/24/2023 | 99 | 73 | 153.6 | ND(0.005) | 249 | 320 | 100 | 35 | NM | 7.89 | 7.83 | 0.0066 | ND(500) | 6,600 |
| Outfall 010/DC 1 | 10/18/2023 | 20 | 54 | 436 | ND(0.005) | 38.9 | 200 | 20 | 15 | ND(9.76) | 8.59 | 7.69 | 0.0017 | 460 | 970 |
| Outfall 010/DC 1 | 6/27/2024 | 160 | 220 | 372 | ND(0.005) | 243 | 850 | 170 | 74 | ND(5.5) | 8.35 | 8.1 | 0.023 | 2,800 | 25,000 |
| Outfall 010/DC 1 | 7/25/2024 | 92 | 88 | 246 | 0.0055 | 31 | 370 | 110 | 36 | ND(10) | 7.23 | 7.7 | 0.012 | 970 | 4,500 |
| Outfall 010/DC 1 | 8/7/2024 | 41 | 110 | 243 | 0.0077 | 67.8 | 400 | 48 | 29 | ND(4.9) | 8.29 | 7.8 | 0.0073 | 750 | 12,000 |
| Outfall 010/DC 1 | 8/14/2024 | 120 | 86 | 174.1 | ND(0.005) | 128 | 360 | 92 | 35 | ND(5.1) | 8.29 | 7.9 | 0.015 | 1,100 | 4,500 |
| Outfall 010/DC 1 | 8/26/2024 | 33 | 48 | 291 | ND(0.005) | 52.8 | 190 | 34 | 16 | ND(5.1) | 8.52 | 7.9 | 0.0048 | 790 | 790 |
| Outfall 010/DC 1 | 10/20/2024 | 8.3 | 29 | 283 | ND(0.005) | 8.23 | 100 | 6.9 | 7.7 | ND(5.2) | 8.4 | 8 | 0.0017 | 490 | 160 |
| Standard | | - | - | | 0.0052 | 15 | - | - | - | - | 6 - 9 | 6 - 9 | 0.005 | 1,000 | - |

Abbreviations:
mg/L - milligrams per liter
mg/L CaCO  - milligrams per liter as calcium carbonate
µS/cm - microSiemens per centimeter
ND - non-detect (detection limit in parentheses)
NM - not measured
pCi/L - picocuries per liter, measure of radioactivity
s.u. - standard units

**TABLE 3-4. HISTORICAL DISCHARGE DATA - OUTFALL 014**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Location | Date Sampled | Aluminum, Total (mg/L) | Calcium, Total (mg/L) | Conductance (µS/cm) | Cyanide, Total (mg/L) | Gross Alpha (pCi/L) | Hardness [3] (mg/L CaCO ) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Oil & Grease (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) | Selenium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outfall 014/SP 3-5 | 9/2/2018 | 66 | NM | 156 | ND(0.01) | 82.5 | 220 | 67.3 | NM | ND(5) | 8.7 | 7.9 | 0.001 | 504 | 2,230 |
| Outfall 014/SP 3-5 | 3/4/2019 | 5.34 | NM | 281 | ND(0.01) | 5.56 | 99.8 | 5.56 | NM | ND(5) | 8.7 | 8.1 | 0.00071 | 182 | 146 |
| Outfall 014/SP 3-5 | 7/27/2022 | 170 | 41 | 131 | 0.0055 | 52.6 | 170 | 79 | 15 | ND(10.1) | 8.6 | 8.01 | 0.0069 | 570 | 1,500 |
| Outfall 014/SP 3-5 | 8/16/2022 | 69 | 32 | 151 | ND(0.005) | 41 | 120 | 47 | 9.8 | ND(10.9) | 8.3 | 7.9 | 0.0029 | 370 | 130 |
| Outfall 014/SP 3-5 | 10/4/2022 | 18 | 29 | 152 | ND(0.005) | 13.7 | 100 | 17 | 7 | ND(9.49) | 7.88 | 7.8 | 0.0017 | 394 | 110 |
| Outfall 014/SP 3-5 | 10/12/2022 | 16 | 32 | 1677 | ND(0.005) | 18.9 | 110 | 18 | 6.8 | ND(10.5) | 8.1 | 7.8 | 0.0023 | 474 | 52 |
| Outfall 014/SP 3-5 | 3/13/2023 | 0.71 | 31 | 267 | ND(0.005) | 29.3 | 99 | 0.7 | 5.5 | ND(9.66) | 8.72 | 7.96 | 0.0011 | 148 | 14 |
| Outfall 014/SP 3-5 | 3/23/2023 | 2.1 | 29 | 262 | ND(0.005) | 244 | 95 | 1.7 | 5.4 | ND(9.64) | 8.6 | 8.2 | ND(0.001) | 136 | 47 |
| Outfall 014/SP 3-5 | 8/15/2023 | 54 | 44 | 143.8 | ND(0.005) | 126 | 180 | 61 | 16 | ND(10.8) | 8.25 | 8.15 | 0.003 | 820 | 3,400 |
| Outfall 014/SP 3-5 | 8/24/2023 | 13 | 33 | 220 | ND(0.005) | 5.33 | 110 | 16 | 7.5 | ND(10) | 7.72 | 8.2 | 0.0012 | 266 | 210 |
| Outfall 014/SP 3-5 | 8/25/2024 | 21 | 35 | 191.2 | ND(0.005) | 30.3 | 130 | 24 | 10 | ND(5) | 8.38 | 7.7 | 0.0036 | 1,000 | 380 |
| Outfall 014/SP 3-5 | 9/17/2024 | 16 | 34 | 216 | 0.15 | 16.4 | 120 | 21 | 8.3 | ND(9.7) | 8.14 | 7.8 | 0.0025 | 550 | 690 |
| Outfall 014/SP 3-5 | 10/29/2024 | 7.8 | 34 | 178.2 | ND(0.005) | 9.18 | 110 | 8.7 | 6.1 | ND(5) | 8.33 | 8.2 | ND(0.001) | 380 | 68 |
| Standard | | - | - | | 0.0052 | 15 | - | - | - | - | 6 - 9 | 6 - 9 | 0.005 | 1,000 | - |

Abbreviations:
mg/L - milligrams per liter
mg/L CaCO  - milligrams per liter as calcium carbonate
µS/cm - microSiemens per centimeter
ND - non-detect (detection limit in parentheses)
NM - not measured
pCi/L - picocuries per liter, measure of radioactivity
s.u. - standard units

**TABLE 3-5. HISTORICAL DISCHARGE DATA - OUTFALL 017**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Location | Date Sampled | Aluminum, Total (mg/L) | Calcium, Total (mg/L) | Conductance (µS/cm) | Cyanide, Total (mg/L) | Gross Alpha (pCi/L) | Hardness [3] (mg/L $CaCO_3$) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Oil & Grease (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) | Selenium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outfall 017/CB 2-21 | 8/19/2022 | 67 | 26 | 188 | ND(0.005) | 31.7 | 92 | 29 | 6.7 | ND(9.57) | 7.75 | 7.89 | 0.0022 | 0.0022 | 100 |
| Standard | | - | - | | 0.0052 | 15 | - | - | - | - | 6 - 9 | 6 - 9 | 0.005 | 1,000 | - |

Abbreviations:
mg/L - milligrams per liter
mg/L $CaCO_3$ - milligrams per liter as calcium carbonate
µS/cm - microSiemens per centimeter
ND - non-detect (detection limit in parentheses)
NM - not measured
pCi/L - picocuries per liter, measure of radioactivity
s.u. - standard units

**TABLE 3-6. HISTORICAL DISCHARGE DATA - OUTFALL 018**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Location | Date Sampled | Aluminum, Total (mg/L) | Calcium, Total (mg/L) | Conductance (µS/cm) | Cyanide, Total (mg/L) | Gross Alpha (pCi/L) | Hardness [3] (mg/L CaCO ) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Oil & Grease (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) | Selenium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outfall 018/CH 2-14 | 7/18/2018 | 26.4 | NM | 159 | ND(0.01) | 51.8 | 130 | 25.4 | NM | ND(5) | 8.5 | 7.9 | ND(0.002) | 384 | 536 |
| Outfall 018/CH 2-14 | 8/11/2021 | 17 | 50 | 299 | ND(0.005) | 9.84 | 170 | 20 | 12 | NM ł | 8.77 | 7.88 | 0.0028 | 530 | 350 |
| Outfall 018/CH 2-14 | 7/27/2022 | 99 | 35 | 231 | ND(0.005) | 16.6 | 130 | 44 | 11 | 46.9 | 8.4 | 7.8 | 0.0029 | 686 | 260 |
| Outfall 018/CH 2-14 | 8/16/2022 | 86 | 36 | 218 | ND(0.005) | 41.6 | 140 | 54 | 12 | ND(9.9) | 74.3 | 7.98 | 0.0038 | 1,240 | 150 |
| Outfall 018/CH 2-14 | 2/21/2023 | 1.8 | 21 | 213 | ND(0.01) | 36.5 | 69 | 1.4 | 4.3 | ND(10.3) | 8.92 | 7.9 | ND(0.001) | 188 | 31 |
| Outfall 018/CH 2-14 | 8/24/2023 | 14 | 36 | 265 | ND(0.005) | 5.86 | 120 | 8.5 | 6.5 | ND(9.62) | 7.5 | 7.94 | ND(0.001) | 174 | 85 |
| Outfall 018/CH 2-14 | 8/14/2024 | 11 | 41 | 316 | ND(0.005) | 11.1 | 140 | 10 | 8.5 | ND(5) | 8.26 | 7.9 | 0.0016 | 350 | 66 |
| Standard | | - | - | | 0.0052 | 15 | - | - | - | - | 6 - 9 | 6 - 9 | 0.005 | 1,000 | - |

ł = The 8/11/2021 oil & grease sample bottle for this outfall arrived at the lab broken.

Abbreviations:
mg/L - milligrams per liter
mg/L CaCO - milligrams per liter as calcium carbonate
µS/cm - microSiemens per centimeter
ND - non-detect (detection limit in parentheses)
NM - not measured
pCi/L - picocuries per liter, measure of radioactivity
s.u. - standard units

**TABLE 3-7. HISTORICAL DISCHARGE DATA - OUTFALL 024**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Location | Date Sampled | Aluminum, Total (mg/L) | Calcium, Total (mg/L) | Conductance (µS/cm) | Cyanide, Total (mg/L) | Gross Alpha (pCi/L) | Hardness[3] (mg/L CaCO ) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Oil & Grease (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) | Selenium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outfall 024/DC 2 | 7/12/2018 | 91.3 | NM | 267 | ND(0.01) | 335 | 579 | 76 | NM | ND(5) | 8.6 | 7.8 | 0.0011 | 351 | 5,860 |
| Outfall 024/DC 2 | 7/18/2018 | 99.6 | NM | 167 | ND(0.01) | 204 | 432 | 101 | NM | ND(5) | 8.6 | 7.9 | 0.001 | 664 | 4,320 |
| Outfall 024/DC 2 | 3/2/2019 | 5.41 | NM | 205 | ND(0.01) | 9.49 | 57.2 | 4.19 | NM | ND(5) | 8.6 | 7.8 | ND(0.002) | 131 | 136 |
| Outfall 024/DC 2 | 7/12/2021 | 230 | 260 | 191.1 | ND(0.005) | 1810 | 1000 | 260 | 85 | ND(9.97) | 8.64 | 7.33 | 0.028 | 520 | 18,000 |
| Outfall 024/DC 2 | 7/24/2021 | 86 | 62 | 244 | ND(0.005) | 117 | 260 | 98 | 26 | ND(9.36) | 8.3 | 7.67 | 0.0073 | 900 | 1,300 |
| Outfall 024/DC 2 | 7/25/2022 | 330 | 220 | 150 | NM | NM | 930 | 370 | 93 | NM | 8.5 | 8.12 | 0.031 | 490 | 12,000 |
| Outfall 024/DC 2 | 7/30/2022 | 130 | 31 | 202 | ND(0.005) | 25.7 | 130 | 52 | 12 | ND(9.29) | 8.4 | 8.02 | 0.0051 | 885 | 460 |
| Outfall 024/DC 2 | 10/17/2022 | 16 | 31 | 210 | ND(0.005) | 17.9 | 110 | 14 | 8.4 | ND(9.59) | 8.29 | 7.93 | 0.0066 | 444 | 130 |
| Outfall 024/DC 2 | 2/20/2023 | 3.7 | 42 | 197.7 | ND(0.005) | 68.2 | 140 | 2.9 | 7.7 | ND(9.61) | 8.35 | 8.05 | 0.002 | 500 | 1,400 |
| Outfall 024/DC 2 | 6/27/2024 | 50 | 200 | 179.5 | 0.008 | 809 | 620 | 160 | 29 | ND(5.2) | 8.75 | 8.1 | 0.0069 | 35,000 | 15,000 |
| Outfall 024/DC 2 | 7/25/2024 | 140 | 170 | 136.6 | 0.0055 | 63.8 | 660 | 160 | 58 | ND(10) | 7.96 | 8 | 0.019 | 1,500 | 7,300 |
| Outfall 024/DC 2 | 8/24/2024 | 37 | 46 | 285 | ND(0.005) | 48.7 | 180 | 45 | 17 | ND(5) | 8.87 | 7.9 | 0.0043 | 490 | 310 |
| Standard | | - | - | | 0.0052 | 15 | - | - | - | - | 6 - 9 | 6 - 9 | 0.005 | 1,000 | - |

Abbreviations:
mg/L - milligrams per liter
mg/L CaCO - milligrams per liter as calcium carbonate
µS/cm - microSiemens per centimeter
ND - non-detect (detection limit in parentheses)
NM - not measured
pCi/L - picocuries per liter, measure of radioactivity
s.u. - standard units

**TABLE 3-8. HISTORICAL DISCHARGE DATA - OUTFALL 060**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Location | Date Sampled | Aluminum, Total (mg/L) | Calcium, Total (mg/L) | Conductance (µS/cm) | Cyanide, Total (mg/L) | Gross Alpha (pCi/L) | Hardness [3] (mg/L CaCO ) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Oil & Grease (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) | Selenium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outfall 060/DC 12 | 8/2/2021 | 78 | 61 | 50.9 | 0.00854 | 54.1 | 240 | 88 | 20 | ND(9.68) | 8.61 | 8.11 | 0.013 | 690 | 3,000 |
| Standard | | - | - | | 0.0052 | 15 | - | - | - | - | 6 - 9 | 6 - 9 | 0.005 | 1,000 | - |

Abbreviations:
mg/L - milligrams per liter
mg/L CaCO - milligrams per liter as calcium carbonate
µS/cm - microSiemens per centimeter
ND - non-detect (detection limit in parentheses)
NM - not measured
pCi/L - picocuries per liter, measure of radioactivity
s.u. - standard units

**TABLE 3-9. HISTORICAL DISCHARGE DATA - OUTFALL 080**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Location | Date Sampled | Aluminum, Total (mg/L) | Calcium, Total (mg/L) | Conductance (µS/cm) | Cyanide, Total (mg/L) | Gross Alpha (pCi/L) | Hardness [3] (mg/L CaCO ) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Oil & Grease (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) | Selenium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outfall 080/DC 27 | 8/2/2021 | 120 | 110 | 245 | ND(0.005) | 312 | 430 | 160 | 36 | ND(9.53) | 8.31 | 7.99 | ND(0.02) | 3,150 | 4,700 |
| Outfall 080/DC 27 | 9/1/2021 | 56 | 42 | 152.5 | 0.0777 | 83.8 | 170 | 59 | 15 | ND(9.39) | 8.26 | 8.12 | 0.007 | 870 | 720 |
| Outfall 080/DC 27 | 10/1/2021 | 370 | 350 | 107.4 | ND(0.01) | 4.66 | 1300 | 610 | 110 | ND(9.4) | 8.9 | 8.23 | 0.13 | 220 | 8,700 |
| Standard | | - | - | | 0.0052 | 15 | - | - | - | - | 6 - 9 | 6 - 9 | 0.005 | 1,000 | - |

ł = The 8/11/2021 oil & grease sample bottle for this outfall arrived at the lab broken.

Abbreviations:
mg/L - milligrams per liter
mg/L CaCO - milligrams per liter as calcium carbonate
µS/cm - microSiemens per centimeter
ND - non-detect (detection limit in parentheses)
NM - not measured
pCi/L - picocuries per liter, measure of radioactivity
s.u. - standard units

**TABLE 3-10. HISTORICAL DISCHARGE DATA - OUTFALL 091**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Location | Date Sampled | Aluminum, Total (mg/L) | Calcium, Total (mg/L) | Conductance (µS/cm) | Cyanide, Total (mg/L) | Gross Alpha (pCi/L) | Hardness [3] (mg/L CaCO ) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Oil & Grease (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) | Selenium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outfall 091/CH 2-11 | 8/11/2021 | 110 | 81 | 93.1 | ND(0.005) | 186 | 320 | 130 | 28 | ND(10.3) | 8.77 | 8.11 | 0.014 | 1,310 | 3,800 |
| Outfall 091/CH 2-11 | 8/16/2022 | 32 | 34 | 253 | ND(0.005) | 11.8 | 120 | 20 | 7.7 | ND(9.58) | 7.49 | 7.71 | ND(0.001) | 880 | 58 |
| Outfall 091/CH 2-11 | 3/6/2023 | 9.8 | 25 | 135.1 | ND(0.005) | 0 | 87 | 9.9 | 5.8 | ND(10.1) | 8.85 | 7.7 | 0.0018 | 236 | 400 |
| Standard | | - | - | | 0.0052 | 15 | - | - | - | - | 6 - 9 | 6 - 9 | 0.005 | 1,000 | - |

ł = The 8/11/2021 oil & grease sample bottle for this outfall arrived at the lab broken.

Abbreviations:
mg/L - milligrams per liter
mg/L CaCO - milligrams per liter as calcium carbonate
µS/cm - microSiemens per centimeter
ND - non-detect (detection limit in parentheses)
NM - not measured
pCi/L - picocuries per liter, measure of radioactivity
s.u. - standard units

**TABLE 3-11. HISTORICAL SURFACE WATER DATA - COAL MINE WASH TRIBUTARY (CMWT)**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Date Sampled | Alkalinity (mg/L $CaCO_3$) | Bicarbonate (mg/L $CaCO_3$) | Calcium, Total (mg/L) | Carbonate (mg/L $CaCO_3$) | Chloride (mg/L) | Hardness (mg/L $CaCO_3$) | Iron, Dissolved (mg/L) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Manganese, Dissolved (mg/L) | Manganese, Total (mg/L) | Mercury (mg/L) | Nitrogen Nitrate (mg/L) | pH, Field s.u. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/26/2013 | 129 | 129 | 169 | ND(2) | 3.8 | NM | 25.5 | 128 | 55.5 | 1.91 | 3.5 | NM | 0.75 | 8.2 |
| 8/7/2013 | 82.5 | 82.5 | 62.6 | ND(2) | 11.6 | NM | 0.0445 | 42.2 | 21.4 | 0.007 | 0.694 | NM | 1.9 | 8 |
| 9/23/2014 | 99.3 | 99.3 | 119 | ND(2) | 4.9 | 449 | 53.7 | 118 | 47.5 | 0.768 | 2.32 | 0.00092 | 1.2 | 8.1 |
| 9/29/2014 | 84.2 | 84.2 | 131 | ND(2) | 5.7 | 422 | 20.3 | 110 | 47.1 | 1.03 | 3.1 | ND(0.0002) | 1.3 | 8.1 |
| 6/13/2015 | 118 | 118 | 331 | ND(2) | 5.7 | 1,690 | 0.711 | 67.7 | 61.9 | 0.0074 | 6.66 | 0.0006 | 2.1 | 8.8 |
| 7/14/2018 | 276 | 236 | 247 | 40.2 | 5.8 | 1,490 | 51.3 | 155 | 91.3 | 1.11 | 5.53 | 0.0019 | 1.5 | 8.8 |
| 9/2/2018 | 128 | 122 | 65 | ND(25) | 4.5 | 154 | 34.4 | 52.7 | 23.5 | 0.858 | 1.11 | ND(0.002) | 1.8 | 8.5 |
| 7/30/2019 | 174 | 174 | 503 | ND(8) | 8.4 | 1,670 | 190 | 295 | 173 | 5.29 | 9.22 | 0.0028 | 0.87 | 8.5 |
| 8/6/2019 | 135 | 135 | 205 | ND(8) | 7.5 | ND(2,000) | 102 | 159 | 75 | 2.24 | 4.7 | 0.00021 | 1.6 | 8.5 |
| 7/12/2021 | 118.8 | 118.8 | 390 | ND(2) | 5.9 | 1,500 | 2.1 | 370 | 140 | 5.4 | 9 | ND(0.0008) | 2 | 8.4 |
| 8/2/2021 | 90.44 | 90.44 | 280 | ND(2) | 6.4 | 1,200 | 5.5 | 340 | 110 | 2.7 | 8.8 | ND(0.0008) | 1.9 | 8.6 |
| 7/30/2022 | 96.68 | 96.68 | 31 | ND(2) | 5.7 | 110 | 0.93 | 26 | 8.7 | 0.03 | 0.16 | ND(0.0002) | 1 | 8.6 |
| 8/17/2022 | 67.96 | 67.96 | 52 | ND(2) | 6.3 | 210 | 3.3 | 75 | 20 | 0.074 | 0.95 | 0.00021 | 1.4 | 8.2 |
| 9/22/2022 | 81.16 | 81.16 | 33 | ND(2) | 5 | 120 | 0.87 | 22 | 9.4 | 0.023 | 0.15 | ND(0.0002) | 0.76 | 8.2 |
| 10/17/2022 | 87.24 | 87.24 | 30 | ND(2) | 5.8 | 100 | 0.7 | 6 | 7.1 | 0.018 | 0.055 | ND(0.0002) | ND(1) | 8.1 |
| 6/27/2024 | 94 | 94 | 320 | ND(2) | 4.1 | 1,200 | 0.03 | 220 | 98 | 0.0021 | 5.8 | ND(0.0002) | 1.3 | 7.95 |
| 7/25/2024 | 79 | 79 | 240 | ND(2) | 3.6 | 920 | ND(0.02) | 190 | 79 | 0.0028 | 5.1 | 0.0014 | ND(1) | 8.78 |
| 8/14/2024 | 92 | 92 | 83 | ND(2) | 6.6 | 350 | 0.04 | 97 | 35 | 0.0027 | 2.1 | ND(0.0008) | ND(1) | 8.43 |
| 8/24/2024 | 100 | 100 | 39 | ND(2) | 7.9 | 140 | 0.039 | 14 | 11 | 0.005 | 0.19 | ND(0.0002) | ND(1) | 8.83 |
| Standard | - | - | - | - | 250 | - | - | - | - | - | - | 0.01 | 10 | 6 - 9 |

Abbreviations:
mg/L - milligrams per liter
mg/L $CaCO_3$ - milligrams per liter as calcium carbonate
ND - non-detect (detection limit in parentheses)
NM - not measured
NTU - Nephelometric Turbidity Units
s.u. - standard units

**TABLE 3-11. HISTORICAL SURFACE WATER DATA - COAL MINE WASH TRIBUTARY (CMWT)**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Date Sampled | pH, Lab s.u. | Phosphate (mg/L) | Phosphorus, Total (mg/L) | Potassium, Total (mg/L) | Selenium, Total (mg/L) | Sodium, Total (mg/L) | Total Dissolved Solids (mg/L) | Total Suspended Solids (mg/L) | Sulfate (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| 7/26/2013 | 8 | NM | 4.1 | 38.3 | ND(0.02) | 26.5 | NM | NM | 13.5 |
| 8/7/2013 | 7.8 | NM | 0.877 | 17.1 | ND(0.02) | 52.3 | 2,760 | 1,770 | 151 |
| 9/23/2014 | 8 | 6.6 | 2.87 | 45.4 | 0.0309 | 28 | 254 | 8,550 | 11.7 |
| 9/29/2014 | 8.2 | 7.8 | 2.98 | 26.8 | 0.0061 | 29 | 682 | 6,640 | 20.9 |
| 6/13/2015 | 8 | 32.2 | 4.3 | 29.9 | 0.0077 | 29.5 | 254 | 30,000 | 70.3 |
| 7/14/2018 | 8.1 | 20.8 | 5.3 | 55.8 | ND(0.05) | 30.9 | 699 | 9,350 | 12.4 |
| 9/2/2018 | 8 | 5 | 1.25 | 20.2 | ND(0.05) | 15.2 | 408 | 2,700 | 18.5 |
| 7/30/2019 | 8 | 25.2 | 8.7 | 82.7 | ND(0.05) | 32.3 | 268 | 2,680 | 17.5 |
| 8/6/2019 | 8.1 | 14.5 | 4.45 | 36.4 | ND(0.05) | 33.1 | 1,030 | 6,780 | 35.5 |
| 7/12/2021 | 7.99 | ND(2.5) | 22 | 63 | 0.035 | 48 | 980 | 38,000 | 35 |
| 8/2/2021 | 8.08 | ND(2.5) | 12 | 51 | 0.054 | 33 | 4,750 | 16,000 | 34 |
| 7/30/2022 | 7.98 | ND(2.5) | 0.42 | 13 | 0.0025 | 23 | 494 | 150 | 40 |
| 8/17/2022 | 8 | ND(2.5) | 1.6 | 16 | 0.012 | 22 | 1,060 | 2,200 | 53 |
| 9/22/2022 | 7.9 | ND(2.5) | 0.46 | 11 | 0.0032 | 24 | 280 | 190 | 48 |
| 10/17/2022 | 7.97 | ND(2.5) | 0.17 | 8.3 | 0.0038 | 28 | 390 | 50 | 48 |
| 6/27/2024 | 8 | ND(2.5) | 14 | 48 | 0.026 | 48 | 3,300 | 21,000 | 35 |
| 7/25/2024 | 8 | ND(0.5) | 10 | 45 | 0.02 | 20 | 1,400 | 16,000 | 13 |
| 8/14/2024 | 7.9 | ND(0.5) | 1.5 | 25 | 0.013 | 19 | 1,200 | 4,400 | 26 |
| 8/24/2024 | 8.1 | ND(2.5) | 0.37 | 12 | 0.0029 | 33 | 400 | 310 | 60 |
| Standard | 6 - 9 | - | - | - | 0.005 | - | 1,000 | - | 600 |

Abbreviations:
mg/L - milligrams per liter
mg/L $CaCO_3$ - milligrams per liter as c
ND - non-detect (detection limit in par
NM - not measured
NTU - Nephelometric Turbidity Units
s.u. - standard units

**TABLE 3-12. HISTORICAL SURFACE WATER DATA - TSE BONITA WASH (TBW)**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Date Sampled | Alkalinity (mg/L $CaCO_3$) | Bicarbonate (mg/L $CaCO_3$) | Calcium, Total (mg/L) | Carbonate (mg/L $CaCO_3$) | Chloride (mg/L) | Hardness (mg/L $CaCO_3$) | Iron, Dissolved (mg/L) | Iron, Total (mg/L) | Magnesium, Total (mg/L) | Manganese, Dissolved (mg/L) | Manganese, Total (mg/L) | Mercury (mg/L) | Nitrogen Nitrate (mg/L) | pH, Field (s.u.) | pH, Lab (s.u.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/20/2013 | 76.4 | 76.4 | 176 | ND(2) | 3.5 | NM | 38.1 | 197 | 59.5 | 0.65 | 3.58 | NM | 0.66 | 7.8 | 7.8 |
| 7/29/2013 | 92.7 | 92.7 | 33.7 | ND(2) | 11.9 | NM | 0.0604 | 19.8 | 9.02 | 0.0194 | 0.222 | NM | 0.72 | 7.9 | 7.8 |
| 8/6/2013 | 79.6 | 79.6 | 85 | ND(2) | 3.7 | NM | 8.44 | 76.8 | 25.6 | 0.136 | 1.76 | NM | 0.42 | 7.8 | 7.7 |
| 9/29/2014 | 87.3 | 87.3 | 55.1 | ND(2) | 8 | 200 | ND(0.2) | 19.4 | 16.5 | 0.0014 | 0.348 | ND(0.0002) | 0.32 | 8.1 | 8 |
| 7/13/2015 | 76.1 | 76.1 | 48.1 | ND(2) | 4.4 | 201 | 0.0546 | 25.3 | 14.6 | 0.0056 | 0.342 | 0.000054 | 0.39 | 9.6 | 7.9 |
| 7/15/2015 | 79.4 | 79.4 | 44.3 | ND(2) | 3.2 | 179 | 0.311 | 28.3 | 13.5 | 0.004 | 0.485 | 0.00011 | 0.38 | 9.5 | 7.9 |
| 8/31/2015 | 127 | 127 | 60.6 | ND(200) | 3.2 | 225 | 0.137 | 41.7 | 18.8 | 0.0107 | 0.689 | 0.00028 | 0.37 | 8.1 | 8.4 |
| 7/24/2017 | 75.9 | 75.9 | 40.3 | ND(5) | 5 | 162 | ND(0.2) | 41.6 | 14.9 | 0.0033 | 0.514 | 0.00014 | 2.8 | 8.5 | 7.6 |
| 7/18/2018 | 127 | 116 | 169 | ND(50) | 3.6 | 554 | 53.1 | 97.9 | 45.2 | 1.44 | 3.85 | 0.00052 | 0.94 | 8.7 | 7.9 |
| 9/2/2018 | 103 | 103 | 58.1 | ND(25) | 4.1 | 151 | 10.4 | 64.3 | 19.5 | 0.139 | 0.951 | ND(0.002) | 1.3 | 8.4 | 7.7 |
| 7/12/2021 | 85.52 | 85.52 | 87 | ND(2) | 6 | 360 | 3.4 | 130 | 36 | 0.8 | 1.7 | ND(0.0008) | ND(1) | 8.26 | 7.9 |
| 7/24/2021 | 72.76 | 72.76 | 34 | ND(2) | 4.7 | 130 | 0.41 | 34 | 11 | 0.0084 | 0.33 | ND(0.0008) | 1.4 | 8.3 | 7.49 |
| 8/3/2021 | 87.64 | 87.64 | 41 | ND(2) | ND(5) | 160 | 0.78 | 38 | 13 | 0.04 | 0.33 | ND(0.0008) | 1.4 | 8.1 | 7.9 |
| 8/11/2021 | 67.76 | 67.76 | 180 | ND(2) | ND(5) | 690 | 5.8 | 230 | 61 | 1 | 4.9 | ND(0.0008) | ND(1) | 8.48 | 8 |
| 10/6/2021 | 89.68 | 89.68 | 35 | ND(2) | 4.7 | 120 | 0.35 | 10 | 7.7 | 0.014 | 0.1 | ND(0.0002) | ND(0.5) | 8.68 | 8.1 |
| 8/17/2022 | 86.04 | 86.04 | 40 | ND(2) | 2.5 | 150 | 4.3 | 49 | 13 | 0.16 | 0.52 | ND(0.0002) | ND(0.5) | 8.5 | 7.8 |
| 9/22/2022 | 86.6 | 86.6 | 42 | ND(2) | ND(2.5) | 160 | 2.1 | 63 | 14 | 0.14 | 0.51 | ND(0.0002) | ND(0.5) | 8.3 | 7.8 |
| 10/17/2022 | 101.4 | 101.4 | 36 | ND(2) | 2.6 | 130 | 1.4 | 15 | 8.9 | 0.056 | 0.19 | ND(0.0002) | ND(1) | 8.6 | 8 |
| 6/27/2024 | 100 | 100 | 350 | ND(2) | 3.5 | 1200 | 0.068 | 230 | 82 | 0.0035 | 4.1 | ND(0.0002) | 1.4 | 8.86 | 8 |
| 7/25/2024 | 95 | 95 | 160 | ND(2) | 3.2 | 620 | 0.02 | 130 | 53 | 0.006 | 3.2 | 0.00093 | ND(1) | 7.76 | 8 |
| 8/24/2024 | 120 | 120 | 62 | ND(2) | 4.3 | 230 | 0.038 | 46 | 18 | 0.0024 | 0.58 | ND(0.0002) | ND(1) | 8.64 | 8 |
| Standard | - | - | - | - | 250 | - | - | - | - | - | - | 0.01 | 10 | 6 - 9 | 6 - 9 |

Abbreviations:
mg/L - milligrams per liter
mg/L $CaCO_3$ - milligrams per liter as calcium carbonate
ND - non-detect (detection limit in parentheses)
NM - not measured
NTU - Nephelometric Turbidity Units
s.u. - standard units

**TABLE 3-12. HISTORICAL SURFACE WATER DATA - TSE BONITA WASH (TBW)**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Date Sampled | Phosphate (mg/L) | Phosphorus, Total (mg/L) | Potassium, Total (mg/L) | Selenium, Total (mg/L) | Sodium, Total (mg/L) | Solids, Total Dissolved (mg/L) | Solids, Total Suspended (mg/L) | Sulfate (mg/L) |
|---|---|---|---|---|---|---|---|---|
| 7/20/2013 | 1.5 | 3.71 | 36.6 | 0.0096 | 37.8 | 574 | 13,700 | 142 |
| 7/29/2013 | 3.6 | 0.408 | 9.69 | ND(0.02) | 18 | 1,050 | 8,300 | 70.4 |
| 8/6/2013 | 0.77 | 1.52 | 16.7 | ND(0.02) | 19.5 | 1,650 | 4,200 | 62.5 |
| 9/29/2014 | ND(0.31) | 0.371 | 9.96 | ND(0.02) | 70.2 | 697 | 860 | 213 |
| 7/13/2015 | 1.2 | 0.454 | 10.1 | ND(0.02) | 33.6 | 370 | 663 | 111 |
| 7/15/2015 | 1.7 | 0.519 | 10.1 | ND(0.02) | 21.1 | 322 | 950 | 68.6 |
| 8/31/2015 | 2.4 | 0.725 | 12.8 | ND(0.02) | 17.9 | 470 | 2,770 | 71.2 |
| 7/24/2017 | 2.6 | 0.769 | 16.5 | ND(0.02) | 17.5 | 424 | 1,360 | 18.7 |
| 7/18/2018 | 7.9 | 2.54 | 27.7 | ND(0.05) | 14 | 1,770 | 6,700 | 9.8 |
| 9/2/2018 | 4.6 | 1.09 | 13.9 | ND(0.05) | 14.6 | 536 | 1,590 | 28.8 |
| 7/12/2021 | ND(2.5) | 3.4 | 28 | 0.011 | 14 | 700 | 5,900 | 17 |
| 7/24/2021 | ND(2.5) | 0.7 | 14 | 0.0059 | 16 | 920 | 250 | 26 |
| 8/3/2021 | ND(2.5) | 0.71 | 13 | 0.0062 | 18 | 1,160 | 520 | 32 |
| 8/11/2021 | ND(5) | 6.6 | 35 | 0.029 | 8.3 | 1,600 | 6,300 | 7.2 |
| 10/6/2021 | ND(2.5) | ND(0.5) | 7.8 | 0.0031 | 15 | 335 | 170 | 39 |
| 8/17/2022 | ND(2.5) | 0.87 | 13 | 0.0048 | 9 | 810 | 920 | 23 |
| 9/22/2022 | ND(2.5) | 0.67 | 13 | 0.0051 | 9.1 | 590 | 980 | 23 |
| 10/17/2022 | ND(2.5) | 0.27 | 8.5 | 0.0032 | 9.3 | 530 | 230 | 22 |
| 6/27/2024 | ND(2.5) | 16 | 38 | 0.022 | 56 | ND(2500) | 62000 | 100 |
| 7/25/2024 | ND(0.5) | 5 | 35 | 0.017 | 26 | 1600 | 9200 | 15 |
| 8/24/2024 | ND(2.5) | 1.2 | 15 | 0.0045 | 14 | 510 | 1600 | 37 |
| Standard | - | - | - | 0.005 | - | 1,000 | - | 600 |

Abbreviations:
mg/L - milligrams per liter
mg/L $CaCO_3$ - milligrams per liter as
ND - non-detect (detection limit in pa
NM - not measured
NTU - Nephelometric Turbidity Units
s.u. - standard units

**TABLE 4-1. ANNUAL WATER LEVEL SUMMARY**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| YEAR | WELL TB3D, TD = 51.7 ft bmp | | WELL 2, TD = 798 ft bmp | | WELL 3A, TD = 882 ft bmp | | WELL MBR2, TD = 179.8 ft bmp | | WELL 2G2, TD = 56.85 ft bmp | |
|---|---|---|---|---|---|---|---|---|---|---|
| | DTW ft bmp | Saturated Thickness ft | DTW ft bmp | Saturated Thickness ft | DTW ft bmp | Saturated Thickness ft | DTW ft bmp | Saturated Thickness ft | DTW ft bmp | Saturated Thickness ft |
| 2013 | **46.61** | 2.29 | NM | NM | NM | NM | 132.84 | 47.63 | 54.59 | 2.26 |
| 2014 | **46.14** | 2.76 | **734.67** | 63.33 | NM | NM | 132.17 | 47.57 | **54.68** | 2.17 |
| 2015 | **48.16** | 0.74 | **738** | 60 | NM | NM | 132.23 | 46.57 | **54.73** | 2.12 |
| 2016 | **50.11** | 0.85 | **764.51** | 33.49 | **702.98** | 179.02 | 133.23 | 46.17 | **55.79** | 1.06 |
| 2017 | **51.32** | 0.38 | **765.66** | 32.34 | **697.20** | 184.80 | 133.63 | 46.12 | **56.69** | 0.16 |
| 2018 | **51.33** | 0.37 | **773.96** | 24.04 | **719.15** | 162.85 | 133.68 | 45.98 | **56.73** | 0.12 |
| 2019 | **51.36** | 0.34 | **778.79** | 19.21 | **706.44** | 175.56 | 133.82 | 45.98 | **56.77** | 0.08 |
| 2020 | **51.52** | 0.18 | **777.63** | 20.37 | **697.20** | 184.80 | 133.86 | 45.94 | 56.82 | 0.03 |
| 2021 | **51.53** | 0.17 | **778.79** | 19.21 | **694.89** | 187.11 | 138.62 | 41.18 | **56.77** | 0.08 |
| 2022 | **ND** | 0 | **779.94** | 18.06 | **700.67** | 181.33 | 134.05 | 45.75 | ND | 0 |
| 2023 | **51.67** | 0.03 | **782.25** | 15.75 | **711.06** | 170.94 | 135.18 | 44.62 | ND | 0 |
| 2024 | **ND** | 0 | **781.1** | 16.9 | **701.82** | 180.18 | 134.40 | 45.40 | ND | 0 |

Note:
1. Values in bold represent arithmetic means calculated from at least two measurements from the same year.

Abbreviations:
bmp - below measuring point
DTW - depth to water
ft - feet
ND - non-detect/dry well
NM - not measured

**TABLE 4-2. WELL 2 HISTORICAL GROUNDWATER QUALITY DATA**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Date Sampled | Alkalinity mg/L CaCO3 | Bicarbonate mg/L CaCO3 | Calcium, Dissolved mg/L | Carbonate mg/L CaCO3 | Chloride mg/L | Fluoride mg/L | Hardness mg/L CaCO3 | Iron, Total mg/L | Magnesium, Dissolved mg/L | Manganese, Total mg/L | pH, Lab (s.u.) | Phosphate mg/L | Potassium, Dissolved mg/L | Sodium, Dissolved mg/L | Solids, Total Dissolved mg/L | Sulfate mg/L | Turbidity NTU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/27/2013 | 217 | 217 | 38.2 | ND(2) | 13.2 | ND(0.5) | 141 | 0.978 | 7.85 | 0.0331 | 7.6 | ND(0.1) | 3.6 | 111 | 458 | 130 | 4.2 |
| 5/23/2013 | 218 | 218 | 37.1 | ND(2) | 13.9 | 0.68 | 132 | 1.48 | 7.75 | 0.0294 | 7.6 | ND(0.1) | 3.52 | 105 | 454 | 136 | 8.2 |
| 8/22/2013 | 234 | 234 | 32.1 | ND(2) | 16.8 | 0.66 | 114 | 2.98 | 6.63 | 0.0436 | 7.6 | ND(0.1) | 3.74 | 152 | 513 | 166 | 7.7 |
| 11/7/2013 | 207 | 207 | 51.1 | ND(2) | 10.3 | 0.4 | 159 | 19.4 | 10.6 | 0.0811 | 7.5 | 1.6 | 3.94 | 77.4 | 393 | 103 | 77.2 |
| 3/19/2014 | 218 | 218 | 61 | ND(2) | 5.5 | ND(0.5) | 203 | 1.08 | 12.4 | 0.0451 | 7.7 | ND(0.31) | 4.19 | 24.7 | 351 | 67.4 | 17.1 |
| 4/15/2014 | 213 | 213 | 42.9 | ND(2) | 6.5 | ND(0.5) | 165 | 1.27 | 8.82 | 0.0582 | 7.4 | ND(0.31) | 4.29 | 119 | 366 | 111 | 4.9 |
| 9/9/2014 | 236 | 236 | 34.4 | ND(2) | 16.4 | 0.75 | 129 | 3.76 | 7.04 | 0.0542 | 7.7 | ND(0.31) | 3.59 | 133 | 521 | 138 | 15 |
| 10/22/2014 | 239 | 239 | 22.9 | ND(2) | 20.7 | 0.58 | 63 | 2.07 | 4.91 | 0.0056 | 7.4 | ND(0.31) | 3.47 | 161 | 591 | 195 | 5.8 |
| 2/10/2015 | 181 | 181 | 55.4 | ND(2) | 5.9 | 0.34 | 193 | 0.404 | 11.4 | 0.018 | 7.6 | ND(0.31) | 4.19 | 46.1 | 337 | 81.8 | 0.91 |
| 4/29/2015 | 199 | 199 | 59.3 | ND(2) | 5.8 | 0.49 | 216 | 0.203 | 12.3 | 0.0195 | 7.3 | ND(0.31) | 4.24 | 36.6 | 341 | 87.8 | 1.3 |
| 9/2/2015 | 195 | 195 | 48.8 | ND(2) | 7.6 | ND(0.5) | 177 | 0.214 | 10.1 | 0.0209 | 7.7 | ND(0.31) | 4.32 | 62.9 | 371 | 89.4 | 0.98 |
| 11/3/2015 | 218 | 218 | 40.6 | ND(2) | 13.9 | ND(0.5) | 154 | 0.722 | 8.4 | 0.0698 | 7.4 | ND(0.31) | 4.02 | 119 | 531 | 139 | 3.2 |
| 2/24/2016 | 208 | 208 | 61.5 | ND(2) | 4.8 | 0.53 | 207 | 10.8 | 12.6 | 0.224 | 7.5 | ND(0.31) | 4.35 | 37.1 | 378 | 73.9 | 15.9 |
| 5/24/2016 | 211 | 211 | 54 | ND(2) | 10.3 | 0.63 | 182 | 0.91 | 11 | 0.0525 | 7.5 | ND(0.31) | 4.18 | 52.9 | 422 | 115 | 2.9 |
| 7/28/2016 | 216 | 216 | 47.7 | ND(5) | 12.4 | 0.72 | 159 | 0.987 | 10.1 | 0.0683 | 7.5 | ND(0.31) | 4.06 | 66.3 | 507 | 131 | 2.6 |
| 11/9/2016 | 186 | 186 | 51.2 | ND(5) | 7.9 | 0.64 | 196 | 4.64 | 10.5 | 0.111 | 7 | ND(0.31) | 4.12 | 57 | 394 | 106 | 3.9 |
| 3/3/2017 | 219 | 219 | 59.4 | ND(5) | 8.6 | 0.53 | 191 | 2.15 | 12.1 | 0.107 | 7.6 | ND(0.31) | 4.27 | 30.6 | 406 | 98.6 | 14.9 |
| 6/7/2017 | 189 | 189 | 55.2 | ND(5) | 8.2 | 0.45 | 132 | 0.265 | 11.2 | 0.0291 | 7.7 | ND(0.31) | 4.13 | 48.8 | 401 | 114 | 0.24 |
| 9/13/2017 | 209 | 209 | 45.7 | ND(5) | 12.3 | 0.65 | 147 | 1.07 | 9.75 | 0.0579 | 7.7 | ND(0.31) | 4.11 | 76.1 | 456 | 133 | 4.2 |
| 11/16/2017 | 205 | 205 | 36.4 | ND(5) | 9.5 | 0.5 | 141 | 0.184 | 7.68 | 0.0195 | 7.4 | ND(0.31) | 3.68 | 96.9 | 448 | 100 | 1.5 |
| 2/21/2018 | 188 | 188 | 50.1 | ND(5) | 8.3 | 0.38 | 164 | 0.0908 | 10.3 | 0.016 | 7.5 | ND(0.31) | 3.93 | 65.1 | 386 | 98.9 | 0.35 |
| 5/16/2018 | 189 | 189 | 35.2 | ND(5) | 7.3 | 0.65 | 167 | 0.271 | 7.48 | 0.0364 | 7.7 | ND(0.31) | 3.85 | 122 | 405 | 89.4 | 2.3 |
| 9/12/2018 | 232 | 232 | 24.4 | ND(5) | 16.1 | 0.75 | 81.1 | 0.229 | 5.24 | 0.013 | 7.8 | ND(0.31) | 3.91 | 155 | 728 | 151 | 2.4 |
| 11/15/2018 | 253 | 253 | 21.8 | ND(5) | 16.8 | 0.83 | 70.4 | 0.657 | 4.65 | 0.0171 | 8.2 | ND(0.31) | 3.58 | 180 | 566 | 153 | 9.5 |
| 2/28/2019 | 255 | 255 | 20.5 | ND(5) | 19.6 | 0.55 | 71.5 | 0.235 | 4.51 | 0.01 | 8 | ND(0.31) | 3.47 | 193 | 574 | 187 | 2.8 |
| 5/14/2019 | 198 | 198 | 50.7 | ND(5) | 11 | 1.1 | 177 | 0.693 | 10.3 | 0.0509 | 7.6 | ND(0.31) | 3.84 | 67.2 | 395 | 136 | 5.2 |
| 9/5/2019 | 189 | 189 | 52.6 | ND(8) | 7.1 | 0.58 | 167 | 0.0573 | 10.9 | 0.0187 | 7.4 | ND(0.31) | 4.14 | 54.3 | 330 | 86.9 | 0.4 |
| 11/13/2019 | 213 | 213 | 24.5 | ND(8) | 13.8 | 0.7 | 107 | 0.127 | 5.31 | 0.0102 | 7.9 | ND(0.31) | 3.57 | 169 | 427 | 138 | 1 |
| 2/19/2020 | 244 | 244 | 25.6 | ND(2.6) | 18 | 1.2 | 76 | 0.13 | 5.33 | 0.0128 | 8 | ND(0.25) | 3.59 | 157 | 584 | 199 | 1.6 |
| 4/29/2020 | 208 | 208 | 42.6 | ND(2.6) | 10.5 | 0.92 | 155 | 4.13 | 8.89 | 0.0444 | 7.7 | ND(0.25) | 3.51 | 95.7 | 441 | 131 | 28 |
| 9/2/2020 | 220 | 220 | 40 | ND(8) | 12 | 0.75 | 140 | 5 | 8.8 | 0.087 | 7.5 | ND(0.25) | 3.6 | 110 | 450 | 130 | 36 |
| 11/4/2020 | 210 | 210 | 43 | ND(8) | 10 | 0.63 | 160 | 2.4 | 8.4 | 0.077 | 8 | ND(0.25) | 3.5 | 96 | 420 | 120 | 16 |
| 2/3/2021 | 210 | 210 | 42 | ND(8) | 11 | 0.56 | 150 | 2.7 | 8.5 | 0.068 | 7.3 | ND(0.25) | 4.2 | 99 | 370 | 120 | 19 |
| 5/12/2021 | 208.4 | 208.4 | 44 | ND(2) | 8.9 | ND(0.28) | 150 | 0.97 | 9.4 | 0.032 | 7.29 | ND(2) | 3.7 | 96 | 435 | 110 | 6.4 |
| 8/10/2021 | 219.6 | 219.6 | 42 | ND(2) | 12 | 0.56 | 140 | 3 | 8.7 | 0.081 | 7.34 | ND(2) | 3.5 | 120 | 430 | 150 | 18 |
| 10/27/2021 | 212 | 212 | 42 | ND(2) | 10 | 0.58 | 140 | 0.25 | 9 | 0.034 | 7.5 | ND(2) | 3.5 | 93 | 432 | 130 | 2.3 |
| 2/10/2022 | 207.5 | 207.5 | 43 | ND(2) | 10 | 0.58 | 130 | 0.96 | 9.2 | 0.033 | 7.21 | ND(2.5) | 3.5 | 86 | 435 | 120 | 6.1 |
| 4/26/2022 | 207.5 | 207.5 | 43 | ND(2) | 11 | 0.47 | 140 | 0.49 | 9 | 0.029 | 7.17 | ND(0.5) | 3.1 | 99 | 446 | 120 | 3.2 |
| 8/31/2022 | 214.3 | 214.3 | 41 | ND(2) | 10 | 0.57 | 130 | 1.4 | 8.9 | 0.038 | 7.34 | ND(2.5) | 3.6 | 110 | 440 | 120 | 11 |
| 12/7/2022 | 217 | 217 | 38 | ND(2) | 10 | 0.59 | 140 | 0.57 | 8.1 | 0.024 | 7.14 | ND(2.5) | 3.6 | 110 | 452 | 120 | 1.4 |
| 2/9/2023 | 209.6 | 209.6 | 45 | ND(2) | 9.2 | 0.58 | 150 | 1.6 | 9.5 | 0.084 | 7.51 | ND(2.5) | 3.6 | 89 | 407 | 120 | 7.5 |
| 5/24/2023 | 208.4 | 208.4 | 43 | ND(2) | 8.5 | ND(0.5) | 150 | 0.11 | 9.3 | 0.018 | 7.59 | ND(2.5) | 3.5 | 87 | 411 | 110 | 1.4 |
| 7/12/2023 | 212.8 | 212.8 | 44 | ND(2) | 9.5 | ND(0.5) | 150 | 0.28 | 9 | 0.029 | 7.42 | ND(2.5) | 3.4 | 98 | 420 | 120 | 2.1 |
| 10/5/2023 | 202.8 | 202.8 | 46 | ND(2) | 8.6 | ND(0.5) | 160 | 0.46 | 10 | 0.022 | 7.54 | ND(2.5) | 3.1 | 81 | 414 | 110 | 7 |
| 1/17/2024 | 202.1 | 202.1 | 45 | ND(2) | 9.6 | 0.42 | 150 | 0.068 | 9.4 | 0.021 | 7.37 | ND(0.5) | 3.5 | 87 | 416 | 110 | 0.75 |
| 11/21/2024 | 220 | 220 | 39 | ND(2) | 13 | 0.54 | 130 | 0.15 | 9.3 | 0.02 | 7.5 | ND(0.5) | 3.8 | 110 | 440 | 130 | 1.8 |
| Standard | - | - | - | - | 250 | 1.6 | - | - | - | - | 6 - 9 | - | - | - | 1,000 | 600 | - |

**Bold** values indicate concentration or detection limit exceeds groundwater quality standard
Abbreviations:
CaCO3 - calcium carbonate, molecular weight of 100.06 g
mg/L - milligrams per liter
ND - non-detect (detection limit in parentheses)
NTU - Nephelometric Turbidity Units
s.u. - standard units

**TABLE 4-3. WELL 3A HISTORICAL GROUNDWATER QUALITY DATA**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Date Sampled | Alkalinity mg/L CaCO3 | Bicarbonate mg/L CaCO3 | Calcium, Dissolved mg/L | Carbonate mg/L CaCO3 | Chloride mg/L | Fluoride mg/L | Hardness mg/L CaCO3 | Iron, Total mg/L | Magnesium, Dissolved mg/L | Manganese, Total mg/L | pH, Lab (s.u.) | Phosphate mg/L | Potassium, Dissolved mg/L | Sodium, Dissolved mg/L | Solids, Total Dissolved mg/L | Sulfate mg/L | Turbidity NTU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/2/2015 | 207 | 207 | 73.9 | ND(2) | 4.6 | ND(0.5) | 264 | 4.45 | 12 | 0.101 | 8.3 | ND(0.31) | 2.8 | 43.1 | 402 | 102 | 28.4 |
| 11/3/2015 | 213 | 213 | 79.9 | ND(2) | 3.3 | ND(0.5) | 274 | 0.498 | 12.9 | 0.101 | 7.8 | ND(0.31) | 2.88 | 42.2 | 460 | 98.3 | 2.3 |
| 2/24/2016 | 215 | 215 | 77.9 | ND(2) | 3.9 | ND(0.5) | 295 | 1.35 | 12.5 | 0.116 | 8.1 | ND(0.31) | 2.76 | 40.1 | 423 | 86.8 | 8.5 |
| 5/24/2016 | 217 | 217 | 75.7 | ND(2) | 3.6 | ND(0.5) | 338 | 0.915 | 12.2 | 0.0984 | 8 | ND(0.31) | 2.7 | 39.1 | 408 | 96.5 | 3.7 |
| 9/14/2016 | 217 | 217 | 72 | ND(5) | 3.9 | ND(0.5) | 227 | 0.463 | 11.7 | 0.087 | 8 | ND(0.31) | 2.66 | 41.3 | 421 | 102 | 2.5 |
| 11/9/2016 | 221 | 221 | 70.8 | ND(5) | 4.1 | ND(0.5) | 246 | 0.318 | 11.4 | 0.0849 | 7.7 | ND(0.31) | 2.68 | 38.5 | 379 | 114 | 1.4 |
| 3/3/2017 | 221 | 221 | 75.6 | ND(5) | 4.4 | ND(0.5) | 267 | 0.841 | 12.6 | 0.0973 | 7.9 | ND(0.31) | 3.37 | 43.9 | 397 | 70.5 | 3.7 |
| 6/7/2017 | 215 | 215 | 77.5 | ND(5) | 3.4 | ND(0.5) | 251 | 0.499 | 12.5 | 0.0918 | 8 | ND(0.31) | 2.99 | 39.9 | 384 | 106 | 3.4 |
| 9/13/2017 | 211 | 211 | 70.2 | ND(5) | 4.3 | 0.3 | 232 | 0.528 | 11.9 | 0.0978 | 7.7 | ND(0.31) | 2.72 | 36.4 | 389 | 98 | 4 |
| 11/16/2017 | 218 | 218 | 69.9 | ND(5) | 4.3 | ND(0.5) | 234 | 0.503 | 11.5 | 0.0889 | 7.9 | ND(0.31) | 2.62 | 36.2 | 392 | 93.2 | 3.6 |
| 2/21/2018 | 212 | 212 | 75.7 | ND(5) | 4.1 | ND(0.5) | 240 | 0.433 | 12 | 0.0925 | 8 | ND(0.31) | 2.75 | 39.3 | 406 | 105 | 1.7 |
| 5/16/2018 | 207 | 207 | 76.8 | ND(5) | 4.4 | 0.45 | 219 | 0.309 | 12.5 | 0.0836 | 8 | ND(0.31) | 2.67 | 40.2 | 388 | 96.1 | 3.5 |
| 9/12/2018 | 220 | 220 | 72.1 | ND(5) | 3.4 | ND(0.5) | 231 | 1.14 | 11.6 | 0.123 | 8 | ND(0.31) | 2.84 | 44.2 | 384 | 73.5 | 12 |
| 11/15/2018 | 224 | 224 | 72.3 | ND(5) | 3.7 | 0.37 | 276 | 0.525 | 11.9 | 0.13 | 8.2 | ND(0.31) | 2.8 | 40.7 | 388 | 74.8 | 7.8 |
| 2/28/2019 | 220 | 220 | 79.2 | ND(5) | 3.9 | ND(0.5) | 232 | 0.337 | 12.7 | 0.0927 | 8.1 | ND(0.31) | 3.1 | 40.7 | 376 | 105 | 2.6 |
| 5/14/2019 | 217 | 217 | 77.4 | ND(5) | 3.9 | ND(0.5) | 235 | 0.336 | 12.1 | 0.0916 | 8 | ND(0.31) | 2.6 | 38.5 | 391 | 120 | 3.2 |
| 8/20/2019 | 222 | 222 | 77.7 | ND(8) | 4.4 | ND(0.5) | 266 | 0.368 | 12.7 | 0.0964 | 8 | ND(0.31) | 2.63 | 39.9 | 392 | 140 | 4.1 |
| 11/13/2019 | 219 | 219 | 71.3 | ND(8) | 3.9 | ND(0.5) | 285 | 0.593 | 11.8 | 0.0924 | 8.1 | ND(0.31) | 2.57 | 36.3 | 388 | 104 | 8.9 |
| 2/19/2020 | 215 | 215 | 74.8 | ND(8) | 4 | ND(0.5) | 277 | 1.22 | 12 | 0.0931 | 7.9 | ND(0.31) | 2.72 | 38 | 399 | 93.4 | 16 |
| 4/29/2020 | 217 | 217 | 74.7 | ND(8) | 3.9 | ND(0.5) | 268 | 0.754 | 12 | 0.09 | 8 | ND(0.31) | 2.63 | 42.1 | 398 | 133 | 10 |
| 9/9/2020 | 220 | 220 | 74 | ND(8) | 4.1 | 0.32 | 270 | 1.1 | 12 | 0.092 | 7.8 | ND(0.31) | 2.7 | 45 | 420 | 270 | 18 |
| 10/22/2020 | 220 | 220 | 73 | ND(8) | 3.6 | ND(0.5) | 290 | 0.55 | 11 | 0.093 | 7.9 | ND(0.31) | 2.9 | 38 | 390 | 93 | 9.3 |
| 1/26/2021 | 210 | 210 | 75 | ND(8) | 5.6 | 0.29 | 260 | 1 | 13 | 0.09 | 8 | ND(0.31) | 2.8 | 45 | 370 | 130 | 11 |
| 5/12/2021 | 219.6 | 219.6 | 76 | ND(2) | 3.4 | ND(0.5) | 240 | 0.91 | 12 | 0.095 | 7.73 | ND(2.5) | 2.7 | 45 | 401 | 97 | 8.1 |
| 8/10/2021 | 218.3 | 218.3 | 81 | ND(2) | 3 | ND(0.5) | 240 | 3.7 | 13 | 0.11 | 7.7 | ND(2.5) | 2.9 | 41 | 378 | 98 | 88 |
| 10/27/2021 | 218.1 | 218.1 | 75 | ND(2) | 3.6 | ND(0.5) | 240 | 0.6 | 12 | 0.085 | 7.93 | ND(2.5) | 2.5 | 37 | 387 | 100 | 5.4 |
| 2/10/2022 | 217.6 | 217.6 | 73 | ND(2) | 3.7 | ND(0.5) | 220 | 0.82 | 12 | 0.091 | 7.76 | ND(2.5) | 2.6 | 41 | 405 | 100 | 10 |
| 4/26/2022 | 219.1 | 219.1 | 77 | ND(2) | 3.4 | 0.23 | 230 | 0.96 | 12 | 0.09 | 7.81 | ND(0.5) | 2.5 | 47 | 409 | 100 | 8.5 |
| 12/7/2022 | 215.4 | 215.4 | 73 | ND(2) | 3.2 | ND(0.5) | 250 | 0.96 | 12 | 0.095 | 7.54 | ND(2.5) | 2.5 | 39 | 388 | 90 | 7.8 |
| 3/15/2023 | 222.4 | 222.4 | 73 | ND(2) | 3.3 | ND(0.5) | 240 | 1.9 | 12 | 0.1 | 7.83 | ND(2.5) | 2.6 | 37 | 404 | 93 | 16 |
| 5/24/2023 | 222.6 | 222.6 | 71 | ND(2) | 3.6 | ND(0.5) | 230 | 0.95 | 12 | 0.081 | 8.08 | ND(2.5) | 2.5 | 47 | 403 | 100 | 11 |
| 7/12/2023 | 221.6 | 221.6 | 76 | ND(2) | 3.4 | ND(0.5) | 240 | 0.7 | 12 | 0.096 | 7.78 | ND(2.5) | 2.6 | 44 | 378 | 97 | 6 |
| 10/18/2023 | 220.6 | 220.6 | 76 | ND(2) | ND(5) | ND(1) | 240 | 1.4 | 13 | 0.12 | 7.92 | ND(5) | 2.6 | 41 | 387 | 92 | 13 |
| 1/30/2024 | 217.1 | 217.1 | 75 | ND(2) | 3.4 | ND(0.5) | 230 | 4.3 | 12 | 0.14 | 7.74 | ND(2.5) | 2.4 | 38 | 384 | 92 | 50 |
| 11/21/2024 | 180 | 180 | 44 | ND(2) | 3 | 0.14 | 150 | 7.4 | 12 | 0.093 | 8 | ND(0.5) | 2.7 | 39 | 270 | 53 | 450 |
| Standard | - | - | - | - | 250 | 1.6 | - | - | - | - | 6 - 9 | - | - | - | 1,000 | 600 | - |

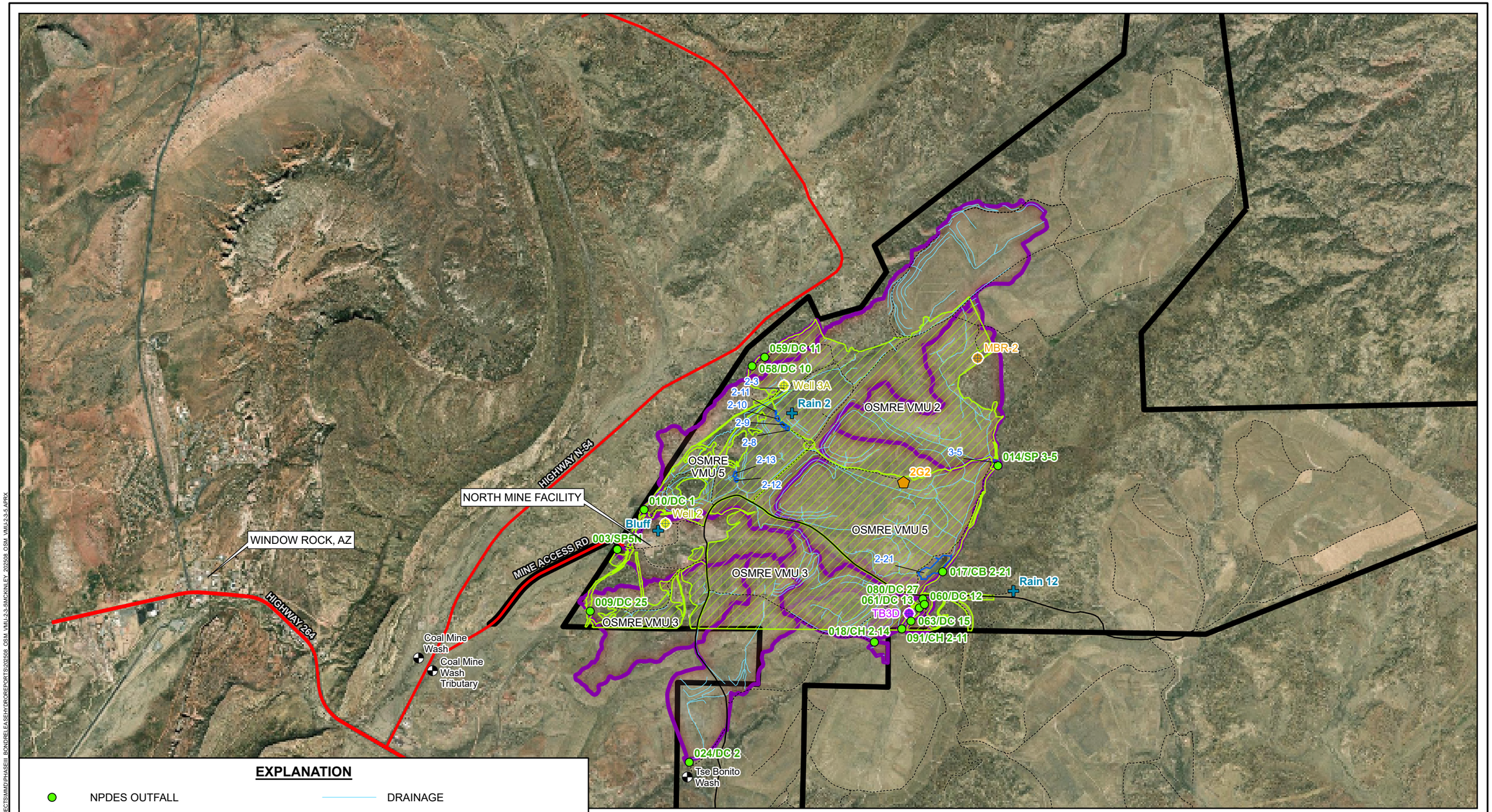
**Bold** values indicate concentration or detection limit exceeds groundwater quality standard
Abbreviations:
CaCO3 - calcium carbonate, molecular weight of 100.06 g
mg/L - milligrams per liter
ND - non-detect (detection limit in parentheses)
NTU - Nephelometric Turbidity Units
s.u. - standard units

**TABLE 4-4. WELL MBR2 HISTORICAL GROUNDWATER QUALITY DATA**
**CHEVRON MINING, INC, McKINLEY MINE**
**NEAR GALLUP, NEW MEXICO**

| Date Sampled | Alkalinity mg/L CaCO3 | Bicarbonate mg/L CaCO3 | Boron, Total mg/L | Calcium, Total mg/L | Carbonate mg/L CaCO3 | Cation-Anion Balance Percent | Chloride mg/L | Conductance, Field µS/cm | Fluoride mg/L | Hardness mg/L CaCO3 | Iron, Dissolved mg/L | Iron, Total mg/L | Magnesium, Total mg/L | Manganese, Dissolved mg/L | Manganese, Total mg/L | Nitrogen Nitrate mg/L | pH, Field s.u. | pH, Lab s.u. | Phosphate mg/L | Phosphorus, Total mg/L | Potassium, Total mg/L | Selenium, Total mg/L | Sodium, Total mg/L | Solids, Total Dissolved | Sulfate mg/L | Zinc, Total mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/12/2013 | 590 | 590 | 0.154 | 5.32 | ND(2) | 0.89 | 6.9 | 2060 | **5.4** | NM | **2.21** | 2.59 | 1.8 | 0.0205 | 0.0214 | ND(0.1) | 7.5 | 7.9 | ND(0.31) | 0.0545 | 3.3 | ND(0.02) | 485 | **1,520** | 581 | 0.0108 |
| 10/22/2014 | 520 | 520 | 0.164 | 6.87 | ND(2) | 38.87 | 6.3 | 2340 | **4.3** | 44.6 | ND(0.2) | 0.353 | 1.54 | 0.0205 | 0.023 | ND(0.1) | 7.3 | 7.9 | ND(0.31) | 0.0196 | 2.48 | 0.0069 | 544 | **1,400** | 595 | 0.0043 |
| 11/19/2015 | 539 | 539 | 0.173 | 6.77 | ND(2) | 1.72 | 7.1 | 2150 | **4.6** | 36.6 | ND(0.2) | 10.5 | 3.93 | 0.0122 | 0.0606 | ND(0.1) | 7.8 | 7.6 | ND(0.31) | 0.135 | 5.77 | ND(0.02) | 490 | **1,500** | 562 | 0.0486 |
| 11/9/2016 | 564 | 564 | 0.159 | 5.14 | ND(5) | 0.12 | 7.7 | 2420 | **5.9** | 25.2 | ND(0.2) | 1.52 | 1.6 | 0.0074 | 0.0172 | 0.055 | 8.0 | 7.9 | ND(0.31) | 0.0456 | 2.79 | ND(0.02) | 490 | **1,400** | 569 | 0.0079 |
| 11/15/2017 | 519 | 519 | 0.159 | 6.43 | ND(5) | 3.55 | 7.3 | 2380 | **4.7** | 22.5 | 0.113 | 0.218 | 1.47 | 0.0322 | 0.0307 | ND(0.1) | 7.7 | 7.9 | ND(0.31) | ND(0.1) | 2.41 | ND(0.02) | 500 | **1,660** | 573 | ND(0.02) |
| 11/14/2018 | 519 | 519 | 0.161 | 7.06 | ND(5) | 1.68 | 6.9 | 2300 | **6.8** | 18.6 | ND(0.2) | 0.313 | 1.53 | 0.0244 | 0.0262 | ND(0.1) | 7.4 | 7.9 | ND(0.31) | ND(0.1) | 2.33 | ND(0.05) | 498 | **1,310** | 595 | ND(0.02) |
| 11/13/2019 | 568 | 568 | 0.151 | 6.1 | ND(8) | 3.88 | 7.6 | 2350 | **5.2** | 25.7 | 0.325 | 3.07 | 2.14 | 0.0129 | 0.0302 | ND(0.1) | 7.4 | 8.1 | ND(0.31) | 0.0809 | 3.84 | ND(0.05) | 511 | **1,400** | 542 | 0.0196 |
| 10/28/2020 | 510 | 510 | 0.17 | 6.7 | ND(8) | 3.63 | 7 | 2040 | **4.7** | 27 | ND(0.21) | 0.068 | 1.5 | 0.022 | 0.022 | 0.1 | 7.5 | 7.5 | ND(0.31) | ND(0.1) | 2.4 | ND(0.05) | 510 | **1,200** | 590 | ND(0.02) |
| 10/27/2021 | 568.5 | 568.5 | 0.2 | 9.5 | ND(2) | 5.27 | 7.1 | 2070 | **4.9** | 36 | 0.53 | 4.3 | 2.8 | 0.06 | 0.083 | ND(0.5) | 7.6 | 7.7 | ND(2.5) | 0.094 | 4.3 | ND(0.005) | 540 | **1,600** | 580 | 0.023 |
| 11/9/2022 | 576.6 | 576.6 | 0.17 | 5.4 | ND(2) | 4.37 | 6.7 | 2300 | **4.9** | 20 | ND(0.02) | 1.1 | 1.6 | 0.011 | 0.018 | ND(0.5) | 7.4 | 7.8 | ND(2.5) | 0.16 | 2.9 | ND(0.001) | 520 | **1,460** | 540 | ND(0.01) |
| 10/17/2023 | 530.1 | 530.1 | 0.18 | 6 | ND(2) | 2.33 | 6.8 | 2330 | **4.6** | 21 | ND(0.02) | 0.29 | 1.5 | 0.011 | 0.018 | ND(0.5) | 7.9 | 7.7 | ND(2.5) | ND(0.05) | 2.4 | ND(0.001) | 510 | **1,510** | 600 | ND(0.01) |
| 10/9/2024 | 580 | 580 | 0.27 | 120 | ND(2) | 5.64 | 7.2 | 2240 | **5.4** | 370 | ND(0.02) | ND(0.05) | 18 | 0.013 | 0.004 | ND(1) | 7.6 | 7.9 | ND(2.5) | 0.12 | 25 | 0.0014 | 250 | **1,600** | 540 | 0.044 |
| Standard | - | - | - | - | - | - | 250 | - | 1.6 | - | 1 | - | - | 0.2 | - | 10 | 6 - 9 | 6 - 9 | - | - | - | 0.05 | - | 1,000 | 600 | 10 |

**Bold** values indicate concentration or detection limit exceeds groundwater quality standard
Abbreviations:
CaCO3 - calcium carbonate, molecular weight of 100.06 g
mg/L - milligrams per liter
ND - non-detect (detection limit in parentheses)
NTU - Nephelometric Turbidity Units
s.u. - standard units

**FIGURE**




## EXPLANATION

- NPDES OUTFALL
- ALLUVIAL WELL
- BEDROCK WELL
- GSA WELL
- STREAM MONITORING STATION (ISCO)
- SPOIL WELL
- WEATHER MONITORING STATION
- DRAINAGE
- HIGHWAY
- ANCILLARY ROAD
- TWO TRACK TRAIL
- PHASE III RELEASE AREA
- POND BOUNDARY
- WATERSHED BOUNDARY
- MINE BOUNDARY

N

0 4,000'


Trihydro CORPORATION
1252 Commerce Drive
Laramie, WY 82070
www.trihydro.com
(P) 307/745.7474 (F) 307/745.7729


**FIGURE 2-1**

**PHASE III AND TOJ RELEASE AREA**

**CHEVRON MINING INC.**
**MCKINLEY MINE**
**MCKINLEY COUNTY, NEW MEXICO**

| Drawn By: PH | Checked By: TR | Scale: 1" = 4,000' | Date: 10/24/25 | File: Fig2-1_VMU_235_PBRA |
|---|---|---|---|---|

M:\CHEVRON\CEMC_MINING\MCKINLEYMINE\GIS\PROJECTS\MMD\PHASEIII_BONDRELEASEHYDROREPORTS\202508_OSM_VMU-2-3-5\MCKINLEY_202508_OSM_VMU-2-3-5.APRX

# APPENDIX A

## MCKINLEY MINE PERMIT SECTION 3.4, HYDROLOGY INFORMATION

- (108°56'40"; 35°41'38") 16.1 ac-ft/annum (File No. G-93)
- (108°54'35"; 35°40'52") 16.1 ac-ft/annum (File No. G-94)
- (SW¼, NW¼, SE¼ Sec 14, T16N, R20W) 16.1 ac-ft/annum (File No. G-95)
- (NW¼, SE¼, NW¼ Sec 9, T16N, R20W) Domestic/Sanitary (File No. G-258)

A search of the Office Of The State (NM) Engineer records indicates the following additional groundwater rights holders in the vicinity of McKinley Mine (Appendix 3.4-A):

- (NW¼, NE¼ Sec 3, T16N, R21W) (File No. G-160, M. Abukhalil, Domestic)
- (NE¼, NW¼, Sec 1, T16N, R21W) (File No. G-28, W. Bald, Domestic)
- (SE¼, NE¼, SE¼ Sec 11, T16N, R20W) (File No. G-51, C. Wilhelm, Stock)
- (NW¼, SE¼, SE¼ Sec 9, T16N, R20W) (File No. G-390, N. Murphy, Domestic)
- (NW¼, NW¼ Sec 9, T16N, R20W) (File No. G-976, B. Nicholson, Domestic)
- (NE¼, NE¼ Sec 7, T16N, R20W) (File No. G-131, C. Harris, Domestic/Stock)
- (SW¼, NW¼, SE¼ Sec 1, T16N, R20W) (File No. G-677, N. Nation, Domestic)

## 3.4.3 HYDROLOGIC MODELING

Appendix 3.4-E contains modeling information which characterizes and contrasts surface water quality and quantity for medium sized watersheds in undisturbed, disturbed, and reclaimed surficial conditions.

## 3.4.4 PROBABLE HYDROLOGIC CONSEQUENCES (PHC)

The PHC addresses existing mining areas and the new mining area referred to as the "East Wing." The addition of 1870 acres in the East Wing Revision does not alter any of the surface or groundwater parameters addressed in the PHC. To address the addition of the East Wing, a separate and detailed update follows this general PHC analysis.

The validity of the PHC for the existing mining areas and the East Wing is supported by surface and ground water sampling programs conducted by P&M since 1980, which verify the original assumptions of runoff quantity and quality in the PHC. Surface and groundwater monitoring data is submitted to the OSM quarterly and as part of the Annual Report. A collection of studies, which analyze the data for both surface and groundwater, further verify the validity of the basis for the PHC and are included in this PAP at Appendix 3.4-G for surface water and Appendix 3.4-H for ground water.

Data collected from the surface water sampling program includes small (1.2 - 6.1 acres), medium (188 - 235 acres) and large (5.7 - 27.5 square miles) paired watersheds. Quarterly ground water sampling results show a slight reduction in the sparse alluvial and bedrock aquifers, and confirm the stagnant nature and poor quality of the aquifers. Sampling of the Gallup Aquifer shows no reduction in pumping quantity other than ordinary well usage drawdown and no change in quality.

In summary, more surface water will be retained on the reclaimed areas resulting in a slight reduction in runoff to the Puerco River drainage. The quality of surface runoff from the reclaimed areas has been shown to improve due to lower suspended solids and total settleable solids. PATFM management will improve effluent levels of dissolved solids, salinity, and alkalinity. The ground water quantity will be reduced slightly in the alluvial and bedrock aquifers. There will be negligible impact on ground water quality in the alluvial and bedrock aquifers, and none in the Gallup Sandstone.

## SURFACE WATER QUANTITY

Surface water quantity may be increased on the reclaimed areas through the construction of small impoundments. These impoundments will be used to provide water for livestock and wildlife and to create small riparian habitats for small mammals, birds and reptiles. The amount of postmining runoff as compared to the premining runoff to the Puerco River drainage will be diminished by the harvesting of the water in the impoundments and other riparian areas. This reduction of runoff is supported by the hydrologic model included in Appendix 3.4-E of this application. However, the impact on the Puerco River drainage will be negligible due to the small percentage of the drainage area that the McKinley Mine comprises.

## SURFACE WATER QUALITY

For a short term following reclamation of an area there may be a slight increase in the levels of total dissolved solids, sulfates, and other soluble elements in the overburden. This increase will eventually lessen as the runoff leaches the overburden. This potential slight increase will be documented by the collection and analysis of surface water runoff during the permit term as described in Section 6.3. The long term surface water PHC is described below.

### Physical Quality

Surface water physical quality will be improved through stabilization of the reclamation areas and the creation of post mining impoundments. These actions will result in lower TSS and T-Set-S in the runoff from the disturbed areas. The PHC is evaluated using hydrologic models contained in Appendix 3.4-E of the permit application, and through the collection of TSS and T-Set-S samples during flow events. The modeling indicated that per acre sediment yields from the mining and post-mining areas will be less than from the pre-mining areas. The analytical results indicate that the TSS concentrations from the disturbed watershed are consistently lower than the undisturbed watershed concentrations since monitoring began as documented in the Annual Hydrology Reports submitted to OSM. The following section provides a summary of the sediment yield modeling provided in Appendix 3.4.E.

The Area 6 total sediment yield from the 10-year, 24-hour precipitation event was estimated to be 415.4 tons, 472.3 tons, and 189.1 tons for the pre-mining, mining and

reclamation, and post-mining evaluations, respectively. On a per acre basis, sediment delivery equates to 0.45 tons/acre, 0.41 tons/acres, and 0.16 tons/acre for the pre-mining, mining and reclamation, and post-mining disturbance phases, respectively.

The average per acre sediment loading for the pre-mining condition is higher than for the mining and reclamation or post-mining conditions. For the mining and reclamation conditions, low sediment volumes are generated from reclaimed areas with BTCA sediment control practices, while somewhat higher sediment volumes are generated from the graded spoils where BTCA practices were not implemented. Nevertheless, the worst-case mining and reclamation condition does not exceed the pre-mining condition's average sediment loading values.

The volume of the sediment generated during the post-mining disturbance phase (when all disturbed areas have received a BTCA sediment control treatment) is significantly lower than either the pre-mining or mining and reclamation conditions. This leads to the conclusion that once BTCA practices are fully implemented, sediment transport is significantly reduced at the Mine compared to pre-mining conditions.

The times to peak sediment loading were estimated to occur at 12.4 hours, 12.0 hours and 12.2 hours for the pre-mining, mining and reclamation, and post-mining disturbance phases, respectively. These represent the period between commencement of the storm event and the time the peak sediment loading will be realized in runoff waters. The time to peak sediment loading for the pre-mining model corresponds to the time of peak runoff. The time to peak loading for the mining and reclamation and post-mining condition occurs approximately one hour before peak runoff occurs.

The predicted runoff volumes from the 10-year, 24-hour precipitation event for the three disturbance phase conditions are as follows: Pre-mining = 0.0389 acre-feet per acre of watershed, Mining and Reclamation = 0.0338 acre-feet per acre of watershed, and Post-mining = 0.023 acre-feet per acre of watershed. On a per acre basis, the largest volume of runoff occurs from lands in the pre-mining condition. The BTCA practices of land imprinting, mulching and revegetation utilized during the mining and reclamation, and post-mining disturbance phases reduce the overland flow velocity. As flow velocity is reduced, the runoff has increased opportunity to infiltrate into the soil and further reduce the volume of overland flow. Reduction in flow in turn reduces runoff, sediment carrying capacity and sediment delivery. Thus, the regulatory objective of preventing the contributions of additional suspended solids is met through the BTCA practices designed to harvest water and enhance soil moisture conditions in reclaimed areas. Also, water harvesting acts to stimulate plant growth and development. Increased vegetation cover in turn acts to improve the hydrologic characteristics of reclaimed lands.

### Chemical Quality

Surface water chemical quality will be unaffected or could possibly improve by minimizing the potential of runoff coming into contact with potentially acid or toxic materials (PATFM). These materials consist of those uncovered during the mining operations, native soil materials that of are poor quality, and naturally occurring exposed coal seams. The PATFM Management program which is discussed in Section 5.2 of this permit, will identify graded spoil areas that have acid or toxic materials present in or near the rooting zone. Areas identified through this program will be mitigated prior to revegetation. These actions will prevent the degradation of the surface water quality within the mine and improve the effluent levels of dissolved solids, salinity, and alkalinity.

## GROUNDWATER QUANTITY

### Gallup Sandstone Aquifer

As discussed above, the Gallup Sandstone Aquifer is used as the primary source of water for the mine and for the McKinley County area. This aquifer occurs 400 to 1,000 feet below the lowest coal seam to be recovered and has no local recharge features. The recharge area for this aquifer is located to the north of McKinley Mine in the Chuska Mountains.

P&M drilled it's first large scale water supply well in 1975 and began measurement of withdrawals from their four supply wells in 1986. The average rate of groundwater withdrawal for the Mine between 1986 and 2002 is 275 ac-ft/yr. Under the imposed pumping stress, the potentiometric surface (as defined by the Mines production wells) has sustained a maximum rate of decline of 3.1 ft/yr in Wells #1 and #3, a 14-foot rise at Well #2, and has remained stable at Well #3A (Tetra Tech EM Inc. 2003).

The potentiometric surface defined by Wells #2 and #3A suggest that water levels in much of the Mine area are stable or rising. This condition has resulted from less water production or use of Wells #2 and 3A over the last five years.

Measured drawdown of the potentiometric surface within the Gallup Sandstone aquifer is between 700 to 1,000 feet in some of the older wells in the Yah-ta-hey well field located east of the Mine (NWCOG, 1998). This is the primary source of water for the City of Gallup. The dramatic decline in local water levels is the result of low storage within the Gallup Sandstone and large pumping interferences between closely spaced production wells.

Under the current Mine water production schedule, the probable hydrologic consequence of continued pumping is minimal to non-existent. Annual water withdrawals at the Mine represent less than 5% of total groundwater withdrawals from the Gallup Sandstone aquifer in the region.

To further substantiate this information and to show current information pertaining to the Gallup Sandstone formation, P&M developed a revised structure map of the Gallup Sandstone formation. This map has been included in this application as Exhibit 3.4-1. It should be noted that this map supplements or supersedes information provided in Appendix 3.4-C pertaining to the Gallup Sandstone formation. The changes made in the Gallup Sandstone Structure map are based on information collected from the drill logs for the four Gallup Sandstone Aquifer wells in use at McKinley Mine, therefore only the information in the immediate vicinity of the Mine has been modified.

In addition, P&M has developed a map showing the potentiometric surface of the Gallup Aquifer (Exhibit 3.4-2). Elevations of the potentiometric surface of the Gallup Sandstone Aquifer reflect an estimate of current static water levels for the four Gallup Sandstone Aquifer wells in use at McKinley Mine. As with Exhibit 3.4-1, only the information in the immediate vicinity of the Mine has been modified.

The potentiometric surface depicted on Exhibit 3.4-2 of the Mine permit application shows that groundwater flows in an east-northeast direction in the vicinity of the Mine. The potentiometric surface slopes from the hogback located immediately west of the Mine toward a pronounced trough defined by the 6600-, 6500-, and 6400-foot contours. The trough appears to drain groundwater toward the northeast or San Juan Basin. Geohydrology Associates, Inc (1980) were the first investigators to identify the trough feature, which appears to still exist.

**Alluvial Aquifers**

As discussed above, alluvial water is practically nonexistent, occurring generally in close proximity to arroyos, and in direct relation to the rate and amount of runoff in the arroyos. Water soaks into the sides and bottoms of the arroyos during runoff events. This type of recharge occurs principally during snowmelt and the summer runoff season. The only instance where this type of groundwater will be affected by the mining operations, is where alluvial areas are actually mined. The hydrologic impact on this groundwater source will be complete removal of the resource when encountered during mining. However, due to the limited areal extent of the resource, any impacts would be considered negligible.

**Bedrock Aquifers**

Bedrock water quantity is minimal in extent, consisting only as small pockets of perched water in the various stratums. The quantity and areal extent of these pockets of water are not of sufficient quantity or quality to be considered significant. This water is normally observed as seepage from the highwall or small amounts of water on the pit floor. The mining operation results in removal of this insignificant groundwater source.

## GROUNDWATER QUALITY

### Gallup Sandstone Aquifer

As noted above in the discussion on groundwater quantity, there will be no impact by mining on the recharge zones of the Gallup Sandstone Aquifer. Therefore, there will be no impact on the quality of the Gallup Sandstone Aquifer by the mining operations.

### Alluvial Aquifers

Alluvial water quality, in undisturbed areas, will continue to be influenced primarily by the amount of runoff in the arroyos and characteristics of the soils in the area of infiltration. There will be minimal impacts on the quality of this resource by the mining operations.

### Bedrock Aquifers

The bedrock water encountered during mining will be removed in the mining process. This removal will have no effect on the water present in areas not affected by mining. This is due to the low transmissivity of the formations associated with this type of water.

## PROBABLE HYDROLOGIC CONSEQUENCES EAST-WING UPDATE

The section contains a detailed East Wing update regarding the Probable Hydrologic Consequences from this operation. The update also provides the necessary background information to show that there are no adverse impacts to the hydrologic regime from current mining and nor any expected from East Wing operations. This information also serves to show that surface and ground water monitoring mechanisms are in place to maintain an active watch over the hydrologic behavior of the East Wing and the rest of the mine. In order to accomplish this update, it was necessary to discuss information collected over the years mine wide from surface and ground water monitoring program.

### Surface Water Monitoring

### Major Drainage results and comparisons

Surface water from major drainages has been monitored since the early 1980's through active surface water monitoring stations. Four stations (TBW, CMWT, DDT6, DD) collect samples that have disturbed-area watersheds. One station (CMW) collects samples from a relatively undisturbed channel. The CMW station data is used as background information to contrast against the other four stations. One additional station has been constructed in the East Wing (EW1). EW1 went online in 2001 and provides baseline information concerning the East Wing area.

Data from the disturbed-watershed monitoring stations was contrasted with information from the undisturbed-drainage monitoring station in the 2000 Annual Report. That data has been included here under Appendix 3.4-I. The data ranges from the early 1980's through 2000. The following parameters are summarized in the report, as agreed upon with OSM, and include: pH, TDS, TSS, dissolved selenium, total iron, and dissolved boron. The data collected for a given year has been averaged and graphed. The original data for the entire list of parameters tested are submitted quarterly and are on file with OSM.

In general, the contrasted data shows a high level of agreement for nearly all the stations for most of the parameters over many years. That is, the background levels did not markedly differ from the disturbed watershed values. In very few instances, did the disturbed exceed the background levels significantly.

Various factors can affect the level of agreement between any of the watersheds. Perhaps of highest consideration is the effect localized thunderstorms can have on each watershed. For example, a high runoff event in one watershed could dilute TDS and raise total suspended solids (TSS). A low runoff event in another watershed could record a more concentrated TDS and lower TSS. Subsequently, the comparability of the two watersheds could be difficult at times. Therefore, to help evaluate the data, standards will be referenced where possible to see how the overall water quality measures up.

The CHIA for McKinley Mine (1984) established a value of 5000 mg/L of total dissolved solids (TDS) that could constitute material damage. The value represents the maximum TDS concentration recommended for livestock or irrigation. In the mid-1980's, a few high TDS averages are observed for some of the disturbed watersheds. While the counterpart TDS from CMW were generally less, the TDS were still below the 5000 mg/L reference.

The CHIA (1984) established that very high concentrations of TSS would be expected. The graphs show that most of the time TSS were higher for the undisturbed wash versus the other four disturbed watersheds. TBW had no data recorded in 1989, subsequently, no valid comparisons can be made that year.

As expected, average pH for both undisturbed and disturbed watersheds were alkaline. Generally, there was relatively good agreement in pH between the undisturbed and disturbed watersheds. The graphs show that pH averages were above 7.0 and below 9.0; quite often, the undisturbed watershed had the higher pH.

The other three parameters of interest are total iron, dissolved selenium, and dissolved boron. Initial data shows that the values for total iron and selenium were higher the first few years of sampling before leveling off. In those instances the undisturbed drainage had the higher values. The total iron for CMW and CMWT seems artificially high, but there is no information available at this point to confirm the data. Subsequent data,

however, reflects constant parallel values between the undisturbed and disturbed watersheds that are low.

Boron comes into play around 1991. While disturbed and undisturbed watershed data for dissolved boron values agree at times, other times they vary by up to 0.2 mg/L. The highest averages do not go above 0.4 mg/L, which is below the New Mexico Administrative Code standard for irrigation of 0.75 mg/L, and 5.0 mg/L for livestock watering.

The EW1 major drainage surface water monitoring station was constructed in late 2000, and data is available for 2001. This data is contained in Appendix 3.4-I. The station captures runoff from an undisturbed watershed that will be affected by the East Wing mining operations. Subsequently, this data will serve as baseline data to contrast against information gathered from the disturbed watershed.

The initial EW1 data for various key parameters is summarized in the Table 3.4-1. The maximum values (pH includes minimum) recorded are shown.

Table 3.4-1
East Wing Surface Water Monitoring Station Data

| Parameter | pH | TDS (mg/L) | TSS (mg/L) | SAR | Sulfate (mg/L) | Total Iron (mg/L) | Boron (mg/L) |
|---|---|---|---|---|---|---|---|
| | 7.78-8.84 | 320 | 83000 | 3025 | 104 | 100 | 0.2 |

In summary, no additional major drainage watershed monitoring stations are necessary to construct. The EW1 surface water monitoring station will provide adequate representation of the East Wing mining areas, and to the overall hydrologic regime.

**Medium Drainage results and comparisons**
There are three medium watershed-monitoring stations at McKinley Mine (DDT9, DDT10, and A12). All three monitoring stations are in the Defiance Draw watershed (the Defiance Draw drainage also includes the East Wing mining area watersheds). DDT9 and DDT10 are downstream from areas affected by mining. The A12 monitoring station is in an undisturbed watershed in Area 12 just southeast of the East Wing mining areas.

The 2000 annual report data from the three stations is provided in Appendix 3.4-I. The data represent average values for the runoff season. Detailed data for parameters in the 2000 annual report, plus all the other parameters tested were submitted to OSM via quarterly reports.

The graphs show consistent ranges of values for most years for the parameters shown for the undisturbed versus the disturbed watersheds. DDT9 shows a spike in total iron in 1998; however, nearly all the runoff to this location came from alluvial areas ahead of mining. Subsequently, it is difficult to quantify the spike. Most other years, there was

good agreement with iron.

No additional medium-drainage monitoring stations are needed for the East Wing since the A12 monitoring station is already near the East Wing. Since the East Wing is in the Defiance Draw drainage, the three medium-drainage monitoring stations are adequate to characterize surface water from medium drainages into Defiance Draw.

## Ground Water Monitoring

### Alluvial wells

Alluvial well transects are located in various locations throughout the mine. The intent of the transects was to monitor valley-fill water resources. The transects are located in five drainage locations that include Tse Bonita Wash, Coal Mine Wash, and Defiance Draw.

These drainages have one or more transects. The Tse Bonita Wash (TB) transect consists of 6 wells at two transects (TB2 and TB3). The Coal Mine wash (CM) transect consists of 6 wells. The Defiance Draw Drainage (the largest of the drainage systems) consists of three transect locations: DT2 (4 wells), D2 (5 wells), and D3 (4 wells).

Well information for key parameters agreed to between OSM and P&M from the 2000 annual report is provided in Appendix 3.4-I. Data is collected quarterly from some wells, and annually from others. Quarterly data was averaged by year for the 2000 annual report. Detailed data for 2000 annual report parameters, and all the other parameters tested were submitted to OSM via quarterly reports. The appendix also includes information regarding what alluvial wells have been historically dry.

The wells nearest to the East Wing are the four DT2 wells located to the southwest in Area 11. Over the past 15 years, water levels in three of the wells have not changed significantly (the 4$^{th}$ well is dry). An overview of the key chemical parameters shows that these values have remained fairly constant with the values originally recorded in the wells. Occasional spikes do appear, but have been short-lived and probably related to precipitation levels.

As reported in the original baseline report done by Geohydrology Associates, Inc., (1980), there were no existing wells which tap the valley-fill deposits of Defiance Draw. It was concluded in the report that Defiance Draw valley-fill material did not constitute an aquifer.
Geohydrology Associates, Inc. (1980) did a water quality evaluation of the well samples using the drinking water standards available at that time from the U.S. Public Health Service. None of the samples met these drinking-water recommendations for sulfate or dissolved solids.

Monitoring over the years has not shown any changes that would negate the original

evaluation. Since the remaining alluvial fills in the East Wing are also tributary to Defiance Draw, it is apparent that drilling more transects in these upper reaches of Defiance Draw would not provide information that is not already captured in the existing wells. Given the proximity of the DT2 wells to the East Wing, and the fact that there already exist three sets of transects in the Defiance Draw watershed, no additional transects are needed in the East Wing.

**Bedrock wells**

Five bedrock wells were drilled to a depth of about 50 feet below the Green coal. The holes were referred to as McKinley bedrock (MBR) wells and distributed around the lease. The five wells are referred to as MBR1, MBR2, MBR3, MBR4, and MBR5. MBR4, located in Area 9 (south of Highway 264) was mined through and not replaced.

Well information for key parameters agreed to between OSM and P&M from the 2000 annual report is provided in Appendix 3.4-I. The wells are sampled annually. Detailed data for 2000 annual report parameters, and all the other parameters tested were submitted to OSM via quarterly reports.

The original baseline report by Geohydrology Associates, Inc. (1980) concluded that the wells had little potential as meaningful groundwater resources. The transmissivity of the bedrock deposits were low, less than 6 $ft^2$/day and not capable of maintaining a constant discharge of 1 gallon per minute sustained yield. Also, even though ground water was present, none of the strata had sufficient continuity to be considered an aquifer.

Quality-wise, Geohydrology Associates, Inc.'s (1980) baseline work showed that the ground water that was there did not meet the recommended maximum drinking-water standards set by the U.S. Public Health Service. The total mineralization was more than twice the recommended standard, fluoride was three times above the standard for MBR 2 and 3, and sulfate values were above the standard (250 mg/L) for MBR 2 (325 mg/L).

The wells that provide the most useful information in assessing the existing and expected bedrock-hydrology of the East Wing are MBR2 and MBR3. MBR2 will be reviewed to see how it has behaved since mining has occurred around that site and because it is the second nearest well to the East Wing. MBR3 will be evaluated since it is located in the middle of the East Wing. The period 1995 – 2000 has been averaged and listed below and contrasted against the 1980 values in the baseline report, and the standards contained in The Safe Drinking Water Act.

Table 3.4-2
MBR2 and MBR3 Quality Evaluation (mg/L)

| | Sulfate | TDS | Nitrate | Chloride | Iron | Fluoride |
|---|---|---|---|---|---|---|
| MBR2 | | | | | | |
| (95-00) | 527 | 1458 | 0.3 | 13.3 | 0.5 | 5.1 |
| 1980 | 325 | 1136 | 0.4 | 6.4 | | 5.5 |
| MBR3 | | | | | | |
| (95-00) | 120 | 1537 | 0.16 | 82.5 | 0.6 | 6.9 |
| 1980 | 70 | 1368 | 0.5 | 86 | | 5.7 |
| Standard | 250 | 500 | 10 | 250 | 0.3 | 2.0 |

The data contrast shows that little has changed in either well. TDS and fluoride still remain unacceptably high in both wells. In MBR2, sulfate that was already above the threshhold, still remains above the threshold. Chloride did increase for MBR2, but still below the standard.

MBR3 shows little change from what was originally reported in the baseline assessment. Given that little has changed from the original 1980 evaluation, the need to keep MBR3 does not seem necessary. The well was originally determined to be a poor resource for ground water from a quantitative and qualitative perspective—nothing has changed to negate that finding. In conclusion, the well will be mined through and not replaced.

**Gallup Sandstone Aquifer**

The potential effect of mining on the Gallup Sandstone Aquifer is monitored through the sampling of four wells: Well 1, Well 2, Well 3, and Well 3A. As stated in the Geohydrology Associates, Inc. report (1980), the Gallup aquifer is under artesian conditions because of the impermeable shales above it. Data from the wells also had shown that transmissivity was quite variable from well to well.

The data from the 2000 annual report is included in Appendix 3.4-I. The data collected quarterly was averaged for each year for the annual report. The information shows key parameters that P&M and OSM agreed to include in the Annual Report. Detailed data for the 2000 annual report parameters, and for all the other parameters tested were submitted to OSM via quarterly reports.

The McKinley Mine CHIA (1984) contained initial information on total dissolved solids (TDS) that will be useful to evaluate. The CHIA states that total dissolved solids for the Gallup Sandstone Aquifer averaged 1,121 milligrams per liter (presumably the overall

aquifer).

Data from the four McKinley Mine wells show that total dissolved solids from these wells had a better quality initially than the average aquifer value of 1,121 mg/L. None of the wells started out with TDS above 700 milligrams per liter. Over the years, TDS for some wells has gone up and down; however, the quality has generally improved or stayed about the same. By 2000, TDS for three of the wells were below 400 mg/L; the fourth well was just below 500 mg/L.

The same trending and conclusions can be made about sulfate values, which also have gone up and down over time. By 2000, sulfate values have either decreased, or stayed close to the original 1983 values.

Iron values have stayed low and fairly constant over the past ten years. One spike, however, is noted in 1990 for Well 1; this anomaly is likely a sample contamination or lab error since the other values were very low (seven times less than the spike) and had not changed very much the other 17 years. Some other high iron values were recorded in the late 1980's for the other wells; since then, however, iron values have stayed consistently low. For the most part, iron values for two wells have been less than the original values (wells 3 and 3A); iron values for the other two wells (1 and 2) have generally stayed near the originally-tested values.

Static water levels have generally increased or stayed close to the initial recorded levels according to the data. Subsequently, no problem is noted with well recharge.

In summary, the well data show that the character of the aquifer has changed little and generally improved. Therefore, it is concluded that mining at the McKinley Mine is not adversely impacting the Gallup Sandstone aquifer. No future impact of the Gallup Sandstone Aquifer is likely; the recharge zone is not located in the McKinley Mine area, and the aquifer lies below impermeable shales.

### 3.4.5 CHIA (SYNOPSIS)

The Cumulative Hydrologic Impact Assessment (CHIA), completed by the Radian Corporation for the Office of Surface Mining as part of the Technical Analyses and Environmental Assessment by OSMRE on Permit No. NM-0001B/3-10P, covers all of the areas to be mined by this application and is still valid. Included below is a brief synopsis of the conclusions of the CHIA:

- Surface water use in the area is primarily stock watering with some irrigation. There are no permitted water rights holders downstream of the mining operation in the cumulative impact area. Indicator parameters related to hydrologic concerns in the basin are total dissolved solids and total suspended solids (TSS) concentrations.
- Cumulative impacts to the quantity of the flow in the Puerco River are

insignificant.

- Cumulative impacts to the quality (TDS and TSS) of flows in the Puerco River are minimal and should not cause significant changes in baseline conditions. No material damage to the hydrologic balance is expected.
- Ground water is an important source of water in the Gallup area. The major ground water pumping centers are at the Santa Fe and Yah-ta-hey well fields, both completed in the Gallup Sandstone and operated by the city of Gallup. Shallow ground water is not widely used owing to the relatively poor chemical quality and small well yields.
- Cumulative impacts related to ground-water quality are not expected: ground-water quality in terms of TDS and sulfate has not been demonstrated to change significantly and the poor physical properties of the near-surface zones are not greatly altered by mining.
- Ground-water quantity in the Gallup aquifer may be affected by the cumulative impacts of mining, particularly if declared water rights are fully used by P&M. Calculations of water-level drawdowns indicate that the Yah-ta-hey well field could experience up to 3 feet of drawdown attributable to mining activities; this does not constitute material damage. No material damage, based upon a criterion of a decline of 25% of available hydraulic head, is predicted as a result of surface coal mining.

Thus, based upon the report, P&M feels that any impacts which have or will occur on the hydrologic systems at the McKinley Mine are insignificant.

### 3.4.6 DEVELOPED WATER RESOURCES

### SURFACE WATER RESOURCES

All identified developed surface water resources within the proposed permit area and within 1000 feet of the proposed permit boundary are shown on Exhibit 3.4-3. A total of 8 developed surface water resources were identified. All six of the resources are stockponds. Two of the resources will be disturbed by mining during this permit term; whereas, the other six resources will not be disturbed during this permit term. Replacement of the stockponds that will be disturbed during this permit term is discussed in Section 5.7.

Permit NM-0001B Exhibit 2.9-1 depicted an impoundment located in the center of section 5. Subsequently, the impoundment was noted as a Stockpond in the original Developed Water Resource documentation. However, this impoundment was not a stockpond but a temporarily abandoned mining pit which was being temporarily used to impound water for dust control. This pit was covered by a surface water user permit which allowed for the diversion of the Tse Bonita Wash into it for water storage. Mining has since resumed in this pit and it no longer exists. At no time was this pit ever used for any other purpose but mining related storage.

# APPENDIX B

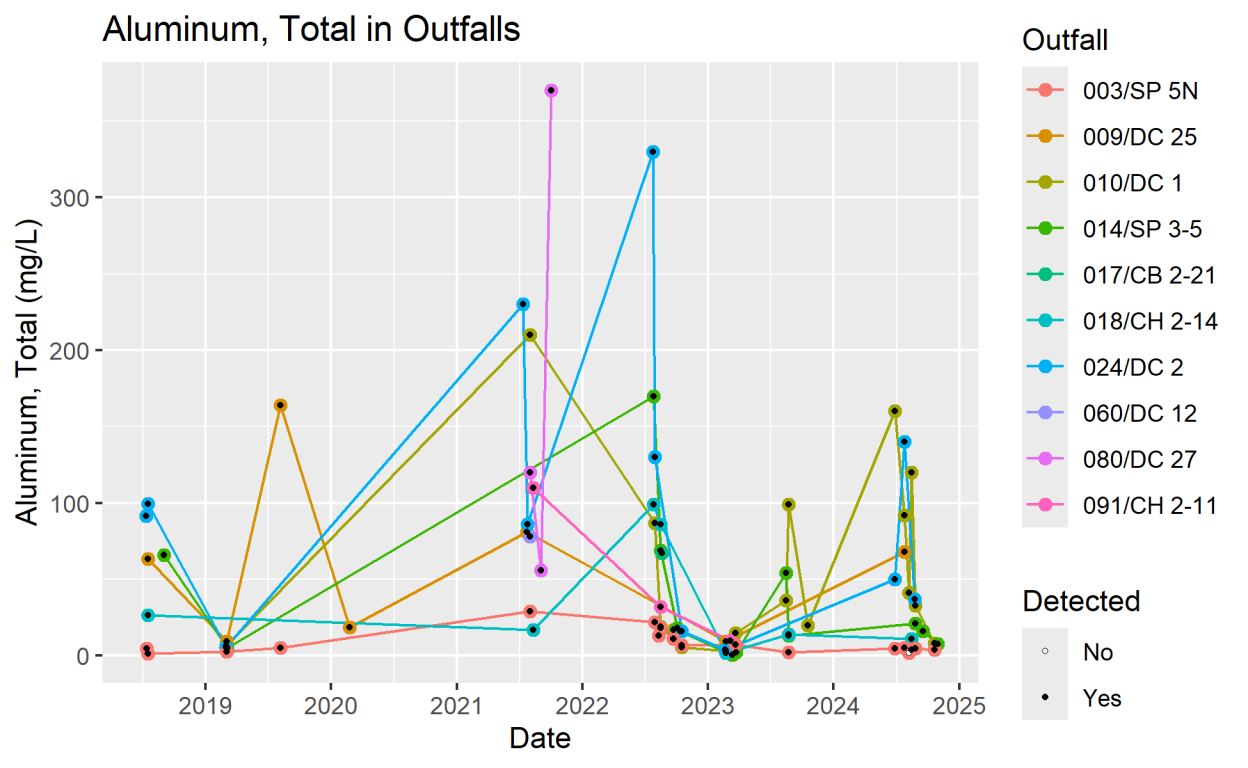
## SURFACE WATER QUALITY TEMPORAL PLOTS

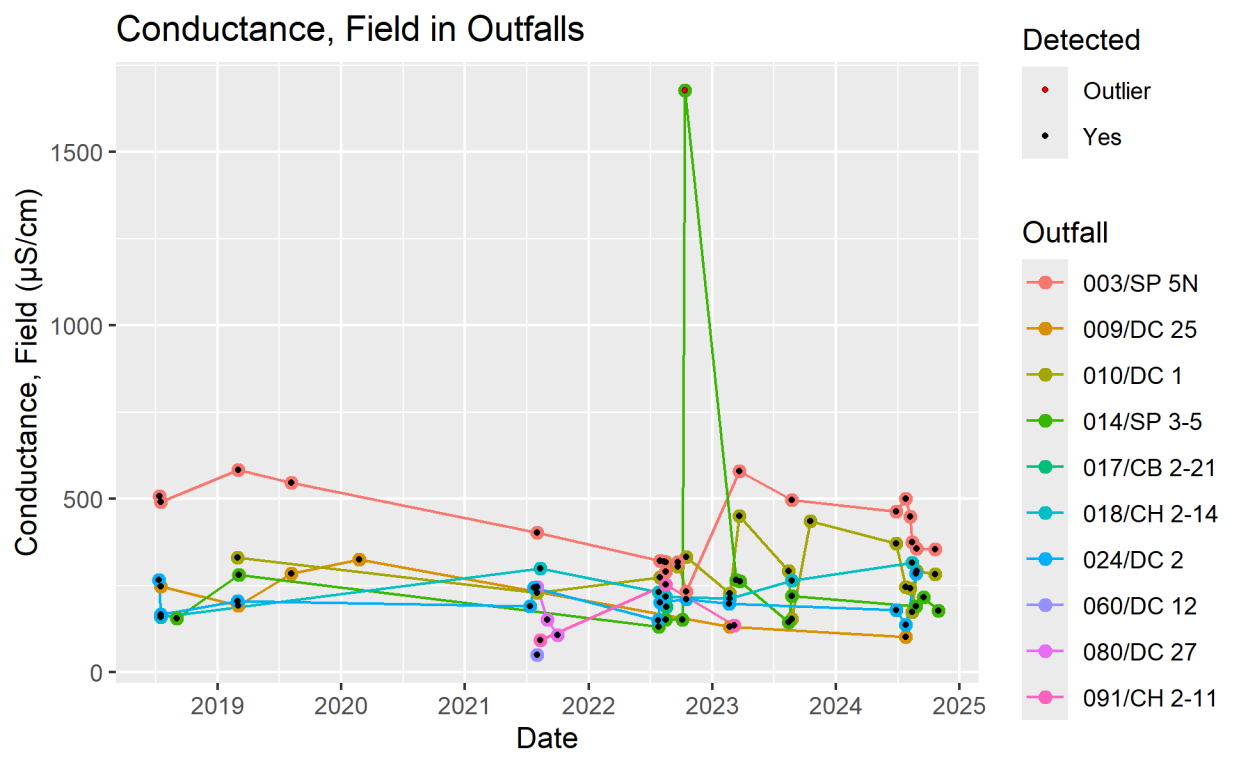
**B-1. DISCHARGE SURFACE WATER QUALITY TEMPORAL PLOTS – OUTFALLS 003/ SP 5, 009/DC-25, 010/DC1, 014/SP-3-5, 017/CB-2-21, 018/CH-2.14, 024/DC-2, 060/DC-12, 080/DC-27 AND 091/CH-2-11**

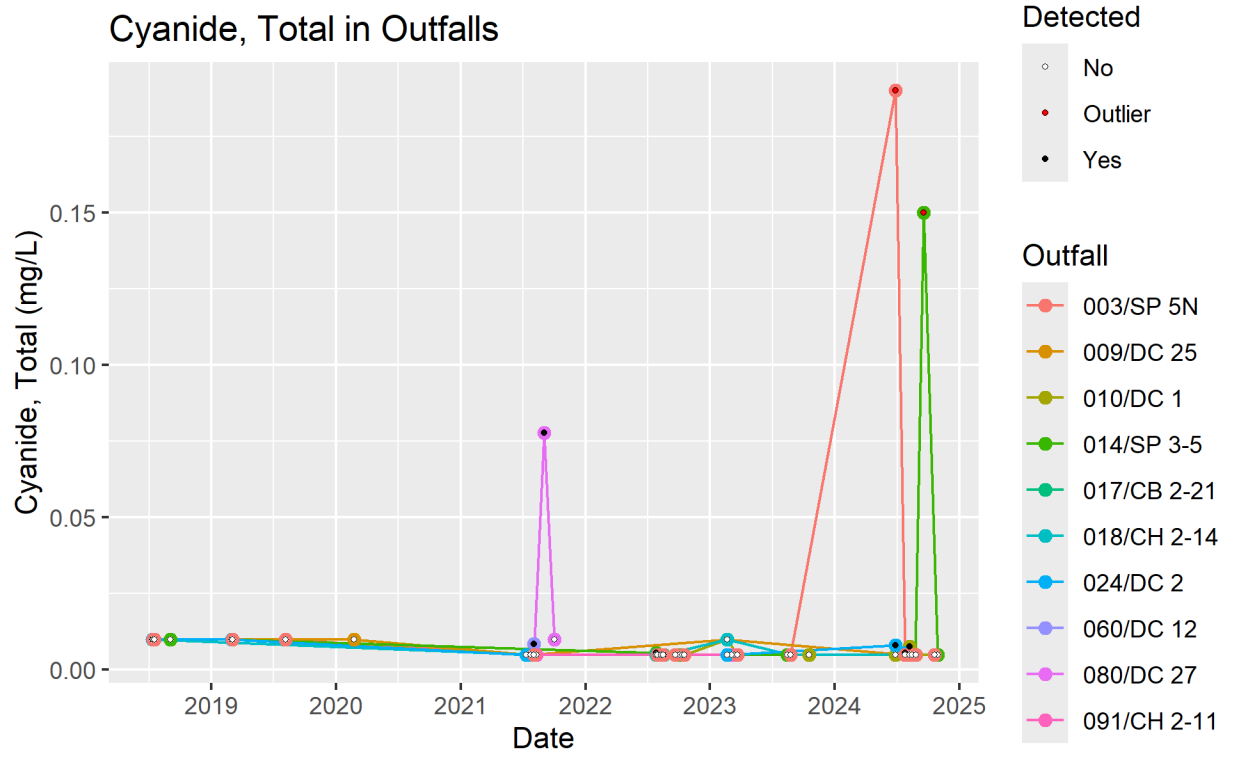
**B-2. SURFACE WATER QUALITY TEMPORAL PLOTS – COAL MINE WASH TRIBUTARY (CMWT) AND TSE BONITA WASH (TBW)**

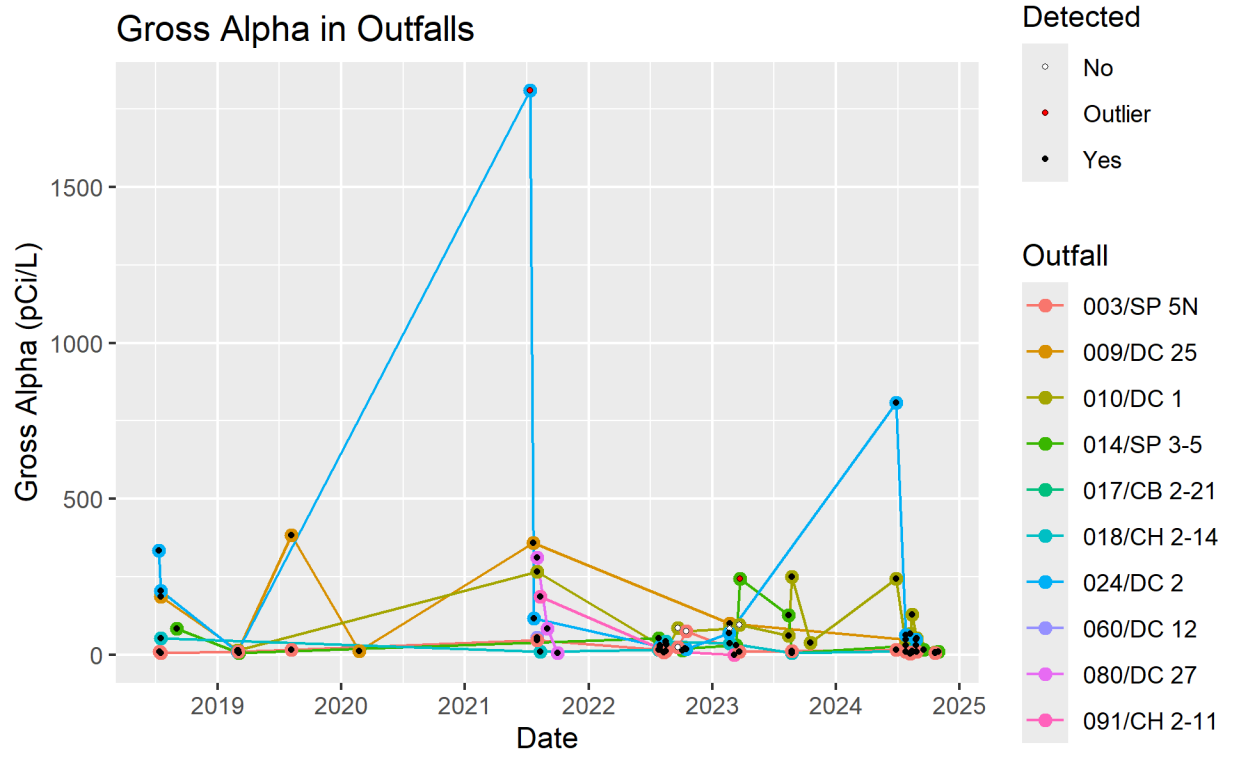
# APPENDIX B-1

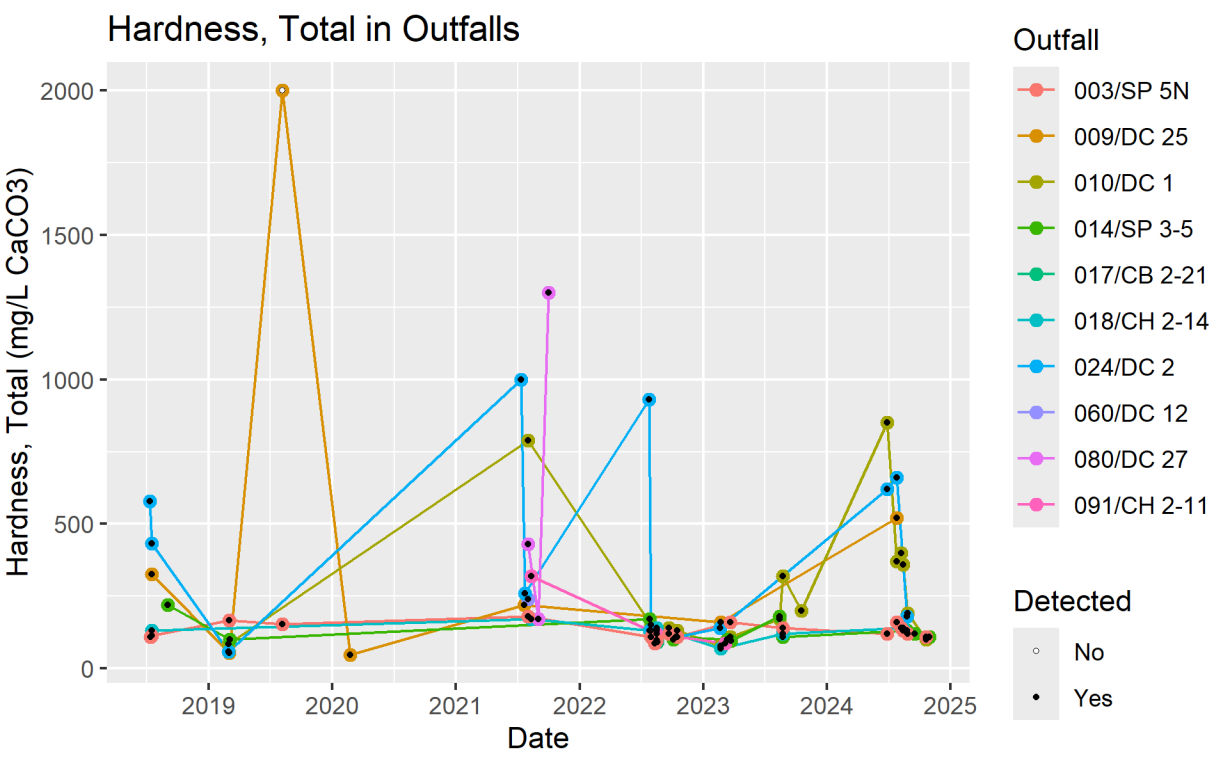
## DISCHARGE SURFACE WATER QUALITY TEMPORAL PLOTS – OUTFALLS 003/SP 5, 009/DC-25, 010/DC1, 014/SP-3-5, 017/CB-2-21, 018/CH-2.14, 024/DC-2, 060/DC-12, 080/DC-27 AND 091/CH-2-11

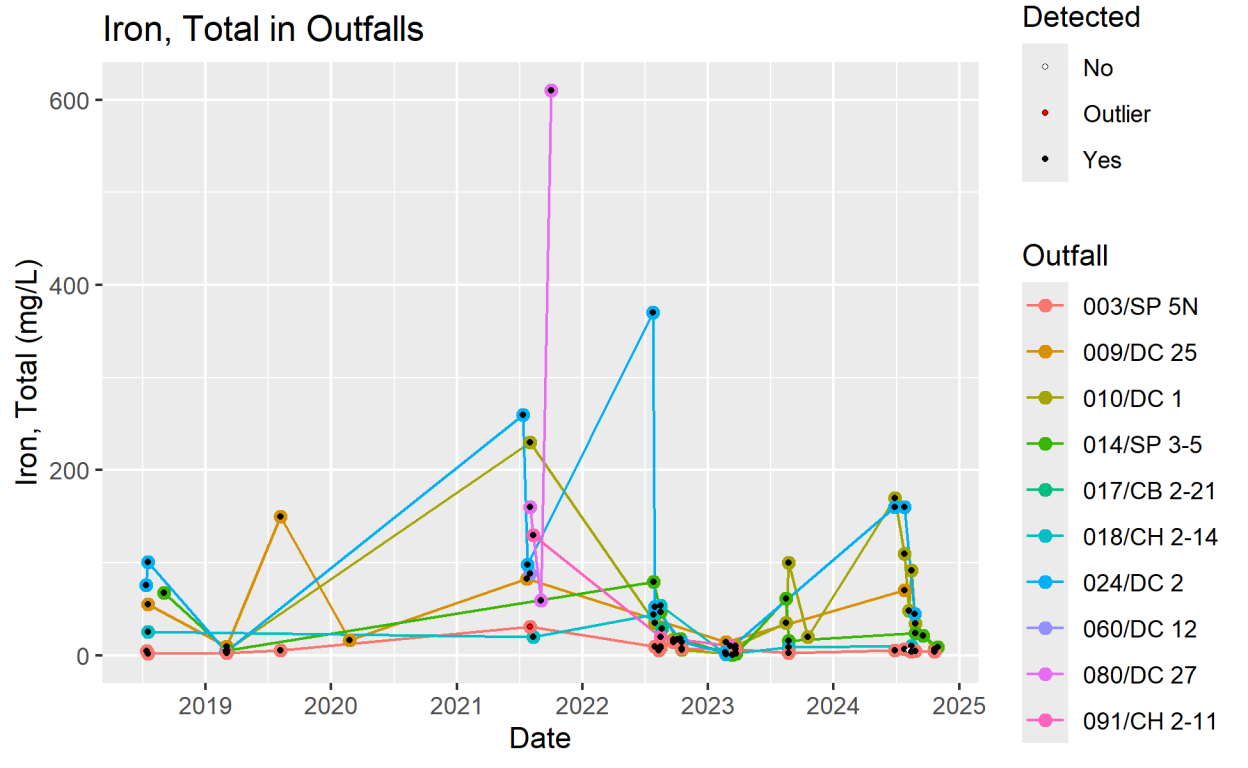

Aluminum, Total in Outfalls
Aluminum, Total (mg/L)
0
100
200
300
2019
2020
2021
2022
2023
2024
2025
Date
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11
Detected
No
Yes

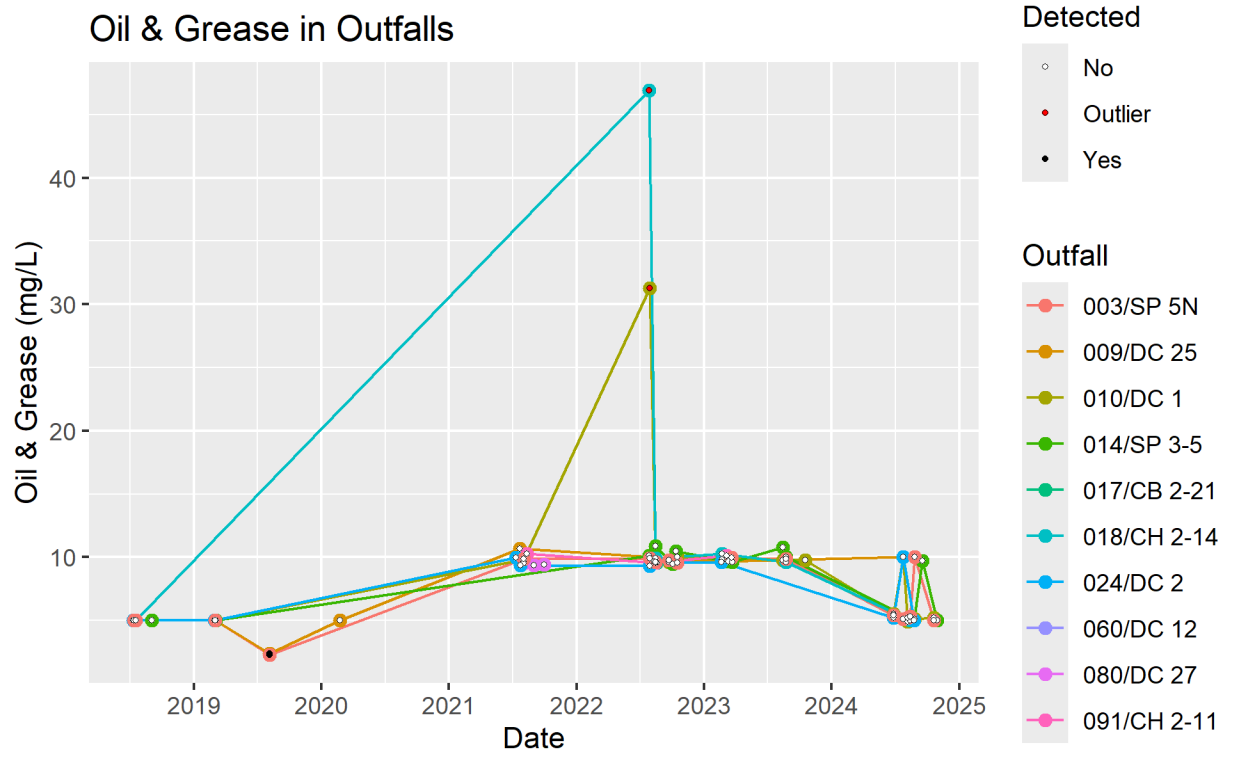

Conductance, Field in Outfalls
Conductance, Field (µS/cm)
1500
1000
500
0
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11

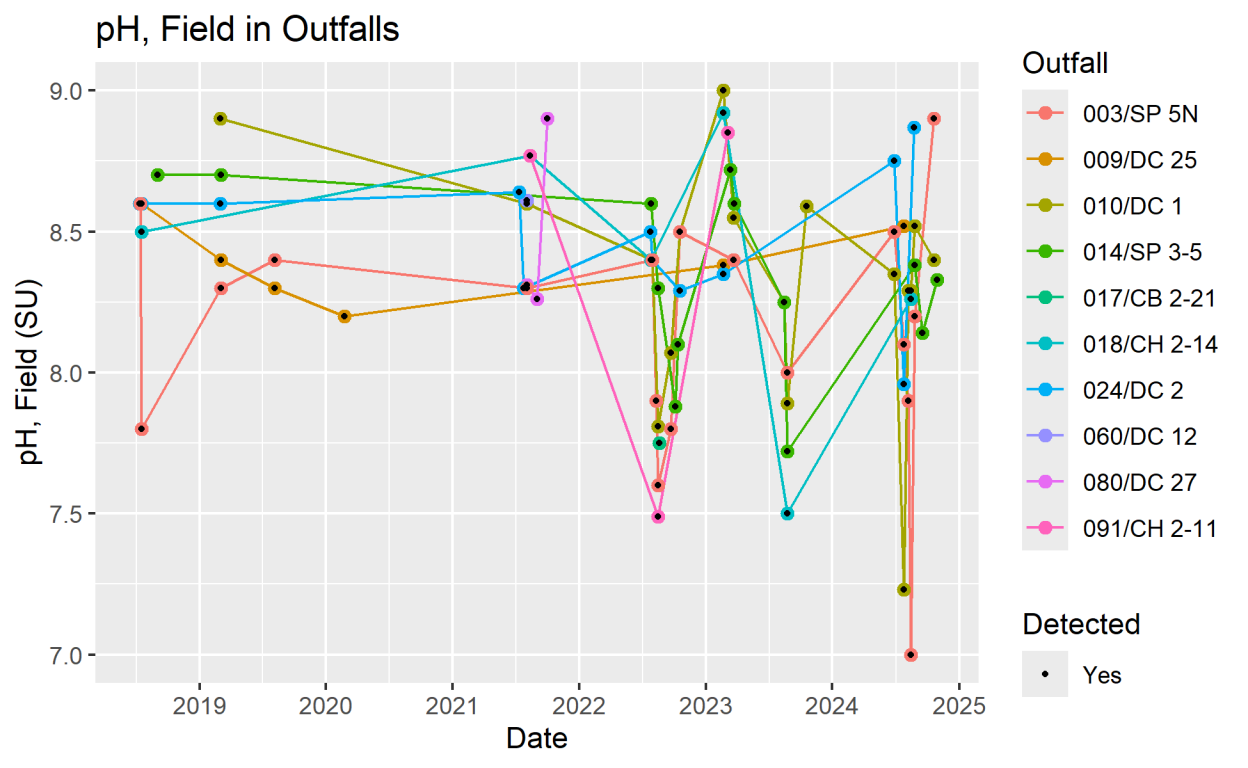

Cyanide, Total in Outfalls
Cyanide, Total (mg/L)
0.15
0.10
0.05
0.00
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11

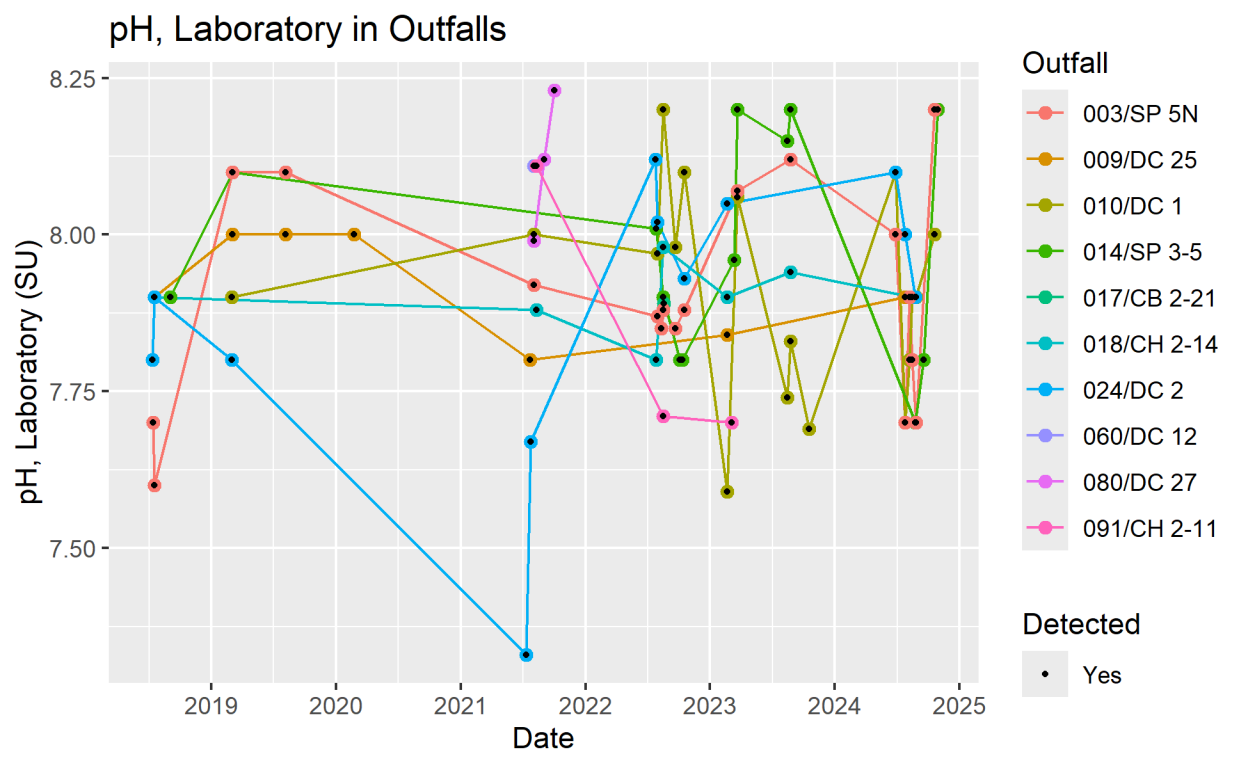

Gross Alpha in Outfalls
Gross Alpha (pCi/L)
1500
1000
500
0
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11

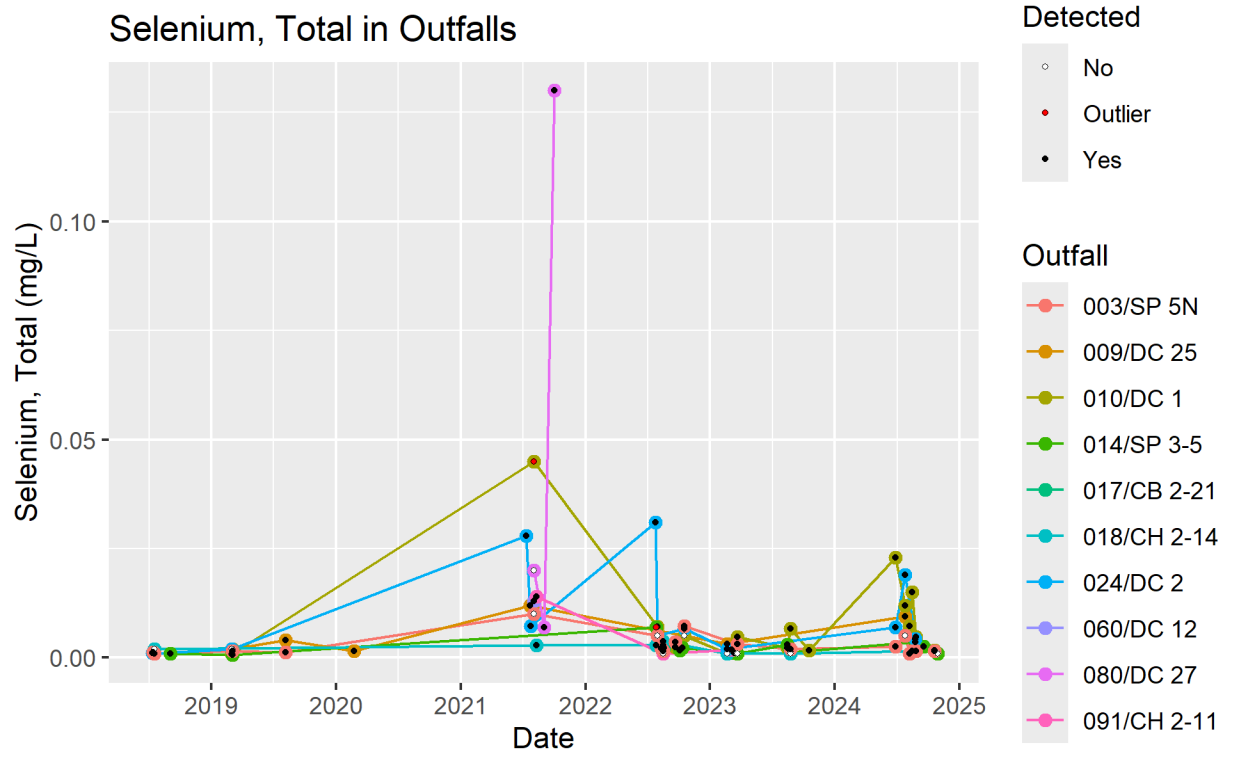

Hardness, Total in Outfalls
Hardness, Total (mg/L CaCO3)
2000
1500
1000
500
0
2019
2020
2021
2022
2023
2024
2025
Date
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11
Detected
No
Yes

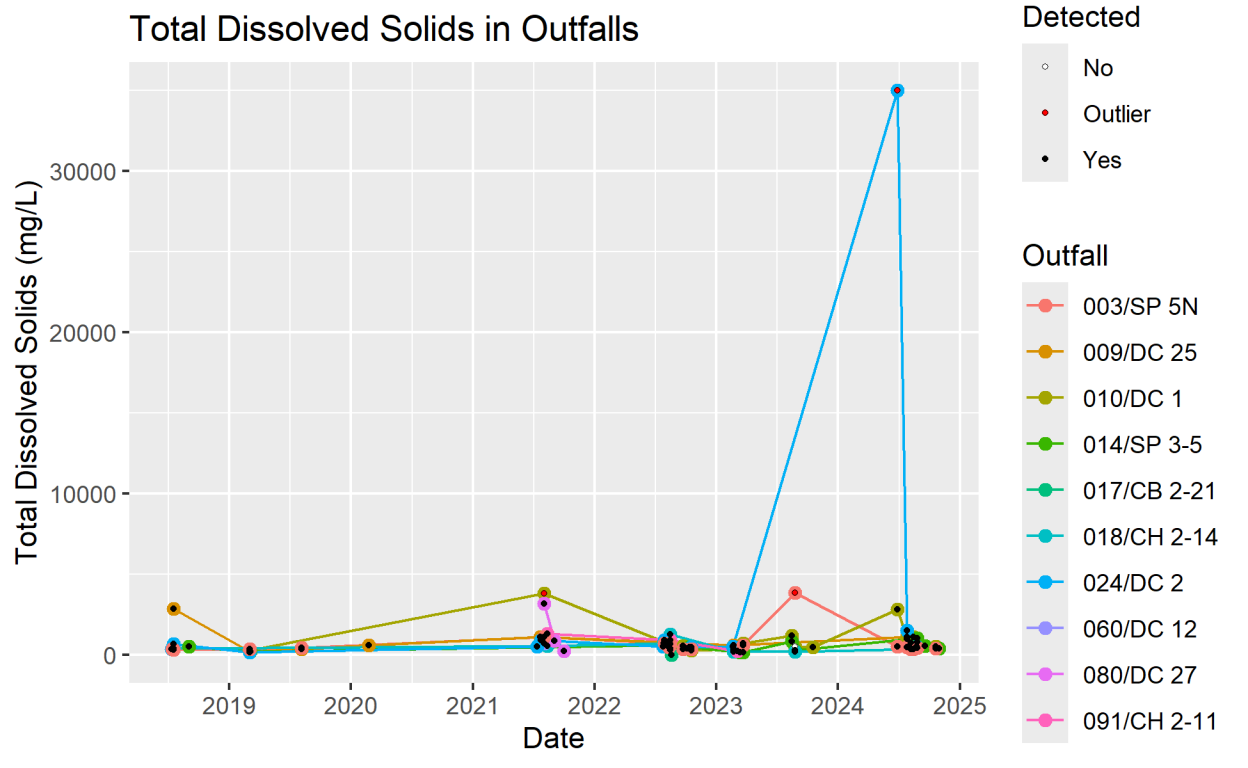

Iron, Total in Outfalls
Iron, Total (mg/L)
600
400
200
0
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11

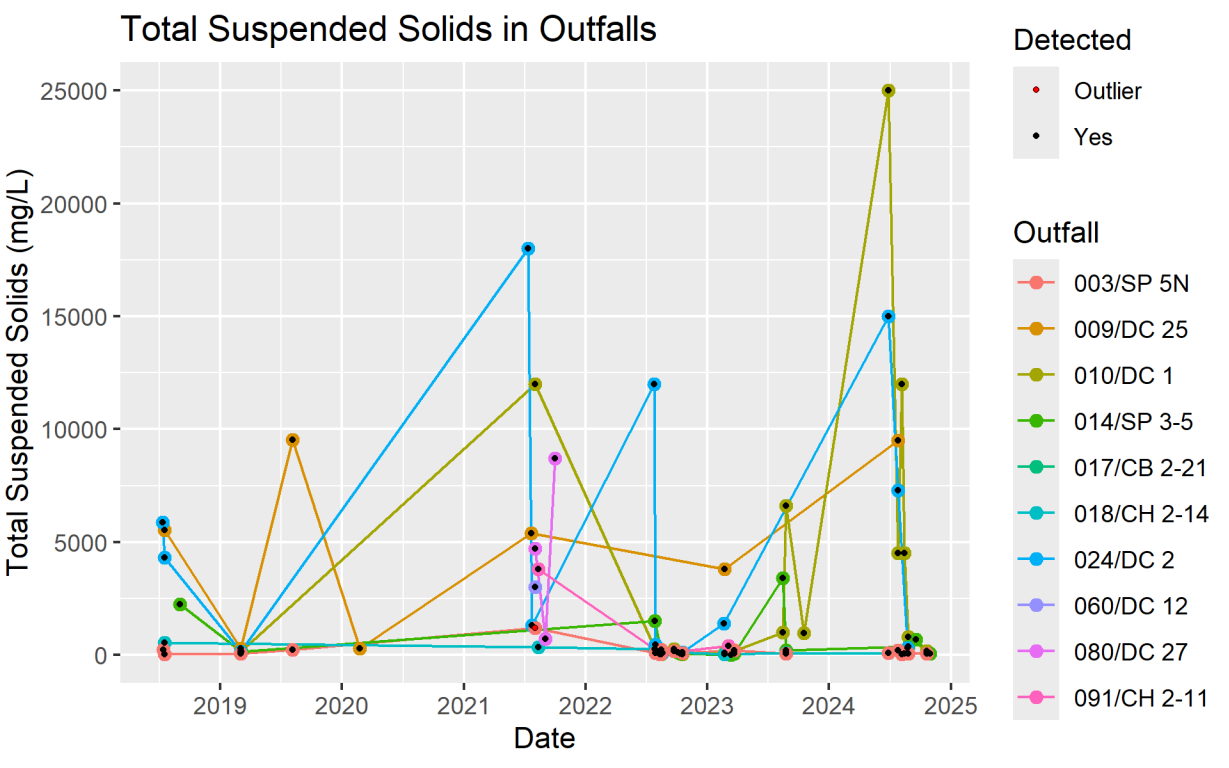

Oil & Grease in Outfalls
Oil & Grease (mg/L)
40
30
20
10
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11


pH, Field in Outfalls
pH, Field (SU)
9.0
8.5
8.0
7.5
7.0
2019
2020
2021
2022
2023
2024
2025
Date
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11
Detected
Yes


pH, Laboratory in Outfalls
pH, Laboratory (SU)
8.25
8.00
7.75
7.50
2019
2020
2021
2022
2023
2024
2025
Date
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11
Detected
Yes

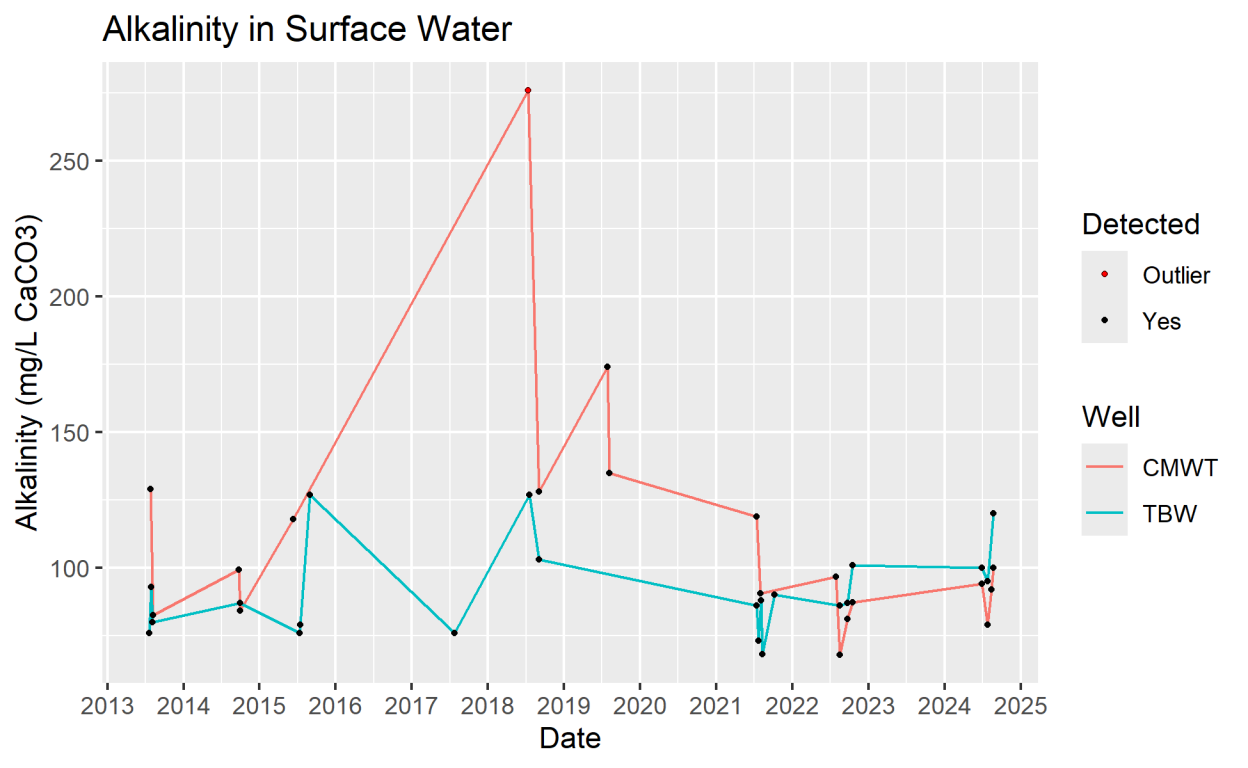

Selenium, Total in Outfalls
Selenium, Total (mg/L)
0.10
0.05
0.00
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11

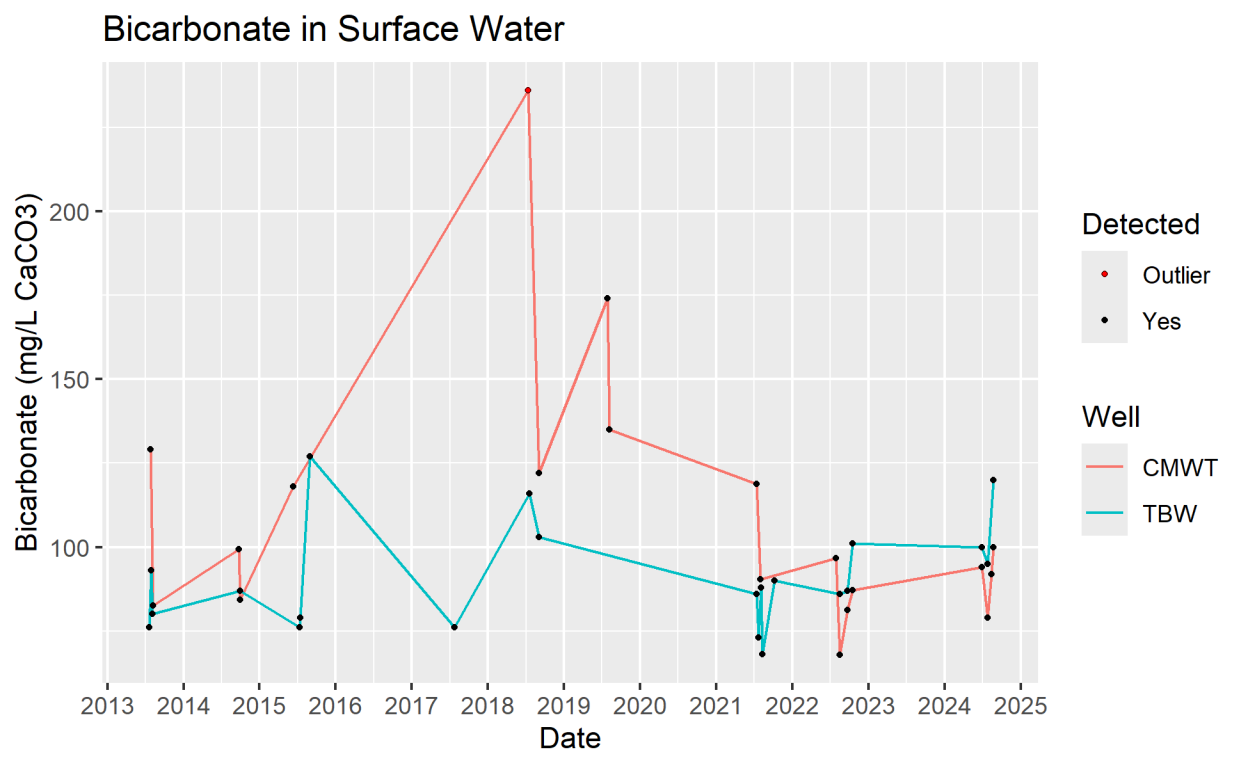

Total Dissolved Solids in Outfalls
Total Dissolved Solids (mg/L)
30000
20000
10000
0
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11

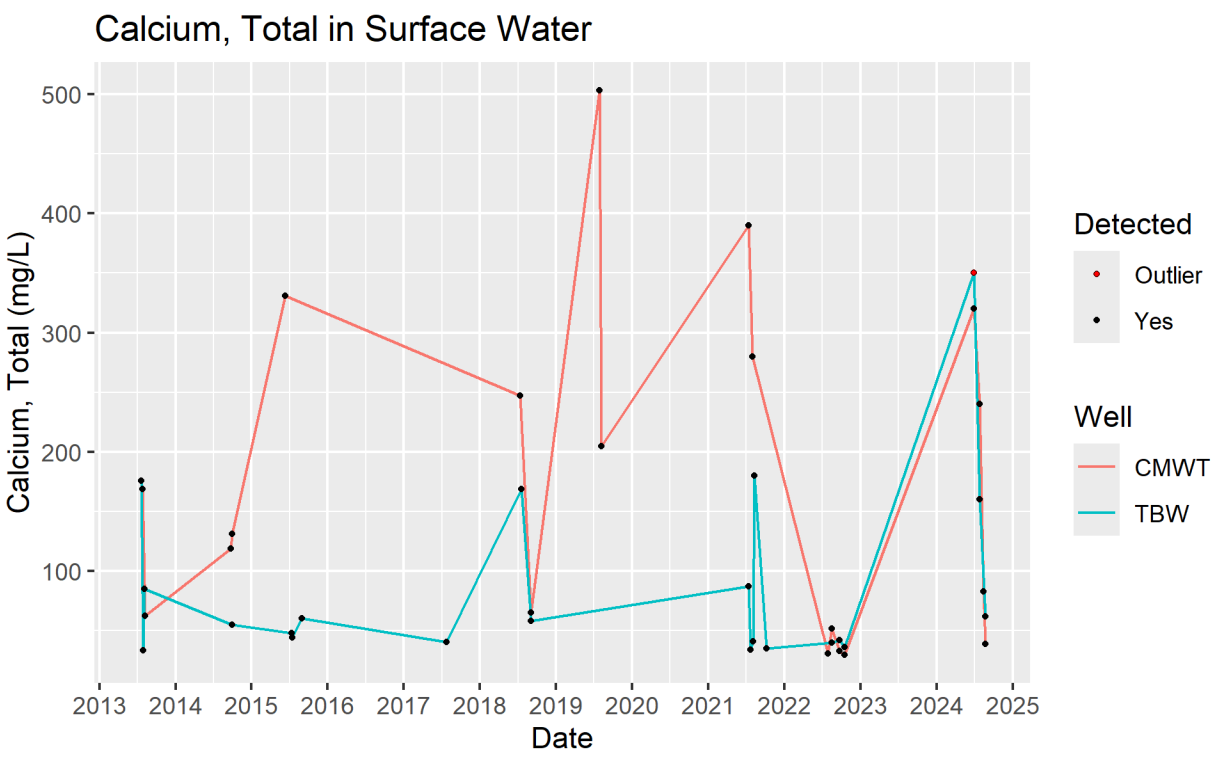

Total Suspended Solids in Outfalls
Total Suspended Solids (mg/L)
25000
20000
15000
10000
5000
0
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Outfall
003/SP 5N
009/DC 25
010/DC 1
014/SP 3-5
017/CB 2-21
018/CH 2-14
024/DC 2
060/DC 12
080/DC 27
091/CH 2-11

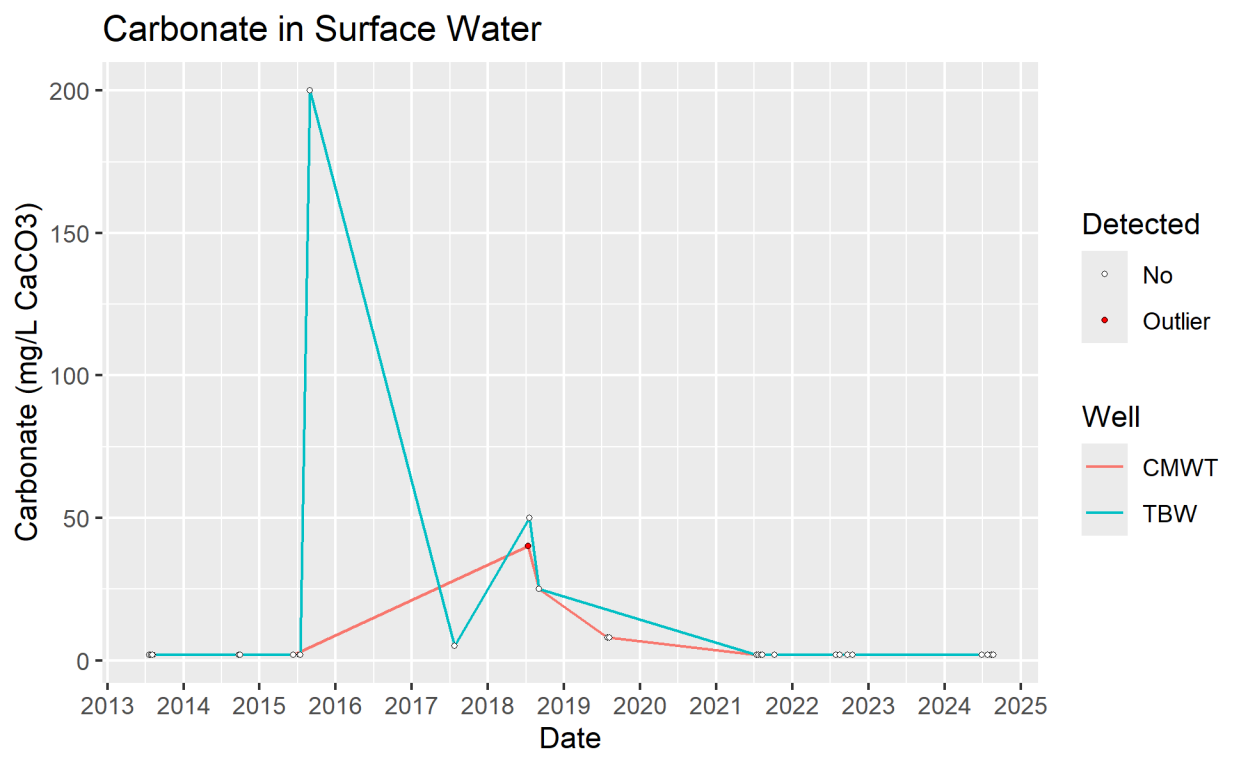
# APPENDIX B-2

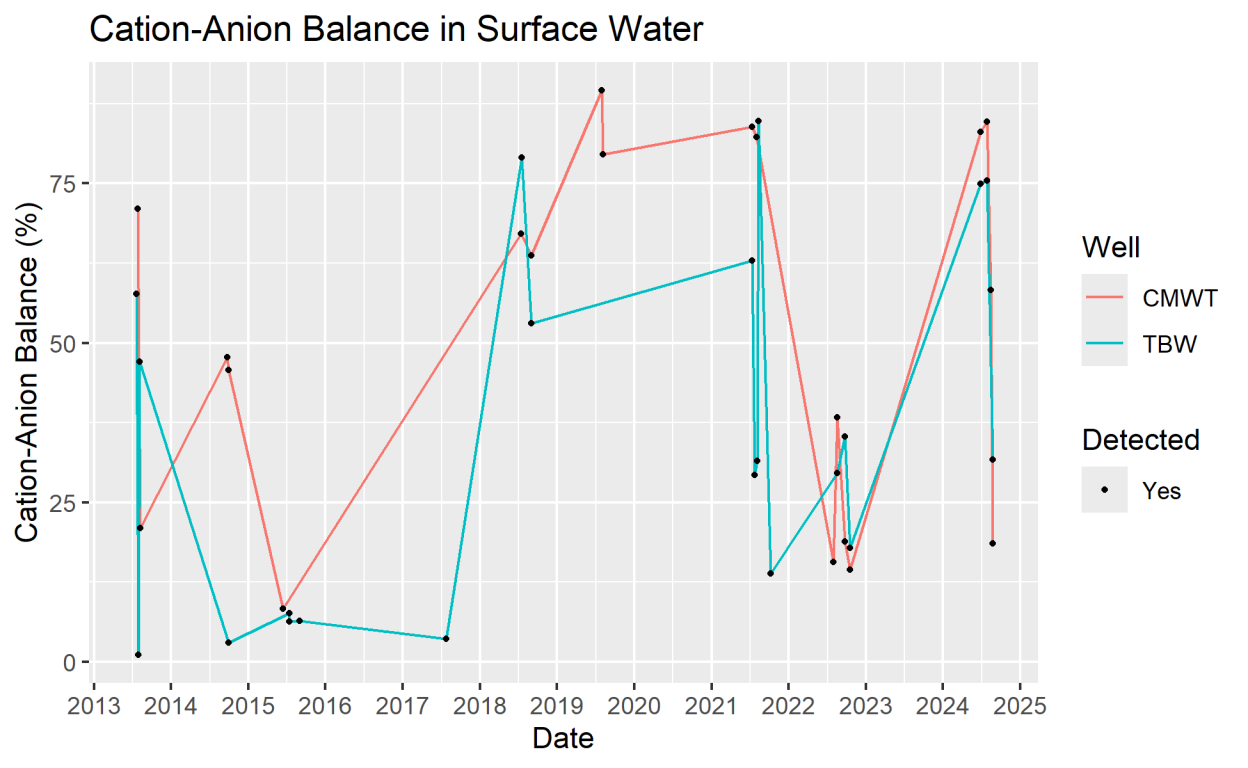
# SURFACE WATER QUALITY TEMPORAL PLOTS – COAL MINE WASH TRIBUTARY (CMWT) AND TSE BONITA WASH (TBW)

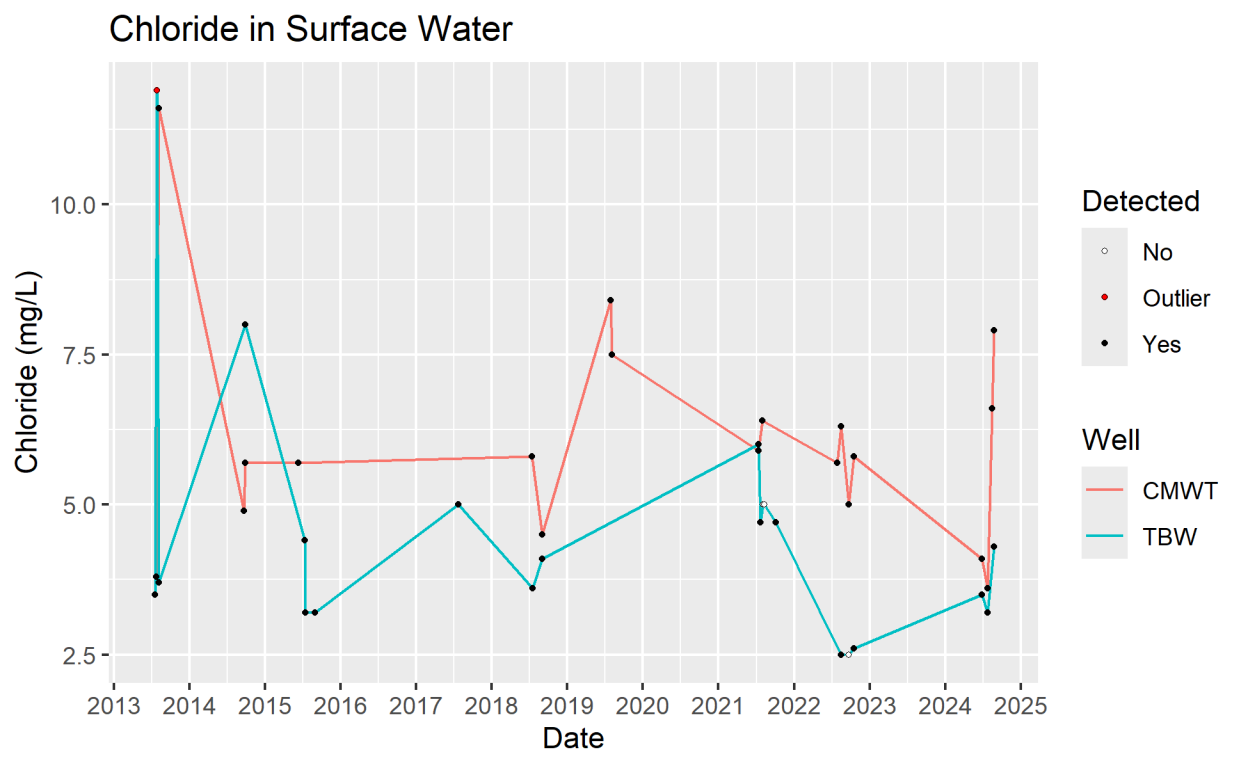

Alkalinity in Surface Water
Alkalinity (mg/L CaCO3)
250
200
150
100
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
CMWT
TBW

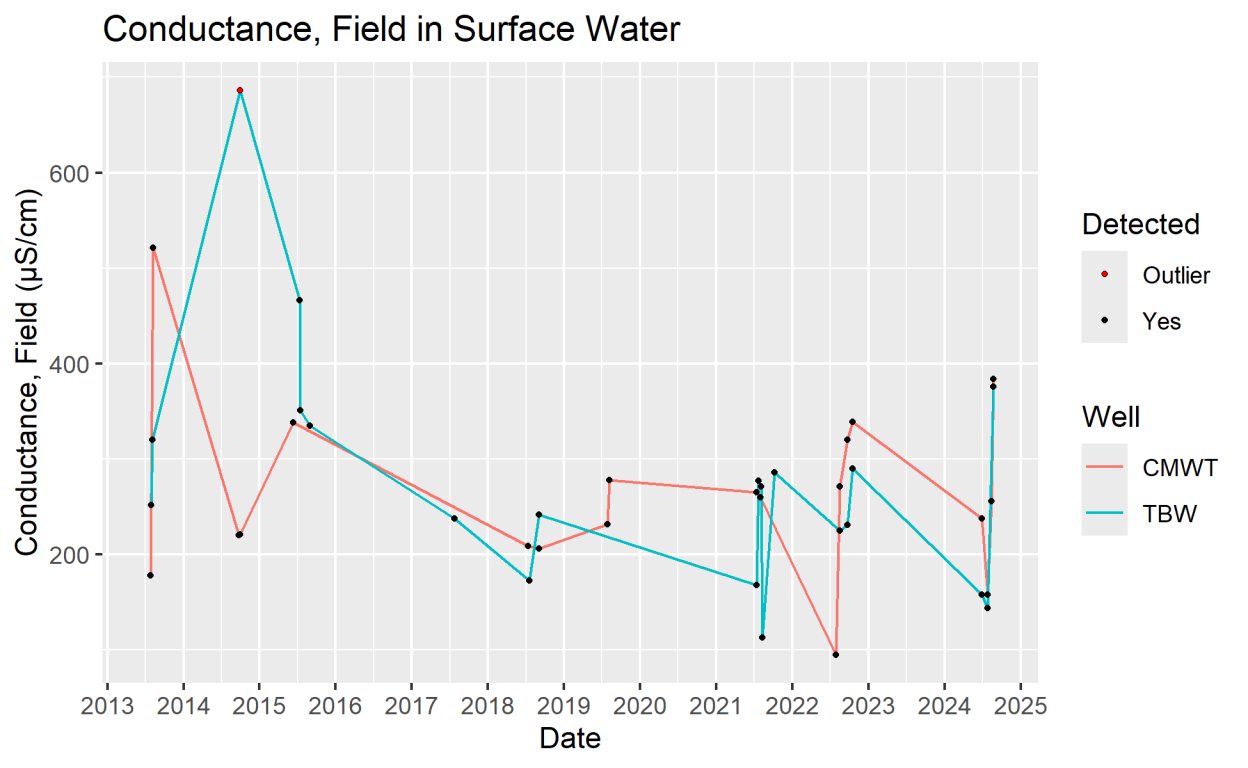

Bicarbonate in Surface Water
Bicarbonate (mg/L CaCO3)
200
150
100
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
CMWT
TBW

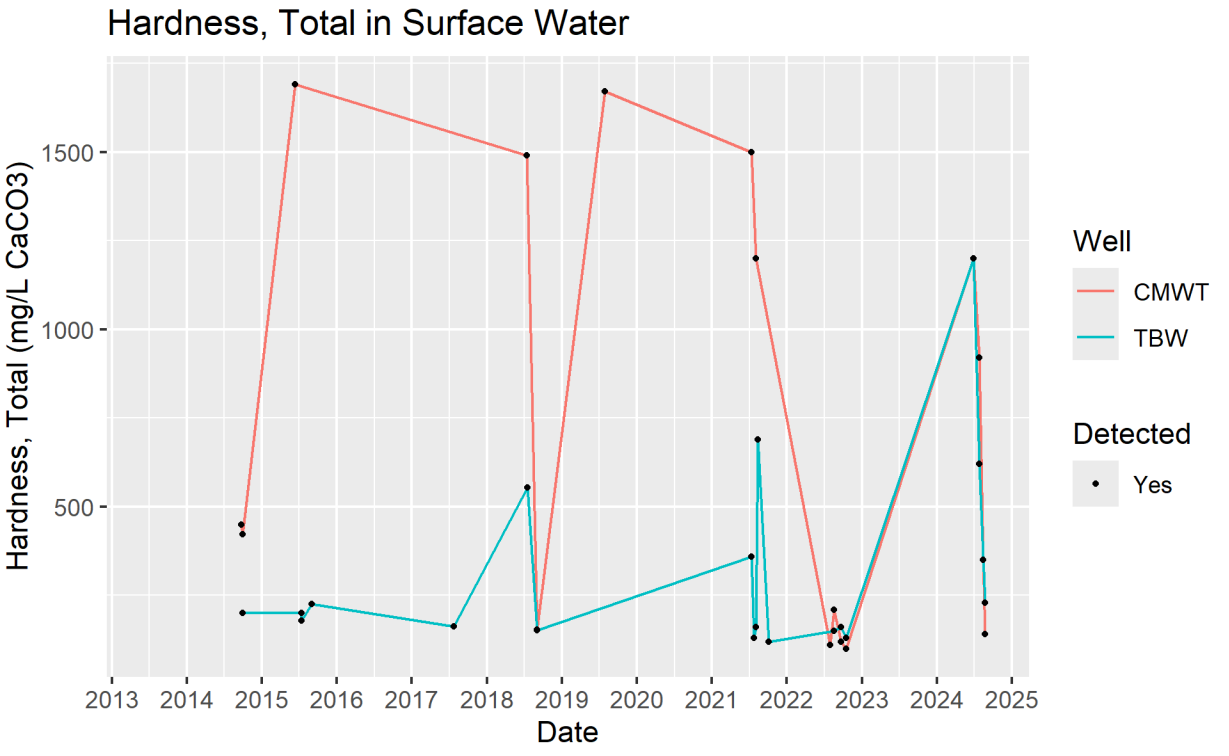

Calcium, Total in Surface Water
Calcium, Total (mg/L)
500
400
300
200
100
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
CMWT
TBW

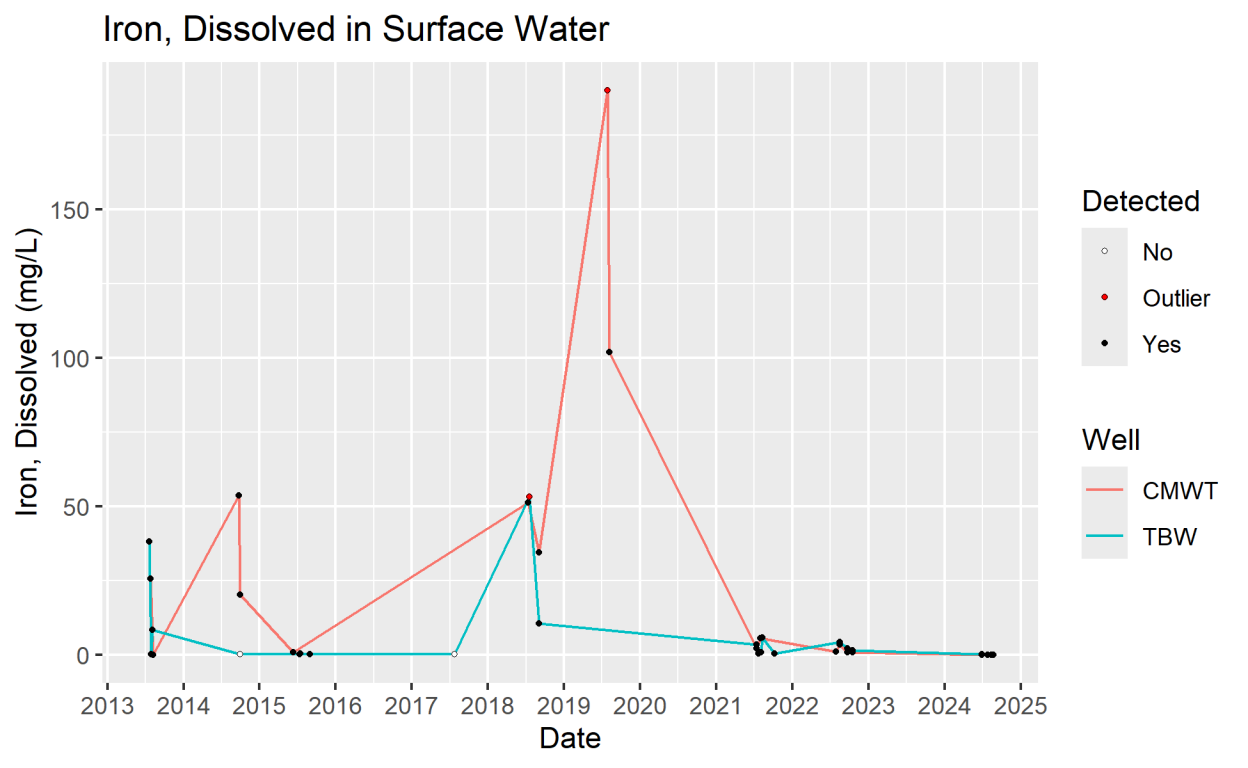

Carbonate in Surface Water
Carbonate (mg/L CaCO3)
200
150
100
50
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Well
CMWT
TBW

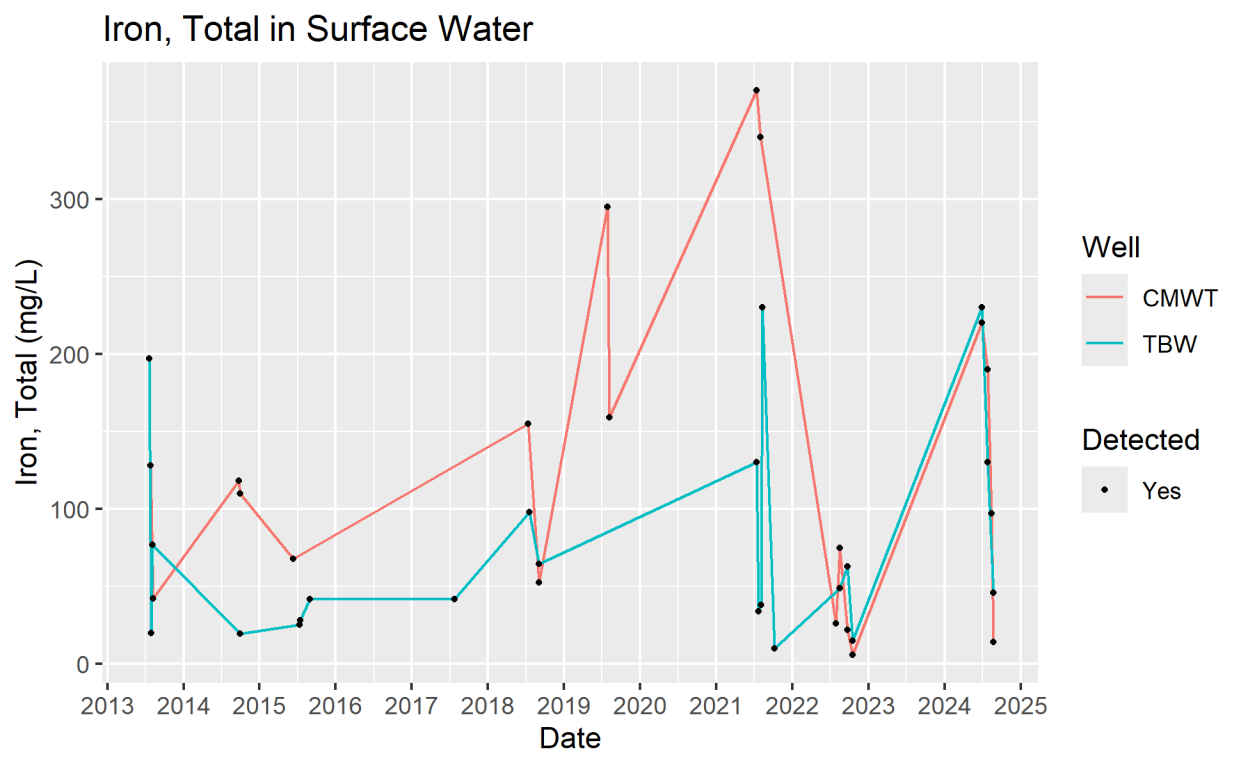

Cation-Anion Balance in Surface Water
Cation-Anion Balance (%)
75
50
25
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
Yes

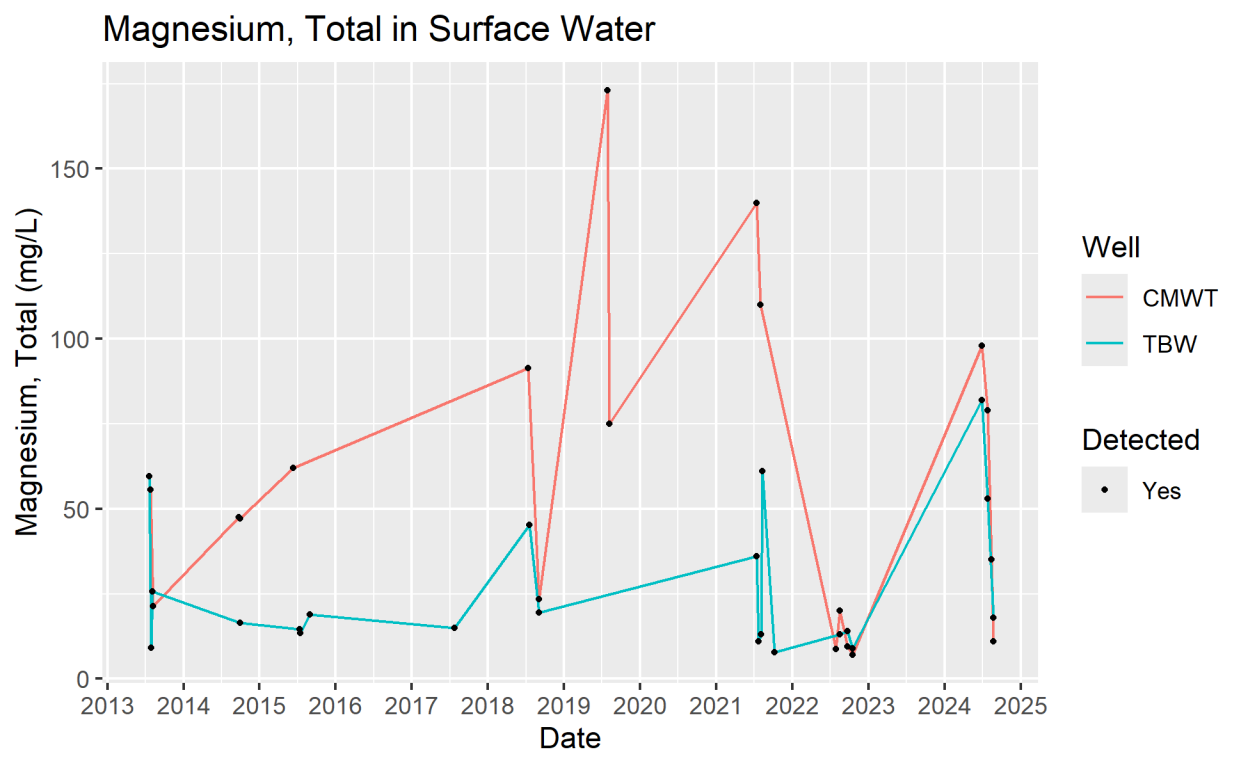

Chloride in Surface Water
Chloride (mg/L)
10.0
7.5
5.0
2.5
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Well
CMWT
TBW

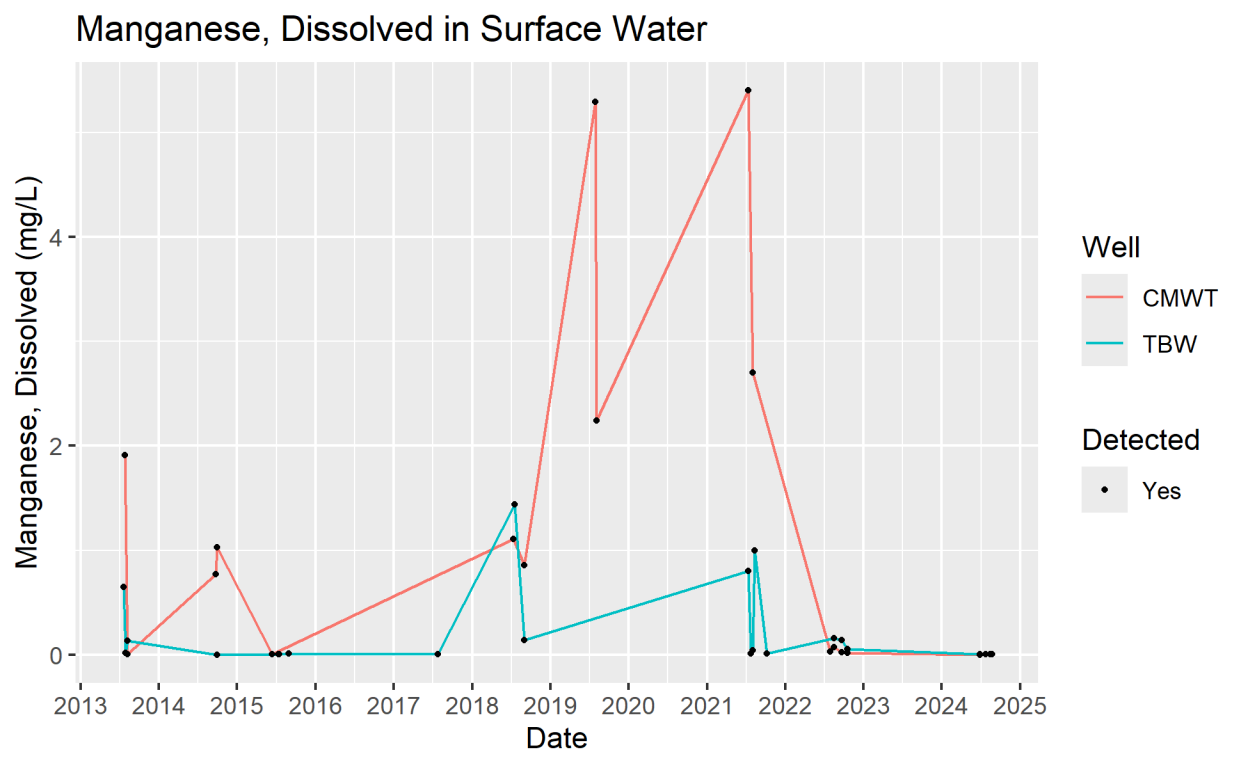

Conductance, Field in Surface Water
Conductance, Field (µS/cm)
600
400
200
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
CMWT
TBW

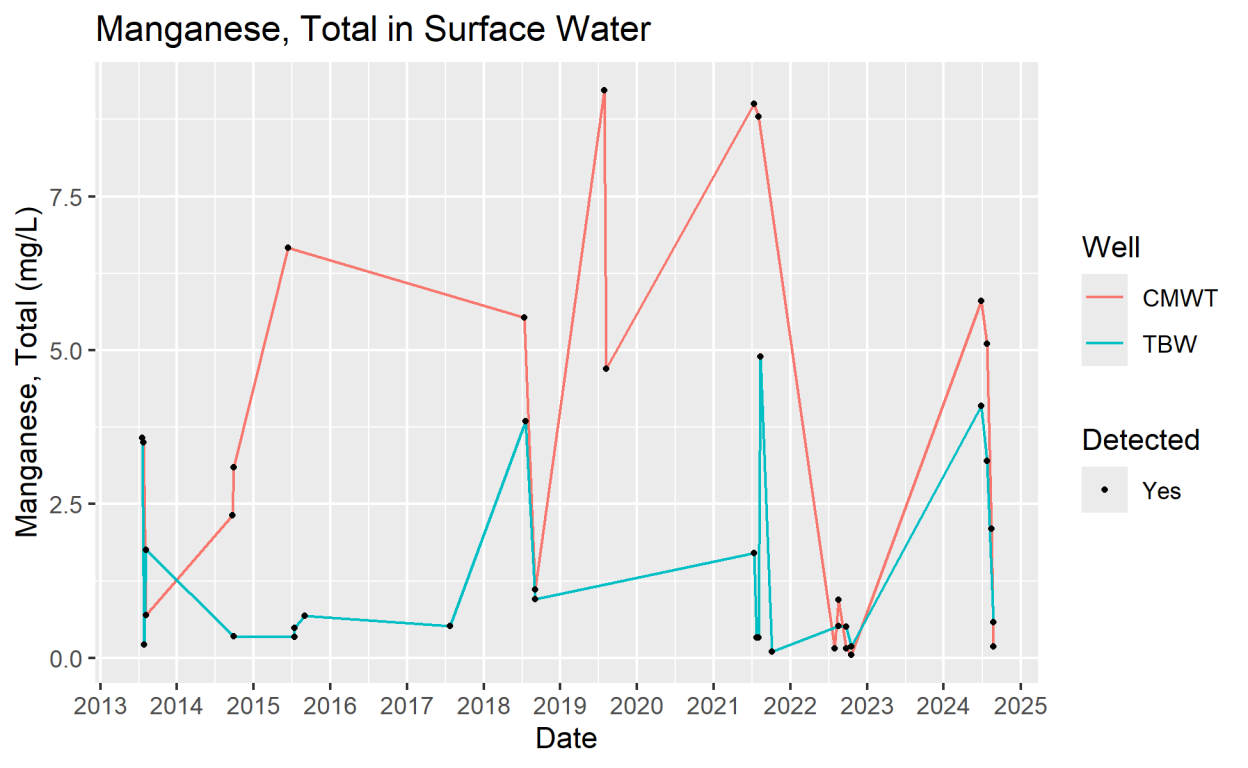

Hardness, Total in Surface Water
Hardness, Total (mg/L CaCO3)
1500
1000
500
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
Yes

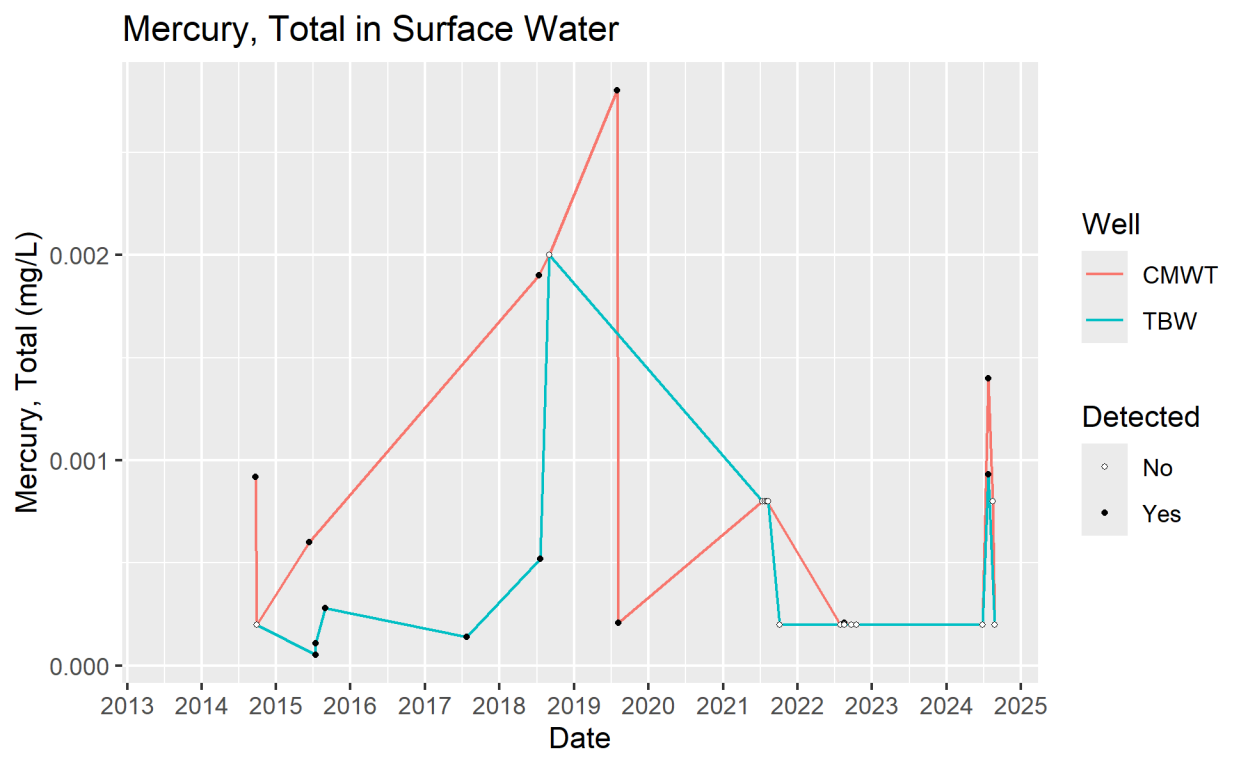

Iron, Dissolved in Surface Water
Iron, Dissolved (mg/L)
150
100
50
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Well
CMWT
TBW

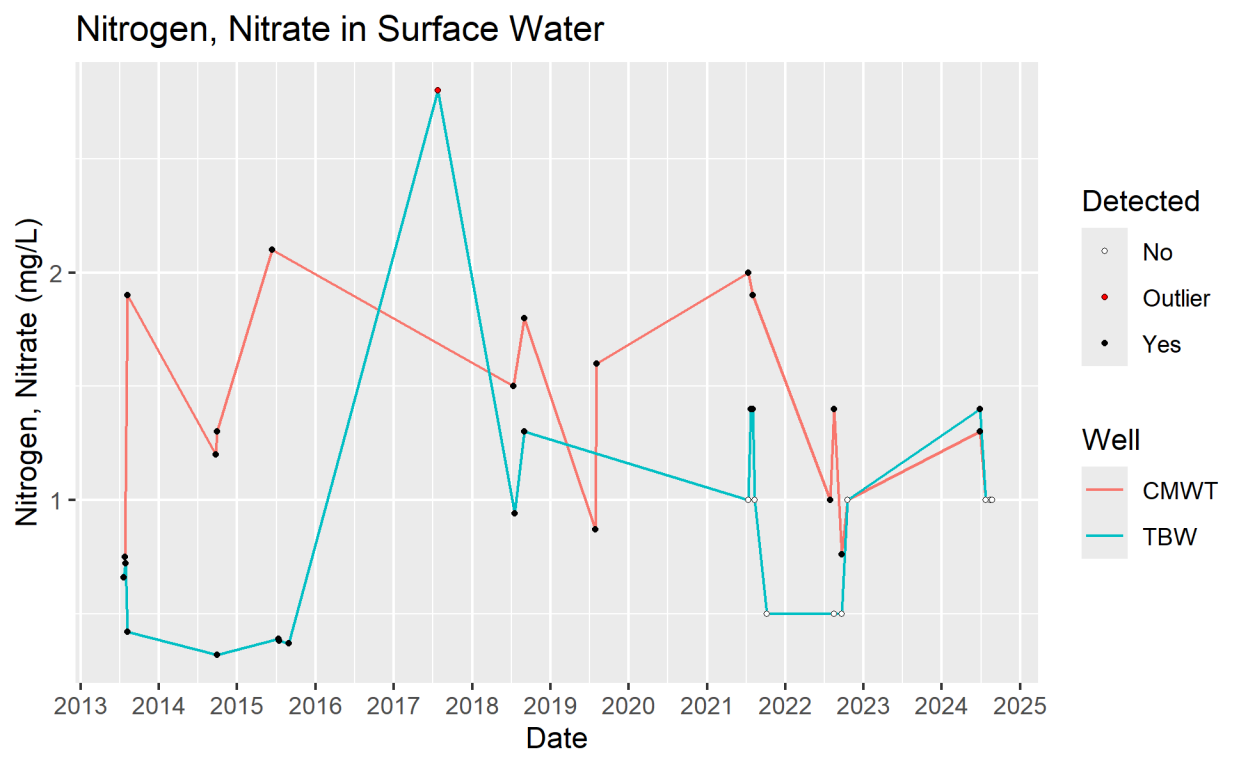

Iron, Total in Surface Water
Iron, Total (mg/L)
300
200
100
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
Yes

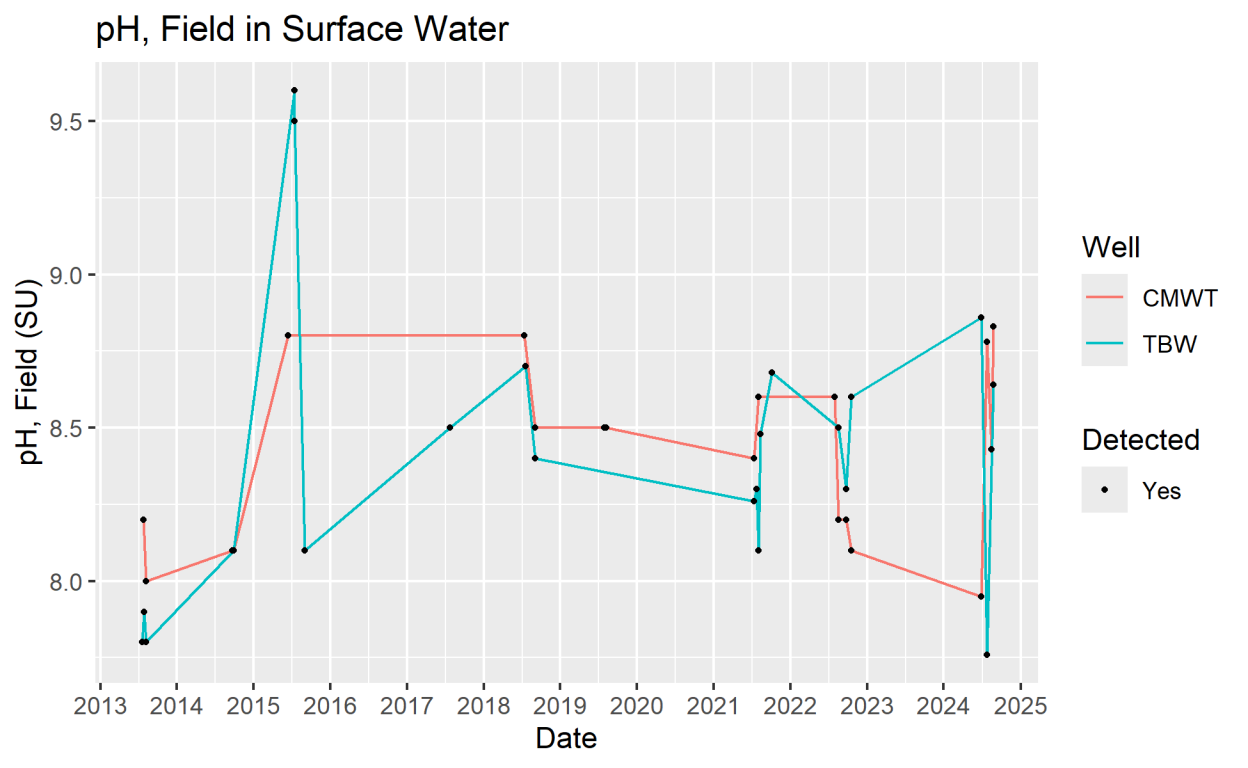

Magnesium, Total in Surface Water
Magnesium, Total (mg/L)
150
100
50
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
Yes

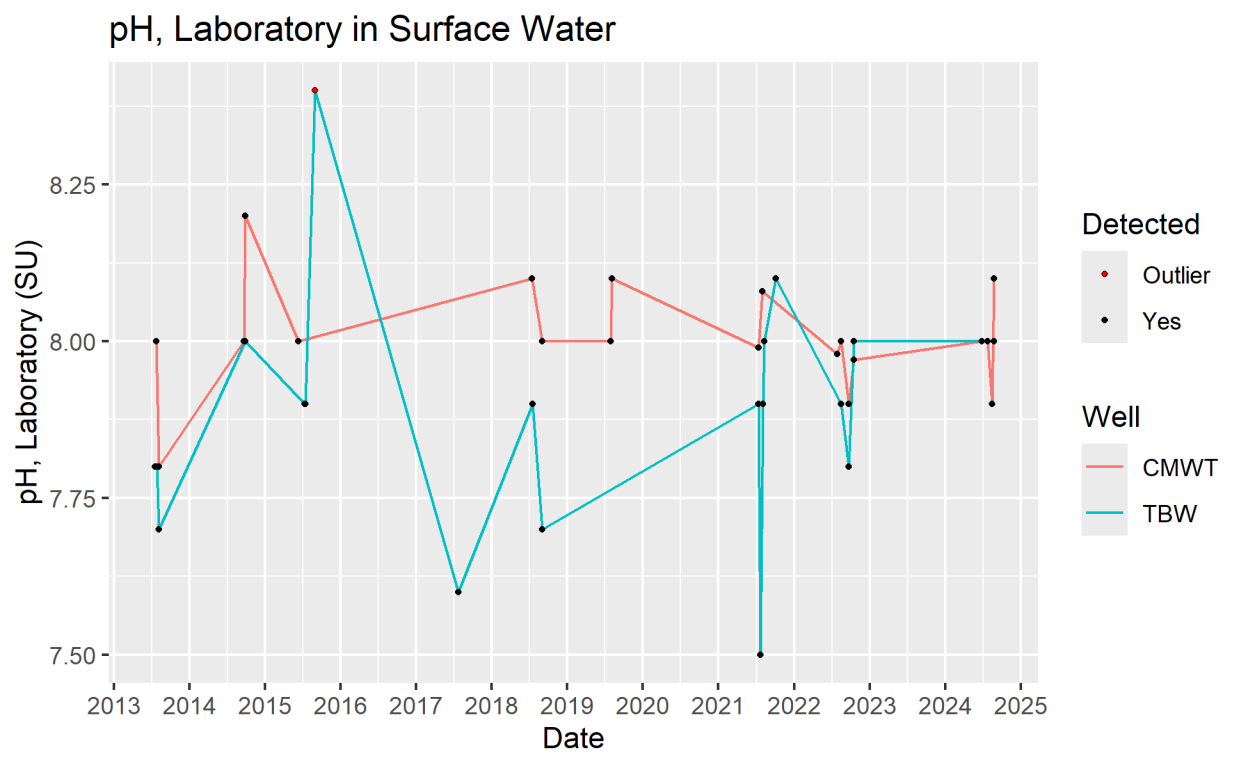

Manganese, Dissolved in Surface Water
Manganese, Dissolved (mg/L)
0
2
4
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
Yes

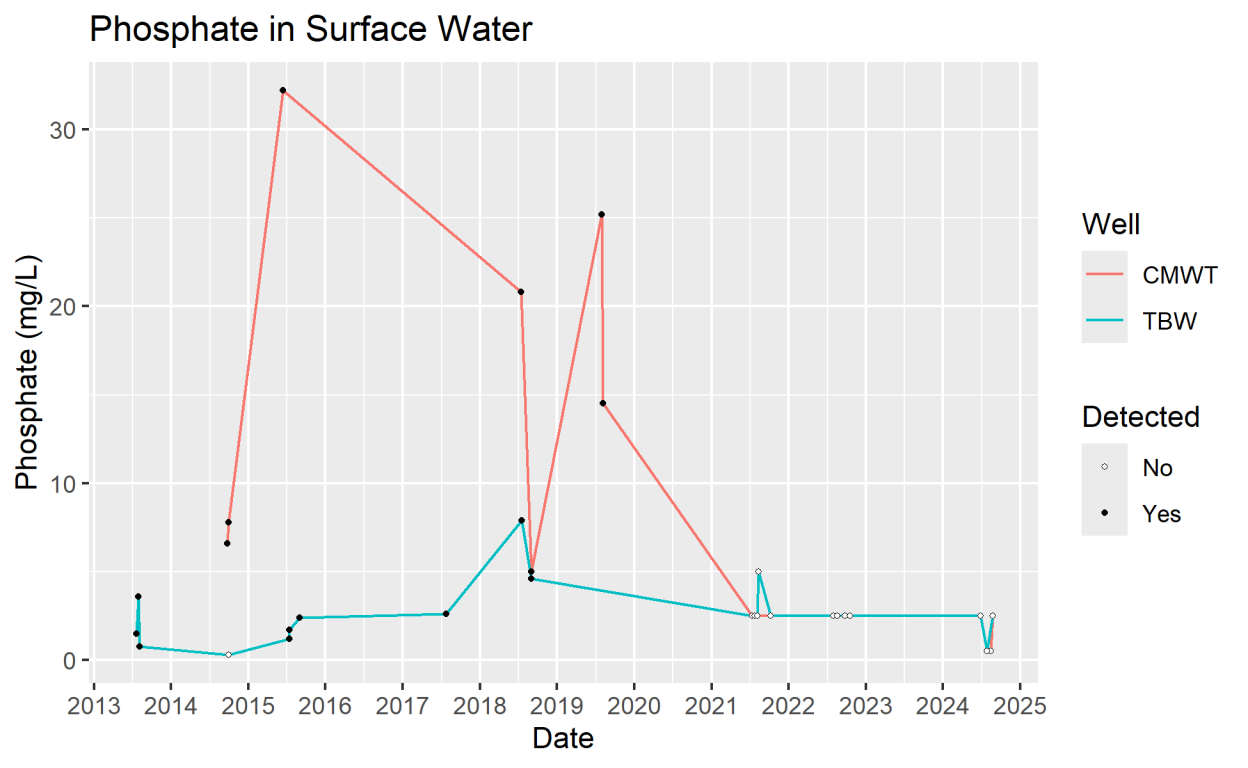

Manganese, Total in Surface Water
Manganese, Total (mg/L)
7.5
5.0
2.5
0.0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
Yes

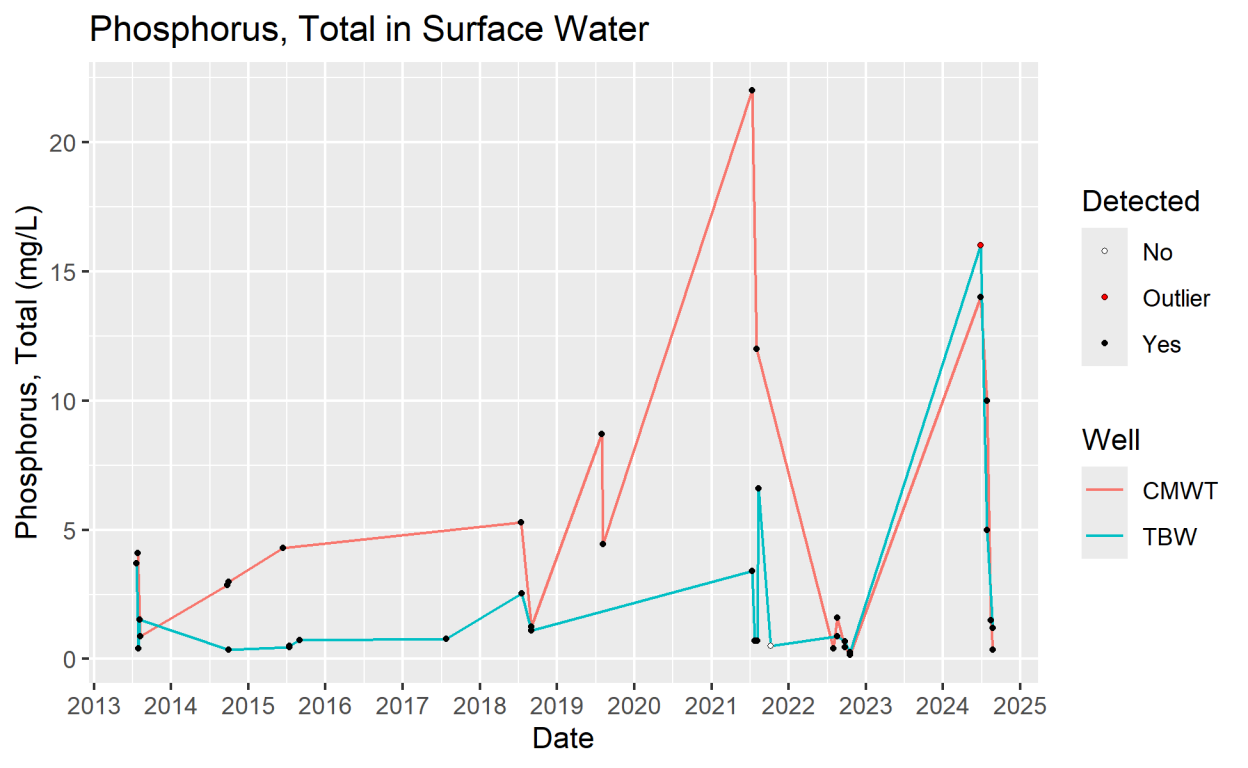

Mercury, Total in Surface Water
Mercury, Total (mg/L)
0.002
0.001
0.000
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
No
Yes

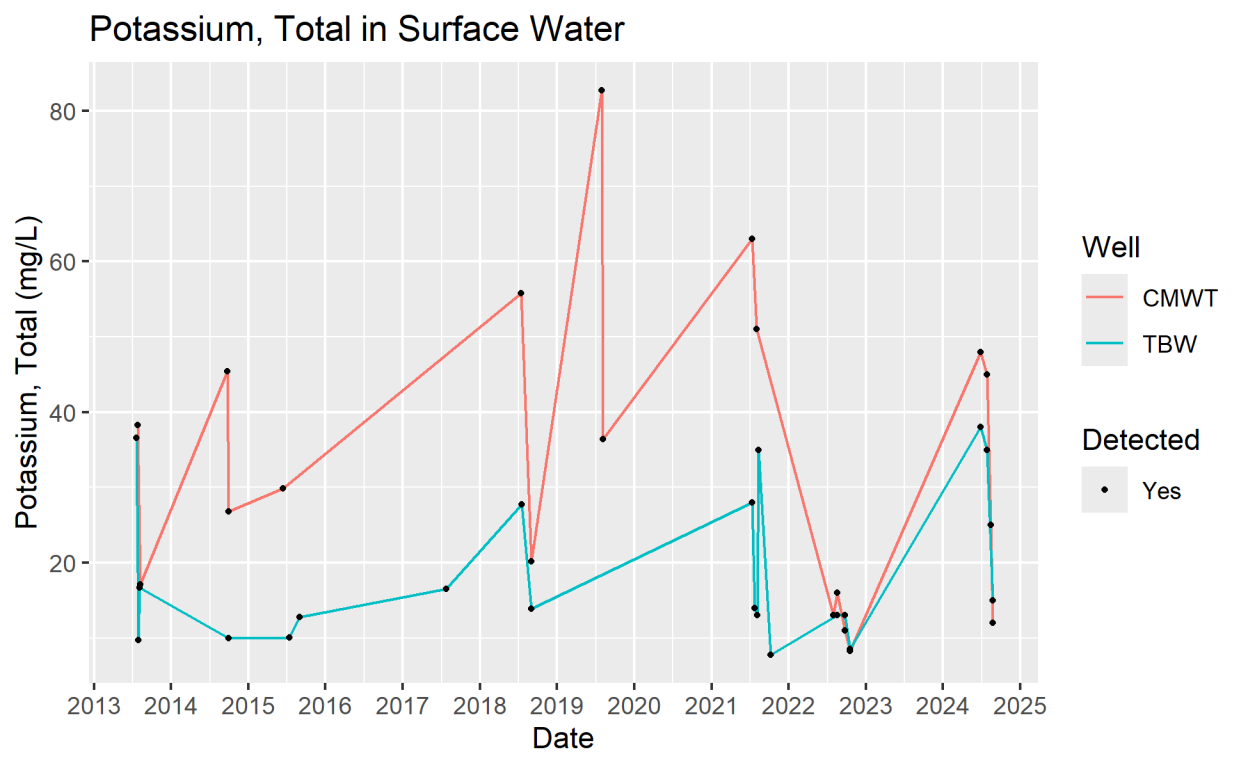

Nitrogen, Nitrate in Surface Water
Nitrogen, Nitrate (mg/L)
2
1
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Well
CMWT
TBW

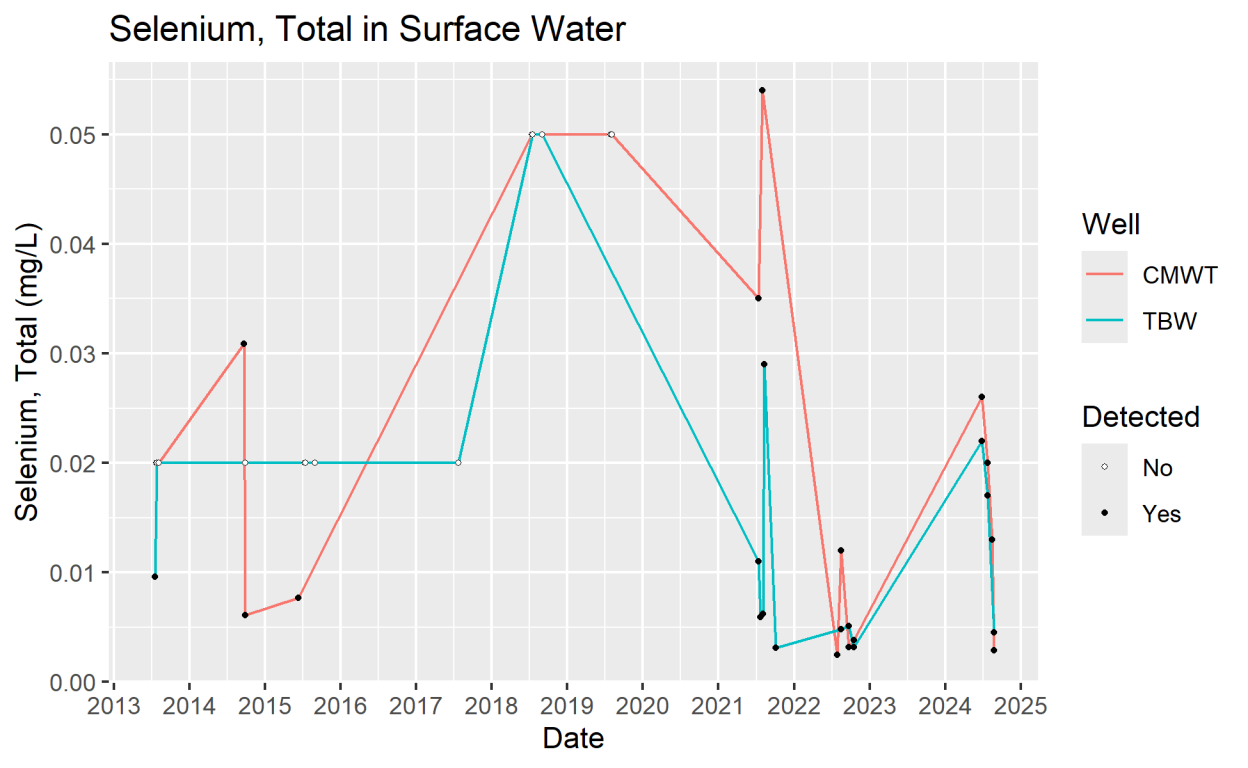

pH, Field in Surface Water
pH, Field (SU)
9.5
9.0
8.5
8.0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
Yes

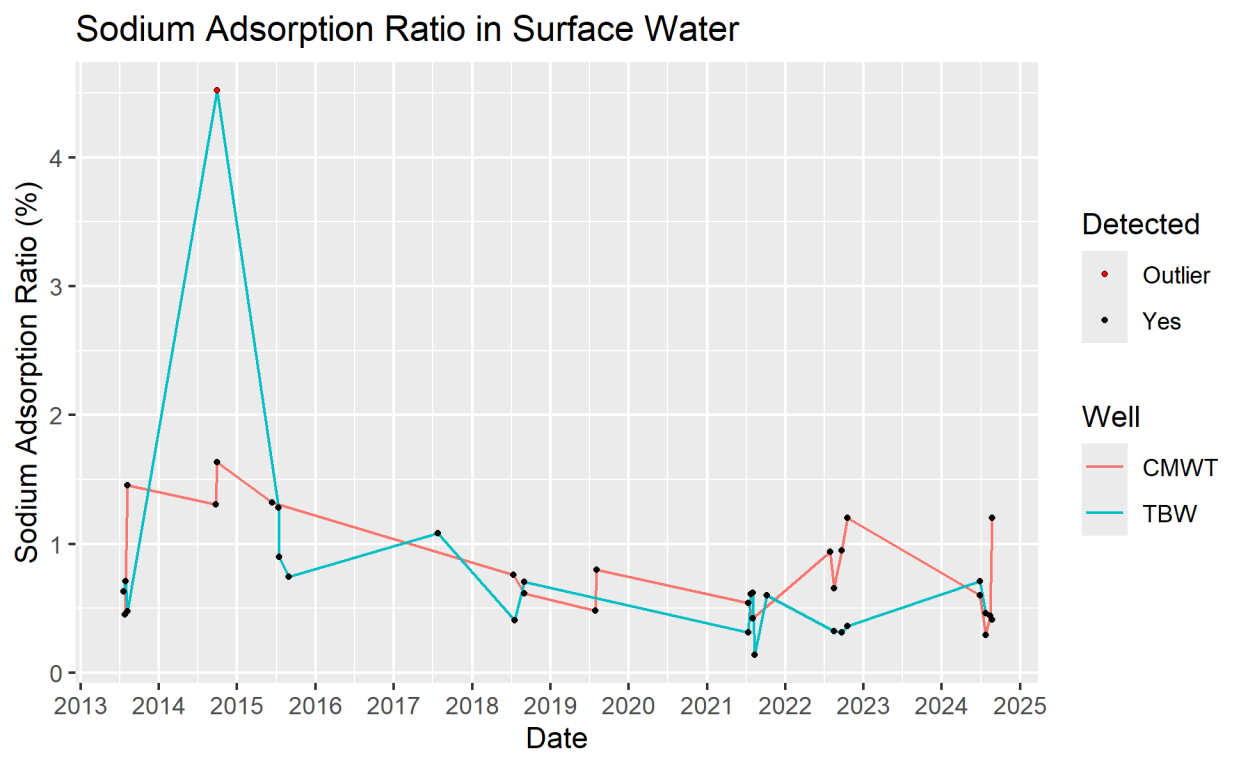

pH, Laboratory in Surface Water
pH, Laboratory (SU)
8.25
8.00
7.75
7.50
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
CMWT
TBW

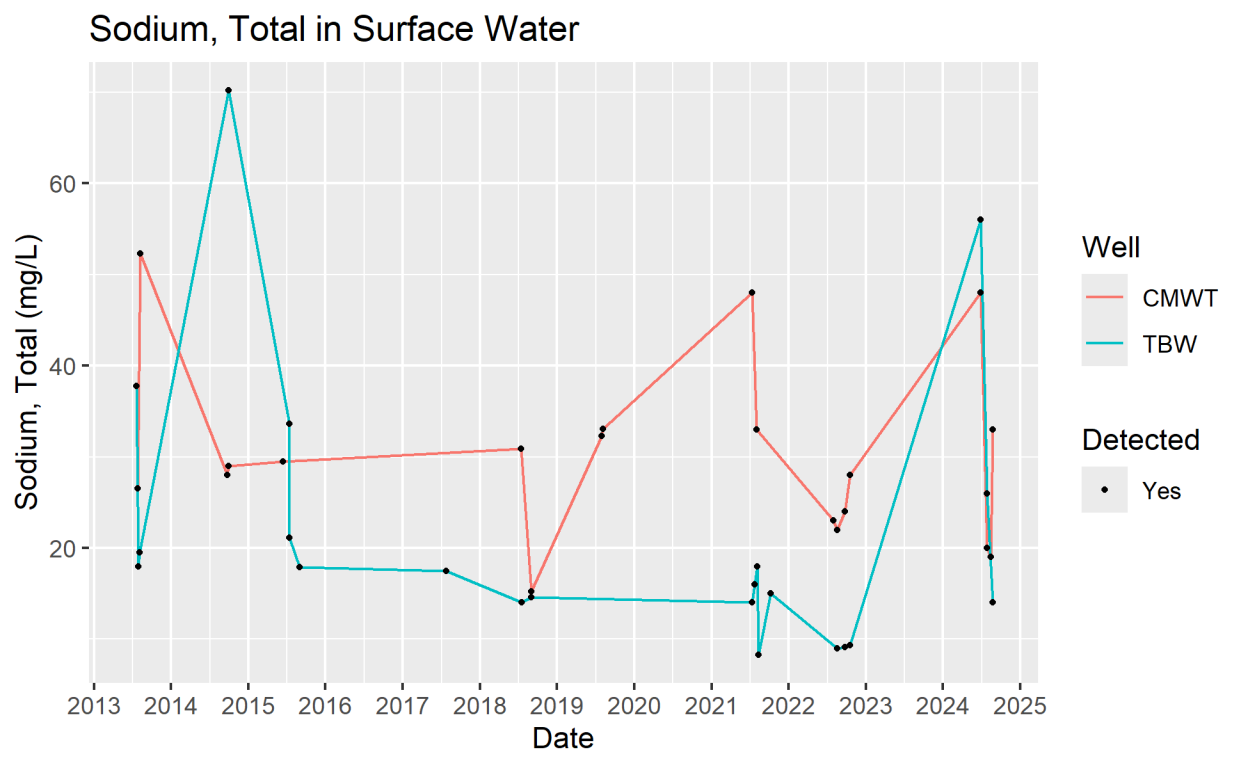

Phosphate in Surface Water
Phosphate (mg/L)
30
20
10
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
No
Yes

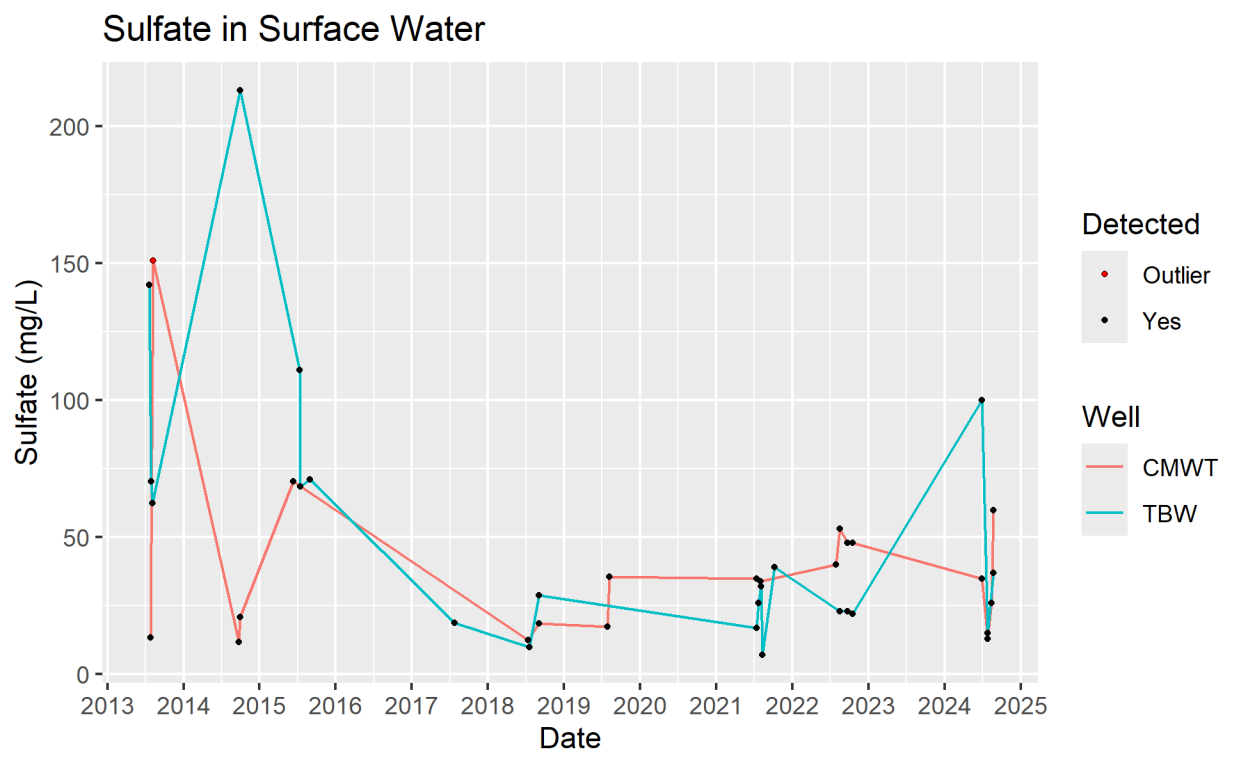

Phosphorus, Total in Surface Water
Phosphorus, Total (mg/L)
0
5
10
15
20
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Well
CMWT
TBW

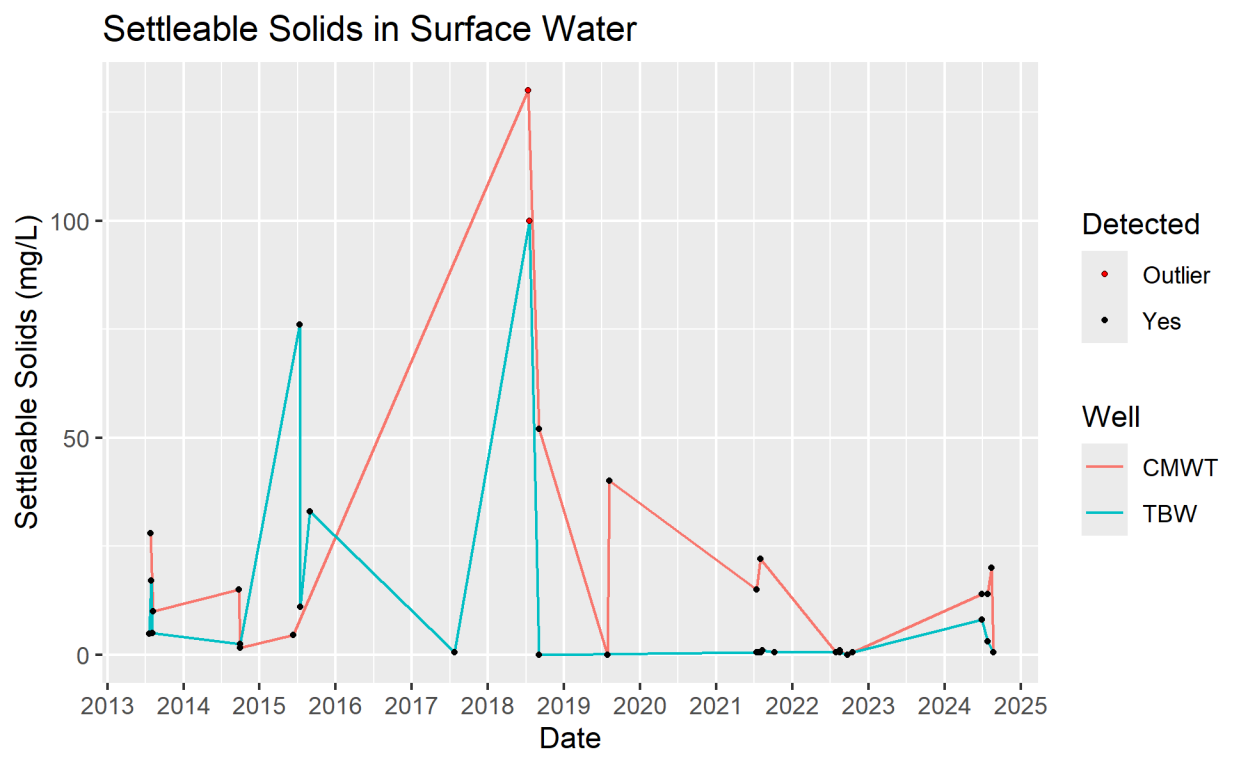

Potassium, Total in Surface Water
Potassium, Total (mg/L)
80
60
40
20
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
Yes

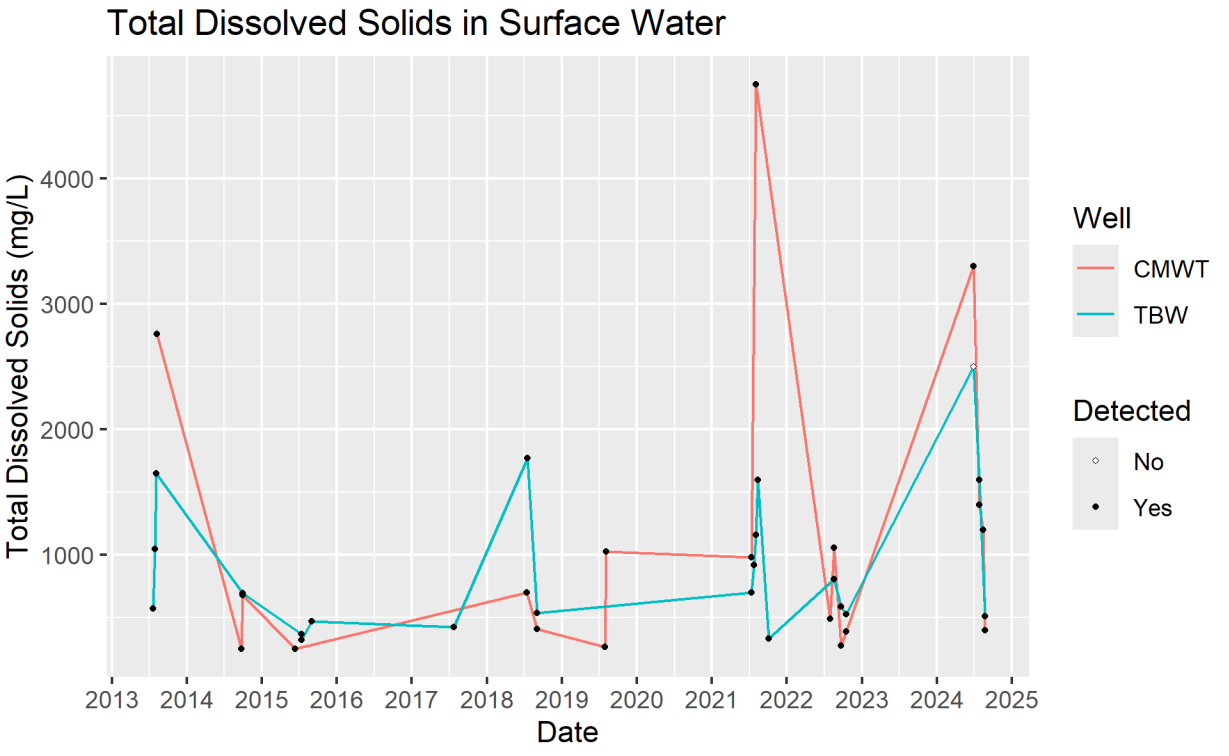

Selenium, Total in Surface Water
Selenium, Total (mg/L)
0.00
0.01
0.02
0.03
0.04
0.05
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
No
Yes

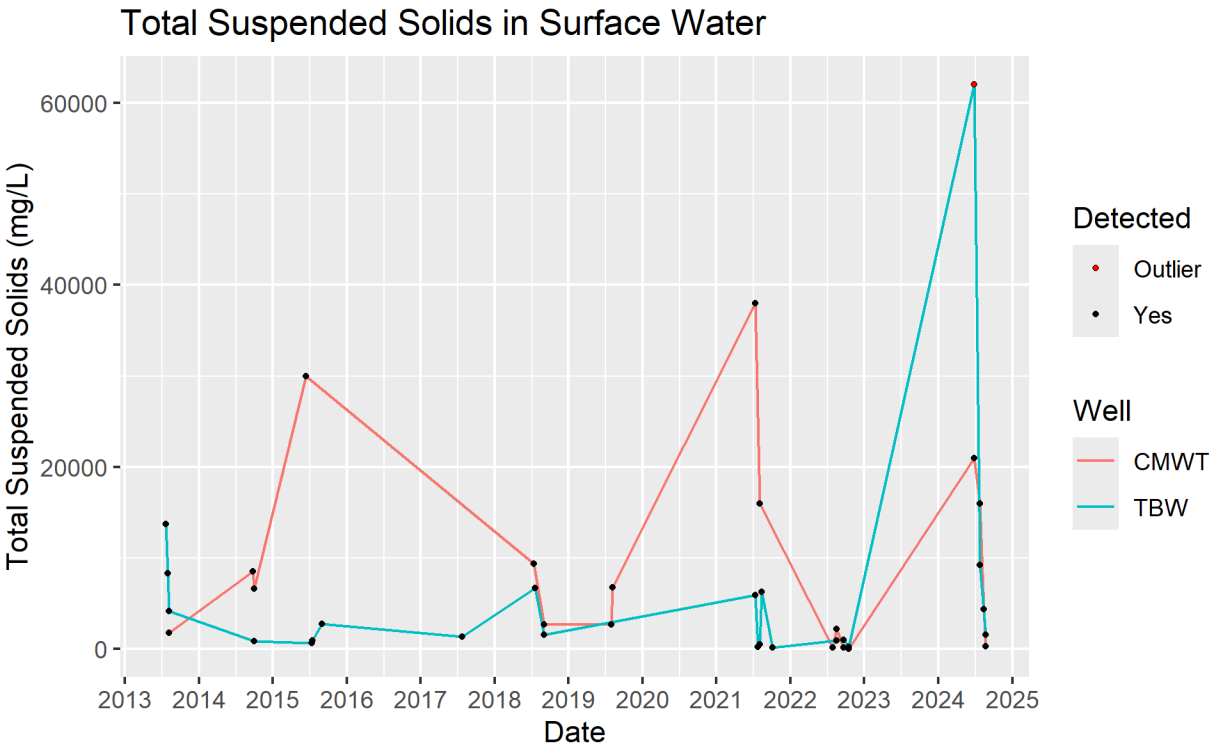

Sodium Adsorption Ratio in Surface Water
Sodium Adsorption Ratio (%)
0
1
2
3
4
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
CMWT
TBW


Sodium, Total in Surface Water
Sodium, Total (mg/L)
60
40
20
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
Yes


Sulfate in Surface Water
Sulfate (mg/L)
0
50
100
150
200
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
CMWT
TBW


Settleable Solids in Surface Water
Settleable Solids (mg/L)
100
50
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
CMWT
TBW


Total Dissolved Solids in Surface Water
Total Dissolved Solids (mg/L)
4000
3000
2000
1000
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
CMWT
TBW
Detected
No
Yes


Total Suspended Solids in Surface Water
Total Suspended Solids (mg/L)
60000
40000
20000
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
CMWT
TBW

# APPENDIX C

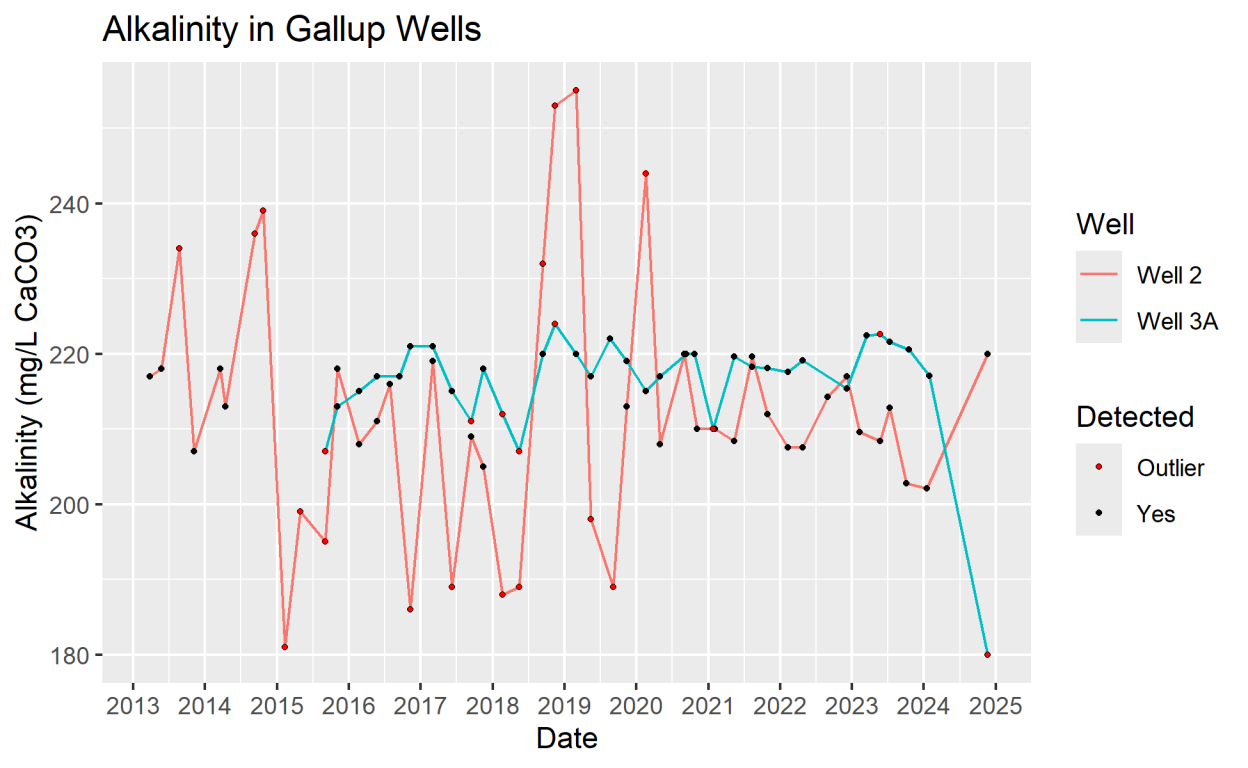
# GROUNDWATER QUALITY TEMPORAL PLOTS

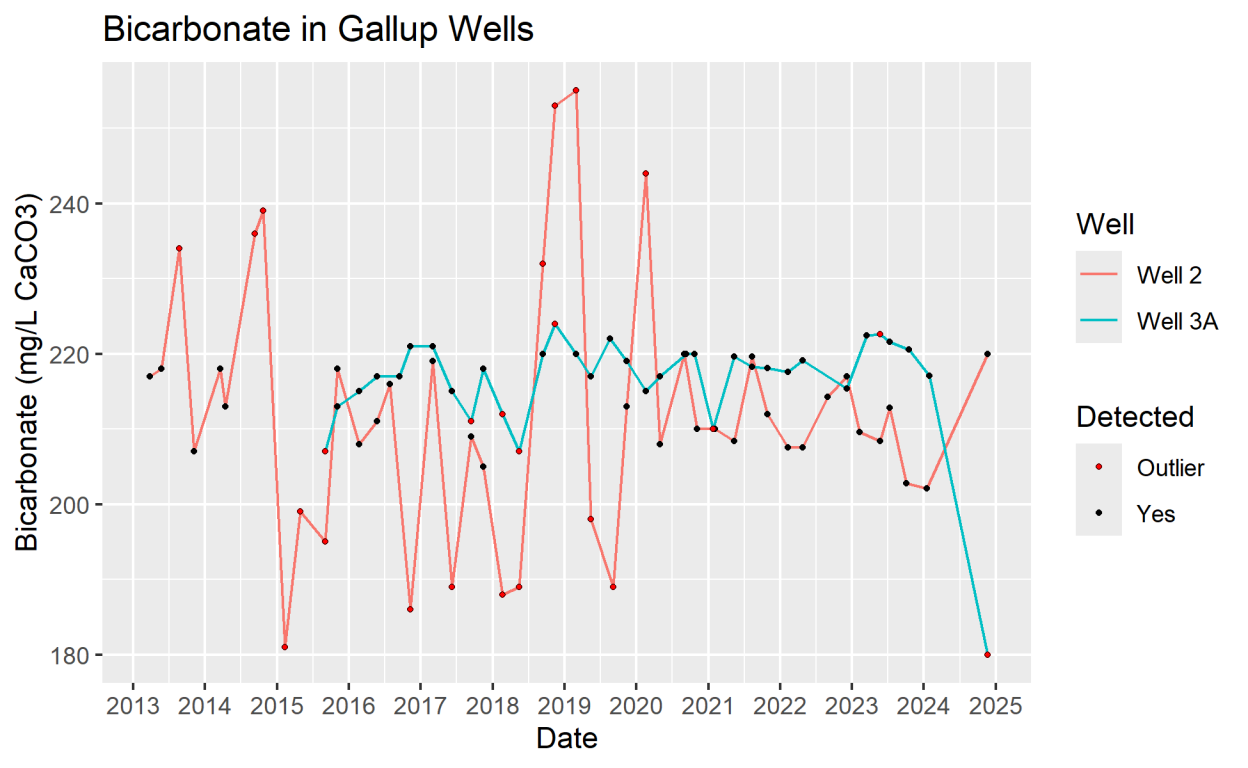
C-1. HISTORICAL GROUNDWATER TEMPORAL PLOTS – GALLUP SANDSTONE AQUIFER WELL 2 AND WELL 3A

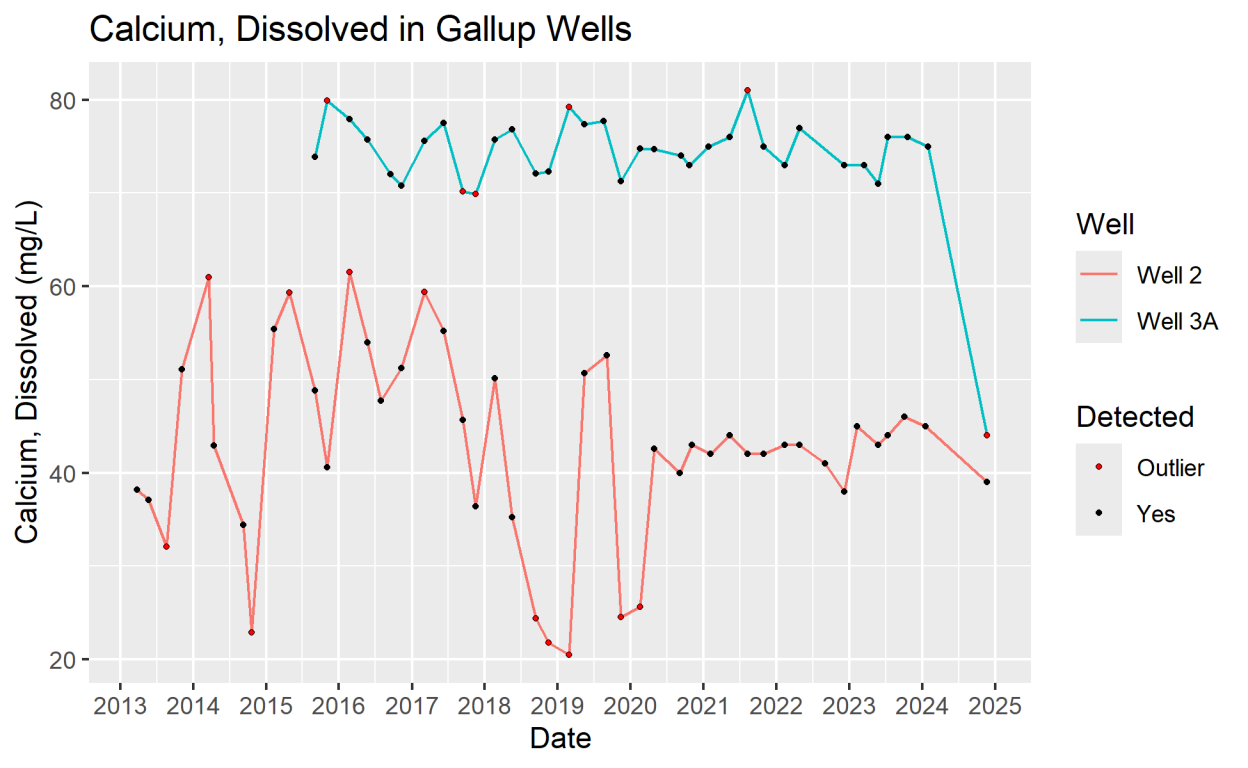
C-2. HISTORICAL GROUNDWATER TEMPORAL PLOTS – BEDROCK MONITORING WELL MBR2

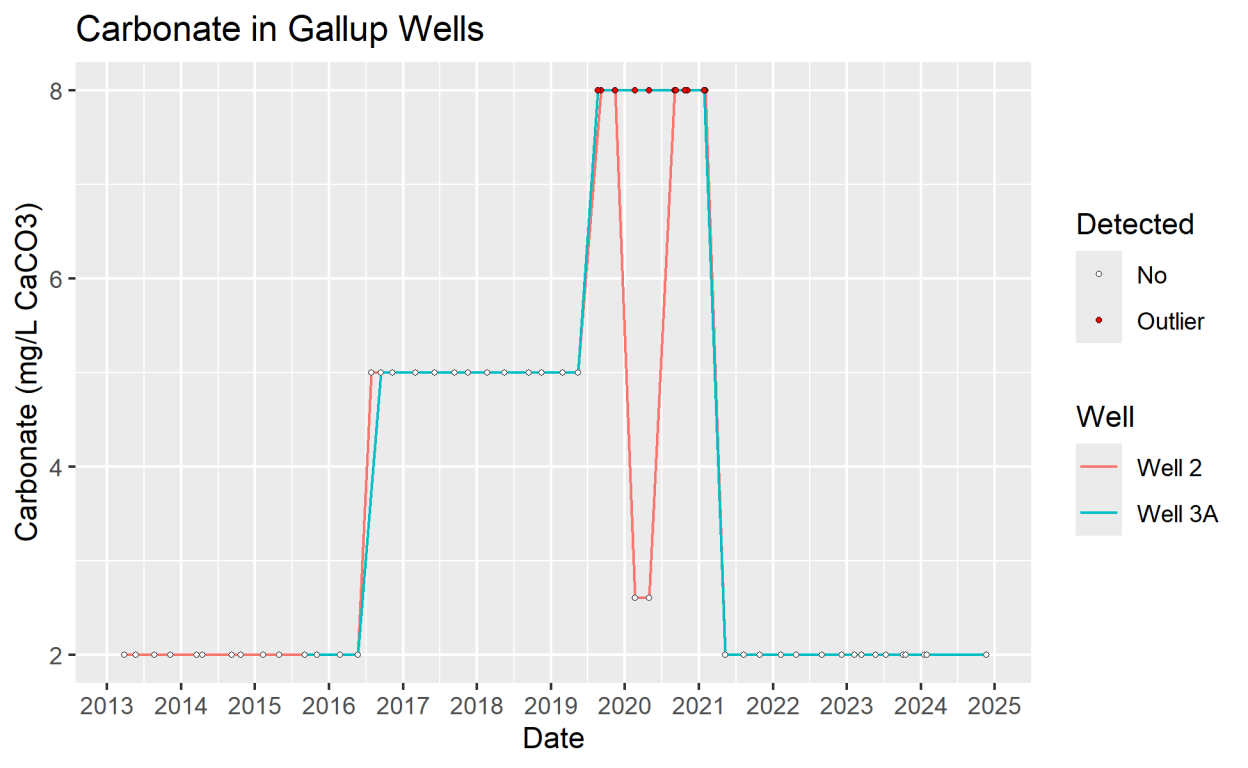
# APPENDIX C-1

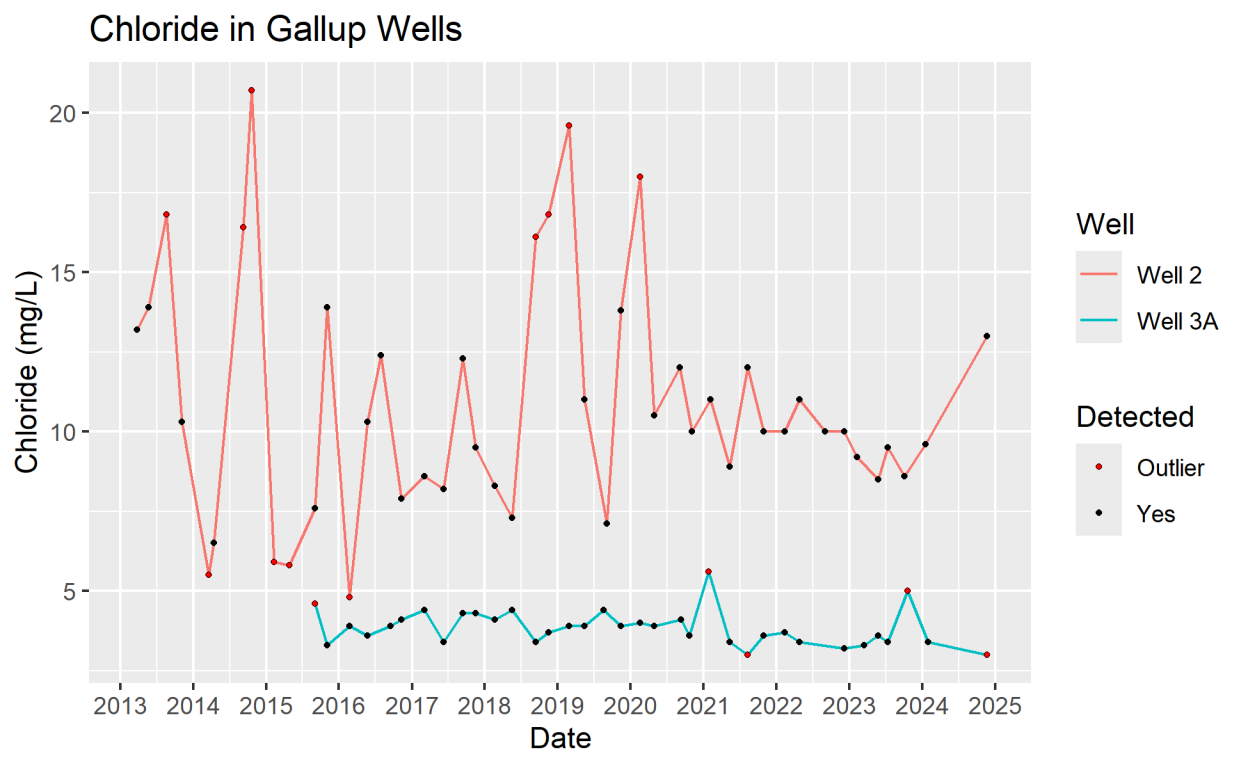
# HISTORICAL GROUNDWATER TEMPORAL PLOTS – GALLUP SANDSTONE AQUIFER WELL 2 AND WELL 3A

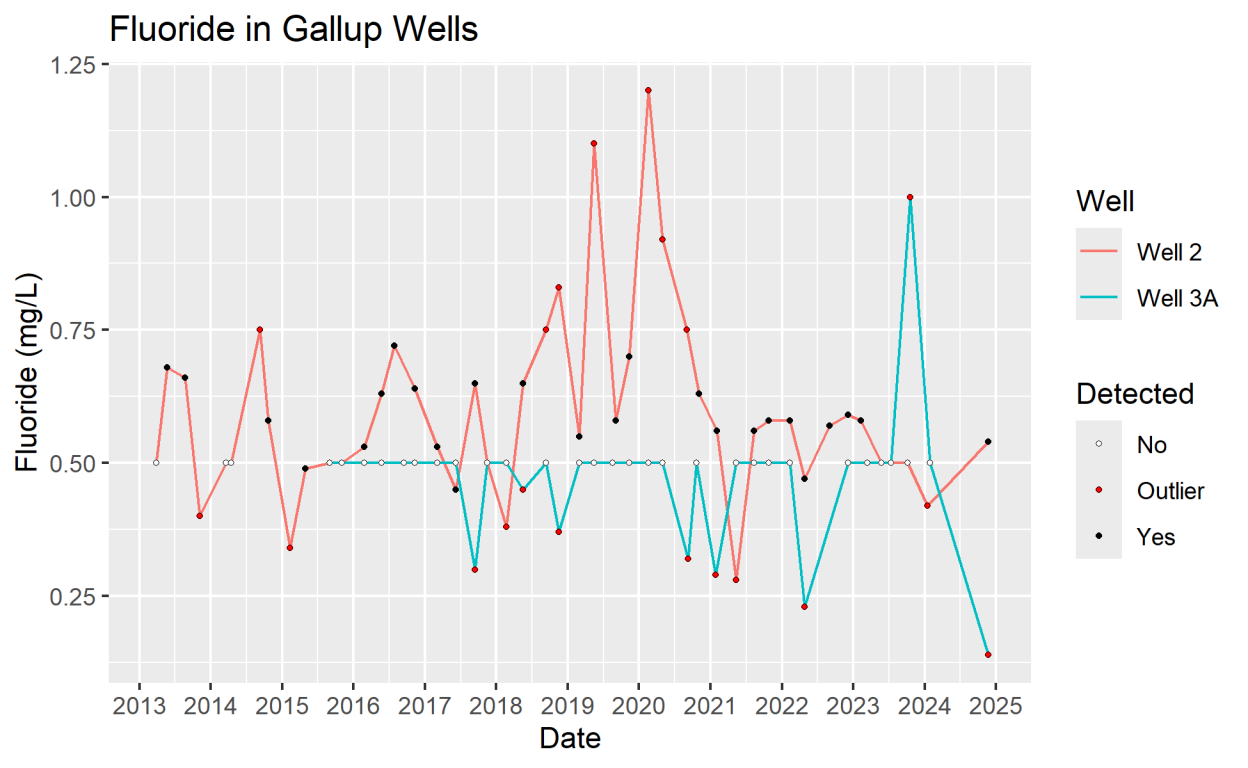

Alkalinity in Gallup Wells
Alkalinity (mg/L CaCO3)
240
220
200
180
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

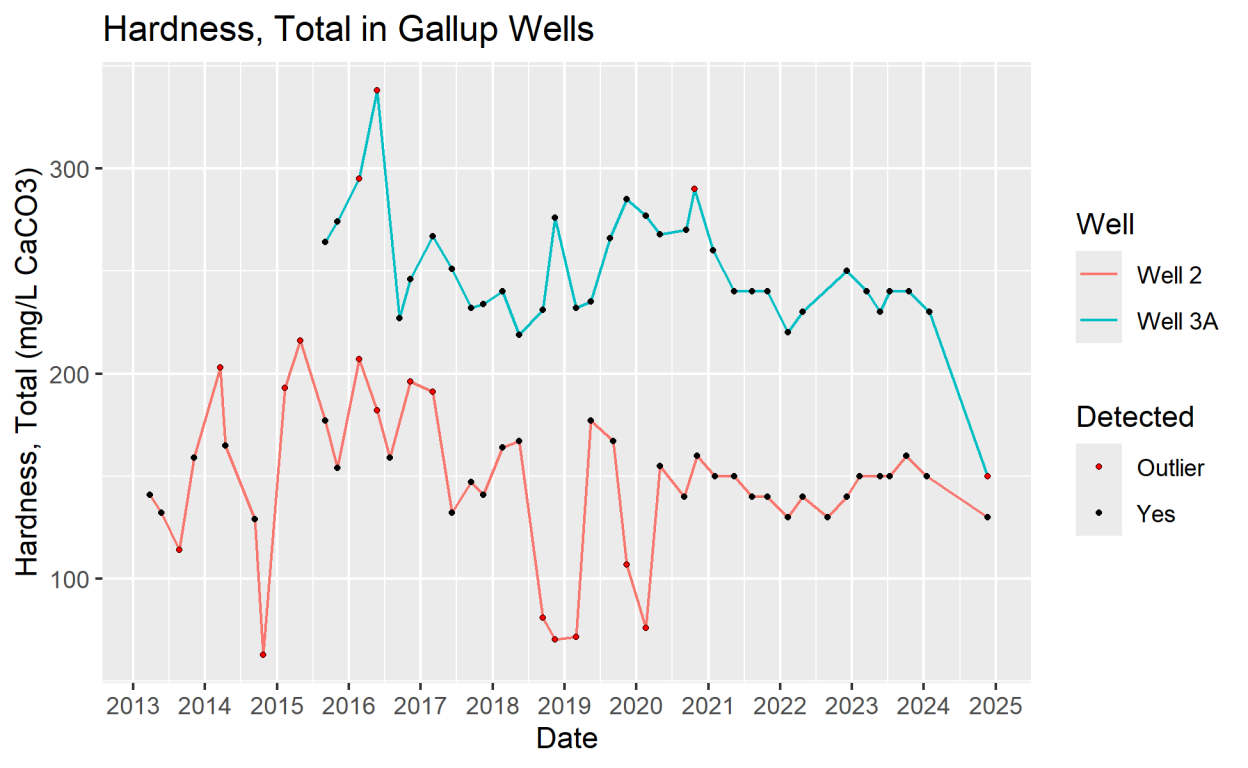

Bicarbonate in Gallup Wells
Bicarbonate (mg/L CaCO3)
240
220
200
180
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

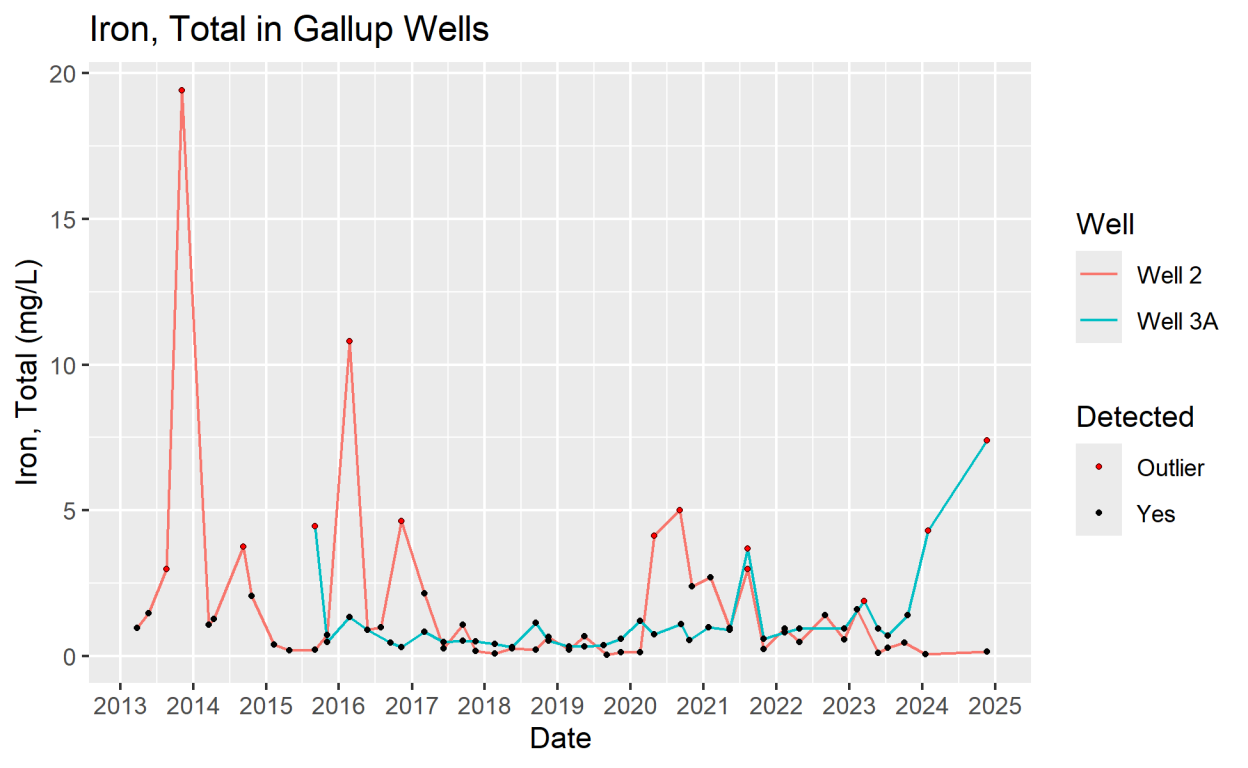

Calcium, Dissolved in Gallup Wells
Calcium, Dissolved (mg/L)
80
60
40
20
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

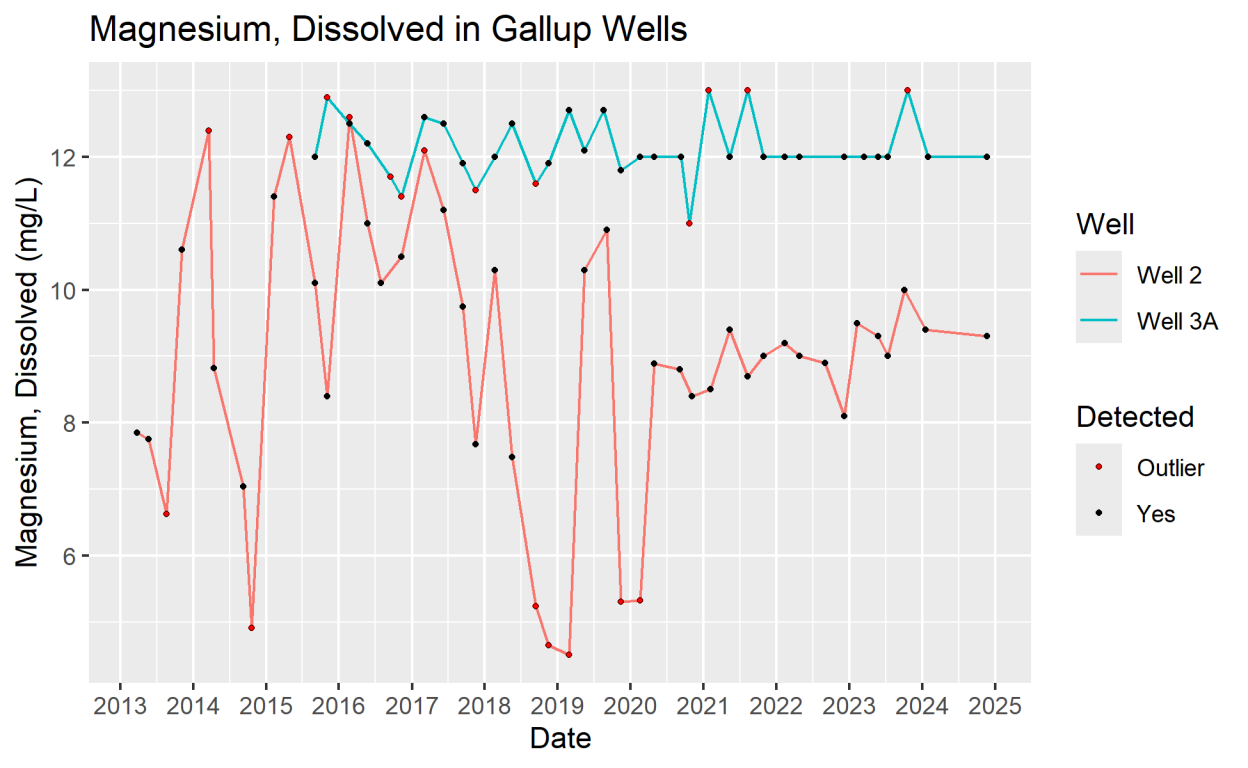

Carbonate in Gallup Wells
Carbonate (mg/L CaCO3)
8
6
4
2
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Well
Well 2
Well 3A

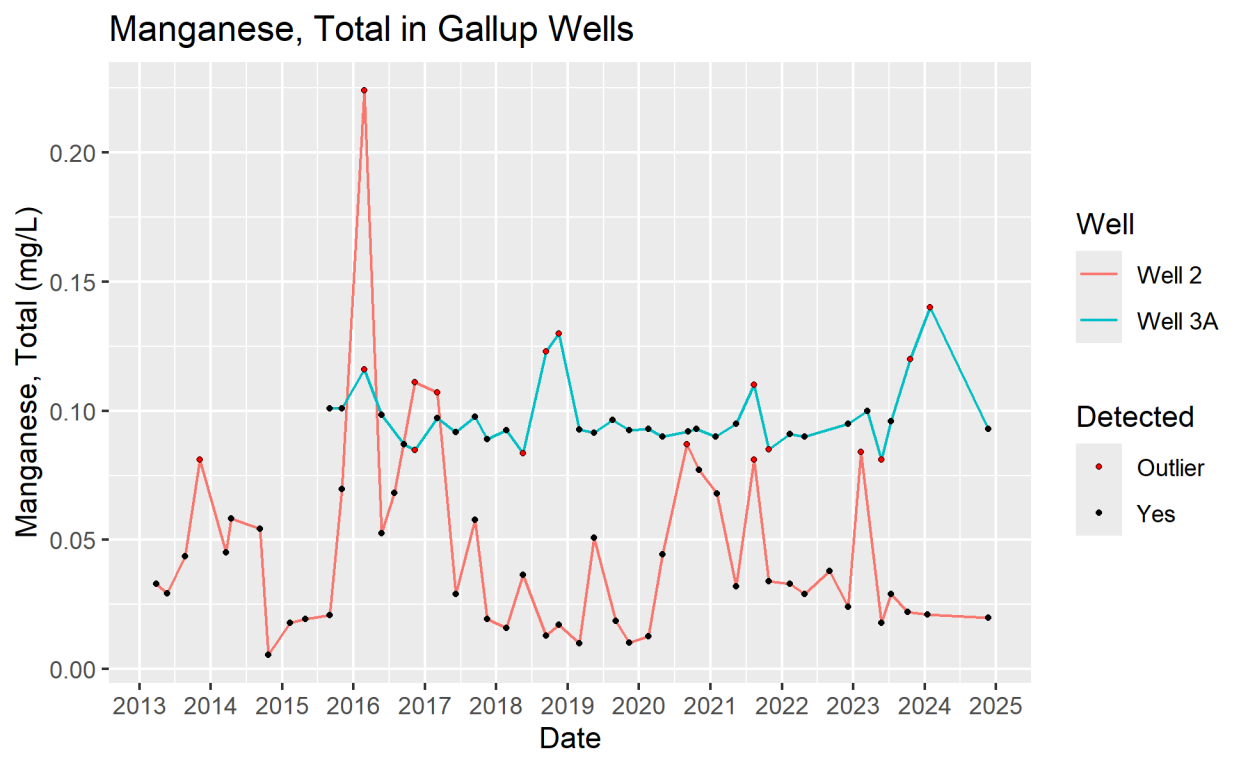

Chloride in Gallup Wells
Chloride (mg/L)
20
15
10
5
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

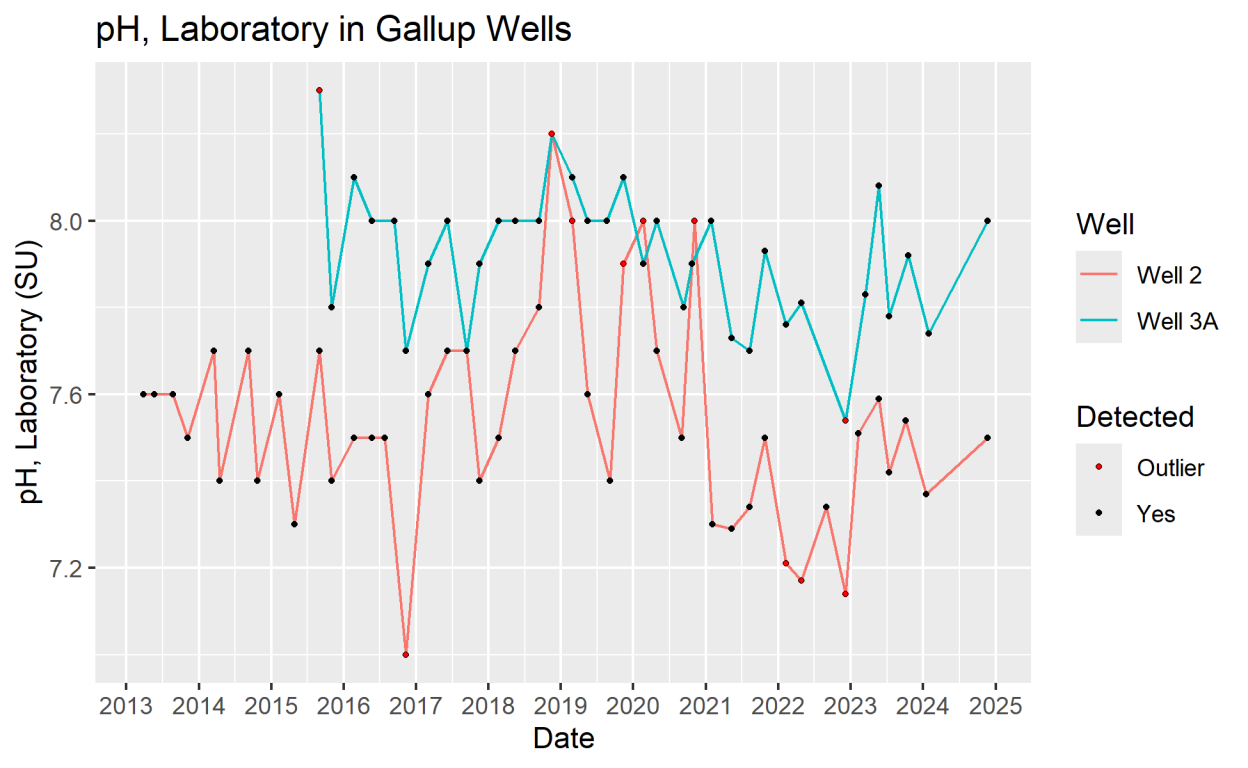

Fluoride in Gallup Wells
1.25
1.00
0.75
0.50
0.25
Fluoride (mg/L)
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
No
Outlier
Yes

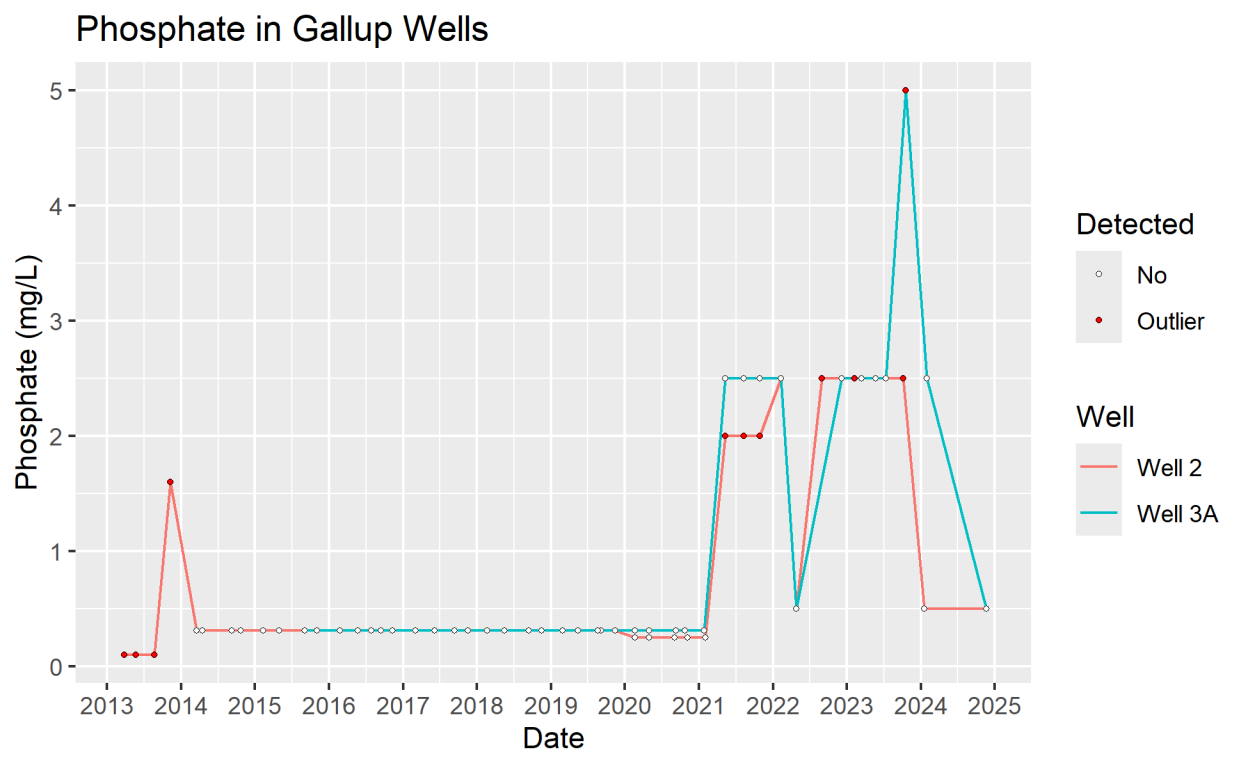

Hardness, Total in Gallup Wells
Hardness, Total (mg/L CaCO3)
300
200
100
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

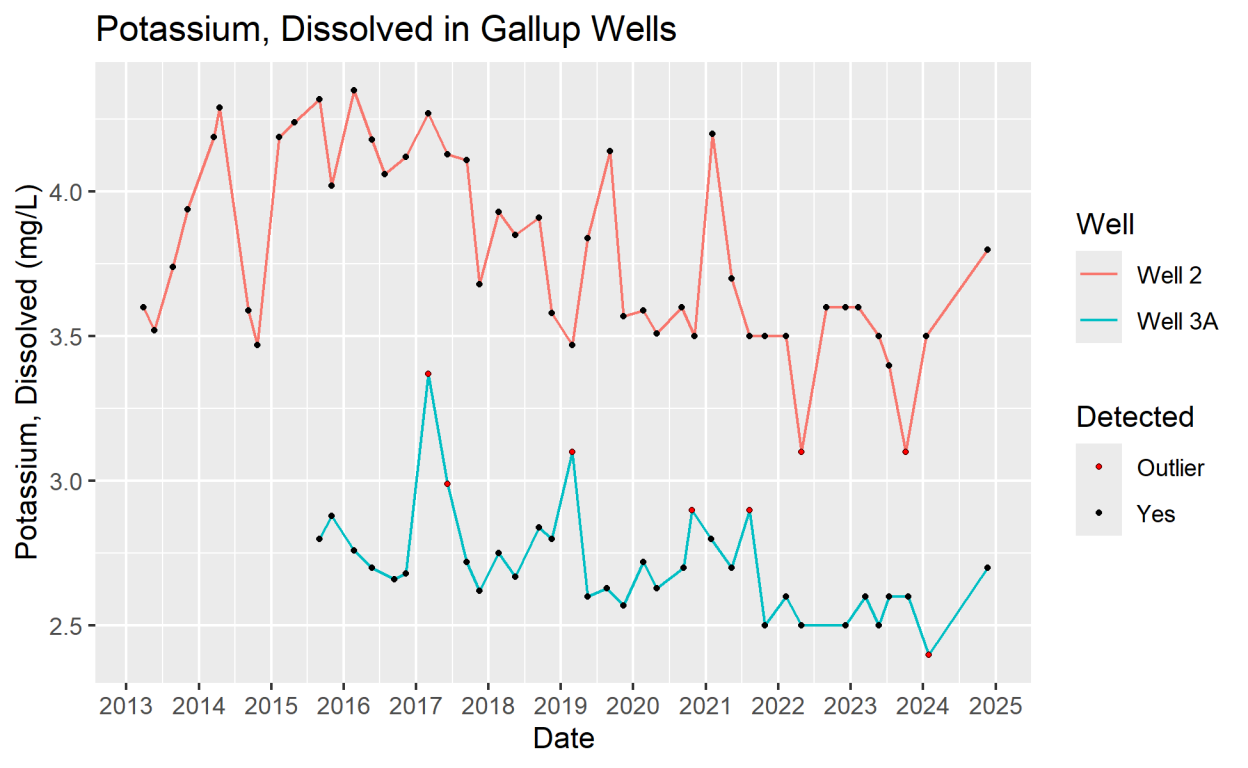

Iron, Total in Gallup Wells
Iron, Total (mg/L)
20
15
10
5
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

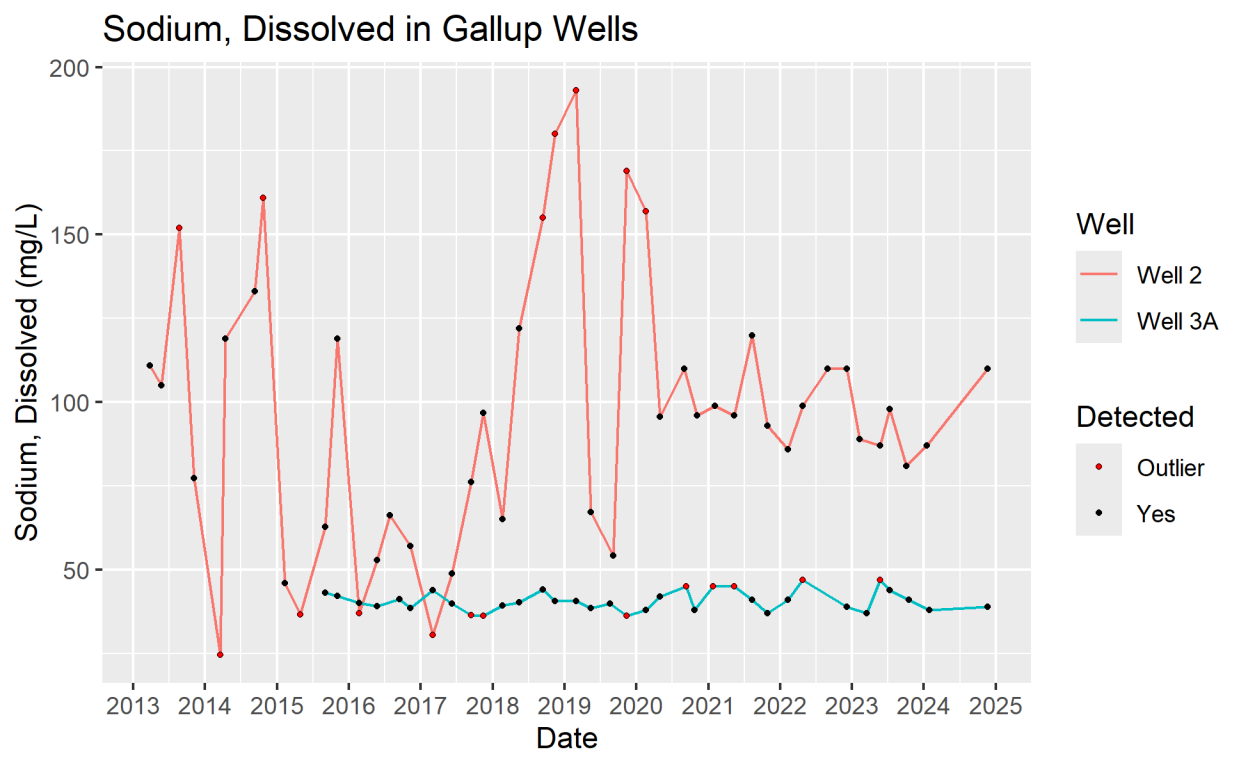

Magnesium, Dissolved in Gallup Wells
Magnesium, Dissolved (mg/L)
12
10
8
6
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

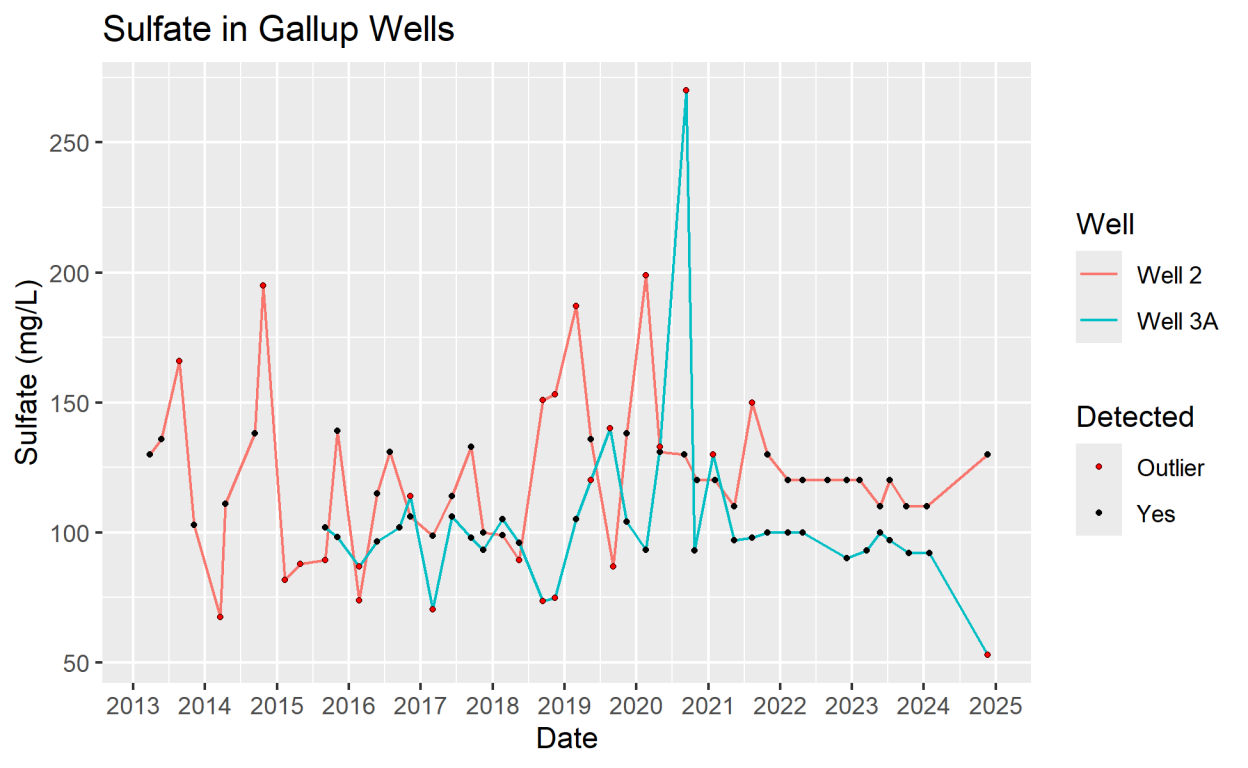

Manganese, Total in Gallup Wells
Manganese, Total (mg/L)
0.00
0.05
0.10
0.15
0.20
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

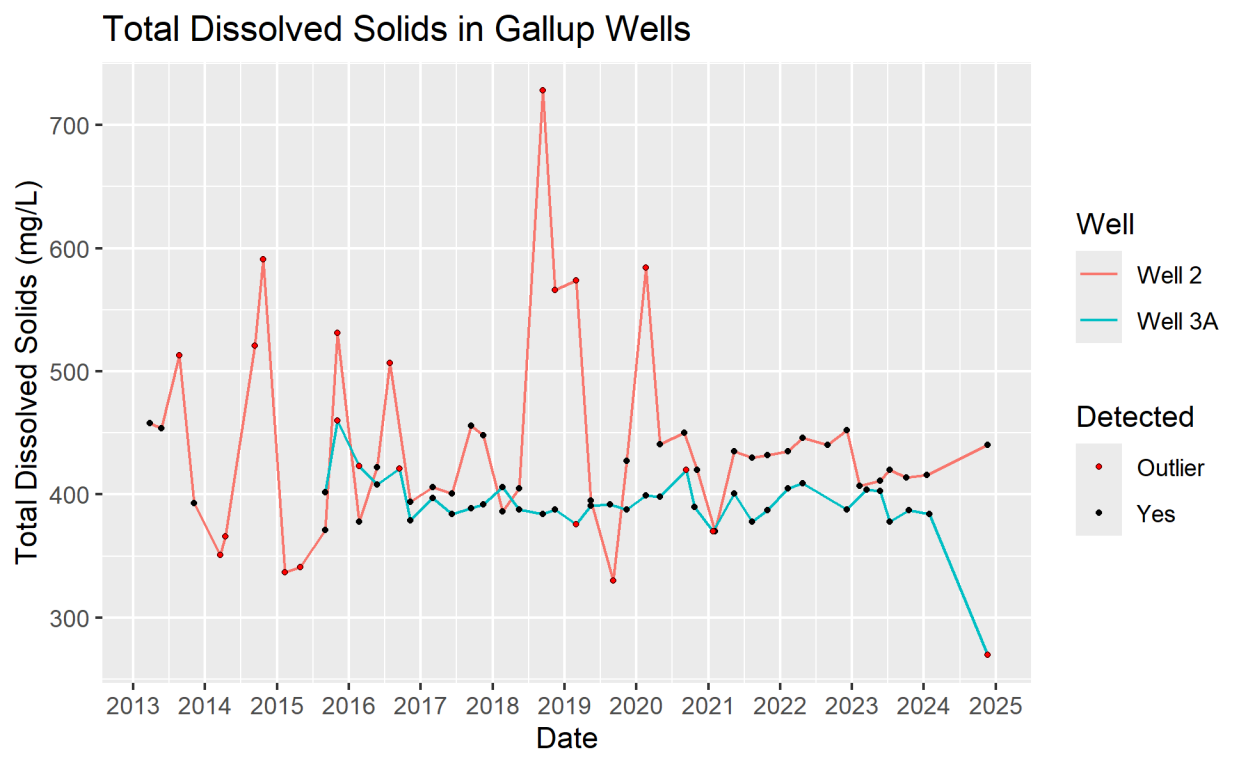

pH, Laboratory in Gallup Wells
pH, Laboratory (SU)
8.0
7.6
7.2
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

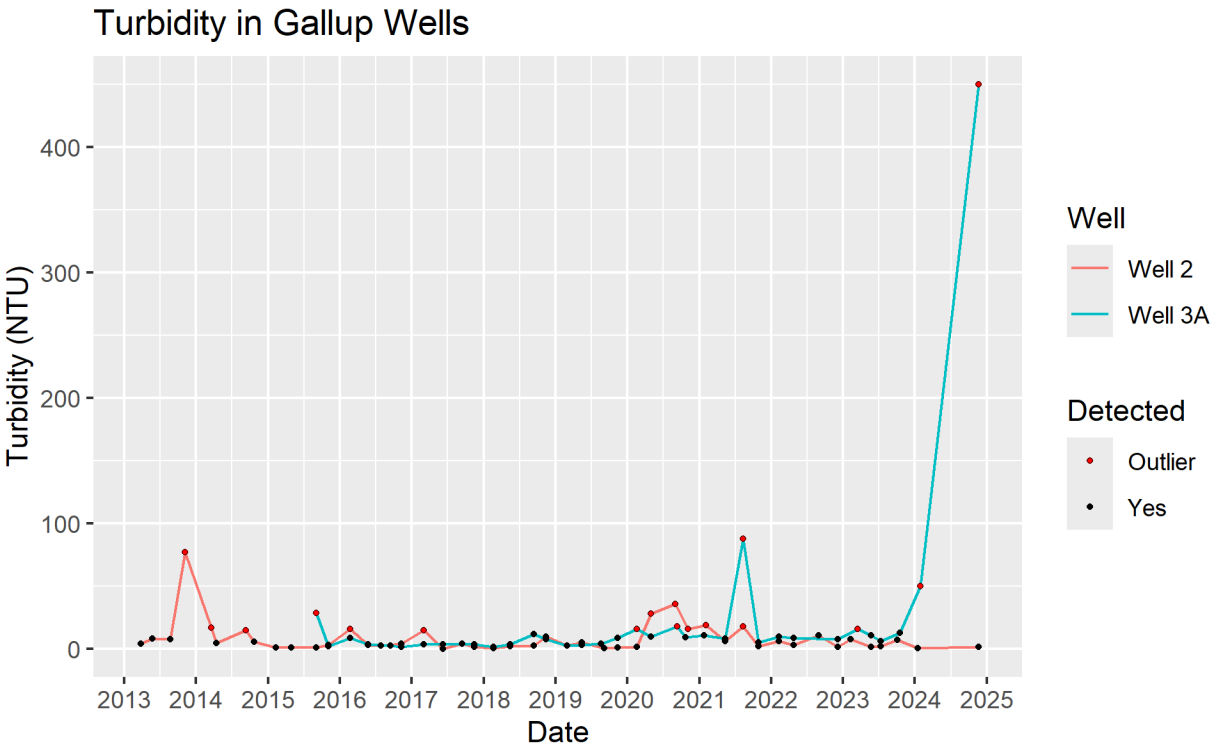

Phosphate in Gallup Wells
Phosphate (mg/L)
0
1
2
3
4
5
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Well
Well 2
Well 3A


Potassium, Dissolved in Gallup Wells
Potassium, Dissolved (mg/L)
4.0
3.5
3.0
2.5
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes


Sodium, Dissolved in Gallup Wells
Sodium, Dissolved (mg/L)
200
150
100
50
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

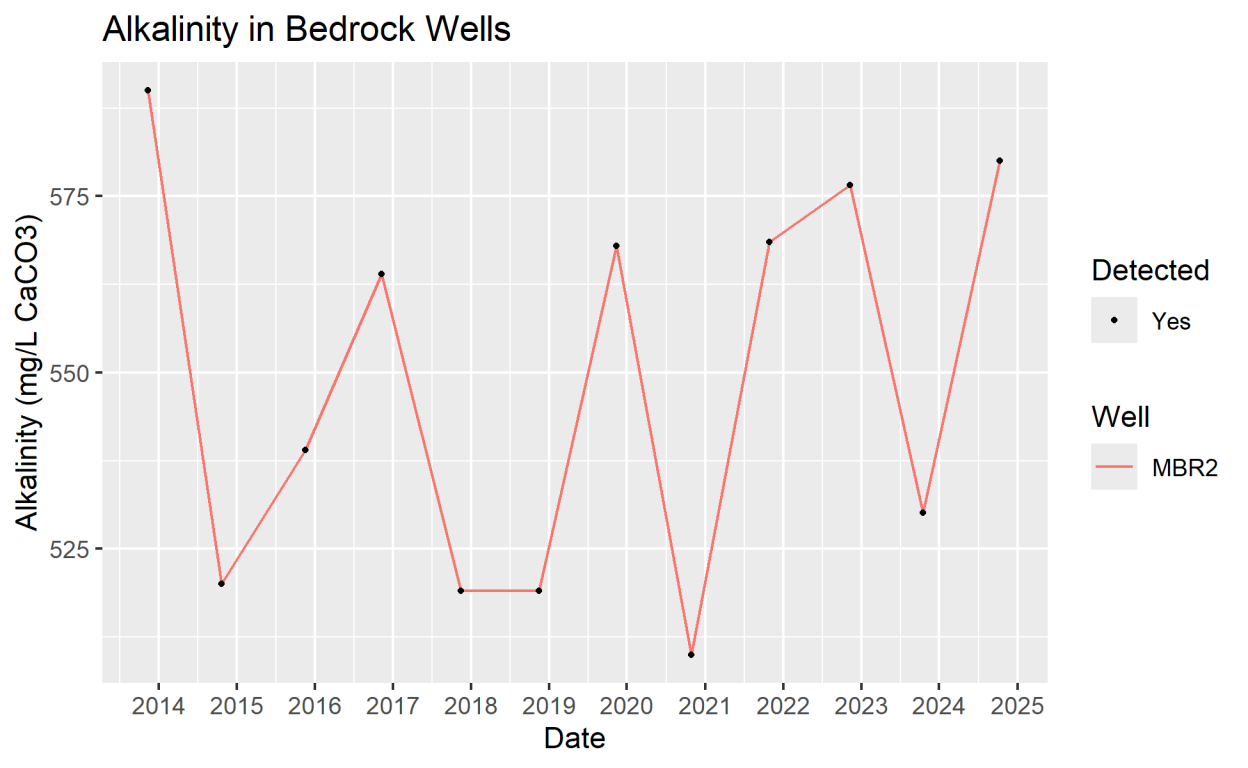

Sulfate in Gallup Wells
Sulfate (mg/L)
250
200
150
100
50
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

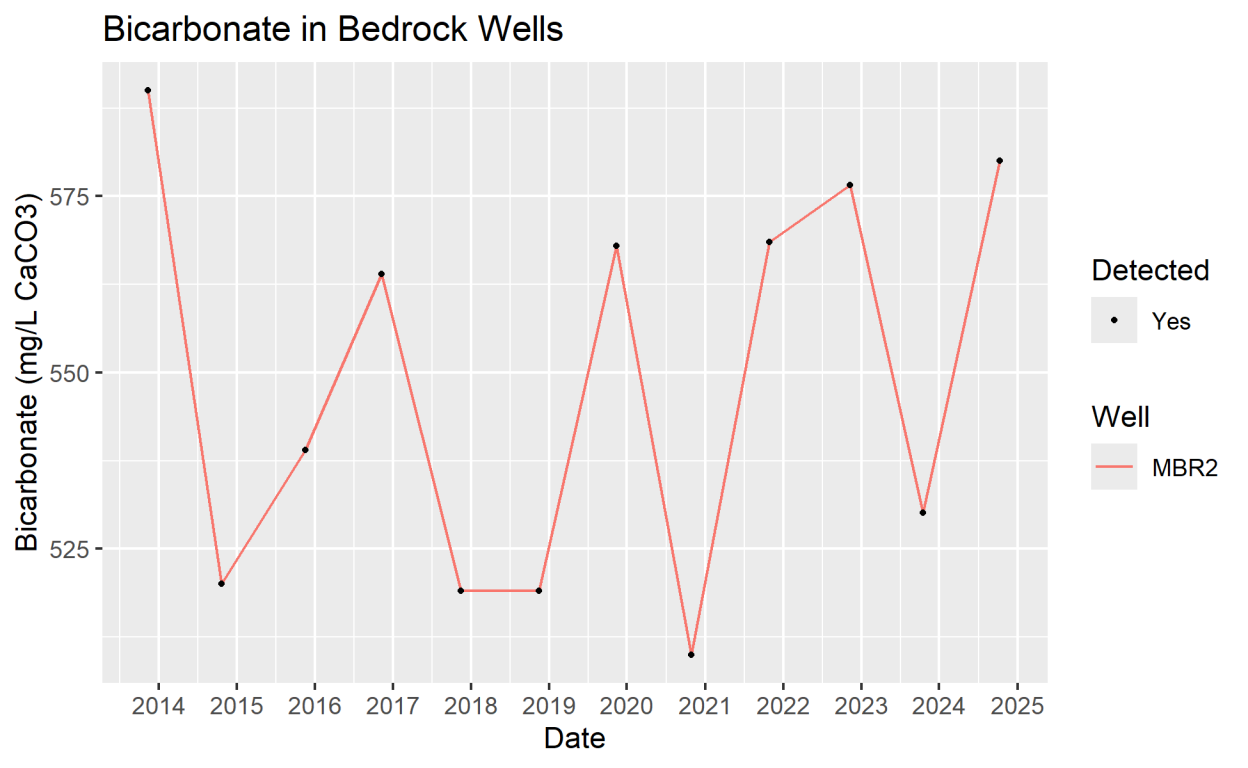

Total Dissolved Solids in Gallup Wells
Total Dissolved Solids (mg/L)
700
600
500
400
300
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

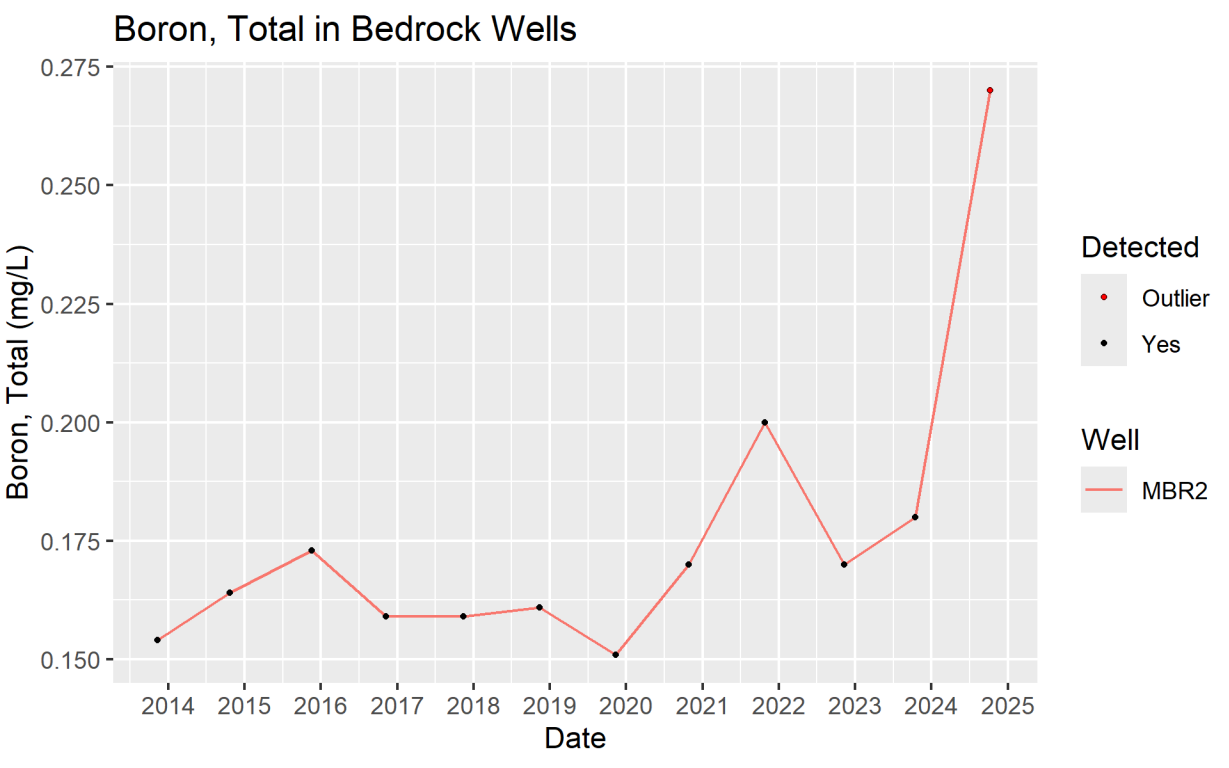

Turbidity in Gallup Wells
Turbidity (NTU)
400
300
200
100
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
Well 2
Well 3A
Detected
Outlier
Yes

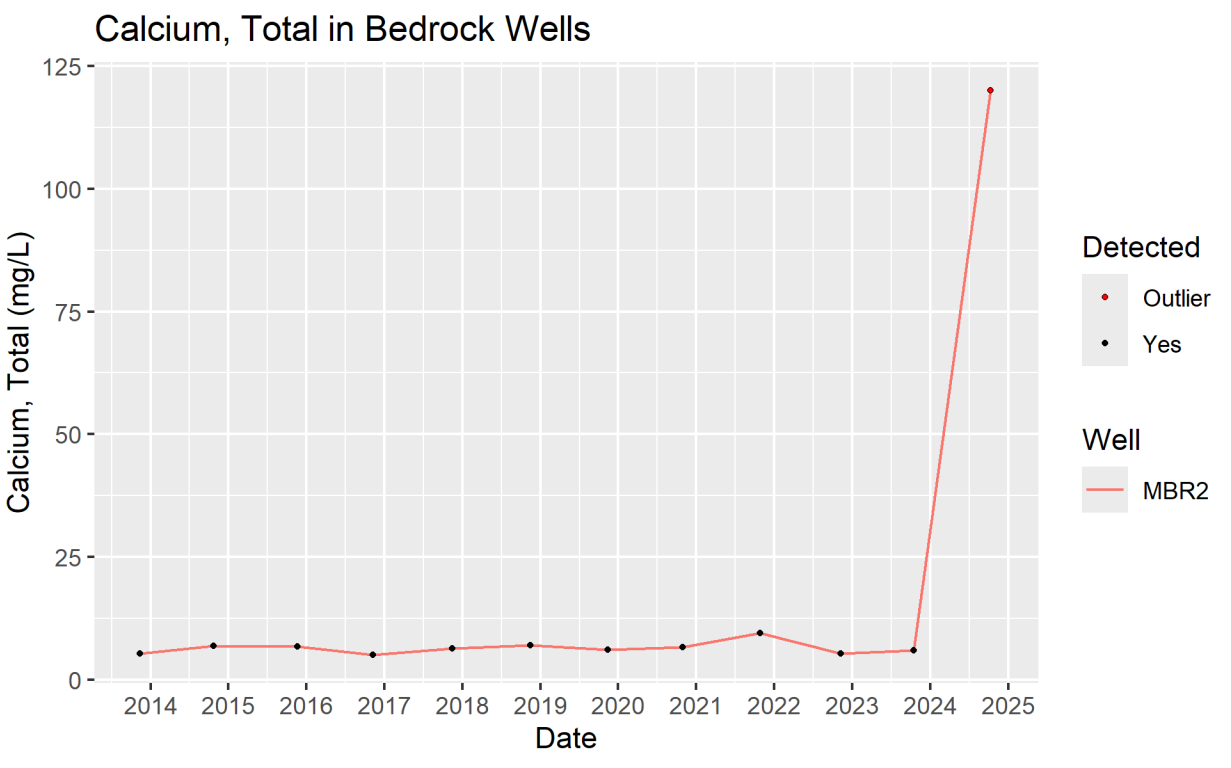
# APPENDIX C-2

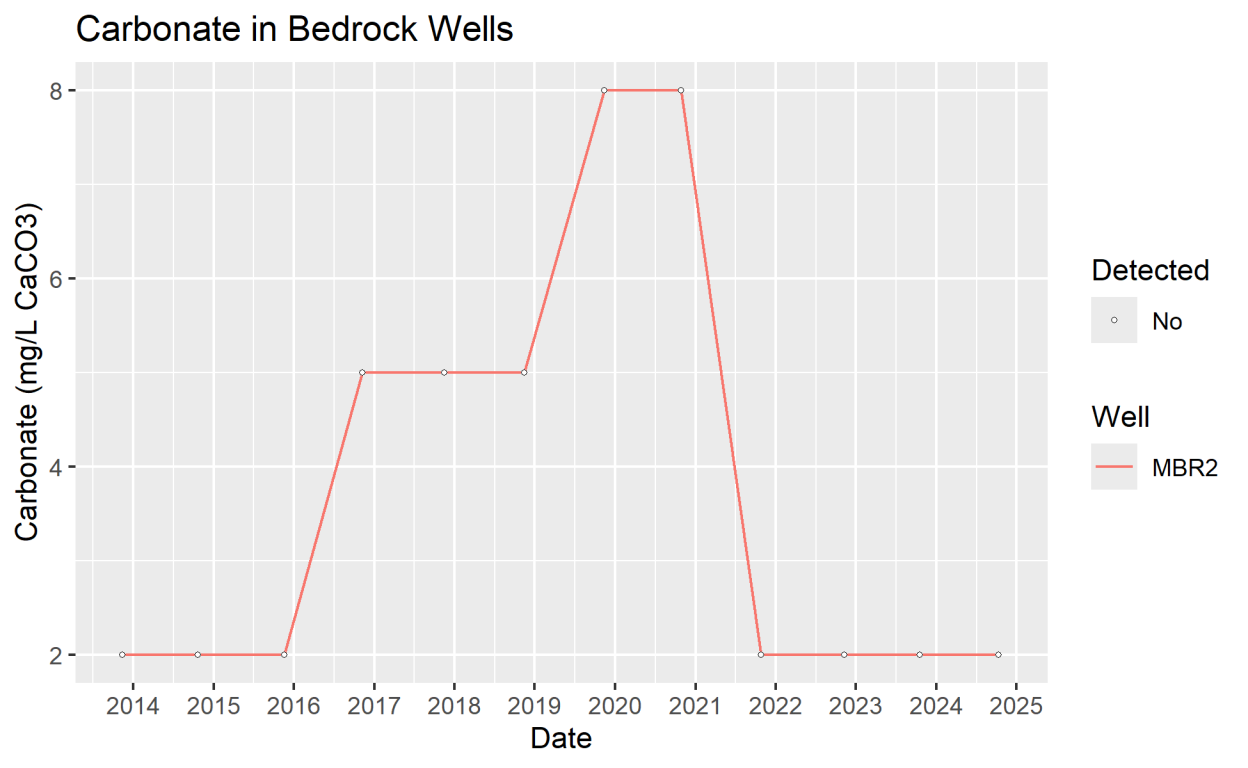
## HISTORICAL GROUNDWATER TEMPORAL PLOTS – BEDROCK MONITORING WELL MBR2

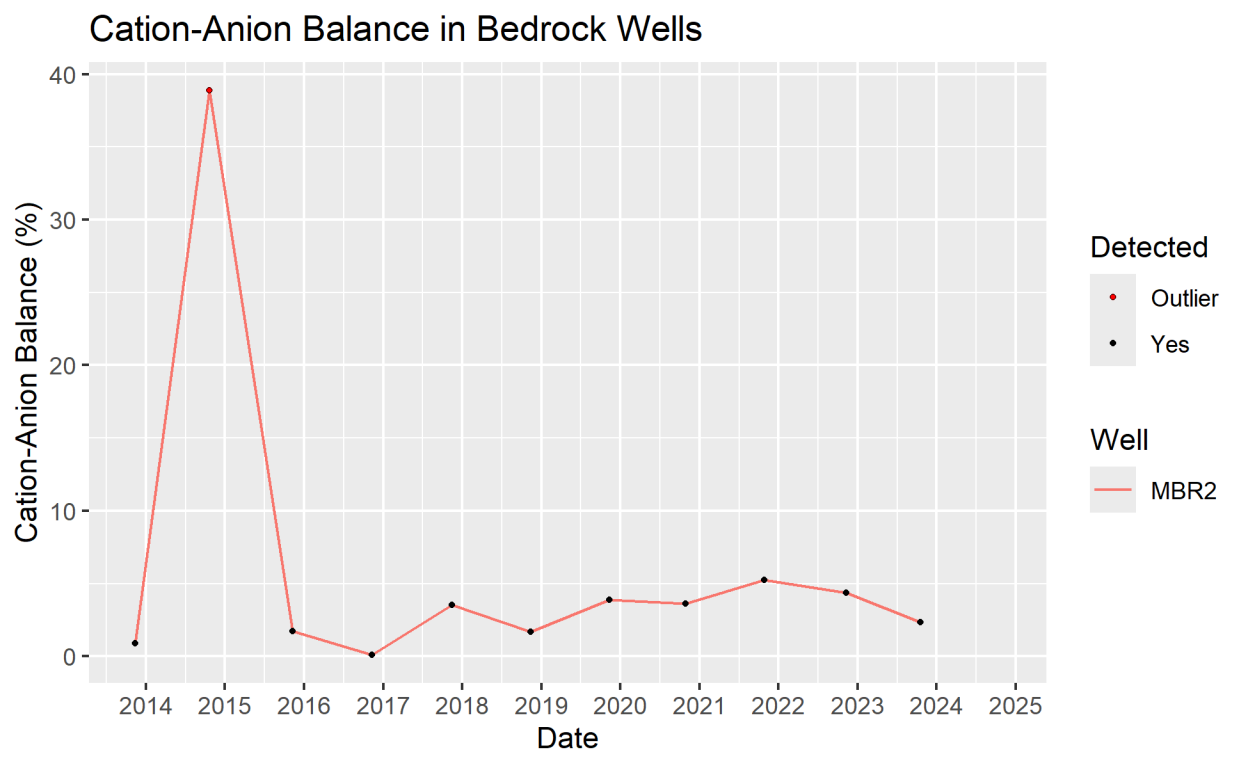

Alkalinity in Bedrock Wells
Alkalinity (mg/L CaCO3)
575
550
525
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Yes
Well
MBR2

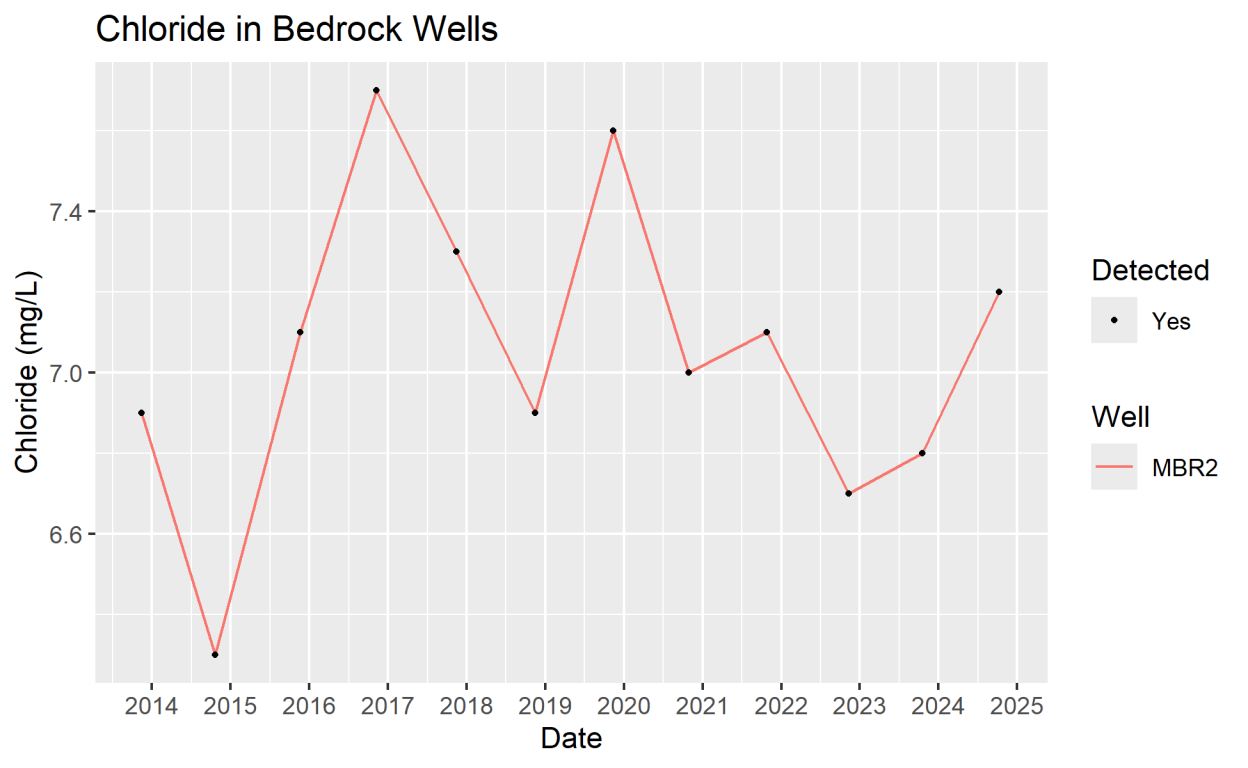

Bicarbonate in Bedrock Wells
Bicarbonate (mg/L CaCO3)
575
550
525
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Yes
Well
MBR2

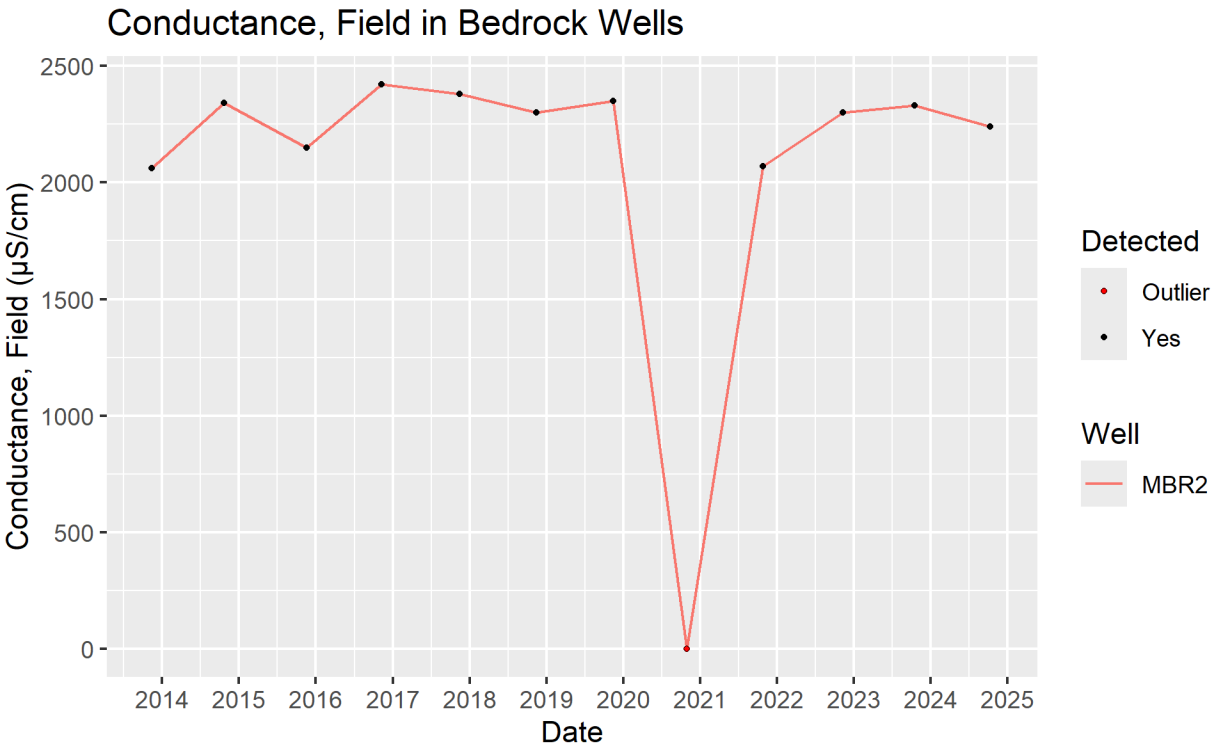

Boron, Total in Bedrock Wells
Boron, Total (mg/L)
0.275
0.250
0.225
0.200
0.175
0.150
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
MBR2

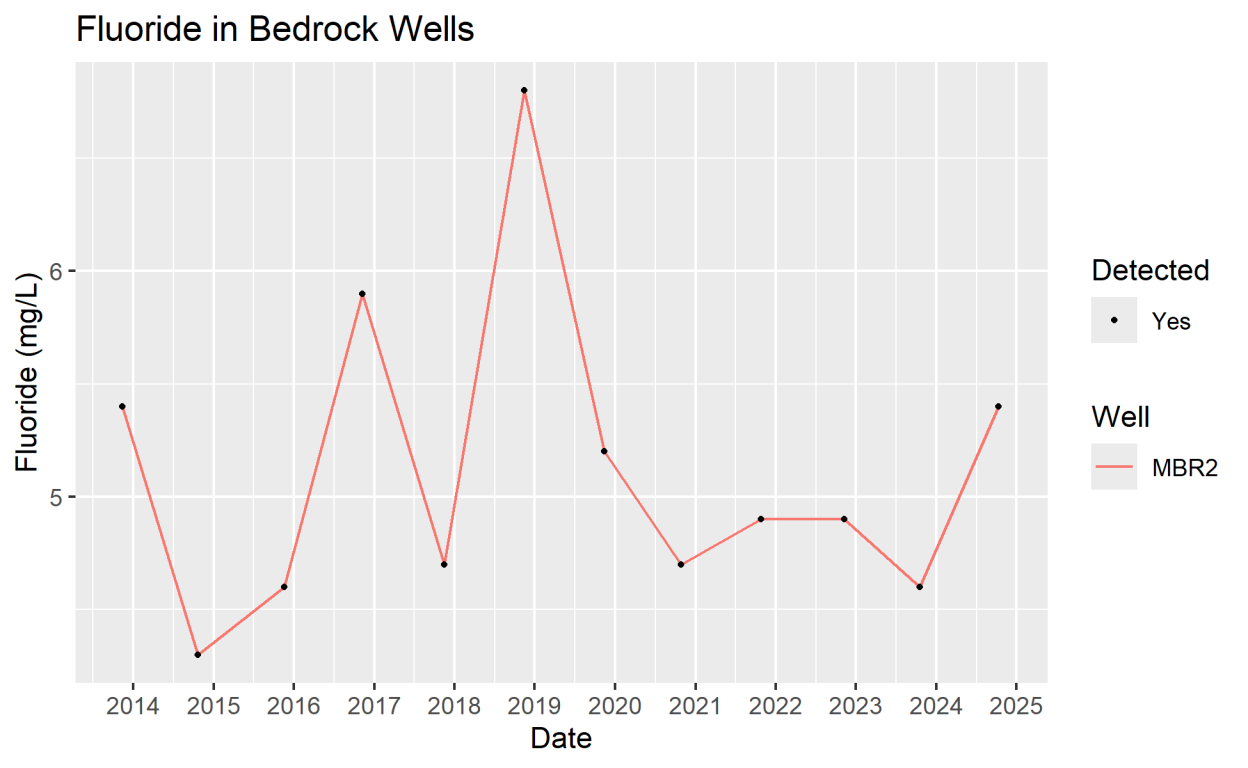

Calcium, Total in Bedrock Wells
Calcium, Total (mg/L)
125
100
75
50
25
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
MBR2

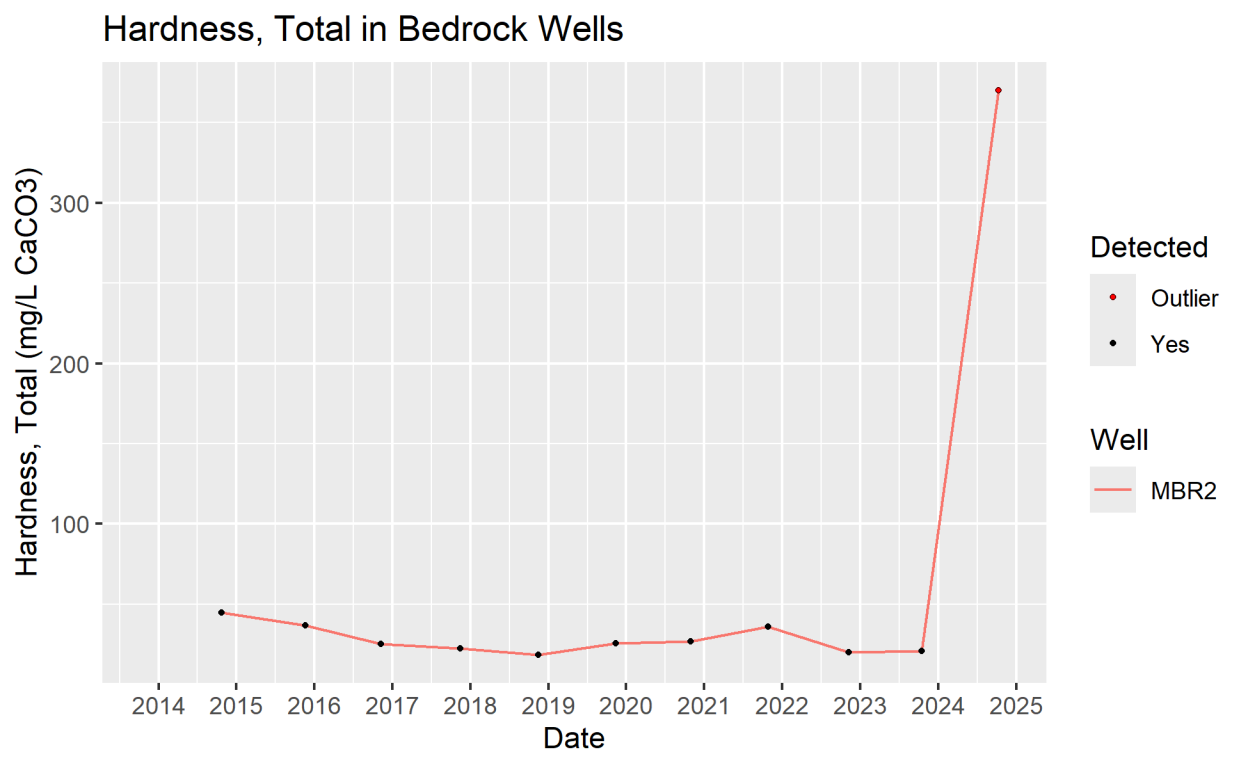

Carbonate in Bedrock Wells
Carbonate (mg/L CaCO3)
8
6
4
2
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Well
MBR2

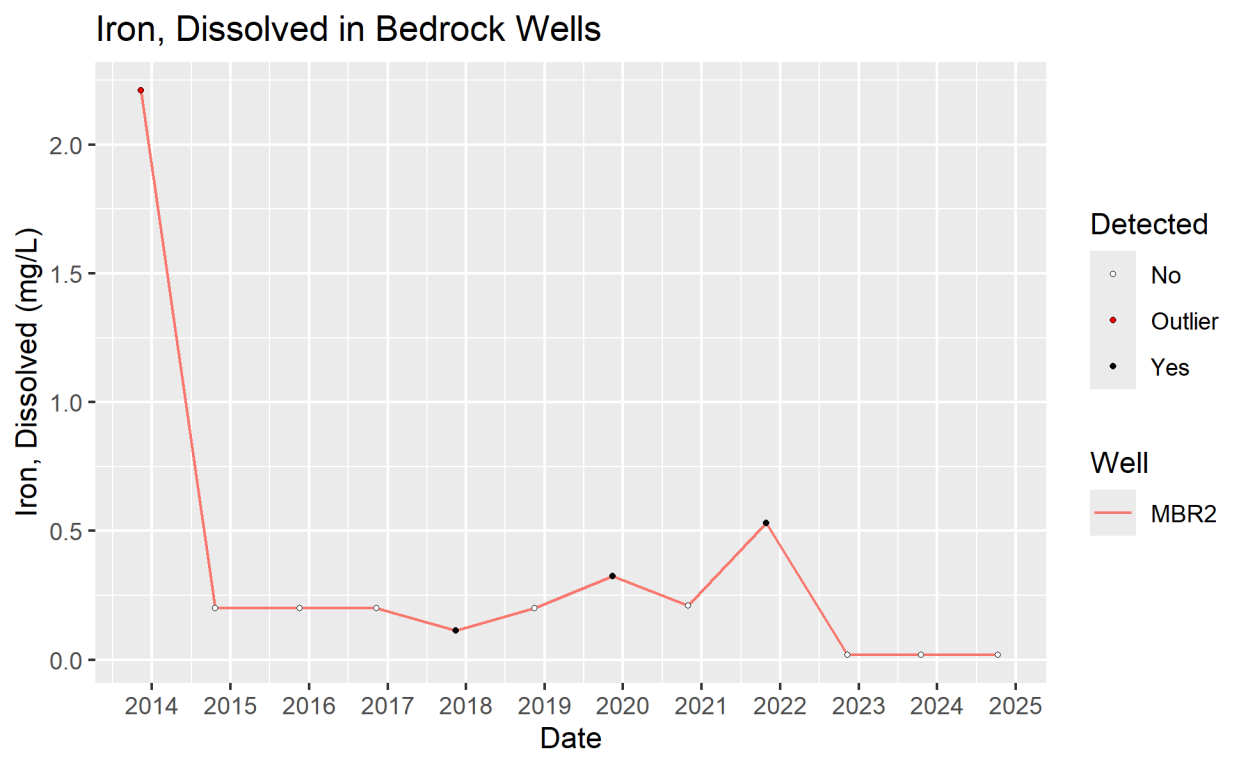

Cation-Anion Balance in Bedrock Wells
Cation-Anion Balance (%)
40
30
20
10
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
MBR2

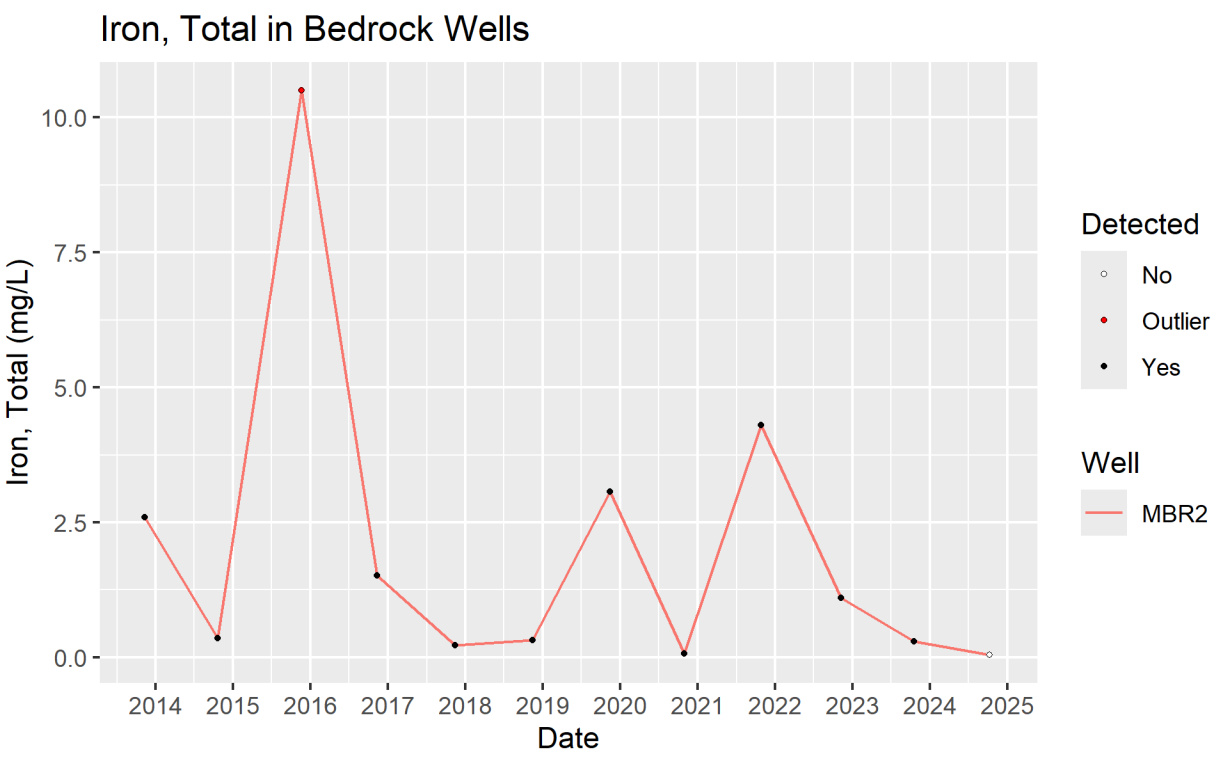

Chloride in Bedrock Wells
Chloride (mg/L)
7.4
7.0
6.6
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Yes
Well
MBR2

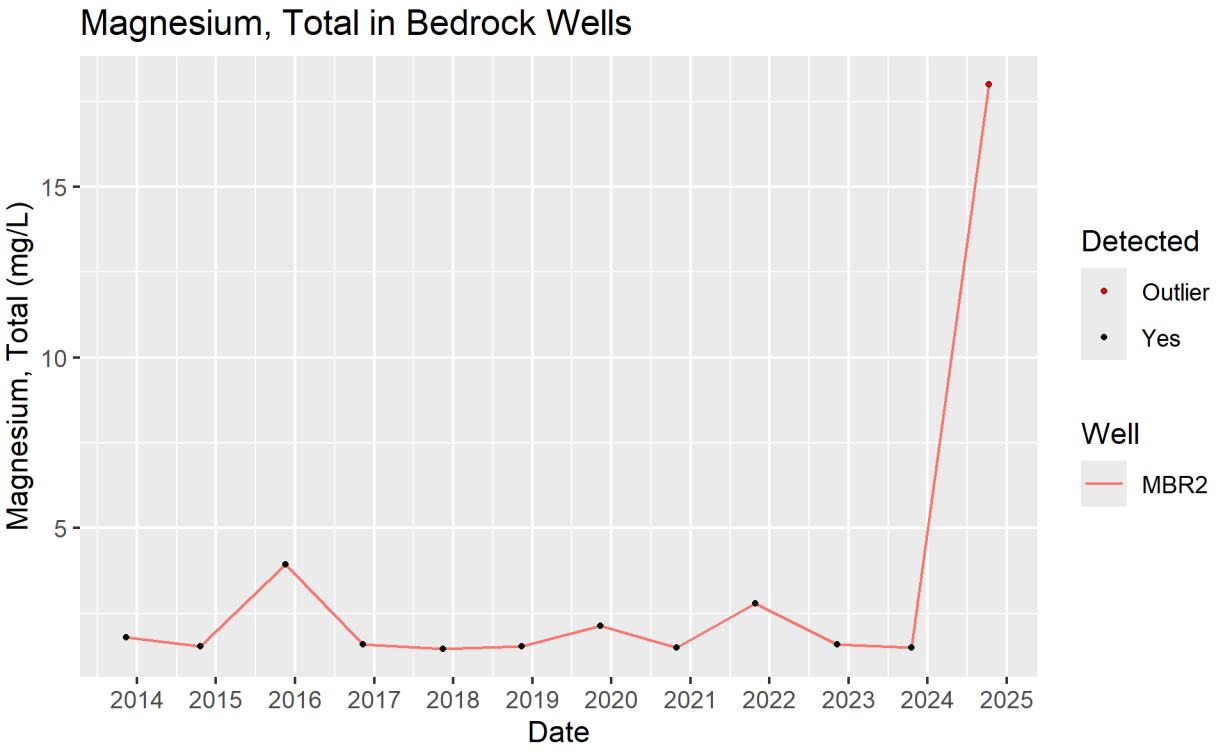

Conductance, Field in Bedrock Wells
Conductance, Field (µS/cm)
2500
2000
1500
1000
500
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
MBR2

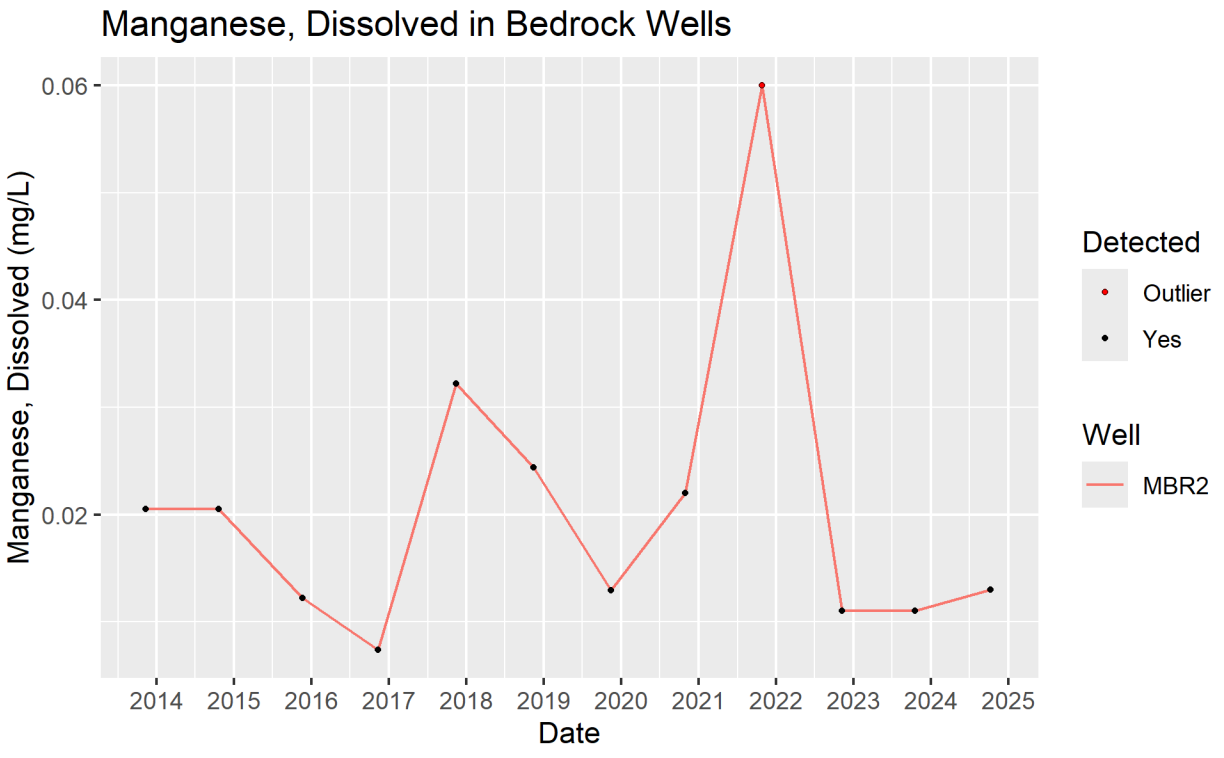

Fluoride in Bedrock Wells
Fluoride (mg/L)
6
5
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Yes
Well
MBR2

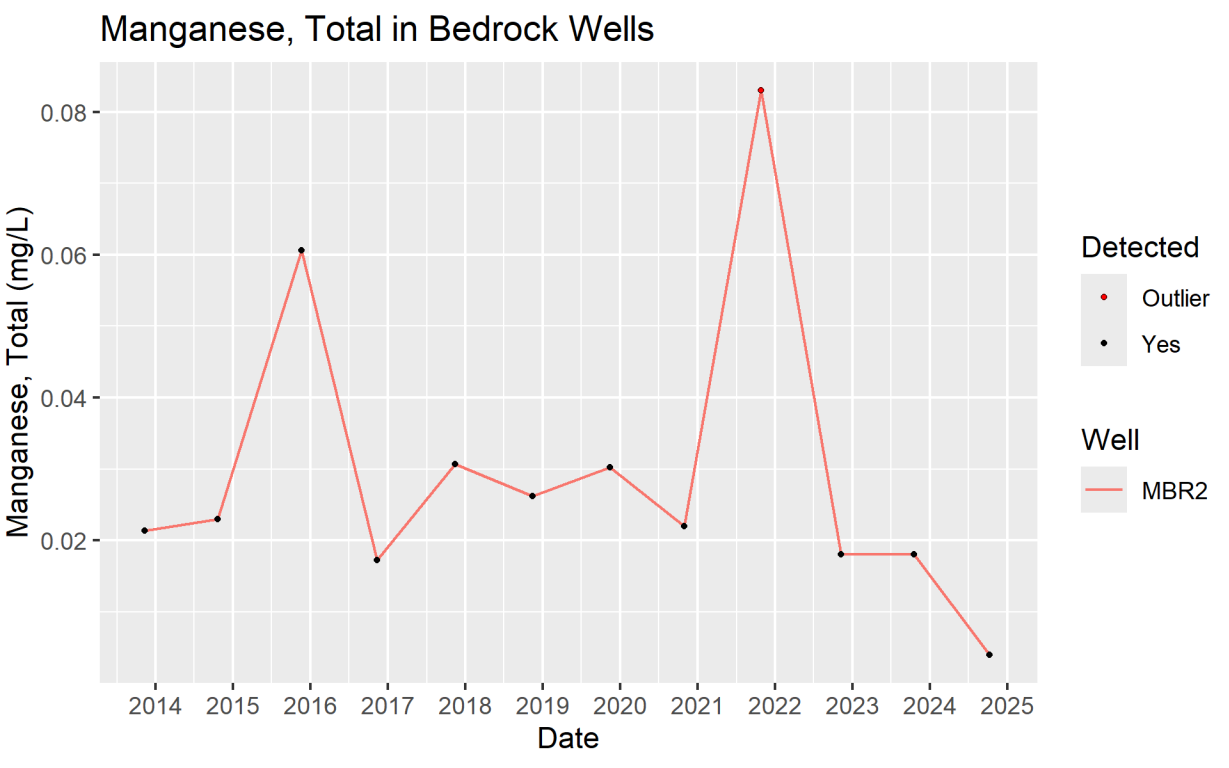

Hardness, Total in Bedrock Wells
Hardness, Total (mg/L CaCO3)
300
200
100
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
MBR2

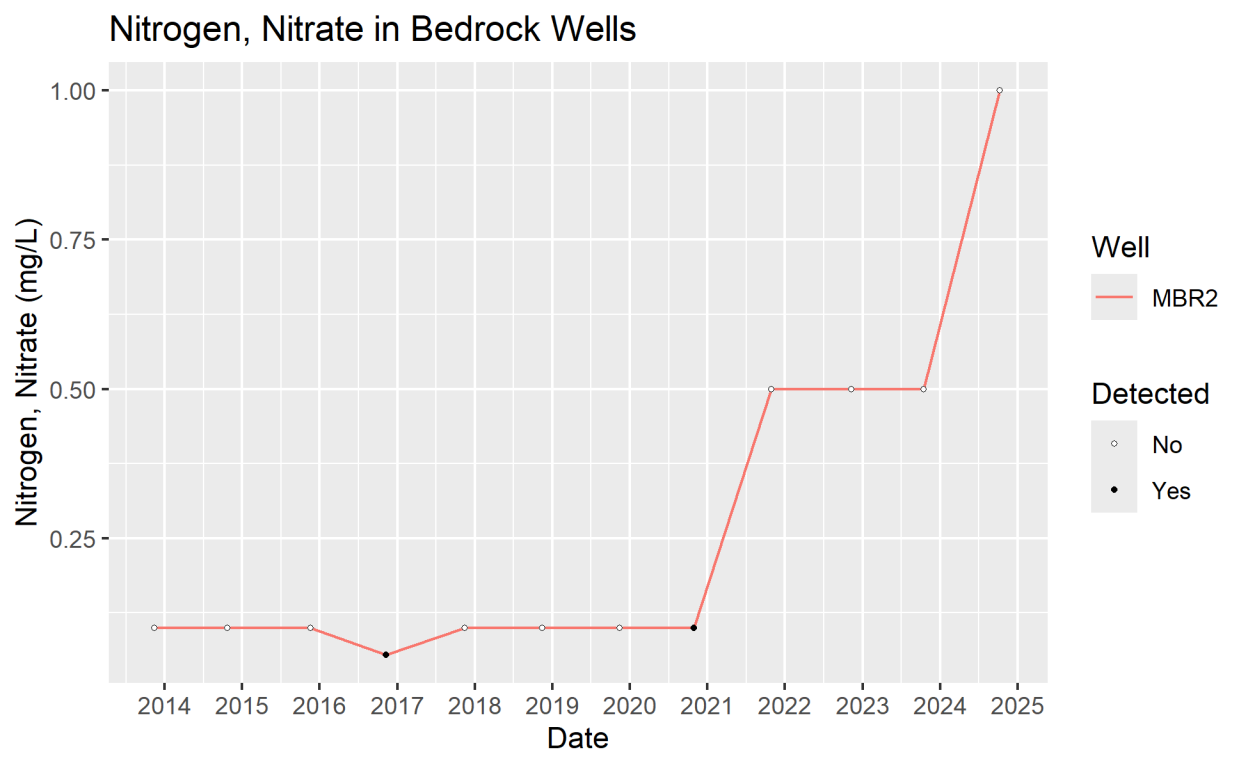

Iron, Dissolved in Bedrock Wells
Iron, Dissolved (mg/L)
2.0
1.5
1.0
0.5
0.0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Well
MBR2

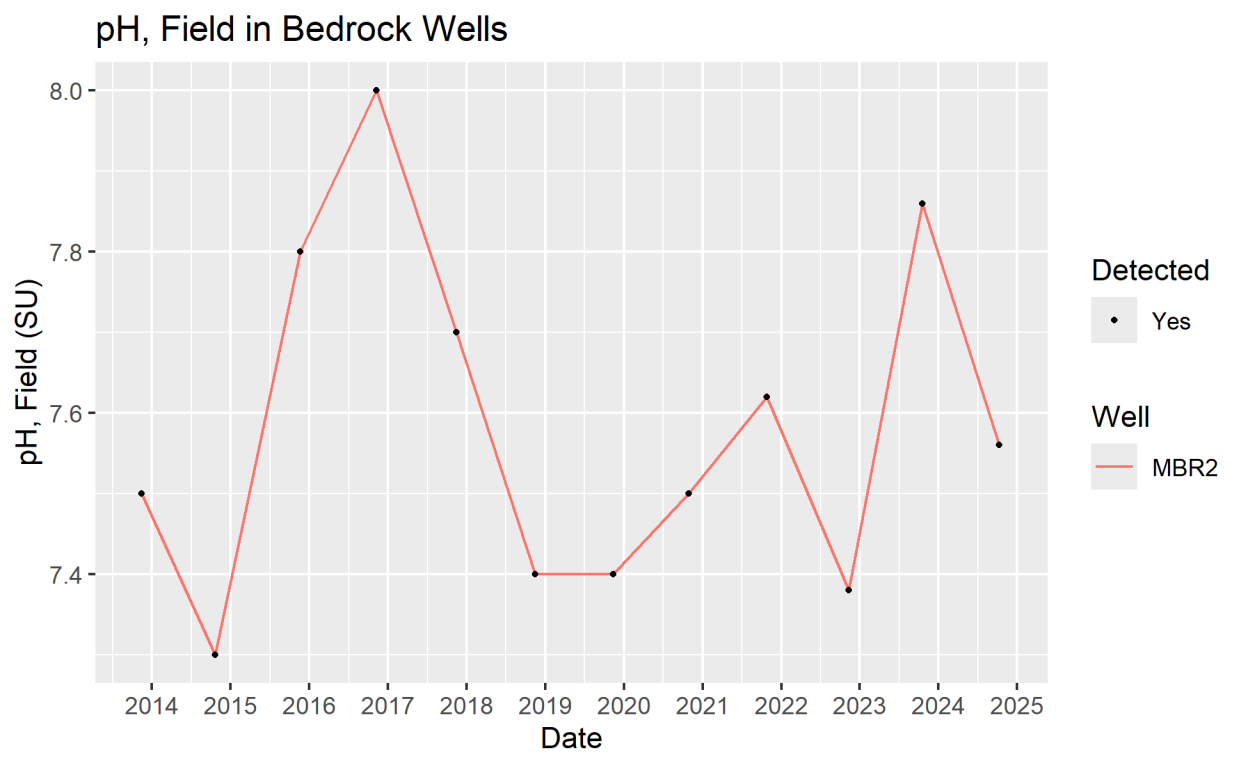

Iron, Total in Bedrock Wells
Iron, Total (mg/L)
10.0
7.5
5.0
2.5
0.0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Outlier
Yes
Well
MBR2

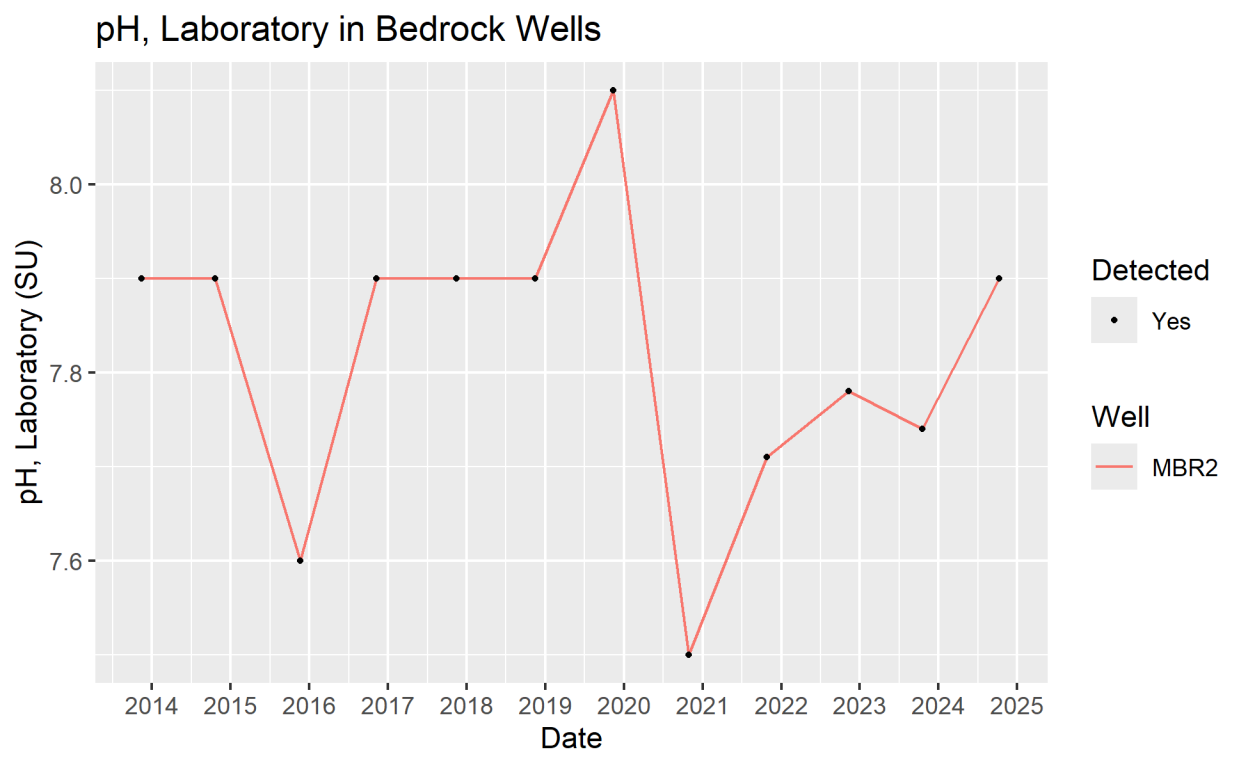

Magnesium, Total in Bedrock Wells
Magnesium, Total (mg/L)
15
10
5
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
MBR2

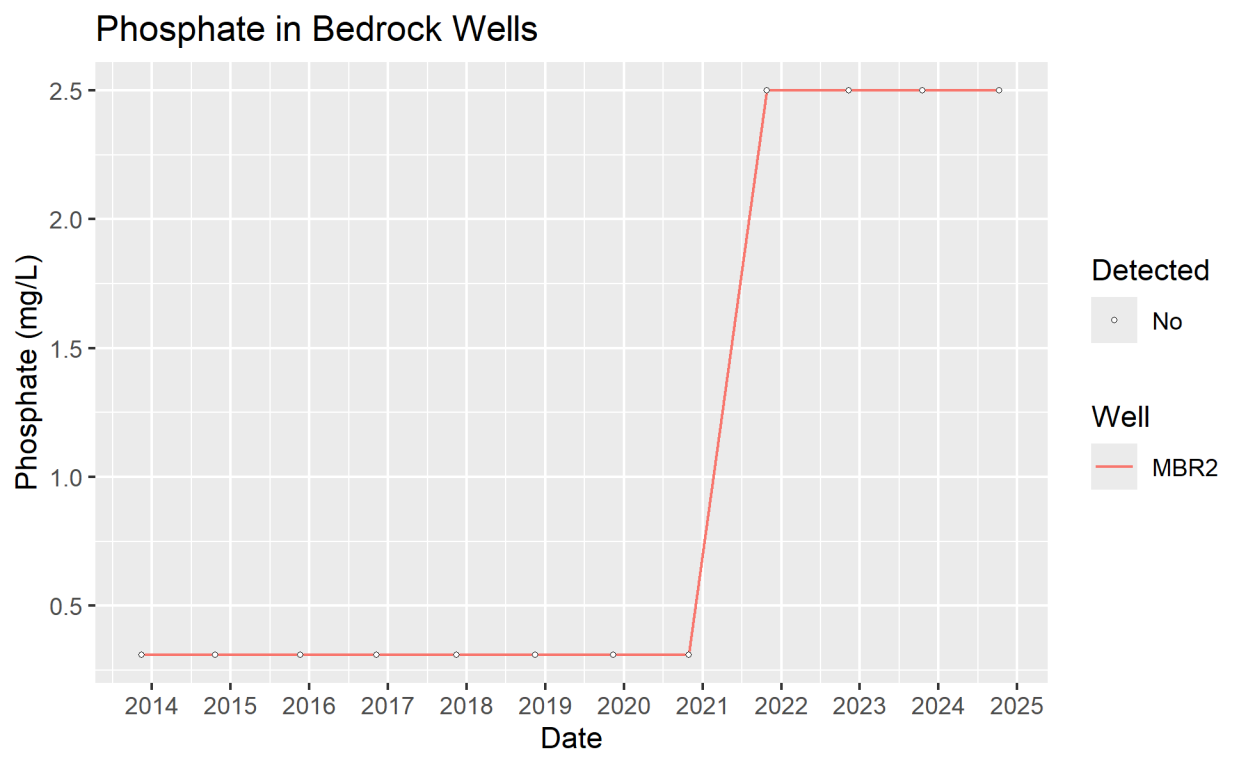

Manganese, Dissolved in Bedrock Wells
Manganese, Dissolved (mg/L)
0.06
0.04
0.02
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
MBR2

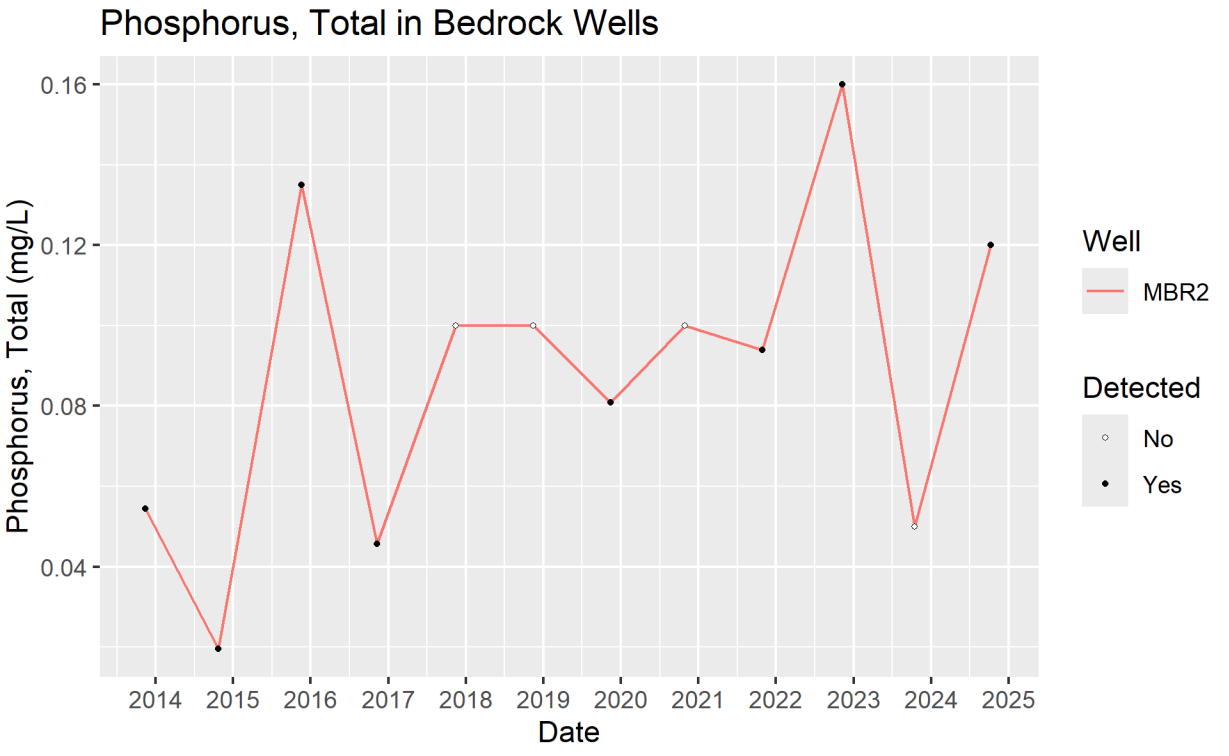

Manganese, Total in Bedrock Wells
Manganese, Total (mg/L)
0.08
0.06
0.04
0.02
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
MBR2

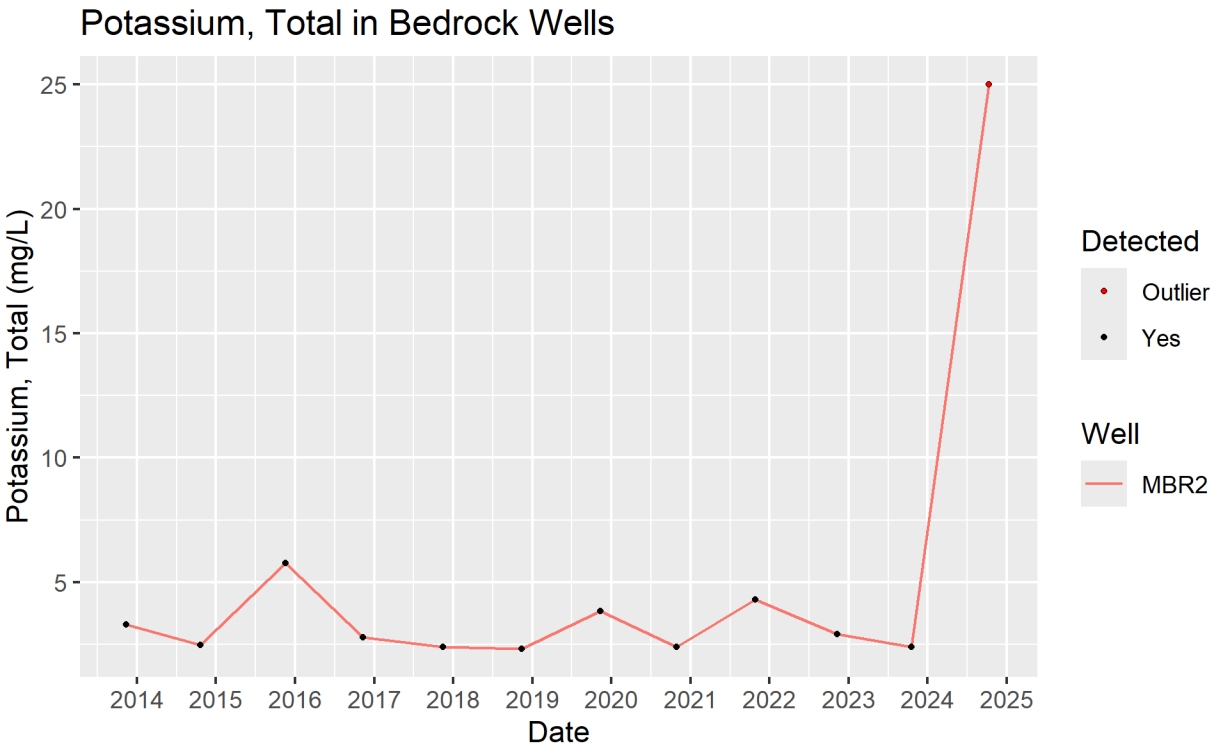

Nitrogen, Nitrate in Bedrock Wells
1.00
0.75
0.50
0.25
Nitrogen, Nitrate (mg/L)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
MBR2
Detected
No
Yes

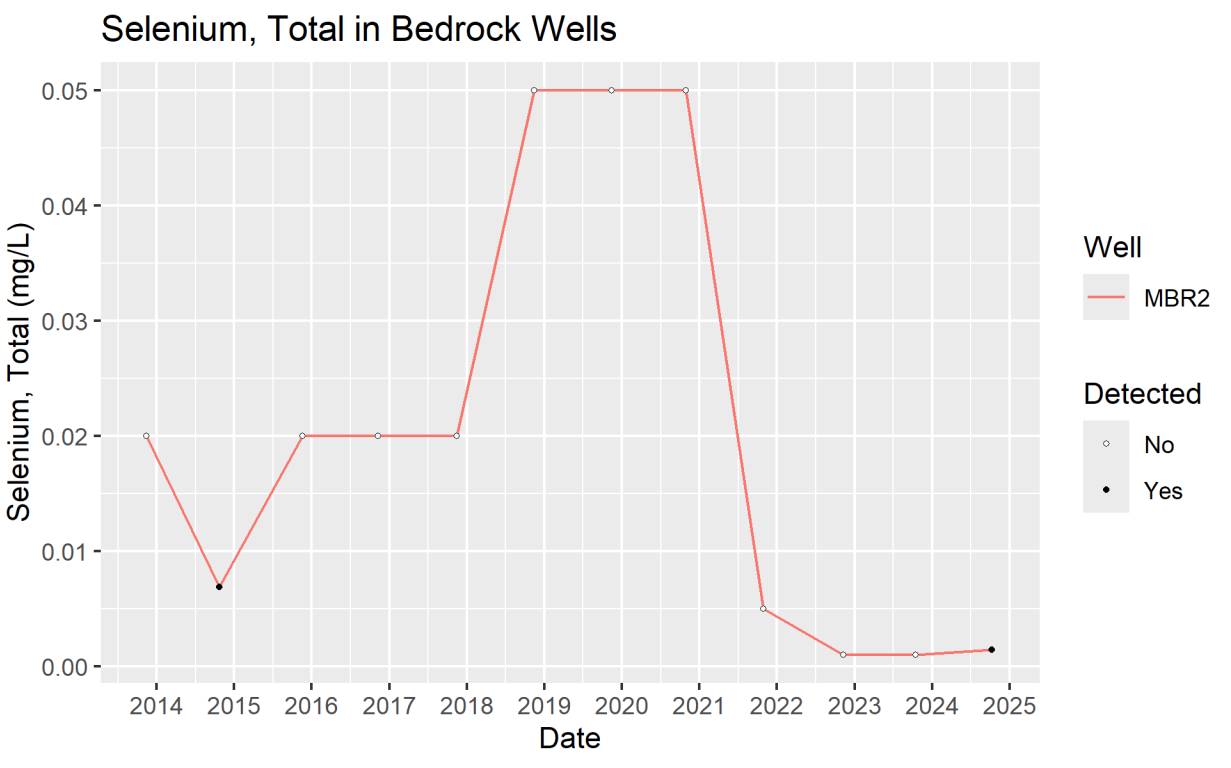

pH, Field in Bedrock Wells
8.0
7.8
7.6
7.4
pH, Field (SU)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Yes
Well
MBR2

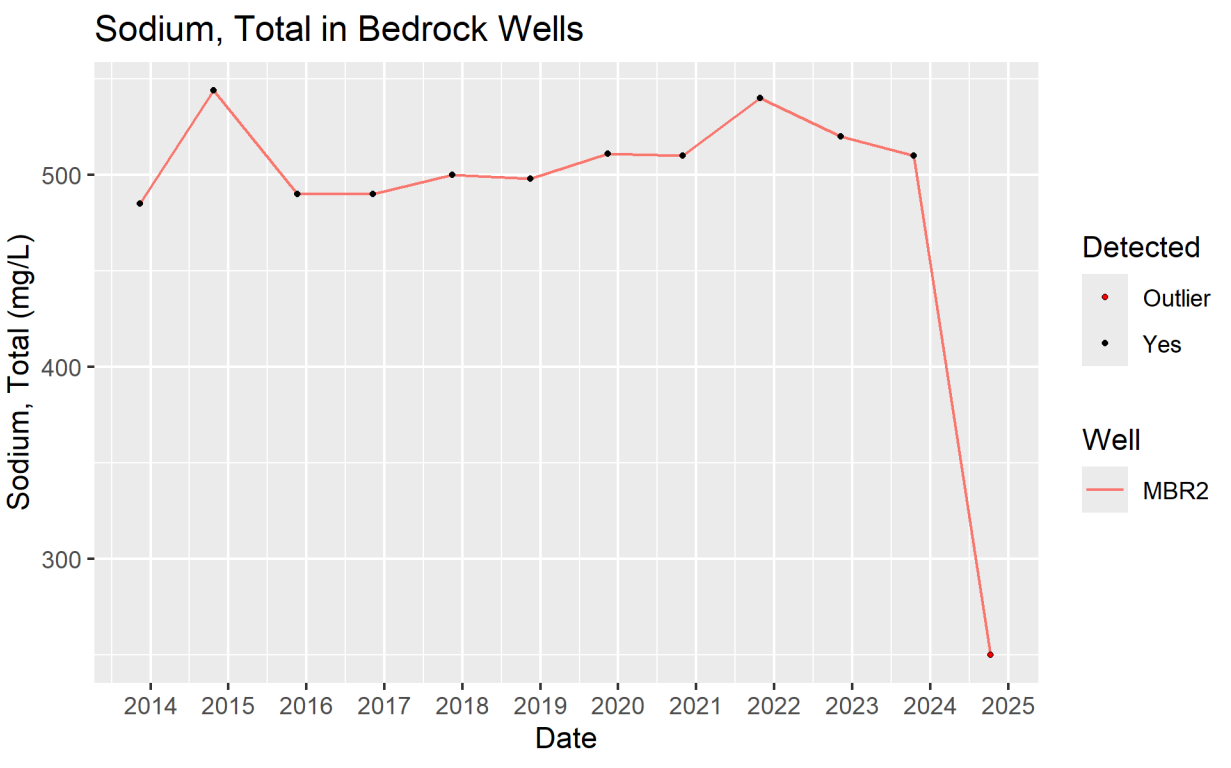

pH, Laboratory in Bedrock Wells
pH, Laboratory (SU)
8.0
7.8
7.6
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Yes
Well
MBR2

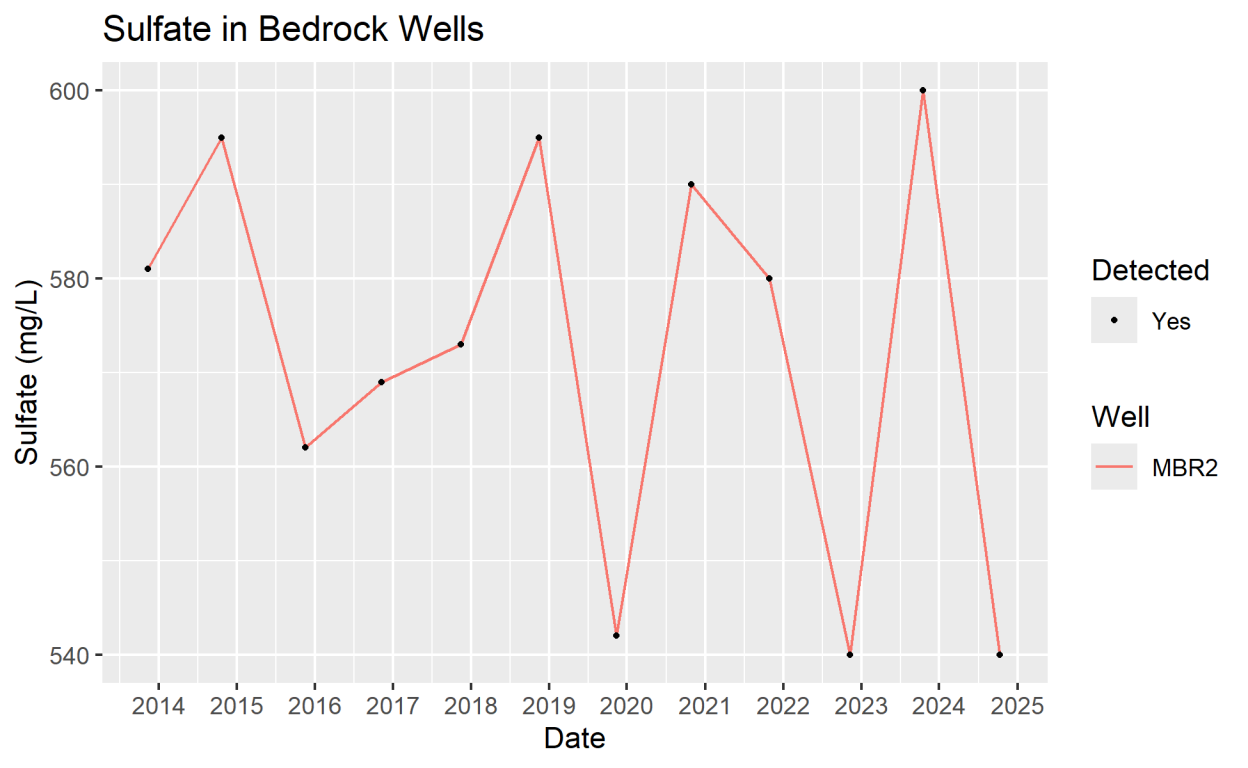

Phosphate in Bedrock Wells
Phosphate (mg/L)
2.5
2.0
1.5
1.0
0.5
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
No
Well
MBR2

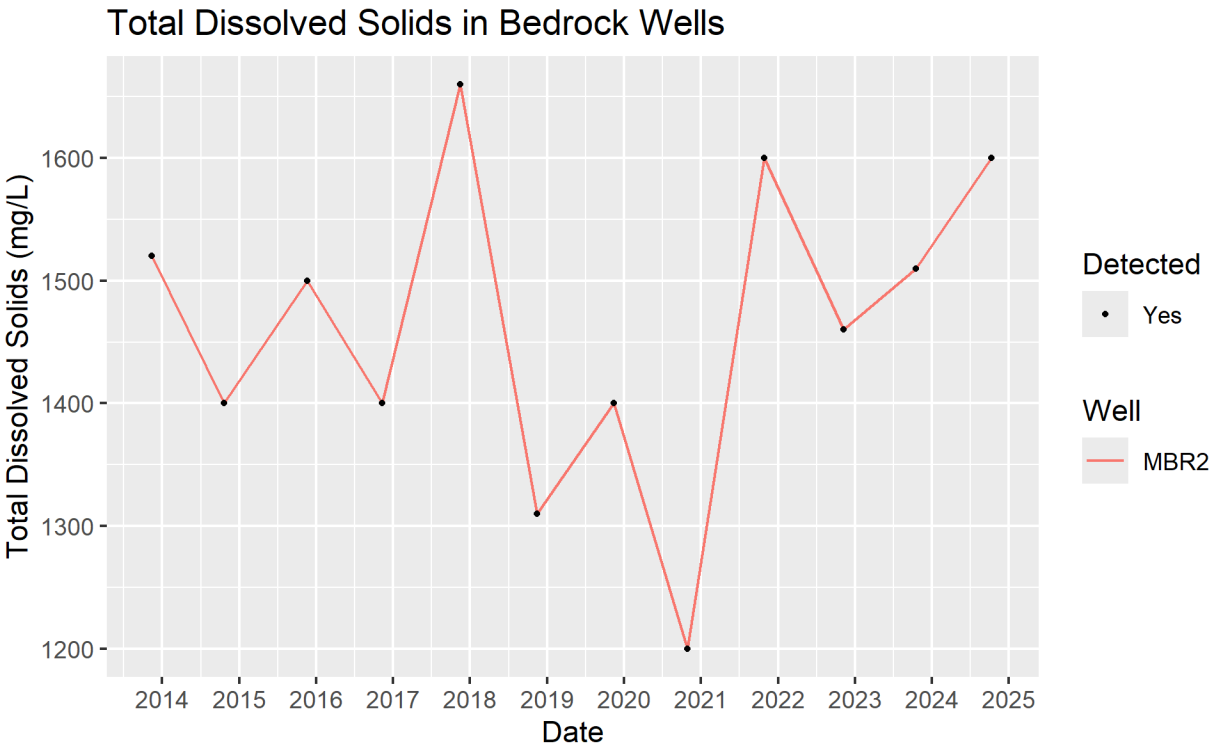

Phosphorus, Total in Bedrock Wells
Phosphorus, Total (mg/L)
0.16
0.12
0.08
0.04
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
MBR2
Detected
No
Yes

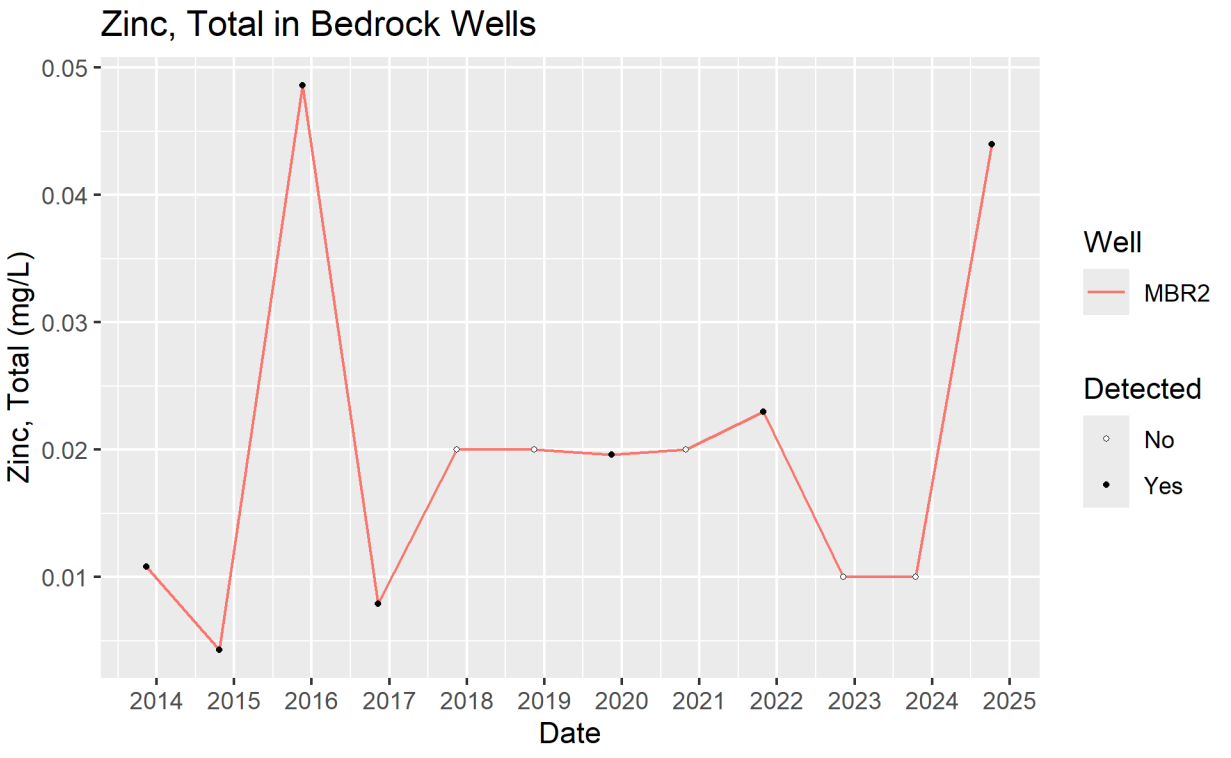

Potassium, Total in Bedrock Wells
Potassium, Total (mg/L)
25
20
15
10
5
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
MBR2


Selenium, Total in Bedrock Wells
Selenium, Total (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
MBR2
Detected
No
Yes


Sodium, Total in Bedrock Wells
Sodium, Total (mg/L)
500
400
300
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Outlier
Yes
Well
MBR2


Sulfate in Bedrock Wells
600
580
560
540
Sulfate (mg/L)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Yes
Well
MBR2


Total Dissolved Solids in Bedrock Wells
Total Dissolved Solids (mg/L)
1600
1500
1400
1300
1200
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Detected
Yes
Well
MBR2


Zinc, Total in Bedrock Wells
0.05
0.04
0.03
0.02
0.01
Zinc, Total (mg/L)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Date
Well
MBR2
Detected
No
Yes

## Appendix A4: Environmental Monitoring and Outfalls Map

| REVISION | DATE | APP'D |
|---|---|---|
| Changed all wells to annual sampling | 12/14/2023 | TFB/F.R. |
| Added TS and SS 10AA-21, 10AA-22, TS and SS 2G-3 | 2/26/2023 | H.J. |
| Removed EW7 and changed EW-9, 15-1, 5-1, and 5-2 to permanent impoundments | 11/15/2021 | T.B.H. |
| Removed EW and A12 SWMS. | 6/2/2021 | T.B.H. |
| Removed Pond 1-5. | 2/24/2021 | T.B.H. |
| Removed Ponds 1-7, 2-14 and 12-2A, and removed topsoil stockpile TS 2B; added CDK and 10-17 topsoil stockpiles. | 3/30/2020 | E.F.T. |
| Made updates to outfall and pond statuses. | 3/27/2019 | E.F.T. |
| Removed CB 9-35. | 3/26/2018 | E.F.T. |
| Topsoil stockpiles were removed from the map; stockpiles are shown in Exhibit 3.14-1 of the OSM Permit. | 10/27/2017 | C.M. |
| All monitoring features with discontinued status were removed from the map. | 12/2/2016 | J.F. |
| SP 1N, SP 3N, SP4N, SP11-9, and CB 5-3 removed from map. Topsoil stockpiles 2B and CDK were added. A12 and EW passive water monitoring stations installed in 2015. | 2/3/2016 | S.K. |
| Wells no longer requiring sampling in 2015 marked with asterisk in label. Well TB3E marked as "Mined Through". | 4/30/2015 | J.F. |
| Removed CB 2-15, CB 2-16, CB 2-17, CB 2-18, CB 2-19, PI 3-4, SP 12-4, SPTS 104, CB 1-8, TS 96, DDT10, berm 104, A12, TS 12-4; updated symbology for 036/PI 11-10, 004/SP 6S, 005/SP 7S; added TS 10-17, TS CDK, TS 2C, 076/DC 26; updated label for 012/SP TI 6-7; Moved 009/DC 25 to updated location. | 3/27/2015 | J.K. |
| Certified berm/sediment ponds 032/DC 10-27 and 033/DC 12-8 changed to discharge channel; Air monitoring stations, discontinued surface water monitoring stations, and wells no longer requiring sampling in 2015 grayed out. | 11/20/2014 | M.S. |
| The following spoil well locations were moved to their surveyed locations: A11, 2G2, 9S. | 10/27/2014 | J.F. |
| Added: updated pond status & NPDES outfalls per EPA 2013 NPDES permit update. | 2/25/2014 | M.K. |
| Removed the following PM-10 air monitoring stations: North Remote (SITE No. 6A, EAST-WING, WILHELMS (SITE No. 5), BLACKHAT (SITE No. 9), & NORTH TIPPLE (A&B)(SITE No. 2A). Removed meteorological monitoring stations A12W (Site No. 10), & SITE No. 2 (NORTH TIPPLE). Added pending spoil well in Area 2. | 2/7/2013 | O.D. |
| Updated for 2011 Annual Report | 2/22/2012 | O.D. |
| Updated for 2010 Annual Report | 2/26/2011 | O.D. |
| Updated for 2009 Annual Report | 2/22/2010 | O.D. |
| Updated for 2008 Annual Report | 2/24/2009 | O.D. |
| Removed "DECOMMISSIONED" label from DDT9P and moved it to A11P. | 8/14/2008 | O.D. |
| No Changes for 2006 Annual Report | 4/12/2007 | F.G.R. |
| Added Decommissioned DDT9P, A11P, A9P, 9TCP. Moved A11 Future Spoil Well, Removed MBR3. | 2/14/2006 | F.G.R. |
| Deleted DDT9P for 2004 Annual Report | 2/21/2005 | G.S. |
| Added Gallup Aquifer Well #4 in East Wing Area | 6/20/2003 | L.L. |
| Deleted station MBR1 & air monitoring station A12 due to mining | 3/16/2003 | L.L. |
| Change DDT9 from automatic and passive sample station to passive only (DDT9P) | 12/6/1999 | A.K.B. |

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## LEGEND

- MMD Permit Boundary
- OSM Permit Boundary
- Well - Alluvial, Annually Monitored
- Well - Bedrock, Annually Monitored
- Well - Spoil Wells, Annually Monitored
- Well - Gallup Aquifer, Annually Monitored
- Stream Monitor - Major Drainage
- Weather Monitor
- NPDES Outfall
- Sediment/Temporary Impoundment
- Permanent Impoundment
- Topsoil Stockpile
- Subsoil Storage
- North Facilities
- South Facilities

**Township Number**

- 001
- Section
- Public Road
- Major Surface Contour (25 ft. Interval)
- Minor Surface Contour (5 ft. Interval)

N

**Chevron Mining Inc.**
**McKINLEY MINE**

# EXHIBIT 6.1-1
# ENVIRONMENTAL MONITORING FACILITIES

Last Revision Date: 12/14/2023
Date Drawn: 02/12/2016
Drawn By: H.J./TFB
Checked By: K.J.K.
Approved By: M.S.
Scale: 1" = 1250'

0 750 1,500 3,000 Feet

## Appendix A5: Riparian PATFM Evaluation

**REPORT**

# McKinley Mine

*Riparian PATFM Assesssment*

Submitted to:

**Chevron EMC**

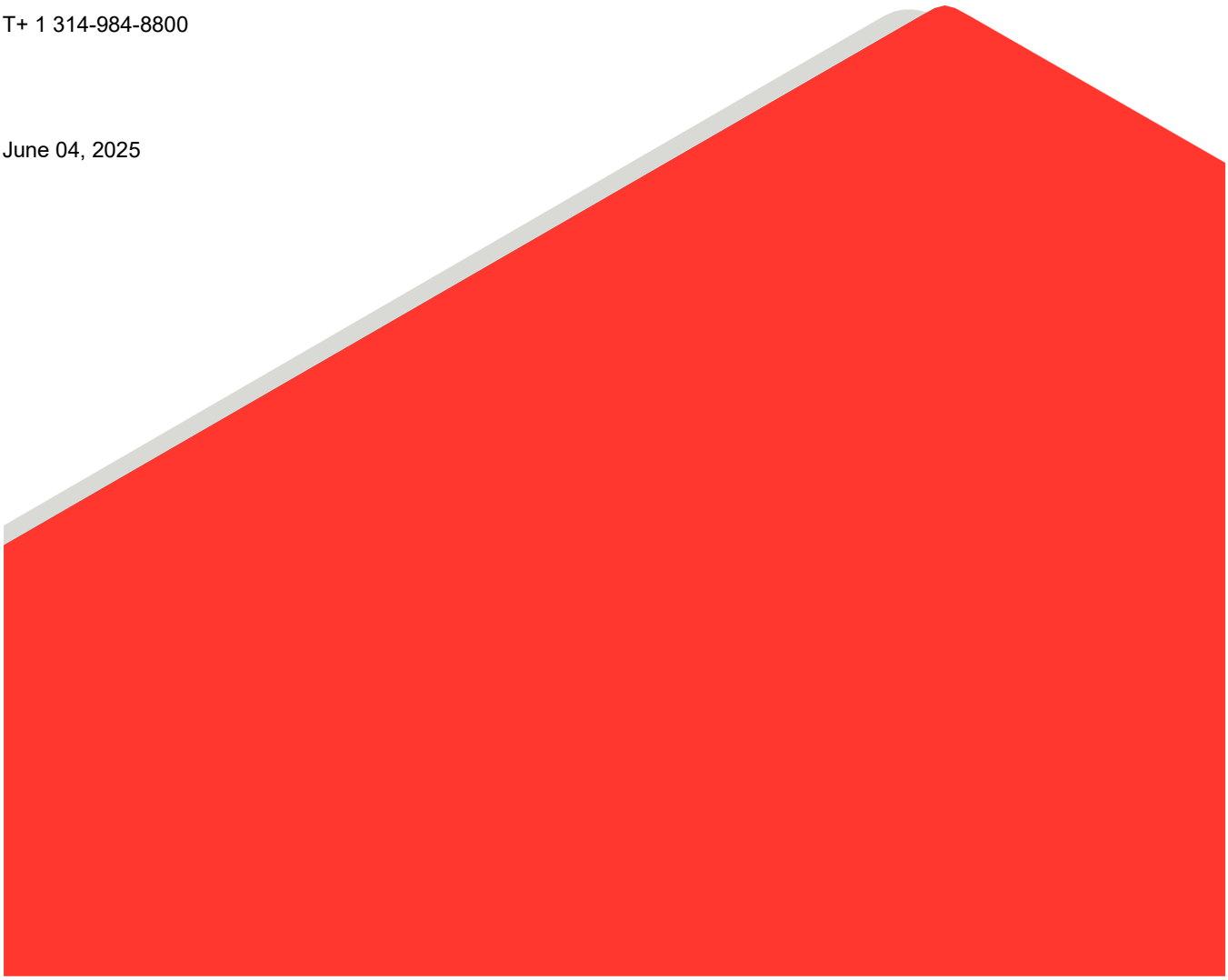
Submitted by:

**WSP USA Inc.**

701 Emerson Road, Suite 250, Creve Coeur, MO, 63141

T+ 1 314-984-8800

June 04, 2025



# 1.0 INTRODUCTION

Section 5.3.5.12 in OSMRE Permit No. NM-0001K requires a demonstration that graded spoil in potential riparian areas within permanent program lands meets the suitability criteria for potentially acid and toxic forming materials (PATFM). To that end, WSP USA Inc., (WSP), on behalf of the Chevron Environmental Management Company (CEMC), worked with the Office of Surface Mining Reclamation and Enforcement (OSMRE) to bring this commitment to a successful conclusion. This report documents the results of those efforts and provides the technical information necessary to make the demonstration, and to complete a permit modification to close out this commitment.

# 2.0 OVERVIEW

Section 5.3.5.12 in OSMRE Permit No. NM-0001K currently states the following:

> Graded spoil sampling will be conducted in grids near or within potential riparian-habitat areas. This sampling program and associated mitigative requirements are designed to prevent the occurrence of potentially acid and toxic-forming materials in the plant-rooting zone of the riparian area. OSMRE will be consulted to review and verify that this program has been completed.

The focus of this permit commitment has been on potential and existing post-mining water-holding structures intended to hold water beneficial for livestock and wildlife including approved and proposed permanent impoundments, reclamation channel pools, and small depressions (all three will be referred to as water-holding structures). These water-holding structures are defined as follows:

Approved and proposed permanent impoundments (impoundments) are former sediment ponds or temporary impoundments intended to be retained for livestock watering and wildlife habitat. Proposed permanent impoundments are those structures that are not yet approved as permanent impoundments as of the date of this report (see Table 1).

Reclamation channel pools (RCPs) are elongated shallow pools constructed in reclaimed-channel reaches, typically less than 3 feet deep, and similar in function to a small depression as allowed in 30 CFR 816.102 (h).

Small depressions (SD) are shallow water-holding structures or low-lying areas capable of retaining water as described in 30 CFR 816.102 (h).

An additional characteristic is that many of these water-holding structures are also capable of supporting riparian vegetation. Water-holding structures targeted for riparian habitat enhancements are discussed in Section 5.8.3.4 of Permit No. NM-0001K.

Table 1 lists all these existing and anticipated post-mining water-holding structures and Exhibit 1 shows their location. Exhibit 1 also shows parts of the PATFM grid system associated with the water-holding structures as discussed in this report.

# 3.0 METHODS

The approximate footprint of the maximum surface-water area for each structure was identified. The surface-water area of each structure was then superimposed onto the PATFM map that shows relevant grids that had already met the graded-spoil suitability criteria contained in Table 5.3-1 in Permit No. NM-0001K.

An assessment was then done to identify the location of passed PATFM grids that would be representative of the graded spoil for a given water-holding structure. The data for those grids was reviewed and verified that it did meet the permit suitability criteria. The criteria includes the following parameters: EC, pH, saturation percentage, SAR, texture, acid-base potential, total selenium, and ABDTPA selenium.

**Table 1: Summary of Water-Holding Structures Assessed for PATFM Grid Data**

| Structure ID | Structure Type |
|---|---|
| | |
| 2-3 | Proposed Permanent Impoundment |
| 2-8 | Proposed Permanent Impoundment |
| 2-9 | Proposed Permanent Impoundment |
| 2-10 | Proposed Permanent Impoundment |
| 2-11 | Proposed Permanent Impoundment |
| 2-12 | Proposed Permanent Impoundment |
| 2-13 | Proposed Permanent Impoundment |
| 2-21 | Proposed Permanent Impoundment |
| 3-7 | Permanent Impoundment |
| 5-1 | Permanent Impoundment |
| 5-2 | Permanent Impoundment |
| 6-8 | Permanent Impoundment |
| RCP 5-1 | Reclamation Channel Pool |
| RCP 5-2 | Reclamation Channel Pool |
| RCP 5-3 | Reclamation Channel Pool |
| 5-SD1 | Small Depression |
| 5-SD2 | Small Depression |
| 5-SD3 | Small Depression |
| 6-SD1 | Small Depression |
| The following structures are not on graded spoil | |
| 3-5 | Proposed Permanent Impoundment |
| 6-7 | Permanent Impoundment |
| 5N | Proposed Permanent Impoundment |
| CDK | Permanent Impoundment |
| 15-1 | Permanent Impoundment |
| EW9 | Permanent Impoundment |

Those water-holding structures that appeared to have adequate passed grids that could be used for the PATFM-free demonstration were then reviewed with OSMRE for concurrence.

The assessment also identified water-holding structures for which grids with passed PATFM information could not be found, which included RCP 5-2, Impoundment 2-13, and the series of impoundments that includes 2-8, 2-9, 2-10, and 2-11 (2-8 series). Proposed grid PATFM sample sites that would best represent these water-holding structures were then reviewed with OSMRE, samples collected, and the data discussed with OSMRE. Impoundment 2-12 was later added to the list; the structure is in series with Impoundment 2-13 and the same PATFM data was used for 2-12 because of its proximity to 2-13.

Finally, water-holding structures that were not constructed on graded spoil were identified, which included Impoundments 5N, CDK, 3-5, and 6-7. Impoundments 15-1 and EW9 were later added to this list since they were proposed and approved as permanent impoundments. All of these impoundments do not require representative graded spoil sample data since they are not on graded spoil; they are, however, included in this report for completeness.

The consultation with OSMRE on the initial list of water-holding structures established demonstration protocols that CMI used to assess any additional structures that were later added to the list. These additional water-holding structures include Impoundment 2-12, 5-SD1, 5-SD2 and 5-SD3.

## 4.0 RESULTS

Table 2 lists the PATFM-sample grids selected to demonstrate that graded spoil criteria were met for a given water-holding structure. The table also shows the year samples were collected, and the name of the files containing PATFM information for a given grid. Also listed in the table were those water-holding structures that were not on graded spoil and that did not require such a demonstration. PATM sample grids selected as representative grids for a given structure are also shown on Exhibit 1. Appendix 1 contains a copy of the lab data files for the representative grids with an index at the beginning listing the order of the files in the appendix.

## 5.0 DISCUSSION

The information presented in this report, demonstrates that there are no PATFM materials in the graded spoil that could adversely affect the plant-rooting zone of riparian areas associated with any of the water-holding structures. While the maps and data provided in the results section are self-explanatory, some additional information is provided here to complement that information.

As stated earlier, various proposed water-holding structures are not located in graded spoil (Impoundment 3-5, 5N, CDK, 6-7, 15-1 and EW9); however, they are included here so all structures are addressed in this report.

During the assessment there were three locations that did not have available PATFM data, which included RCP 5-2, Impoundment 2-13, and the series of Impoundments that includes 2-8, 2-9, 2-10, and 2-11 (2-8 series). OSM was consulted on where to collect graded-spoil samples for these three water-holding structures; the locations selected are shown on Exhibit 1. The results of this additional sampling and any explanatory information were reviewed for acceptability with OSMRE; this additional sampling information is also included in Appendix 1.

Only one sample site was necessary for the 2-8 series given the proximity of the impoundments to one another. All the depth intervals for the Impoundment 2-8 samples met all suitability criteria except the saturation percentage of the lowermost 30–42-inch interval, which was 89.3 (the permit standard is 85). This higher saturation value, however, does not pose an actual problem to the rooting zone. Merrill et al (Williams and Shuman, 1987) state that saturation percentages in the 80% to 95% range can be indicative of swelling tendency associated with sodic hazard (see attached excerpt in Appendix 2). There is no concern for sodic hazard in this instance, however, since the data for this interval also showed an SAR of 16.1 and clay at 23.8%. It was concluded that this exceedance of saturation percentage was acceptable given the following: the saturation percentage is just above the threshold, but the low SAR and low clay content show that there would be no sodic hazard; there is existing successful cattail growth in Pond 2-8 near the sample site; and the soil sample with the high saturation percentage is at the bottom of the soil profile. These findings and conclusion were also reviewed with OSMRE for concurrence.

## 6.0 CONCLUSION

All the impoundments, RCPs, and small depressions meet the graded-spoil suitability requirements and intent of Section 5.3.5.12 in OSMRE Permit No. NM-0001K. Subsequently, the permit can be modified to close out this commitment.

**Table 2: Grid and PATFM Data Summary by Structure**

| Structure ID | Structure Type | Representative Grids | *Yr Sampled or Ann Rpt Yr | File Name with PATFM Data | Comments |
|---|---|---|---|---|---|
| | | | | | |
| 2-3 | Impoundment | 2-53-16 | 12 | 2012 Grid 2-53-16 (From HTM) | |
| 2-8 | Impoundment | 2-59-16 (PATFM2-8) | 19 | 2018 RiparianPATFM 1802-011EDD | One sample collected to represent 2-8, 2-9, 2-10 & 2-11 |
| 2-9 | Impoundment | 2-59-16 (PATFM2-8) | 19 | 2018 RiparianPATFM 1802-011EDD | One sample collected to represent 2-8, 2-9, 2-10 & 2-11 |
| 2-10 | Impoundment | 2-59-16 (PATFM2-8) | 19 | 2018 RiparianPATFM 1802-011EDD | One sample collected to represent 2-8, 2-9, 2-10 & 2-11 |
| 2-11 | Impoundment | 2-59-16 (PATFM2-8) | 19 | 2018 RiparianPATFM 1802-011EDD | One sample collected to represent 2-8, 2-9, 2-10 & 2-11 |
| 2-12 | Impoundment | 2-64--9 (PATFM2-13) | 19 | 2018 RiparianPATFM 1802-011EDD | One sample collected to represent 2-12 and 2-13 |
| 2-13 | Impoundment | 2-64-9 (PATFM2-13) | 19 | 2018 RiparianPATFM 1802-011EDD | One sample collected to represent 2-12 and 2-13 |
| 2-21 | Impoundment | 2-74-35, 2-74-36, 2-75-34,2-76-32, 2-76-33, 2-77-32, 2-77-33, | 07, 07, 07, 07,10,07,11 | 2007 OSM Soils-Passed GridsRip; 2010 OSM Passed Grids Revised_CompleteRip, 2011 OSM Passed Grids Revised_CompleteRip | |
| 3-7 | Impoundment | 3-47-48, 3-47-49, 3-47-50, 3-48-48 | 05, 05, 05, 05 | 2005_AR_PATFM_PassingA35Rip | |
| 5-1 | Impoundment | 5-45-29, 5-46-29 | 94, 94 | 1994_AR_PATFM_PassingA35Rip | |
| 5-2 | Impoundment | 5-34-35 | 94 | 1994_AR_PATFM_PassingA35Rip | |
| 6-8 | Impoundment | 6-41-57, 3-42-56 | 06, 10 | 2006 ARRip,2010 OSM Passed Grids Revised_CompleteRip | |
| RCP 5-1 | Reclamation Channel Pool | 5-30-46 | 92 | PATFM_90s_All_A35RIP | |
| RCP 5-2 | Reclamation Channel Pool | 5-31-42 (RCP-5-2) | 18 | 2018 RiparianPATFM 1802-011EDD | |
| RCP 5-3 | Reclamation Channel Pool | 5-39-31 | 94 | 1994_AR_PATFM_PassingA35Rip | |
| 5-SD1 | Small Depression | 5-31-41 | 19 | 2019_PATFM_PassingA35 | |
| 5-SD2 | Small Depression | 5-31-45 | 92 | PATFM_90s_All_A35RIP | |
| 5-SD3 | Small Depression | 5-31-50 | 94 | 1994_AR_PATFM_PassingA35Rip | |
| 6-SD1 | Small Depression | 6-38-54, 6-39-54 | 94, 97 | Early_90s, 1997ARRip | |
| The following structures are not on graded spoil | | | | | |
| 3-5 | Impoundment | Not applicable | NA | | Located in unmined land with no graded spoil |
| 6-7 | Impoundment | Not applicable | NA | | Located in unmined land with no graded spoil |
| 5N | Impoundment | Not applicable | NA | | Located in unmined land with no graded spoil |
| CDK | Impoundment | Not applicable | NA | | Located in unmined land with no graded spoil |
| 15-1 | Impoundment | Not applicable | NA | | Located in unmined land with no graded spoil |
| EW9 | Impoundment | Not applicable | NA | | Located in unmined land with no graded spoil |
| Notes | | | | | |
| *Yr corresponds respectively to grid numbers in previous column (e.g, 6-SD1 Grid 6-38-54 info is in 19 annual report and 6-39-54 info is in 97 annual report). | | | | | |
| HTM is a Golder internal data base | | | | | |

# 7.0 LITERATURE

Williams, R.D and Shuman, G.E., Editors. 1987. Reclaiming Mine Spoils and Overburden in the Western United States, Analytic Parameters and Procedures. Soil Conservation Society of America.

# 8.0 CLOSING

Frank G. Rivera, P.E.

WSP USA Inc.



wsp.com

## Appendix A6: Initial Program Lands Seeding




| REVISION | Date | Appd. By |
|---|---|---|
| | | |

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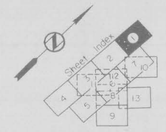
Copper Aerial Survey Co.
TUCSON, ARIZONA

LEGEND

| | |
|---|---|
| Lease Boundary – Permitted | |
| Lease Boundary – Not Permitted | |
| SEEDING YEAR BOUNDARY | |
| YEAR SEEDED OR RESEEDED | 85 |
| SEEDED | S |
| RESEEDED | RS |
| INTERSEEDED | |
| CUSTOM PLANTING | |
| CUSTOM PLANTING IDENTIFICATION | 2 G |

NOTE: THIS MAP SHOWS THE LAST DATE SEEDING OR RESEEDING WAS DONE ON LANDS WITHIN THE SETTLEMENT AGREEMENT AREAS.

NOTE: INTERSEEDINGS SHOWN WERE DONE WITH 1992 PERMANENT SEED MIX UNLESS OTHERWISE NOTED ON MAP.




P&M The Pittsburg & Midway Coal Mining Co.
A Chevron Company

**McKINLEY MINE**
EXHIBIT 2

# SETTLEMENT AGREEMENT SEEDING DATES (THROUGH 1992)

Photo Base Date: 7-28-92
Drawn By: C.F.T.
Date Drawn: 7/29/93
Checked By: J.A.R., W.B. 08-25-93
Approved By: J.A.R.
Scale: 1" = 400'
Drawing No.




| REVISION | Date | App'd By |
|---|---|---|
| | | |

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Cooper Aerial Survey Co.
TUCSON, ARIZONA

LEGEND

| | |
|---|---|
| Lease Boundary – Permitted | |
| Lease Boundary – Not Permitted | |
| SEEDING YEAR BOUNDARY | |
| YEAR SEEDED OR RESEEDED | 85 |
| SEEDED | S |
| RESEEDED | RS |
| INTERSEEDED | |
| CUSTOM PLANTING | |
| CUSTOM PLANTING IDENTIFICATION | 2 G |

NOTE THIS MAP SHOWS THE LAST DATE SEEDING OR RESEEDING WAS DONE ON LANDS WITHIN THE SETTLEMENT AGREEMENT AREAS

NOTE INTERSEEDINGS SHOWN WERE DONE WITH 1992 PERMANENT SEED MIX UNLESS OTHERWISE NOTED ON MAP

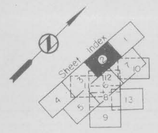


Photo Base Date 7-28-92

P&M The Pittsburg & Midway Coal Mining Co.
A Chevron Company

McKINLEY MINE
EXHIBIT 2

SETTLEMENT AGREEMENT
SEEDING DATES
(THROUGH 1992)

Drawn By: C.F.T.
Date Drawn: 7/29/93

Checked By: FAR, JG 08-05-93
Approved By: FAR

Scale: 1" = 400'
Drawing No.




| REVISION | Date | App'd By |
|---|---|---|
| | | |

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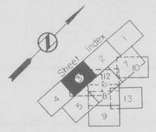
Cooper Aerial Survey Co.
TUCSON, ARIZONA

LEGEND

| | |
|---|---|
| Lease Boundary – Permitted | |
| Lease Boundary – Not Permitted | |
| SEEDING YEAR BOUNDARY | |
| YEAR SEEDED OR RESEEDED | 85 |
| SEEDED | S |
| RESEEDED | RS |
| INTERSEEDED | |
| CUSTOM PLANTING | |
| CUSTOM PLANTING IDENTIFICATION | 2 G |

NOTE: THIS MAP SHOWS THE LAST DATE SEEDING OR RESEEDING WAS DONE ON LANDS WITHIN THE SETTLEMENT AGREEMENT AREAS

NOTE: INTERSEEDINGS SHOWN WERE DONE WITH 1992 PERMANENT SEED MIX UNLESS OTHERWISE NOTED ON MAP




P&M The Pittsburg & Midway Coal Mining Co.
A Chevron Company

McKINLEY MINE
EXHIBIT 2

SETTLEMENT AGREEMENT
SEEDING DATES
(THROUGH 1992)

Photo Base Date: 7-28-92
Drawn By: C.F.T.
Date Drawn: 7/29/93
Checked By: 7-4-2 CJB 08-05-93
Approved By: 7-4-2
Scale: 1" = 400'
Drawing No:

## Appendix A7: Revegetation Monitoring Reports

REPORT

# Vegetation Management Unit 2
# Vegetation Success Monitoring, 2023

Submitted to:

**Chevron Mining Inc. - McKinley Mine**

24 Miles NW HWY 264

Mentmore, NM 87319

Submitted by:

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March 2024



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Vegetation Data Summary

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# 1.0 INTRODUCTION

Mining at the McKinley Mine ceased in 2009 and reclamation of remaining support facilities (e.g., impoundments, roads, etc.) is nearing completion. Reclamation practices have been applied at the McKinley Mine under various programs since at least the early 1970s. Chevron Mining Inc. (CMI) is assessing the vegetation in reclaimed areas in anticipation of future bond and liability release. CMI understands the importance of returning the mined lands to productive traditional uses in a timely manner. To qualify for release, the increment, or permit area as a whole, must meet the Permit No. NM-0001K (2016) (the Permit) permanent-program revegetation-success criteria as shown in Table 1 of this report. In general, the lands must be in a condition that is as good as or better than the pre-mine conditions, stable, and capable of supporting the designated postmining land uses of grazing and wildlife. WSP USA, Inc. (WSP) was retained to monitor and assess the vegetation relative to the established vegetation success standards.

This report documents the vegetation community attributes collected in 2023 in O-VMU-2 and compares them to the Permit's vegetation-success criteria. Section 1 includes the introduction and a general overview. Section 2 describes the vegetation monitoring methods that were used in 2023. Section 3 presents the results of the assessment with respect to total ground cover, perennial vegetation cover, forage production, woody plant density (shrub density), and composition and diversity. Section 4 is a summary of the results for O-VMU-2 with emphasis on vegetation success.

The 2023 sampling program was conducted and evaluated in accordance with the updated monitoring methods and revegetation success standards contained in Permit Modification Number 23-03. More details beyond what is already discussed throughout this report may be found in the Permit.

## 1.1 Vegetation Management Unit 2

This report presents results from 2023 quantitative vegetation monitoring conducted in Vegetation Management Unit 2 (O-VMU-2), which is in the western portion of Area 2N and all of Area 3 (Figure 1). The configuration of the vegetation monitoring units within the U.S. Department of the Interior – Office of Surface Mining Reclamation and Enforcement (OSMRE) Permit Area, were developed in consultation with OSMRE. Undisturbed lands included within the VMU were not part of the sampling program. O-VMU-2 encompasses about 1,085 acres, comprised of permanent program lands (PPL), and initial program lands (IPL). Both PPL and IPL as one unit must meet the PPL success criteria as discussed in the Permit in Section 6.5.1.2. The 10-year period of extended responsibility, however, only applies to PPL.

The elevation of O-VMU-2 ranges from about 7,150 to 7,400 feet above mean sea level. Reclamation started in 1975 with the vast majority seeded by 2003. Thus, the reclamation in the majority of O-VMU-2 ranges from 21 to almost 50 years old. This section provides a general description of the reclamation activities that were implemented. Additional details of the reclamation for specific areas can be obtained through review of the McKinley Mine annual reports.

## 1.2 Reclamation and Revegetation Procedures

Reclamation of permanent program lands included grading of the spoils to achieve a stable configuration, positive drainage, and approximate original contour. After grading, graded spoil monitoring was conducted to determine the suitability of the materials. A minimum of 6 inches of topdressing (topsoil or topsoil substitute) were then applied over suitable spoils.

After topdressing placement, the seedbed was scarified or ripped on the contour to a depth of about 8 to 12 inches. Seeding was done using various implements that drilled and/or broadcast the seed. After the seeding, certified weed-free, long-stem, hay mulch, or straw was applied at a rate of about 2 tons per acre. The mulch was anchored 3 to 4 inches into the cover with a tractor-drawn straight coulter disc. The seeding was generally performed in the fall, which tends to favor the establishment of cool-season grasses and shrubs. The approved seed mixes used at McKinley have varied over time but included both warm-season grasses, and introduced and native cool-season grasses, introduced and native forbs, and shrubs. The early seed mixes tended to emphasize the use the alfalfa and cool-season grasses. The majority of seed mixes planted on IPL consisted of native and introduced cool season grasses, limited warm-season grasses, some shrubs, but no forbs. Over time the seed mixes on PPL shifted to include more warm-season grasses, more shrub species, and a variety of forbs.

Initial program lands were typically graded so they were no steeper than 3:1 and topsoiled. Seeding practices were like those done on permanent program lands.

## 1.3 Prevailing Climate Conditions

The amount and distribution of precipitation are important determinants for vegetation establishment and performance. Once vegetation is established, the precipitation dynamics affect the amount of vegetation cover and biomass on a year-to-year basis with grasses and forbs showing the most immediate response. Precipitation has been monitored at the McKinley Mine throughout most of its life at two primary precipitation stations (Bluff and South Tipple). The mine added a system of 8 additional seasonal precipitation gauges to better capture more representative data from the various mining areas in 2011-2012 (gauges named by area). Data from the Rain 2 gauge was used to evaluate precipitation in O-VMU-2 (Figure 2).

Table 2 contains a summary of precipitation recorded at all the rain gauges in the North Mine Area. Total annual precipitation measured at the Bluff gauge near the mine entrance was 8.59 inches, below the regional average of 11.8 inches at Window Rock. Rain 2 gauge recorded 4.35 inches of precipitation from late April to mid-November (the period these stations operate), whereas the Bluff gauge recorded approximately 5.24 inches of rain for the same period with data throughout all of November. Mine wide, the precipitation recorded in 2023 between April and November at the other eight gauges indicate below average precipitation, on a scale of about 2-3 inches below average, with variation both spatially and temporally.

Growing season precipitation provides additional context to evaluate vegetation performance in O-VMU-2. The departure of growing season precipitation (April through September) between the Rain 2 and Window Rock (1937-1999) long-term seasonal mean is illustrated in Figure 2. Growing season precipitation in O-VMU-2 was well below the long-term seasonal mean from 2018 to 2023, with the exception of the 2022 growing season wherein the Rain 2 gauge was above the seasonal mean, measuring approximately 2.42 inches above the mean. Growing season precipitation from the Rain 2 gauge in 2023 was 2.43 inches below average.

## 1.4 Livestock

CMI has been aggressively managing trespass livestock and as a result evidence of trespass horses was less apparent in 2023 in O-VMU-2. The combination of past grazing pressure with exceptional drought, however, may in some years adversely affect the ability to demonstrate that the vegetation is meeting or can meet the revegetation success standards.

# 2.0 VEGETATION STANDARDS AND MONITORING METHODS

Vegetation attributes in O-VMU-2 were quantified using the methods described in Section 6.5 of the Permit as modified in Permit Modification 23-03. Vegetation monitoring in O-VMU-2 was conducted from September 21 through September 23, 2023.

## 2.1 Vegetation Success Standards

The vegetation success standards for the Permit Area consist of five vegetative parameters: total cover, perennial cover, forage production, woody plant density, and diversity (Table 1). The total ground cover requirement, or the combined means for live vegetation cover and litter cover on the reclamation is 52%. The perennial vegetation cover requirement is 24%. Both total ground and perennial vegetation cover use absolute cover. The annual forage production requirement is 550 air-dry pounds per acre (lbs/ac). The shrub density success standard is 400 live woody stems per acre. In accordance with 30 CFR 816.116 (a)(2), success for total cover, perennial cover, forage production, and shrub density shall be ≥ 90% of the standard.

Cover is defined in three ways for accurate evaluation of diversity according to Table 1.

1) Absolute cover utilizes first-hit line point intercept (LPI) data and is used to assess the perennial grass diversity standard.
2) Relative perennial cover, the metric used to assess some grass, forb, and shrub standards, compares the cover of perennial species relative to the sum of perennial plants calculated from all-hit LPI data (excluding noxious weeds) within the VMU.
3) Relative total cover, the metric used to assess the any-single-species diversity standard, is calculated by dividing the percent cover of each perennial/biennial species by the total live vegetative cover from all-hit LPI data (excluding noxious weeds) within a VMU.

Biennial forbs are included in the vegetation cover analyses and biennial forb diversity standards because they are important to long term ecological success of the reclamation. As monocarpic, or single flowering species, these forbs produce a high number of seeds, and as a result, persist long-term in the reclamation plant community. Future mention of “perennial” in this report thus includes biennial species.

Relative shrub density, the metric used to assess the single shrub species standard, is calculated using belt-transect data by dividing the density of each species by the total density within a sampling unit. Relative calculations are valuable to determine whether a species or functional group is excessively dominant. The number of species requirement for the various diversity standard components (e.g., ≥ 2 species cool-season grasses) is calculated by adding the total number of unique species captured in the LPI surveys.

Diversity is evaluated against numerical guidelines for different vegetation types. In summary, the diversity guideline is met if perennial grasses contribute 7% or more absolute vegetation cover; at least two cool-season perennial grasses have individual relative perennial vegetation covers of 5% and 1.5% or more; at least two warm-season perennial grasses species with the highest cover species 5% or more relative perennial vegetation cover and the remaining species combining to contribute 1.5% or more relative perennial vegetation cover, at least three non-annual non-noxious forbs combining to contribute 1% or more relative total vegetation cover; shrubs combining to 6% or more relative perennial vegetation cover and no single shrub species with greater than 70% relative shrub density, and no single species of any functional group with 40% or more relative total vegetation cover. Diversity is also demonstrated by evidence of colonization or recruitment of native (not-seeded) plants from adjacent undisturbed native areas.

## 2.2 Sampling Design

All lands (PPL, Prelaw and IPL) were included in the vegetation-sampling pool for unbiased random sampling. The transect locations were reviewed with OSMRE in advance of sampling. A 100-meter (m) by 100 m square grid was superimposed over the entire VMU to delineate vegetation sample plots. Random points were created in a geographic information system and the locations including the program land (IPL or PPL) designations are shown in Figure 3. In the field, the randomly selected transect locations were assessed in numerical order with 40 primary transects accompanied by 10 alternate transects. If a transect location was determined to be unsuitable, the next alternative location was assessed for suitability. Transects that fell on or would intersect roads, drainage ways, wildlife rock piles, or prairie dog colonies were considered unsuitable.

Figure 4 shows the 100 m by 100 m vegetation plot with the cover transect orientation, and the location of the production quadrats and belt transect. The origin of the LPI transect is situated at the grid centroid and transect orientation (from 0° to 360°) is chosen randomly beginning from the transect origin, the point navigated to. LPI points are traversed to on transect left with the laser pointed towards transect right, to limit disturbance from walking on the quad and belt survey areas located on transect right. Each LPI transect is 50 m long with three half square meter (½ $m^2$) production quadrats placed flush with the meter tape with the bottom left corner at the 10, 25, and 40 m mark to the right of the transect. The belt transect corridor is 2 m by 50 m along the transect's right side.

## 2.3 Foliar, Canopy and Ground Cover

The LPI method is used to collect cover measurements required by the Permit to evaluate total cover, perennial cover, and diversity. Prior to production clipping, a 50 m measuring tape is suspended between two metal pins to extend the tape fully. A tripod mounted laser is then held along the edge of the tape, and readings are taken every meter for living plants, plant litter, rock fragments, and bare ground. When a live plant is encountered as a direct foliar hit, the species is recorded, and direct lower canopy live plant hits are also recorded that are observed down the profile. The LPI-derived data were evaluated against the permit area vegetation success standards for vegetation cover and diversity provided in Table 1, with first hits used in absolute cover calculations and all hits (upper and lower canopy hits) used in relative cover calculations.

Additional cover measurements were estimated from each production quadrat including relative cover for each species and total canopy cover, surface litter, rock fragments, and bare soil. Quadrat canopy cover data is not analyzed for success and is only briefly discussed in this report as additional support information (Table A-4). Canopy cover estimates include the foliage and foliage interspaces of all individual plant species rooted in the quadrat. Canopy cover is defined as the percentage of quadrat area included in the vertical projection of the canopy. The canopy cover estimates made on a species basis may exceed 100 percent in individual quadrats where the vegetation has multi-layered canopies. In contrast, the sum of the total canopy cover, surface litter, rock fragments, and bare soil does not exceed 100 percent. All cover estimates were made in 0.05 percent increments. Percent area cards were used to increase the accuracy and consistency of the cover estimates.

Not all plant species are expected to occur in the sampling transects and quadrats. Plants observed growing within the vegetation plots and across the reclaimed facility were inventoried while moving between sample locations and during formal sampling (Table A-7).

## 2.4 Annual Forage and Total Production

Forage production required by the Permit was determined by clipping and weighing all annual (current year's growth) above-ground forage biomass within the vertical confines of the three ½ $m^2$ quadrats placed systematically along the same 50 m transect used for LPI measurements. Biomass from all three quads from each transect are combined by species and the combined values for the transect (not the quads) are treated as a sampling unit. Production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. The Permit allows for excessively grazed production quadrats to be considered for exclusion from the sampling analysis in consultation with OSMRE, but no quadrats needed to be excluded in O-VMU-2 (the Permit, Section 6.5.2.2).

Grasses and forbs were clipped to within 5 centimeters (cm) of the soil surface, and the current year's growth was segregated from the previous year's growth (e.g., gray, weathered grass leaves, and dried culms). Production from shrubs was determined by clipping the current year's growth. Annuals and noxious weeds (e.g., Russian knapweed [*Acroptilon repens*]), when encountered, were not clipped. Photographs of the individual production quadrats are included in Appendix B.

The plant biomass samples of every species collected per transect were placed individually in labeled paper bags. The samples were air-dried (~ 90 days) until no weight changes were observed with repeated measurements on representative samples. The average tare weight of the empty paper bags was determined to correct the total sample weight to air-dry vegetation weights. The net weight of the air-dried vegetation was converted to a lbs/ac.

## 2.5 Shrub Density

Shrub density (as required by the Permit), or the number of stems per square meter (stems/$m^2$), was determined using the belt transect method (Bonham 1989). The belt transect was located parallel to the 50 m transect used to determine cover. Shrubs rooted in the 2 m belt transect were counted on a species basis. A 2 m folding ruler was horizontally oriented perpendicular to the tape to ensure that observations were taken within the 2 m corridor. The number and species of woody plant stems within the belt transect were recorded.

## 2.6 Statistical Analysis

The procedures for liability release and the basis for statistical analysis applied in this report may be found in the Permit, and as referenced in the Permit: the Wyoming Department of Environmental Quality (WDEQ) handbook of sampling and statistical methods (WDEQ 2012), and the New Mexico Mining and Minerals Division (MMD) Coal Mine Reclamation Program guidelines (MMD 1999). Additional resources include Evaluation and Comparison of Hypothesis Testing Techniques for Bond Release Applications (McDonald et al. 2003), which was the basis of the WDEQ handbook, and other sources referenced herein. More specifically, Figure 6.5-1 and Appendix 6.5-B of the Permit guide the statistical approach in determining vegetation success for total ground cover, perennial vegetation cover, annual forage production, and shrub density. The statistical analyses applied to the O-VMU-2 vegetation data are presented in Appendix C including equations for vegetation data analysis, vegetation attribute data with descriptive statistics, the statistical analyses comparing these attributes to the revegetation success standards, the statistical model, and descriptive statistics and normality for the vegetation attributes.

Descriptive statistics and statistical adequacy are presented for total ground cover, perennial vegetation cover, annual forage production, and shrub density in Tables 3 and C-2. Vegetation attribute data (Table C-2) was evaluated with the Shapiro-Wilk test to determine if data are normally distributed (Figures C-2 to C-6). For normally distributed data, statistical adequacy was assessed (Snedecor and Cochran 1967). Hypothesis testing

for normal data that met sample adequacy was conducted using a one-sample, one-sided t-test under the classical null hypothesis. A one-sample, one-sided t-test using the reverse null hypothesis was applied for normally distributed data which failed to meet statistical adequacy. A non-parametric one-sample, one-sided sign test using the reverse null hypothesis was applied to data that was not normally distributed and did not meet sample adequacy. While transformed data was not used in hypothesis testing for satisfying standards, as a supplemental analyses, non-normal data were log-transformed. If the transformed data resulted in a normal distribution, one of the t-tests previously described was performed depending on sample adequacy. If transformed data were also non-normal, data were analyzed using the non-parametric one-sample, one-sided sign test using the reverse null hypothesis on the non-transformed data.

The following presents the statistical approach in more detail. Descriptive statistics and statistical tests were performed using both Microsoft® Excel and R-Studio (version 4.2.2).

### 2.6.1 Normality and Statistical Adequacy

The normality of each dataset was first assessed using the Shapiro-Wilk test to determine the appropriate hypothesis test method (i.e., parametric versus non-parametric). The Shapiro-Wilk null hypothesis is that the samples (of size n) come from a normal distribution. Data were considered normal when the test statistic had a p-value > 0.10 for alpha (α) = 0.10. If the data failed hypothesis testing and was not normal, a log or Box Cox transformation was performed and if the transformation resulted in a normal distribution, the appropriate hypothesis test was chosen depending on sample adequacy ($N_{min}$) as outlined in Figure 6.5-1 of the Permit (2016).

The number of samples required to characterize a particular vegetation attribute depends on the uniformity of the vegetation and the desired degree of certainty required for the analysis. The number of samples necessary to meet $N_{min}$ was calculated assuming the data were normally distributed using Snedecor and Cochran (1967) equation below.

$$N_{min} = \frac{t^2 s^2}{(\overline{x}D)^2}$$

Where $N_{min}$ equals the minimum number of samples required, $t$ is the two-tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom, $s$ is the standard deviation of the sample data, $\overline{x}$ is the mean, and $D$ is the desired level of accuracy, which is 10 percent of the mean in this case.

In addition to $N_{min}$, the standard deviation and the 90% confidence interval (CI) about the sample means are reported in Table 3.

It is often impractical to achieve sample adequacy in vegetation monitoring studies based on Snedecor and Cochran's equation listed above. In such cases, the Permit allows a maximum sample number approach to compare the data regardless of the distribution (WDEQ 2012, MMD 1999). Where sample adequacy cannot be met because of operational constraints or for other reasons, 40 samples is considered adequate as stated in the Permit. The 40-sample maximum is based on an estimate of the number of samples needed for a t-test under a normal distribution (Sokal and Rohlf 1981). Schulz et al. (1961) demonstrated that 30 to 40 samples provide a robust estimate for most cover and density measures with increased numbers of samples only slightly improving the precision of the estimate.

The maximum 40 samples were collected at the outset of sampling based on the guidance discussed above. Each transect is considered a unique sampling unit. Sample adequacy was calculated to determine the number of samples that would have been required for adequacy by the Snedecor and Cochran equation. Further analysis for sample adequacy of cover, production and density attributes was also demonstrated using a graphical stabilization of the mean method (Clark 2001).

### 2.6.2 Hypothesis Testing

The emphasis on statistical adequacy assumes that parametric tests of normally distributed data will be conducted to demonstrate compliance with the vegetation success standards. Thus, if statistical adequacy is met for normally distributed data, the data would be analyzed with a one-sample, one-sided t-test using the classical null hypothesis. Non-parametric hypothesis tests have sufficient power to analyze data that are not normally distributed. Thus, if data is not-normal then it is permissible based on the Permit and technically appropriate to use one-sample, one-sided sign test using the reverse null approach as encouraged by OSMRE.

Hypothesis testing used to demonstrate compliance with the vegetation success standards for total ground cover, perennial vegetation cover, annual forage production, and shrub density were structured as follows (in accordance with Appendix 6.5-B of the Permit):

Classical Null Hypothesis:

$H_0$: Reclaim ≥ 90% of the Performance Standard

$H_a$: Reclaim < 90% of the Performance Standard

Where $H_0$ is the null hypothesis, and $H_a$ is the alternative hypothesis.

The one-sample, one-sided t-test using the classical null hypothesis decision rules based on the test statistic are:

If $t^* \geq t_{(\alpha; n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha; n-1)}$, conclude failure to meet the performance standard.

Test Statistic:

$$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

Where t* is the calculated t-statistic, $\bar{x}$ is the sample mean, s is the standard deviation, n is the sample size, and α = 0.10.

Reverse Null Hypothesis:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

One-sample, one-sided sign test using the reverse null hypothesis decision rules are:

If P < 0.10 or z < $z_\alpha$ (for α = 0.10, $z_\alpha$ = -1.282), conclude that the performance standard was met (i.e., $H_o$ is rejected, the revegetation values tend to be statistically greater than 90% of the technical standard).

If P ≥ 0.10 or z ≥ $z_\alpha$ (α = 0.10, $z_\alpha$ = -1.282), conclude failure to meet the performance standard (i.e., $H_o$ is NOT rejected, the revegetation values tend to be statistically less than or equal to 90% of the technical standard).

The z critical values of the normal distribution can be found in WDEQ, Table 1 (2012)

Sign Test Statistic:

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

Where z is the sign test statistic (Daniel 1990), k is the test statistic resulting from the number of measurements that were less than 90% of the technical standard, and n is the sample size.

All hypothesis tests were performed with a 90% level of confidence. Hypothesis testing was not conducted for parameters where the mean or median did not exceed the minimum permit requirements.

# 3.0 RESULTS

The vegetation in O-VMU-2 is well established and dominated by perennial plants and the vegetation community and met all but one vegetation success standard in 2023. Table 3 summarizes the results for total ground cover, perennial vegetation cover, annual forage production and woody plant density (shrub density) along with their corresponding technical standard.

Field data for LPI foliar cover, quadrat canopy cover, annual forage production and shrub density by the belt transect are included in Appendix A (Tables A1-A7). Photographs of the individual production quadrats are included in Appendix B and a representative photograph of the vegetation and topography is shown in Figure 5.

Table 4 summarizes the attributes for plants recorded in the LPI transects and production quadrats and Table A-7 summarizes all species observed within belt and quadrat surveys as well as those recorded opportunistically between survey areas during monitoring. Recruitment of additional native plant species is indicative of ecological succession and the capacity of the site to support a self-sustaining ecosystem.

Field data results and statistics are discussed by parameter in the sections that follow.

## 3.1 Total Ground and Perennial Vegetation Cover

Total ground cover exceeded the revegetation success standard and met the required statistical demonstration. Total ground cover based on first hit LPI data in O VMU-2 in 2023 had a mean of 59.8 ± 2.9% and a median of 58% (Table 3), exceeding the revegetation success standard. This was composed of live vegetation cover (43.0 ± 3.4%) and litter cover (16.8 ± 2.4%). Live vegetation foliar cover in individual transects ranged from 9 to 37 hits (18 to 74% cover) and litter cover ranged from 2 to 28 hits (4 to 56% cover) calculated from first hit LPI data (Table A-1).

Perennial vegetation cover, based on first hit LPI data, was calculated by summing the perennial and biennial species vegetation cover of the sampling unit excluding annuals and noxious weeds. The average perennial cover

was 40.5 ± 3.4% and the median cover was 41% (Table 3), exceeding the revegetation success standard. Perennial vegetation cover in the individual transects varied from 8 to 37 hits (16 to 74% cover) (Table A-1). For quadrat cover data (not used in evaluating standards), the mean total vegetation canopy cover was 26.9%, ranging from 0 to 95% among individual quadrats (Table A-4).

Total ground cover and perennial vegetation cover data for O-VMU-2 were normally distributed (Figures C-1 and C-2 respectively). Sample adequacy, estimated using the Snedecor and Cochran (1967) equation, was 10 samples for total ground cover and 26 samples for perennial vegetation cover, the minimum sample sizes needed to meet sample adequacy ($N_{min}$) at the 90% confidence level (Table 3). Both met sample adequacy with a sample size of 40.

Because total ground cover and perennial vegetation cover data were normally distributed and met sample adequacy, data were statistically analyzed using a one-sample, one-sided t-test using the classical null hypothesis. The resulting t*-statistic for total ground cover was 7.381, with a sample mean of 59.8%, a standard deviation of 11.1%, measured against a one-tail t (0.1, 39) value of -1.304. Therefore, testing under the classical null hypothesis ($t^* \geq t(\alpha; n-1)$), we conclude that the performance standard of 52% total ground cover was met (Table C-3). The resulting t*-statistic for perennial vegetation cover was 9.158, with a sample mean of 40.6%, a standard deviation of 13.1%, measured against a one-tail t (0.1, 39) value of -1.304. So, under the classical null hypothesis ($t^* \geq t(\alpha; n-1)$), we conclude that the performance standard of 24% perennial vegetation cover was met (Table C-4).

## 3.2 Production

While the forage production mean exceeded the revegetation success standard by over 200 lbs/ac, statistical testing using raw values showed the standard was not met in 2023 due to high variability. Forage production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. Annual forage production in O-VMU-2 in 2023 was 768 ± 144 lbs/ac (median of 631 lbs/ac), the highest values since sampling began in 2019 (Table 3). Annual forage production in individual transects ranged from 43 to 2,324 pounds per acre (Table A-5). Perennial grasses (17 species) contributed the most forage with 496 lbs/ac, while shrubs (seven species) contributed 232 lbs/ac and 12 perennial forbs contributed 40 lbs/ac (Table 4).

Annual forage production data for O-VMU-2 were not normally distributed (Figure C-3), but the Box Cox transformed values were normally distributed (Figure C-5). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for annual forage production was 146 samples (Table 3). Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean method (Clark 2001) with 90% CI (Figure 6). The mean begins to stabilize at about 24 samples and the confidence levels show little change after that. The analysis suggests that improvements in variability around the mean would likely not have improved with additional samples beyond the 40 samples collected for annual forage production.

The one-sample, one-sided sign test with the reverse null hypothesis was used to test the mean against 90% of the technical standard of 550 lbs/ac. Of the 40 transects, 24 exceeded 90% of the technical standard (Table C-5) resulting in a probability (P) of 0.134 of observing a z-value of -1.068., which is greater than a z-critical value of -1.282 and a P-value of 0.10. Because the raw production data did not meet the standard by one transect, further analysis was warranted. A Box Cox transformation of the data using R and verified by Statgraphics 19-X64 Centurian (2023), however, normalized the data (Figure C-5) allowing for the data to be further tested. The one-

sample-one-sided t-test with the reverse null hypothesis performed on this transformed data resulted in a t*statistic of 1.952, with a sample mean of 23.9, a standard deviation of 7.3, measured against a one-tail t (0.9, 39) value of 1.304 (Table C-7). Therefore, testing under the reverse null hypothesis ($t^* \geq t(1-\alpha; n-1)$), the performance standard using Box Cox transformed values did meet the performance standard of 550 lbs/ac in 2023. Given the actual mean and median are well above the performance standard, the closeness of the raw data to passing the sign test, and the transformed data solidly passing hypothesis testing, it is reasonably concluded that the production standard was met in 2023.

## 3.3 Shrub Density

Shrub density exceeded the revegetation success standard and met the required statistical demonstration. In 2023 shrub density in O-VMU-2 substantially exceeded the vegetation success standard of 400 stems/ac from belt transect data with an average of 2,631 ± 505 stems/ac and a median of 2,327 stems/ac (Table 3). Twenty-one woody plant species were encountered in the belt and LPI transect sampling. Fourwing saltbush (*Atriplex canescens*) was the most common shrub encountered in both methods (Tables 5, A-1 and A-4).

The shrub density data for O-VMU-2 were not normally distributed (Figure C-4) but the log transformed data were normal (Figure C-6). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for shrub density was 154 samples (Table 3). Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean method (Clark 2001) showing 90% CI (Figure 7). The mean remains stable after 16 samples onward, and the 90% CI shows very little change after this. This analysis suggests that 40 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of shrub density.

The one-sample, one-sided sign test with the reverse null hypothesis was used to test the mean against the 90% of the technical standard of 400 stems per acre. Of the 40 transects, 38 exceeded 90% of the technical standard (Table C-6) resulting in a probability (P) of <0.001 of observing a z-value less than -5.53. Therefore, under the reverse null hypothesis we conclude that the woody plant density performance standard is met in 2023.

## 3.4 Composition and Diversity

In 2023, the standards were met for all of the individual diversity standards in O-VMU-2 (Table 6). The revegetation diversity standards are based on a “lifeform statement” for grasses, forbs, and shrubs (Table 1) that consists of 12 individual parameters. The results for composition and diversity are discussed below by parameter. Relative perennial values of individual species and functional groups are calculated relative to the total perennial vegetation cover of 40.1% reported in Section 3.1. This data is calculated from all-hit LPI data (Table A-2). Relative perennial vegetation cover of individual species is listed in Table 4.

Grasses dominated the perennial vegetation cover with James’ galleta (*Pleuraphis jamesii*) representing the highest cover of the warm-season grasses by far (Table 4). Cool-season grasses also dominated the vegetation reflecting the past seed mixes, season of seeding, and the site’s continued ability to support a diverse group of cool-season grasses. Western wheatgrass (*Pascopyrum smithii*), thickspike wheatgrass (*Elymus lanceolatus*), and Indian ricegrass (*Achnatherum hymenoides*) represented the highest cover of the cool-season grasses. Shrubs are important components of the reclamation due to their persistence and tolerance to harsh conditions. The woody plant component is dominated primarily by fourwing saltbush, with rubber rabbitbrush (*Ericameria nauseosa*) subdominant. Perennial forb species occurred on the LPI transects, though they are minor contributors to vegetation cover, accounting for 1.7% absolute vegetation cover with hoary tansyaster (*Machaernathera canescens*) contributing the highest cover.

The perennial grass diversity standard requires a total absolute vegetation cover of at least 7%, which was achieved in 2023 with 27.8%. The diversity standard for cool-season perennial grasses was achieved with 11 total species, and two species that represent at least 5 and 2.5% relative perennial vegetation cover (western wheatgrass [10.2%] and thickspike wheatgrass [7.7%]). The diversity standard for warm-season grasses is achieved with four total species, one species representing at least 5% (James' galleta [19.5%]) and all remaining species representing over 1.5% relative perennial vegetation cover at 3.7%.

The perennial forb diversity standard requires at least three perennial/biennial forbs (not including noxious weeds) combining to at least 1% relative perennial vegetation cover (calculated based on the percent foliar cover of perennial species excluding annuals and noxious weeds). This standard was achieved in 2023 with ten species totaling 4.3% relative perennial vegetation cover with the greatest contributions from hoary tansyaster (1.5 %), ragleaf bahia (0.7%, *Bahia dissecta*), and curlycup gumweed (0.6%, *Grindelia squarrosa*).

The diversity standard for shrubs requires the relative perennial vegetation cover for all shrub species to total at least 6% with no single shrub exceeding or equal to 70% relative shrub density. Both of these standards were achieved with 26.7% relative perennial vegetation cover of all shrubs and 42.0% relative shrub density of fourwing saltbush – the most dominant shrub.

Lastly, the diversity standards require that no single species of any functional group represent greater than 40% relative total vegetative cover. Relative total vegetative here is defined as the percent foliar cover of any recorded species divided by the total foliar cover for all live vegetation of the sampling unit, including annuals and noxious weeds. James' galleta represented the highest relative total vegetation cover at 18.2%, thus the reclamation achieved the single species diversity standard.

From 2019 through 2023, 159 plant species have been observed within reclaimed areas in O-VMU-2 including 33 grasses, 84 forbs, and 42 shrubs, trees, and cacti (Table A-7). Of the 33 grasses, 17 are cool-season perennials, three are cool-season annuals, eight are warm-season perennials and five are warm-season annuals. Of the 84 forbs, 28 are annuals and the remaining 56 are perennials and/or biennials. Cacti (one species), succulents (two species), and trees (seven species) were rare on the reclamation but provide diverse habitat or browse for wildlife. Shrubs and subshrubs were the most common woody plants observed (42 species). The recruitment of native plants and establishment of seeded species within is indicative of ecological succession and the capacity of the site to support a diverse and self-sustaining ecosystem.

Multi-hit LPI data provide an opportunity to investigate faciliatory relationships among plants (Table A-3). This summary suggests that fourwing saltbush is a common upper canopy species in O-VMU-2, most commonly harboring thickspike wheatgrass, which is also common outside of shrub canopies as well. Associations such as this may be informative in future management activities.

## 3.5 Noxious Weeds

During the 2023 monitoring program, Class C noxious weeds (NMDA 2020) were rarely encountered in O-VMU-2. Class C noxious weeds are generally widespread in the state and managed at the local level based on feasibility of control and level of infestation. Cheatgrass was encountered infrequently in LPI surveys and production quadrats. Noxious weeds are not used in the assessment of revegetation success but are included in the single species cover standard (Table 1). Noxious trees and shrubs observed on O-VMU-2 in past years include saltcedar (*Tamarix ramosissima*), Siberian elm (*Ulmus pumila*) and Russian olive (*Elaeagnus angustifolia*) but their presence in the reclaimed vegetation community is insignificant with densities much lower than native rangeland beyond the permit boundary. CMI continues to monitor for noxious weeds and actively controls them

through husbandry practices that include annual services for weed management. Further, competition from desirable seeded and native species is expected to inhibit any substantial increase of noxious weeds in the reclamation.

# 4.0 SUMMARY

McKinley Mine's vegetation success standards for the post-mining land uses of grazing and wildlife are based on total ground cover, perennial vegetation cover, annual forage production, shrub density, and diversity. The technical standards (Table 1) were developed through negotiations with OSMRE based on the analysis of historical vegetation data, interpretation of the ecological site potential, and the anticipated post-mining land uses. The vegetation monitoring results for the past five years indicate that the vegetation community in O-VMU-2 is progressing well having met the shrub density and total ground cover standards in every year and the perennial vegetation cover standard in all but one year (Table 3). A summary of the findings from the past five years are:

1. Vegetation Cover: The total ground cover standard and perennial vegetation cover standard have been met every year since monitoring began in 2019 with the exception of perennial vegetation cover in 2021.
2. Forage Production: In 2020 and 2021, O-VMU-2 only received 63% and 50% of normal growing season precipitation, respectively, that led to a significant decline in forage production. In 2022, with above normal precipitation, average forage production recovered, and the average was above the performance standard, but variability among samples was high. As such, hypothesis testing could not demonstrate the standard was met. In 2023, a year receiving below average precipitation, average annual forage production exceeded the performance standard and passed hypothesis testing using Box Cox transformed data.
3. Shrub Density: O-VMU-2 has exceeded the success parameters for shrub density in all five monitoring years.
4. Diversity: All plant diversity standards were met in 2020, 2022, and 2023. In 2021 and 2019 the second warm-season grass species fell short of the standard. Perennial forbs also fell short in 2021. In 2023, revised standards were adopted that more accurately represent expected vegetation composition in semi-arid shrubland/grasslands, and all diversity standards passed.

Overall, vegetation performance in O-VMU-2 over the past five years is encouraging considering below-average precipitation for four of the past five years including the exceptional drought in 2020 and 2021. The performance of the vegetation under these conditions suggests that the reclaimed plant communities are resilient and capable of sustaining themselves under adverse conditions that are characteristic of this region. The reclamation in O-VMU-2 has demonstrated the capability of meeting and sustaining the post-mining land use.

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# Tables

**Table 1: Revegetation Success Standards in the McKinley Mine OSMRE Permit**

| Vegetative Parameter | Components | | Success Standards | |
|---|---|---|---|---|
| | | | 2019-2022 | 2023 |
| Cover | Total Ground Cover | | ≥ 52% | ≥ 52% |
| | Perennial Vegetation Cover | | ≥ 24% | ≥ 24% |
| Diversity "Lifeform Statement" | Perennial Grasses | All Grasses | ≥ 7% absolute cove | ≥ 7% absolute cove |
| | | Cool-Season | ≥ 2 species, each ≥ 1.5% cover | ≥ 2 species, **1st species ≥ 5% relative perennial cover, 2nd species ≥ 2.5% relative perennial cove** |
| | | Warm-Season | ≥ 2% contribution, ≥ 2 species, each ≥ 0.5% cover | ≥ 2 species, **1st species ≥ 5% relative perennial cover, all other species combined ≥ 1.5% relative perennial cove** |
| | Perennial Forbs | | ≥ 3 species, combining for ≥ 1% relative | ≥ 3 species, combining for ≥ 1% relative perennial cov |
| | Shrubs | All Shrubs | ≥ 3% absolute cove | **≥ 6% relative total perennial cove** |
| | | Any Single Species | ≤ 70% relative total shrub cove | ≤ 70% relative total **shrub density** |
| | Any Single Species (including weeds) | | ≤ 40% relative total vegetative cover | ≤ 40% relative total vegetative cover |
| Production | Pounds/acre (air dry) | | ≥ 550 lbs/ac | ≥ 550 lbs/ac |
| Woody Plant Density | Stems/acre | | ≥ 400/acre | ≥ 400/acre |

Notes:
Success for cover, production, and stocking shall be ≥ 90% of the standard in accordance with 30 CFR 816.116 (a)(2).
Total ground cover does not include noxious weeds.
Perennial vegetation cover is foliar cover from LPI, not including annuals and noxious weeds.
Relative cover is the percent cover of a species or functional group divided by the total vegetation cover including annuals and noxious weeds.
Relative perennial cover is the total cover of a perennial species or perennial functional group divided by the total perennial cover (see below).
Total perennial cover includes shrubs, cactus, trees, perennial grasses and perennial forbs not including noxious species.
Relative total shrub density is the density of each woody species divided by the total woody plant density not including noxious weeds.
Production includes above-ground biomass of forage species only.
Bolded standards are those that changed in 2023

## Table 2: North Mine Seasonal and Annual Precipitation, 2015-2023

| Year | Station | Area | Precipitation (inches) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | January | February | March | April | May | June | July | August | September | October | November | December | Annual Total | Growing Season Total |
| 2015 | Rain Bluff | North Shop | 1.39 | 1.21 | 0.11 | 0.35 | 1.54 | 1.15 | 2.81 | 1.91 | 0.51 | 1.18 | 1.16 | 0.74 | 14.06 | *8.27* |
| | Rain 2 | 2 | NA | NA | NA | 0.52 | 1.51 | 1.98 | 3.17 | 1.39 | 0.50 | 1.08 | 0.92 | NA | NA | *9.07* |
| | Rain 3 | 3 | NA | NA | NA | 0.57 | 1.80 | 1.77 | 3.61 | 3.06 | 0.44 | 1.36 | 0.86 | NA | NA | *11.25* |
| | Rain 6 | 6 | NA | NA | NA | 0.54 | 0.71 | 2.12 | 2.66 | 2.12 | 0.00 | 0.92 | 0.70 | NA | NA | *8.15* |
| | Rain 10 | 10 | NA | NA | NA | 0.42 | 1.32 | 1.11 | 2.59 | 1.39 | 0.30 | 1.10 | 0.78 | NA | NA | *7.13* |
| | Rain 12 | 12 | NA | NA | NA | 0.49 | 1.59 | 1.39 | 2.88 | 2.14 | 0.47 | 1.17 | 1.29 | NA | NA | *8.96* |
| | Rain 15 | 15 | NA | NA | NA | 0.46 | 1.90 | 1.62 | 3.17 | 2.88 | 0.32 | 0.94 | 0.69 | NA | NA | *10.35* |
| 2016 | Rain Bluff | North Shop | 0.39 | 0.25 | 0.03 | 1.28 | 0.70 | 0.19 | 1.15 | 1.85 | 1.79 | 0.69 | 1.18 | 1.98 | 11.48 | *6.96* |
| | Rain 2 | 2 | NA | NA | NA | 0.17 | 0.58 | 0.14 | 2.22 | 0.71 | 0.87 | 0.21 | 0.02 | NA | NA | *4.69* |
| | Rain 3 | 3 | NA | NA | NA | 0.20 | 0.72 | 0.45 | 1.62 | 0.11 | 0.50 | 0.33 | 0.02 | NA | NA | *3.60* |
| | Rain 6 | 6 | NA | NA | NA | 0.20 | 0.75 | 0.29 | 2.00 | 0.40 | 1.19 | 0.19 | 0.02 | NA | NA | *4.83* |
| | Rain 10 | 10 | NA | NA | NA | 0.13 | 0.55 | 0.20 | 2.75 | 0.38 | 0.99 | 0.14 | 0.02 | NA | NA | *5.00* |
| | Rain 12 | 12 | NA | NA | NA | 0.30 | 0.78 | 0.36 | 1.34 | 0.49 | 1.16 | 0.18 | 0.05 | NA | NA | *4.43* |
| | Rain 15 | 15 | NA | NA | NA | 0.31 | 0.85 | 0.04 | 1.95 | 0.35 | 1.31 | 0.18 | 0.05 | NA | NA | *4.81* |
| 2017 | Rain Bluff | North Shop | 0.81 | 0.04 | 0.70 | 0.32 | 0.41 | 0.16 | 3.71 | 0.37 | 0.62 | 0.54 | 0.05 | 0.02 | 7.75 | *5.59* |
| | Rain 2 | 2 | NA | NA | NA | 1.28 | 0.66 | 0.22 | 0.78 | 2.08 | 1.46 | 0.63 | 0.44 | NA | NA | *6.48* |
| | Rain 3 | 3 | NA | NA | NA | 1.04 | 1.16 | 0.06 | 0.99 | 2.71 | 1.63 | 0.56 | 0.44 | NA | NA | *7.59* |
| | Rain 6 | 6 | NA | NA | NA | 0.86 | 1.50 | 0.02 | 0.96 | 2.04 | 1.52 | 0.38 | 0.51 | NA | NA | *6.90* |
| | Rain 10 | 10 | NA | NA | NA | 1.00 | 0.67 | 0.08 | 0.94 | 1.63 | 1.36 | 0.34 | 0.81 | NA | NA | *5.68* |
| | Rain 12 | 12 | NA | NA | NA | 1.17 | 0.91 | 0.05 | 0.88 | 1.89 | 1.77 | 0.47 | 0.46 | NA | NA | *6.67* |
| | Rain 15 | 15 | NA | NA | NA | 1.15 | 1.36 | 0.02 | 0.68 | 1.91 | 1.56 | 0.40 | 0.41 | NA | NA | *6.68* |
| 2018 | Rain Bluff | North Shop | 0.23 | 0.48 | 0.44 | 0.08 | 0.22 | 0.28 | 2.17 | 0.00 | 1.00 | 1.51 | 0.14 | 0.43 | 6.98 | *3.75* |
| | Rain 2 | 2 | NA | NA | NA | 0.06 | 0.26 | 0.30 | 1.10 | 0.90 | 1.40 | 1.48 | 0.00 | NA | NA | *4.02* |
| | Rain 3 | 3 | NA | NA | NA | 0.04 | 0.30 | 0.35 | 0.92 | 0.91 | 1.27 | 1.69 | 0.00 | NA | NA | *3.79* |
| | Rain 6 | 6 | NA | NA | NA | 0.03 | 0.21 | 0.46 | 0.97 | 0.56 | 1.02 | 1.45 | 0.00 | NA | NA | *3.25* |
| | Rain 10 | 10 | NA | NA | NA | 0.08 | 0.20 | 0.27 | 3.05 | 1.15 | 0.92 | 1.51 | 0.00 | NA | NA | *5.67* |
| | Rain 12 | 12 | NA | NA | NA | 0.06 | 0.37 | 0.26 | 1.08 | 1.36 | 1.09 | 1.54 | 0.00 | NA | NA | *4.22* |
| | Rain 15 | 15 | NA | NA | NA | 0.05 | 0.32 | 0.28 | 1.16 | 0.63 | 1.31 | 1.31 | 0.00 | NA | NA | *3.75* |
| 2019 | Rain Bluff | North Shop | 0.95 | 0.98 | 1.10 | 0.24 | 0.17 | 0.03 | 0.03 | 1.14 | 0.10 | 0.04 | 1.15 | 0.97 | 6.90 | *1.71* |
| | Rain 2 | 2 | NA | NA | NA | 0.22 | 1.41 | 0.15 | 0.35 | 0.73 | 1.35 | 0.04 | 0.05 | NA | NA | *4.21* |
| | Rain 3 | 3 | NA | NA | NA | 0.39 | 1.50 | 0.32 | 0.70 | 0.11 | 1.72 | 0.06 | 0.06 | NA | NA | *4.74* |
| | Rain 6 | 6 | NA | NA | NA | 0.36 | 1.20 | 0.00 | 0.01 | 0.34 | 1.82 | 0.04 | 0.03 | NA | NA | *3.73* |
| | Rain 10 | 10 | NA | NA | NA | 0.20 | 1.49 | 0.37 | 0.19 | 0.27 | 1.34 | 0.03 | 0.05 | NA | NA | *3.86* |
| | Rain 12 | 12 | NA | NA | NA | 0.20 | 1.59 | 0.28 | 0.35 | 0.14 | 1.38 | 0.07 | 0.04 | NA | NA | *3.94* |
| | Rain 15 | 15 | NA | NA | NA | 0.22 | 1.17 | 0.14 | 0.78 | 0.15 | 1.60 | 0.05 | 0.05 | NA | NA | *4.06* |
| 2020 | Rain Bluff | North Shop | 1.00 | 1.35 | 1.15 | 0.26 | 0.02 | 0.14 | 0.89 | 0.26 | 0.21 | 0.33 | 0.28 | 0.32 | 6.21 | *1.78* |
| | Rain 2 | 2 | NA | NA | NA | 0.26 | 0.09 | 0.05 | 1.65 | 0.20 | 0.17 | 0.31 | 0.16 | NA | NA | *2.42* |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.01 | 0.05 | 1.06 | 0.62 | 0.16 | 0.27 | 0.19 | NA | NA | *1.90* |
| | Rain 6 | 6 | NA | NA | NA | 0.05 | 0.02 | 0.02 | 0.82 | 0.55 | 0.14 | 0.08 | 0.16 | NA | NA | *1.60* |
| | Rain 10 | 10 | NA | NA | NA | 0.11 | 0.02 | 0.13 | 0.79 | 0.14 | 0.14 | 0.16 | 0.09 | NA | NA | *1.33* |
| | Rain 12 | 12 | NA | NA | NA | 0.25 | 0.08 | 0.06 | 0.97 | 0.47 | 0.35 | 0.29 | 0.28 | NA | NA | *2.18* |
| | Rain 15 | 15 | NA | NA | NA | 0.32 | 0.01 | 0.05 | 0.65 | 0.87 | 0.28 | 0.09 | 0.44 | NA | NA | *2.18* |
| 2021 | Rain Bluff | North Shop | 1.13 | 0.21 | 0.46 | 0.04 | 0.04 | 0.20 | 2.17 | 1.31 | 1.13 | 0.86 | 0.20 | 0.92 | 8.67 | *4.89* |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.03 | 0.16 | 0.99 | 1.09 | 1.04 | 0.93 | 0.00 | NA | NA | *3.31* |
| | Rain 3 | 3 | NA | NA | NA | 0.03 | 0.09 | 0.05 | 0.69 | 1.04 | 1.64 | 1.16 | 0.00 | NA | NA | *3.54* |
| | Rain 6 | 6 | NA | NA | NA | 0.02 | 0.06 | 0.03 | 0.83 | 0.19 | 0.47 | 1.05 | 0.00 | NA | NA | *1.60* |
| | Rain 10 | 10 | NA | NA | NA | 0.01 | 0.06 | 0.24 | 2.48 | 1.80 | 0.96 | 0.80 | 0.00 | NA | NA | *5.55* |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.08 | 0.22 | 1.58 | 2.08 | 1.24 | 1.01 | 0.00 | NA | NA | *5.20* |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.07 | 0.05 | 1.04 | 2.58 | 1.47 | 1.00 | 0.00 | NA | NA | *5.21* |
| 2022 | Rain Bluff | North Shop | -- | -- | 0.59 | 0.03 | 0.00 | 1.24 | 3.13 | 4.66 | 1.27 | 1.40 | 0.48 | 0.58 | 13.38 | *10.33* |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 3.00 | 3.77 | 1.22 | 1.14 | 0.39 | NA | NA | *9.02* |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 2.99 | 3.07 | 1.18 | 1.19 | 0.54 | NA | NA | *8.27* |
| | Rain 6 | 6 | NA | NA | NA | 0.01 | 0.00 | 0.66 | 2.55 | 3.05 | 0.69 | 0.28 | 0.47 | NA | NA | *6.96* |
| | Rain 10 | 10 | NA | NA | NA | 0.00 | 0.00 | 0.69 | 3.57 | 4.27 | 1.02 | 1.83 | 0.33 | NA | NA | *9.55* |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.00 | 0.91 | 3.76 | 4.07 | 1.08 | 1.57 | 0.52 | NA | NA | *9.82* |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.01 | 0.91 | 4.06 | 3.84 | 1.12 | 1.68 | 0.50 | NA | NA | *9.94* |
| 2023 | Rain Bluff | North Shop | 1.21 | 0.50 | 1.64 | 0.05 | 0.55 | 0.13 | 0.03 | 3.16 | 0.33 | 0.57 | 0.42 | NA | 8.59 | *4.25* |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.48 | 0.09 | 0.08 | 3.08 | 0.44 | 0.09 | 0.09 | NA | NA | *4.17* |
| | Rain 3 | 3 | NA | NA | NA | 0.01 | 0.84 | 0.22 | 0.26 | 2.93 | 0.54 | 0.08 | 0.08 | NA | NA | *4.80* |
| | Rain 6 | 6 | NA | NA | NA | 0.00 | 1.49 | 0.22 | 0.07 | 1.97 | 0.49 | 0.05 | 0.00 | NA | NA | *4.24* |
| | Rain 10 | 10 | NA | NA | NA | 0.03 | 0.53 | 0.13 | 0.06 | 2.61 | 0.51 | 0.03 | 0.00 | NA | NA | *3.87* |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.74 | 0.21 | 0.10 | 2.47 | 0.41 | 0.05 | 0.00 | NA | NA | *3.93* |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.79 | 0.21 | 0.43 | 2.67 | 0.56 | 0.05 | 0.00 | NA | NA | *4.66* |
| Window Rock, Long | | | 0.72 | 0.68 | 0.88 | 0.61 | 0.49 | 0.47 | 1.75 | 2.05 | 1.23 | 1.14 | 0.83 | 0.95 | 11.80 | *6.60* |

Notes:
Long-term averages are from Window Rock, Arizona Station (029410), 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season total precipitation is between April and September
NA=rain gauges taken offline due to freezing conditions, data unavailable.
-- Rain gauge malfunction
In 2017 Rain Bluff experienced power issues in the summer that may have resulted in inaccurate precipitation readings.
data incomplete

**Table 3: Summary Statistics, O-VMU-2, 2019-2023**

| | 2019 | 2020 | 2021 | 2022 | 2023 | Technical Standard |
|---|---|---|---|---|---|---|
| **Total Ground Cover (%)[1]** | | | | | | |
| Mean | 63.2 | 57.5 | 54.5 | 51.5 | 59.8 | ≥ 52% |
| Standard Deviatior | 10.9 | 10.3 | 11.6 | 11.2 | 11.1 | |
| 90% Confidence Interva | 2.8 | 2.7 | 3 | 2.9 | 2.9 | |
| Median | -- | 58 | 54 | 54 | 58 | |
| Nmin[2] | 8.5 | 9.1 | 12.8 | 13 | 10 | |
| **Live Vegetation Cover (%)[3]** | | | | | | |
| Mean | 46 | 32 | 18 | 36.6 | 43.0 | None |
| Standard Deviatior | 11 | 8 | 6.5 | 10.9 | 12.9 | |
| 90% Confidence Interva | 2.8 | 2.1 | 1.7 | 2.8 | 3.4 | |
| Nmin[2] | 15 | 17 | 37 | 25 | 26 | |
| **Litter Cover (%)** | | | | | | |
| Mean | 17 | 25 | 37 | 14.9 | 16.8 | None |
| Standard Deviatior | 8.7 | 9.1 | 13 | 6.9 | 9.1 | |
| 90% Confidence Interva | 2.3 | 2.4 | 3.2 | 1.8 | 2.4 | |
| Nmin[2] | 73 | 37 | 33 | 62 | 85 | |
| **Perennial Vegetation Cover (%)[4]** | | | | | | |
| Mean | 40 | 32 | 17 | 31.0 | 40.5 | ≥ 24% |
| Standard Deviatior | 12 | 8.3 | 6.2 | 10.3 | 13.1 | |
| 90% Confidence Interva | 3 | 2.1 | 1.6 | 2.7 | 3.4 | |
| Median | -- | 32 | 18 | 30 | 41 | |
| Nmin[2] | 24 | 19 | 38 | 32 | 30 | |
| **Annual Forage Production (lbs/ac)[5]** | | | | | | |
| Mean | 656 | 472 | 210 | 560 | 768 | ≥ 550 lbs/ac |
| Standard Deviatior | 561 | 461 | 207 | 416 | 552 | |
| 90% Confidence Interva | 146 | 120 | 53 | 108 | 144 | |
| Median | -- | 365 | 146 | 529 | 631 | |
| Nmin[2] | 208 | 271 | 275 | 156 | 146 | |
| **Woody Plant Density (stems/acre) from Belt Transec** | | | | | | |
| Mean | 3,149 | 2,239 | 2,375 | 2,555 | 2,631 | ≥ 400/ac |
| Standard Deviatior | 2,617 | 1,409 | 1,799 | 1,916 | 1,940 | |
| 90% Confidence Interva | 681 | 367 | 462 | 498 | 505 | |
| Median | -- | 1,862 | 2,145 | 2,226 | 2,327 | |
| Nmin[2] | 196 | 112 | 163 | 160 | 154 | |

Notes:

[1] Mean foliar cover of live vegetation and litter

[2] Minimum number of samples to obtain 90% probability that the sample mean is within 10% of the population mean

[3] Mean vegetation foliar cover not including noxious weeds

[4] Mean foliar cover not including annuals and noxious weeds

[5] Annual forage production in air dry pounds per acre (lbs/ac) not including annuals or noxious weeds

Hypothesis testing found the success standard was not met

**Table 4: Average and Relative Foliar Cover and Production by Species, O-VMU-2, 2023**

| Scientific Name | Common Name | Code | Mean Vegetation Cover (%) | | | | Mean Annual Production (lbs/ac) |
|---|---|---|---|---|---|---|---|
| | | | All Hit Foliar | First Hit Foliar | Relative Perennial[1] | Relative Total[2] | |
| **Cool-Season Grasses (13)** | | | | | | | |
| **Annuals (2)** | | | | | | | |
| *Bromus arvensis* | Field brome | BRAR5 | 0.10 | 0.05 | -- | 0.2 | NA |
| *Bromus tectorum* | Cheatgrass | BRTE | 0.40 | 0.40 | -- | 0.9 | NA |
| **Perennials (11)** | | | | | | | |
| *Achnatherum hymenoides* | Indian ricegrass | ACHY | 3.10 | 3.10 | 7.4 | 6.9 | 32.1 |
| *Agropyron cristatum* | Crested wheatgrass | AGCR | 0.95 | 0.85 | 2.3 | 2.1 | 12.2 |
| *Bromus inermis* | Smooth brome | BRIN2 | 0.40 | 0.35 | 0.9 | 0.9 | 11.1 |
| *Elymus elymoides* | Bottlebrush squirreltai | ELEL5 | 0.20 | 0.20 | 0.5 | 0.4 | 7.8 |
| *Elymus lanceolatus* | Thickspike wheatgrass | ELLA3 | 3.25 | 2.85 | 7.7 | 7.2 | 52.2 |
| *Elymus trachycaulus* | Slender wheatgrass | ELTR7 | 1.90 | 1.80 | 4.5 | 4.2 | 25.3 |
| *Hesperostipa comata* | Needle and thread | HECO26 | 2.00 | 1.85 | 4.7 | 4.4 | 41.4 |
| *Pascopyrum smithii* | Western wheatgrass | PASM | 4.30 | 4.15 | 10.2 | 9.5 | 37.3 |
| *Psathyrostachys juncea* | Russian wildrye | PSJU3 | 2.10 | 2.05 | 5.0 | 4.7 | 48.6 |
| *Pseudoroegneria spicata* | Bluebunch wheatgrass | PSSP6 | 0.50 | 0.50 | 1.2 | 1.1 | 0.7 |
| *Thinopyrum intermedium* | Intermediate wheatgrass | THIN6 | 0.65 | 0.65 | 1.5 | 1.4 | 15.2 |
| **Warm-Season Grasses (7)** | | | | | | | |
| **Annuals (1)** | | | | | | | |
| *Bouteloua simplex* | Matted grama | BOSI2 | 0.05 | 0.05 | -- | 0.1 | NA |
| **Perennials (6)** | | | | | | | |
| *Bouteloua dactyloides* | Buffalograss | BODA2 | NA | NA | NA | NA | 1.4 |
| *Bouteloua gracilis* | Blue grama | BOGR2 | 1.05 | 1.05 | 2.5 | 2.3 | 16.4 |
| *Pleuraphis jamesii* | James' galleta | PLJA | 8.20 | 7.90 | 19.5 | 18.2 | 187.5 |
| *Schedonnardus paniculatus* | Tumblegrass | SCPA | 0.05 | 0.05 | 0.1 | 0.1 | <0.1 |
| *Sporobolus airoides* | Alkali sacaton | SPAI | 0.45 | 0.45 | 1.1 | 1.0 | 1.6 |
| *Sporobolus cryptandrus* | Sand dropseed | SPCR | NA | NA | NA | NA | 4.8 |
| **Forbs (20)** | | | | | | | |
| **Annuals (4)** | | | | | | | |
| *Chamaesyce glyptosperma* | Ribseed sandmat | CHGL13 | 0.05 | 0.05 | -- | 0.1 | NA |
| *Portulaca oleracea* | Little hogweed | POOL | 0.40 | 0.40 | -- | 0.9 | NA |
| *Salsola tragus* | Prickly Russian thistle | SATR12 | 1.85 | 1.75 | -- | 4.1 | NA |
| *Schkuhria multiflora* | Manyflower false threadleaf | SCMU6 | 0.10 | 0.10 | -- | 0.2 | NA |
| **Perennials/Biennials (16)** | | | | | | | |
| *Acroptilon repens* | Russian knapweed | ACRE3 | 0.05 | 0.05 | 0.1 | 0.1 | NA |
| *Bahia dissecta* | Ragleaf bahia | BADI | 0.30 | 0.25 | 0.7 | 0.7 | 2.3 |
| *Chaetopappa ericoides* | Rose heath | CHER2 | 0.05 | 0.05 | 0.1 | 0.1 | NA |
| *Descurainia pinnata* | Western tansymustard | DEPI | NA | NA | NA | NA | 2.4 |
| *Erigeron divergens* | Spreading fleabane | ERDI4 | NA | NA | NA | NA | 0.2 |
| *Erodium cicutarium* | Redstem stork's bill | ERCI6 | 0.10 | 0.10 | 0.2 | 0.2 | NA |
| ***Gaillardia aristata*** | **Blanketflower** | **GAAR** | **NA** | **NA** | **NA** | **NA** | **0.1** |
| *Grindelia squarrosa* | Curlycup gumweed | GRSQ | 0.25 | 0.25 | 0.6 | 0.6 | 17.7 |
| *Lactuca serriola* | Prickly lettuce | LASE | NA | NA | NA | NA | 0.2 |
| *Lappula occidentalis* | Flatspine stickseed | LAOC3 | 0.05 | 0.05 | 0.1 | 0.1 | 0.2 |
| *Machaeranthera canescens* | Hoary tansyaster | MACA2 | 0.65 | 0.65 | 1.5 | 1.4 | 11.5 |
| *Medicago sativa* | Alfalfa | MESA | 0.05 | 0.05 | 0.1 | 0.1 | NA |
| *Melilotus officinalis* | Sweetclover | MEOF | 0.20 | 0.15 | 0.5 | 0.4 | 0.7 |
| *Sphaeralcea coccinea* | Scarlet globemallow | SPCO | 0.10 | 0.10 | 0.2 | 0.2 | 2.1 |
| *Tragopogon dubius* | Yellow salsify | TRDU | NA | NA | NA | NA | 2.7 |
| ***Tragopogon pratensis*** | **Jack-go-to-bed-at-noon** | **TRPR** | **NA** | **NA** | **NA** | **NA** | **<0.1** |

**Table 4: Average and Relative Foliar Cover and Production by Species, O-VMU-2, 2023**

| Scientific Name | Common Name | Code | Mean Vegetation Cover (%) | | | | Mean Annual Production (lbs/ac) |
|---|---|---|---|---|---|---|---|
| | | | All Hit Foliar | First Hit Foliar | Relative Perennial[1] | Relative Total[2] | |
| **Shrubs, Trees, and Cacti (13)** | | | | | | | |
| *Artemisia cana* | Silver sagebrush | ARCA13 | 0.10 | 0.10 | 0.2 | 0.2 | NA |
| *Artemisia frigida* | Prairie sagewor | ARFR4 | 0.05 | 0.05 | 0.1 | 0.1 | <0.1 |
| *Artemisia nova* | Black sagebrush | ARNO4 | 0.05 | -- | 0.1 | 0.1 | NA |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.25 | 0.25 | 0.6 | 0.6 | NA |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 5.45 | 5.45 | 12.9 | 12.1 | 95.4 |
| *Atriplex confertifolia* | Shadscale saltbush | ATCO | 0.20 | 0.20 | 0.5 | 0.4 | 45.0 |
| ***Chrysothamnus greenei*** | **Greene's rabbitbrush** | **CHGR6** | **0.10** | **0.10** | **0.2** | **0.2** | **NA** |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 2.40 | 2.35 | 5.7 | 5.3 | 37.3 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 1.05 | 1.00 | 2.5 | 2.3 | 40.1 |
| *Heterotheca villosa* | Hairy false goldenaster | HEVI4 | 0.05 | 0.05 | 0.1 | 0.1 | NA |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 1.05 | 1.05 | 2.5 | 2.3 | 14.0 |
| *Purshia mexicana* | Mexican cliffrose | PUME | 0.10 | 0.10 | 0.2 | 0.2 | 0.4 |
| *Purshia tridentata* | Antelope bitterbrush | PUTR2 | 0.40 | 0.40 | 0.9 | 0.9 | NA |
| **Cover Components** | | | | | | | |
| Total Ground Cover[3] | | | 59.80 | | | | |
| *Live Vegetation Foliar Cover* | | | 43.00 | | | | |
| *Perennial Vegetation Cover* | | | 40.50 | | | | |
| Rock | | | 6.25 | | | | |
| Litter | | | 16.75 | | | | |
| Bare Soil | | | 33.55 | | | | |

Notes:

[1] Relative % perennial/biennial foliar cover divided by mean foliar cover NOT including annuals and noxious weeds using all hits

[2] Relative % foliar cover for a species divided by the mean foliar cover for all live vegetation including noxious weeds using all hits

[3] % live vegetation foliar cover plus litter using first hits

Growing season for grasses from Allred (2005)

Plant duration from USDA Plants Database

NA = species captured in either LPI or quadrats but not both

"--" = annuals not included in relative perennial cover calculations

Bolded species are newly observed on O-VMU-2 in 2023

**Table 5: Relative Shrub, Tree, and Cacti Density, O-VMU-2, 2023**

| Scientific Name | Common Name | Code | Relative Density (%) |
|---|---|---|---|
| *Artemisia cana* | Silver sagebrush | ARCA13 | 1.35 |
| *Artemisia frigida* | Prairie sagewort | ARFR4 | 0.77 |
| *Artemisia nova* | Black sagebrush | ARNO4 | 0.42 |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.23 |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 42.00 |
| *Atriplex confertifolia* | Shadscale saltbush | ATCO | 2.23 |
| *Atriplex corrugata* | Mat saltbush | ATCO4 | 0.50 |
| *Cactaceae* sp. | Unknown Cactaceae Species | CACTUS | 0.04 |
| ***Chrysothamnus greenei*** | **Greene's rabbitbrush** | **CHGR6** | **1.15** |
| *Ephedra viridis* | Mormon tea | EPVI | 0.23 |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 8.58 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 21.65 |
| *Juniperus monosperma* | Oneseed juniper | JUMO | 0.04 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 17.54 |
| *Lycium pallidum* | Pale desert-thorn | LYPA | 0.46 |
| *Opuntia* sp. | Pricklypear | OPUNT | 0.12 |
| *Pinus edulis* | Twoneedle pinyon | PIED | 0.04 |
| *Purshia mexicana* | Mexican cliffrose | PUME | 0.85 |
| *Purshia tridentata* | Antelope bitterbrush | PUTR2 | 1.77 |
| *Senecio flaccidus* | Threadleaf ragwort | SEFL3 | 0.04 |

Notes:
Relative density derived from belt method
Relative Density = (avg density per species per VMU ÷ avg total shrub density per VMU) * 100
Bolded species are newly observed on O-VMU-2 in 2023

**Table 6: Results for Diversity, O-VMU-2, 2023**

| Diversity Component | Metric | Standard | 2023 | |
|---|---|---|---|---|
| | | | Result | Species |
| **Perennial Grasses** | Absolute cover | ≥ 7% | 27.8 | -- |
| Cool-season Grasses | # Species | ≥ 2 | 11 | -- |
| Grass 1 | Relative perennial cove | ≥ 5% | 10.2 | Western wheatgrass |
| Grass 2 | Relative perennial cove | ≥ 2.5% | 7.7 | Thickspike wheatgrass |
| Warm-season Grasses | # Species | ≥ 2 | 4 | -- |
| Grass 1 | Relative perennial cove | ≥ 5% | 19.5 | James' galleta |
| All remaining species | Relative perennial cover | ≥ 1.5% | 3.7 | -- |
| **Perennial Forbs** | # Species | ≥3 | 10 | -- |
| | Relative perennial cover | ≥ 1% | 4.3 | -- |
| **Shrubs or Subshrubs** | Relative perennial cover | ≥ 6% | 26.7 | -- |
| Single Shrub Species | Relative shrub density | ≤ 70% | 42.0 | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 18.2 | James' galleta |

**Table 7: Results for Diversity, O-VMU-2, 2019-2022**

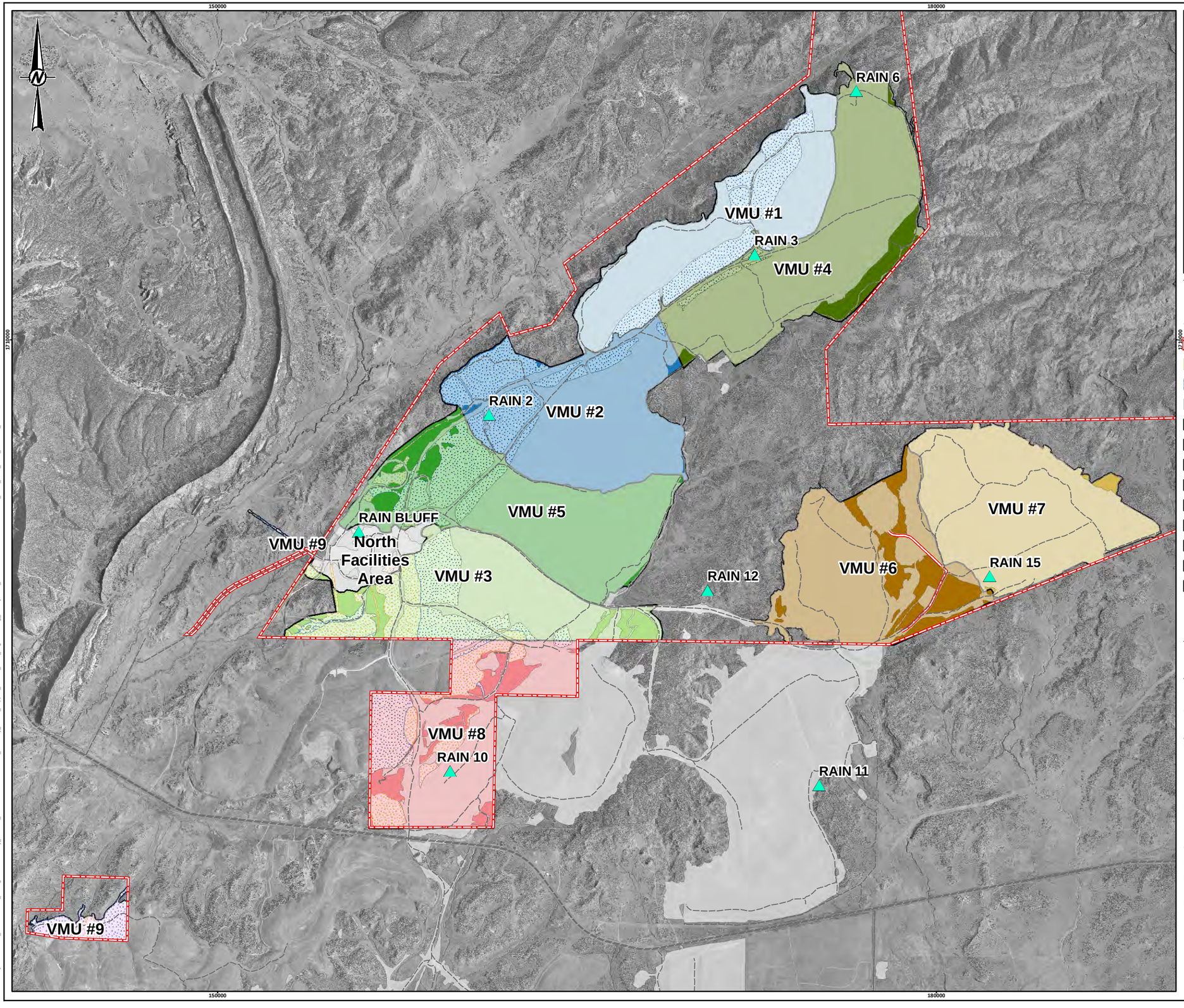
| Diversity Component | Metric | Standard | 2019 | | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Result | Species | Result | Species | Result | Species | Result | Species |
| **Perennial Grasses** | Total absolute cover | ≥ 7% | 20.8% | -- | 21.8% | -- | 11.4% | -- | 20.7% | -- |
| Cool-season Grasses | # Species | ≥ 2 | 12 | -- | 11 | -- | 11 | -- | 11 | -- |
| Grass 1 | Absolute cover | ≥ 1.5% | 7.6% | Western wheatgrass | 7.3% | Western wheatgrass | 1.8% | Western wheatgrass | 3.7% | Western wheatgrass |
| Grass 2 | Absolute cover | ≥ 1.5% | 2.8% | Thickspike wheatgrass | 2.0% | Slender wheatgrass | 1.5% | Thickspike wheatgrass | 1.9% | Slender wheatgrass |
| Warm-season Grasses | # Species | ≥ 2 | 4 | -- | 4 | -- | 4 | -- | 3 | -- |
| | Total absolute cover | ≥ 2.0% | 4.5% | -- | 5.7% | -- | 4.6% | -- | 9.5% | -- |
| Grass 1 | Absolute cover | ≥ 0.5% | 3.5% | James' galleta | 3.8% | James' galleta | 4.0% | James' galleta | 6.6% | James' galleta |
| Grass 2 | Absolute cover | ≥ 0.5% | 0.4% | Blue grama | 1.0% | Blue grama | 0.3% | Alkali sacaton | 1.5% | Blue grama |
| **Perennial Forbs** | # Species | ≥ 3 | 19 | -- | 5 | -- | 1 | -- | 14 | -- |
| | Relative perennial cover | ≥ 1% | 20.4% | -- | 2.2% | -- | 0.3% | -- | 5.6% | -- |
| **Shrubs or Subshrubs** | Total absolute cover | ≥ 3% | 11.0% | -- | 9.4% | -- | 5.2% | -- | 8.1% | -- |
| Single Shrub Species | Relative shrub cover | ≤ 70% | 68.0% | Fourwing saltbush | 58.5% | Fourwing saltbush | 66.0% | Fourwing saltbush | 67.3% | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 15.7% | Western wheatgrass | 21.8% | Western wheatgrass | 22.1% | James' galleta | 0.18 | James' galleta |

Notes:

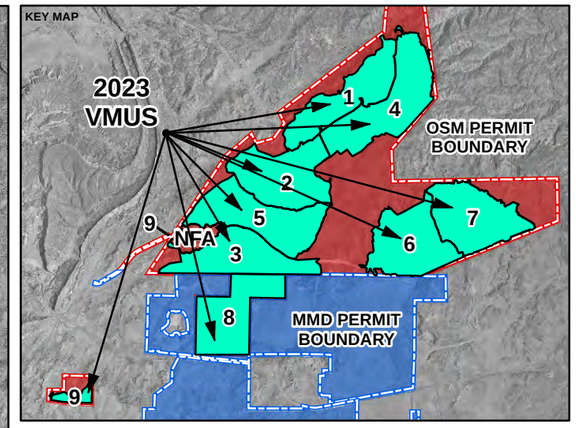
Diversity calculated in accordance with Table 1 in either absolute or relative % cover

Success standard was not met

# Figures




KEY MAP




LEGEND

- Rain Gauges
- Mine Site Roads
- OSM Permit Boundary
- Prelaw (~ 387 acres)
- Initial Program (~ 1,248 acres)
- Permanent Program (~ 11,327 acres)
- OSM VMU 1 (~ 934 acres)
- OSM VMU 2 (~ 1,085 acres)
- OSM VMU 3 (~ 959 acres)
- OSM VMU 4 (~ 1,242 acres)
- OSM VMU 5 (~ 1,129 acres)
- OSM VMU 6 (~ 1,024 acres)
- OSM VMU 7 (~ 1,045 acres)
- OSM VMU 8 (~ 953 acres)
- OSM VMU 9 (~ 96 acres)

0 4,000 8,000

1 inch = 4,000 feet FEET

**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT

CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT

MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2023 VEGETATION MONITORING

TITLE

**GENERAL OVERVIEW OF THE MCKINLEY OSMRE PERMIT AREA VEGETATION MANAGEMENT UNITS (VMU), 2023**

CONSULTANT

wsp

| | |
|---|---|
| YYYY-MM-DD | 2023-11-29 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MR |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | B003 | 0 | 1 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

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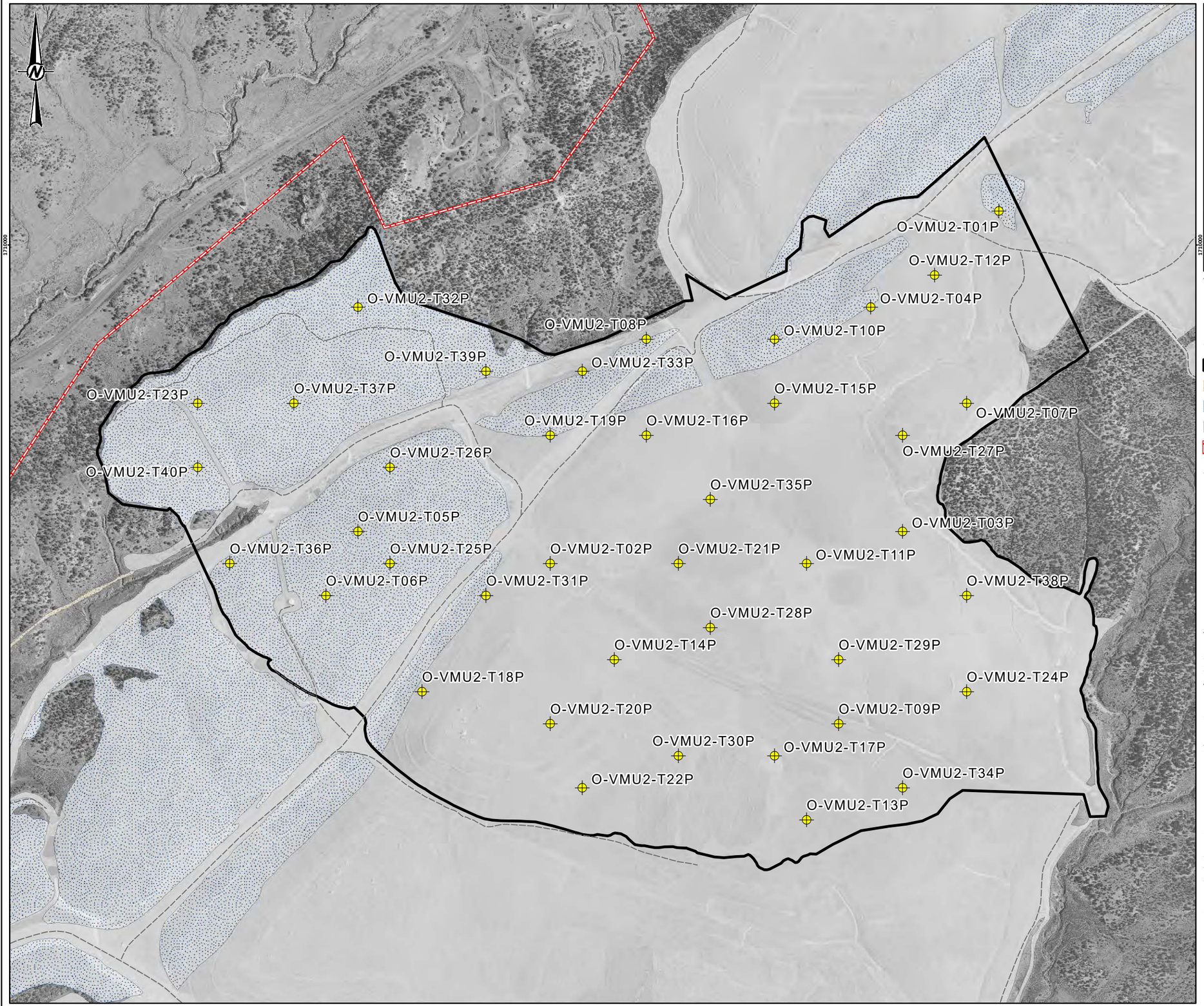
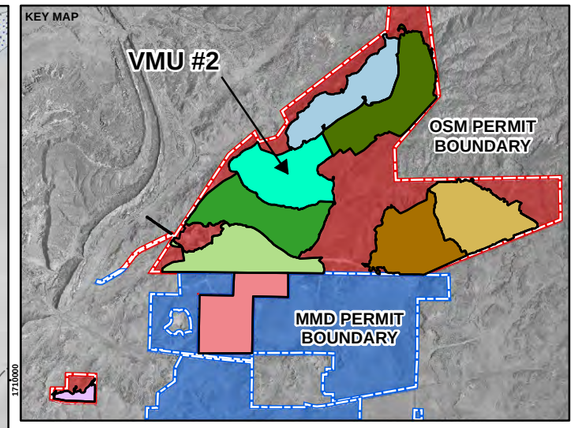
**Figure 2: Departure of Growing Season Precipitation from Long-Term Mean at Window Rock: Rain 2 Gauge**




Notes:
Long-term seasonal mean is from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season precipitation is April through September
Source data is in Table 1



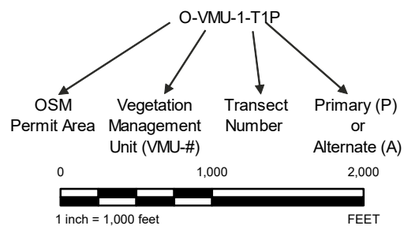

KEY MAP




LEGEND

- Primary Transect
- Alternate Transect
- Mine Site Roads
- OSM VMU 2 (~ 1,085 acres)
- Prelaw (~ 0 acres)
- Initial Program (~ 302 acres)
- Permanent Program (~ 766 acres)
- OSM Permit Boundary

TRANSECT LABEL EXPLANATION




**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN
2. KEY MAP SCALE IS DIFFERENT FROM OVERVIEW OF VMUS
3. TRANSECT LOCATIONS WERE CREATED IN ACCORDANCE WITH THE METHODS OUTLINED IN THE PERMIT

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT
CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT
MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2023 VEGETATION MONITORING

TITLE
**VEGETATION MONITORING TRANSECTS 2023, VEGETATION MANAGEMENT UNIT 2**

CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2023-11-29 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MR |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | B005 | 0 | 3 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

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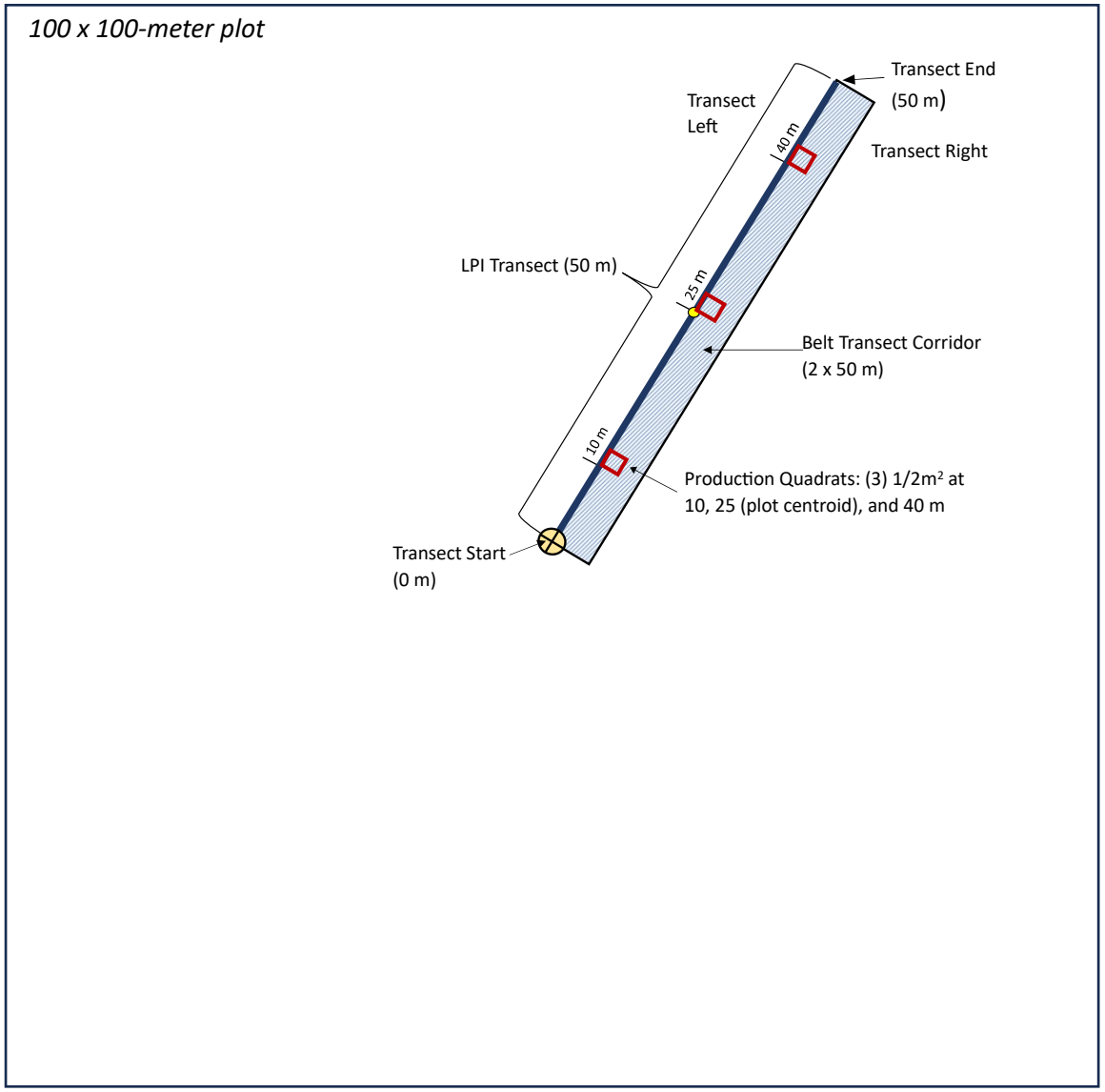
**Figure 4: Vegetation Plot and Transect Layout**




**Transect start placed on plot centroid and oriented randomly (0-360 degrees)* **Not to Scale**

**Figure 5: Typical Grass-Shrubland Vegetation in O-VMU-2, September 2023**



**Figure 6: Stabilization of the Annual Forage Production, O-VMU-2, 2023**

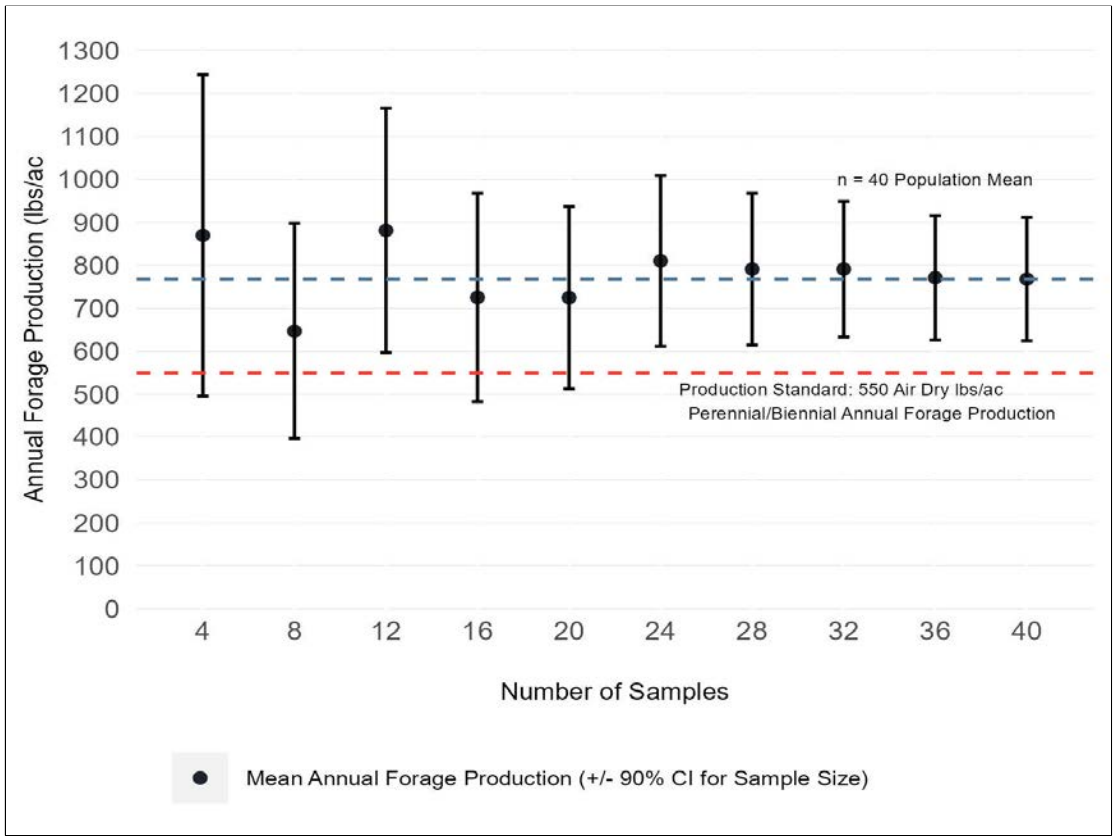
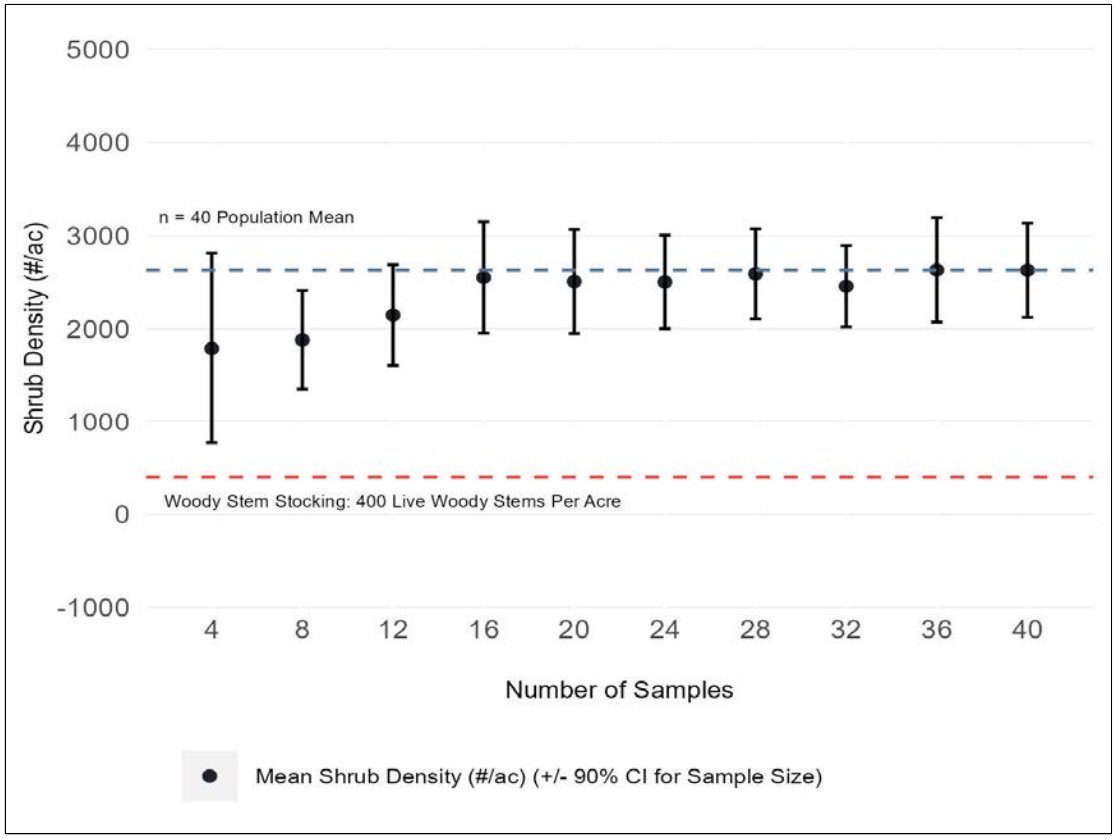


**Figure 7: Stabilization of the Mean for Shrub Density, O-VMU-2, 2023**



**APPENDIX A**

# Vegetation Data Summary

## Table A-1: O-VMU-2 Line Point Intercept Foliar Cover Data (first hits), 2023

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRAR5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| BRTE | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | -- | 2 | 2 | -- | 1 | 5 | 4 | 11 | -- | 1 | 2 | 1 | 2 | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | -- | 6 | -- | 5 | 5 | 2 | -- | 2 | -- | 5 | 4 | -- | -- | -- | -- | -- | -- |
| AGCR | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 2 | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| BRIN2 | -- | 5 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELLA3 | 1 | 6 | 5 | -- | -- | -- | 3 | 2 | 3 | 1 | 3 | 6 | -- | 4 | -- | 2 | 3 | -- | -- | -- | 2 | -- | -- | -- | 1 | -- | 1 | 1 | 3 | -- | -- | 2 | 1 | 2 | -- | 1 | 1 | 3 | -- | -- |
| ELTR7 | -- | -- | -- | 2 | -- | -- | -- | 2 | 2 | 1 | -- | -- | 2 | -- | -- | 2 | 2 | -- | -- | 8 | 1 | 2 | 1 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 8 | -- | -- | -- | 2 | -- | -- |
| HECO26 | 2 | -- | 3 | 7 | -- | -- | 4 | -- | 1 | -- | 2 | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | 5 | -- | 1 | -- | -- | 2 | 2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| PASM | 4 | -- | 1 | -- | 2 | 6 | -- | 14 | -- | -- | -- | 3 | -- | -- | 1 | 9 | 1 | -- | 1 | 2 | -- | -- | -- | 1 | -- | 7 | 5 | -- | 1 | 6 | 2 | 8 | -- | 1 | -- | 5 | -- | -- | 3 | -- |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | 7 | 2 | -- | -- | -- | 12 | 1 | -- | 3 | -- | -- | -- | -- | 7 | -- | 1 | -- | -- | 4 | -- | -- | -- | 2 |
| PSSP6 | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | 7 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- |
| Warm-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOSI2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOGR2 | 4 | 3 | -- | 2 | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 2 | -- | -- | -- | 1 | -- | 5 |
| PLJA | 6 | 4 | 13 | 10 | -- | -- | 8 | -- | 2 | 3 | 1 | 1 | -- | -- | 1 | -- | 2 | -- | 15 | -- | 28 | 15 | 1 | 5 | 2 | -- | 3 | -- | 1 | 11 | -- | 5 | 2 | 3 | -- | -- | 1 | 8 | 1 | 6 |
| SCPA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| SPAI | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 2 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CHGL13 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| POOL | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | 1 | -- | 1 | -- | -- | 1 | -- | -- | -- | 1 | -- |
| SATR12 | 3 | -- | -- | -- | -- | 9 | -- | -- | 1 | -- | -- | -- | 3 | -- | 2 | 1 | -- | 2 | -- | 4 | -- | 1 | -- | -- | 3 | -- | 3 | -- | -- | -- | -- | 1 | -- | 2 | -- | -- | -- | -- | -- | -- |
| SCMU6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACRE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BADI | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHER2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| ERCI6 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| LAOC3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| MACA2 | 1 | -- | -- | -- | -- | 1 | 1 | -- | 2 | -- | 2 | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- |
| MEOF | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MESA | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARCA13 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARFR4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCA2 | -- | 3 | -- | 1 | 4 | 5 | -- | -- | -- | 3 | 5 | 1 | 1 | 3 | 8 | 6 | 1 | -- | 2 | 5 | 2 | 1 | 2 | 5 | 4 | 5 | 1 | 3 | -- | 1 | 3 | -- | -- | 4 | 3 | 3 | 5 | 4 | 11 | 4 |
| ATCO | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| ERNA10 | 3 | -- | -- | -- | 1 | -- | 1 | 3 | -- | -- | 1 | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | 27 | -- | -- | -- | -- | -- | 5 | -- |
| GUSA2 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | 2 | -- | -- | 6 | -- | -- | -- | -- | 1 | -- | -- | -- | 8 | -- | -- | -- | -- | -- |
| HEVI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | 3 | -- | -- | 1 | 2 | 1 | -- | -- | -- | -- | -- | 1 | 4 | -- | -- | -- | -- | -- | 7 | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| **Biocrust** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BIOCRU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation | 28 | 22 | 24 | 27 | 20 | 25 | 28 | 30 | 23 | 21 | 21 | 20 | 11 | 17 | 14 | 22 | 18 | 10 | 31 | 22 | 35 | 28 | 18 | 15 | 27 | 25 | 24 | 16 | 14 | 24 | 15 | 24 | 37 | 28 | 14 | 20 | 9 | 19 | 23 | 19 |
| Live Vegetation[1] | 28 | 22 | 24 | 27 | 18 | 25 | 28 | 30 | 23 | 21 | 21 | 20 | 11 | 17 | 13 | 21 | 17 | 10 | 31 | 22 | 34 | 28 | 18 | 15 | 27 | 23 | 24 | 16 | 14 | 24 | 15 | 24 | 37 | 28 | 14 | 19 | 9 | 19 | 23 | 19 |
| Perennial Vegetation[2] | 25 | 22 | 24 | 27 | 18 | 16 | 28 | 28 | 22 | 21 | 21 | 20 | 8 | 17 | 11 | 20 | 17 | 8 | 31 | 16 | 34 | 27 | 18 | 15 | 24 | 21 | 21 | 16 | 14 | 23 | 15 | 21 | 37 | 26 | 13 | 19 | 8 | 19 | 21 | 19 |
| Rock | 1 | 1 | 1 | 4 | 8 | 9 | 1 | 0 | 4 | 0 | 2 | 0 | 1 | 13 | 4 | 3 | 6 | 7 | 1 | 0 | 1 | 1 | 2 | 0 | 3 | 10 | 1 | 4 | 1 | 1 | 1 | 2 | 4 | 1 | 3 | 9 | 6 | 0 | 8 | 1 |
| Litter | 9 | 6 | 7 | 4 | 7 | 4 | 5 | 9 | 5 | 11 | 5 | 8 | 10 | 10 | 18 | 6 | 5 | 28 | 5 | 8 | 6 | 14 | 11 | 9 | 5 | 7 | 10 | 12 | 15 | 5 | 13 | 7 | 2 | 8 | 6 | 8 | 8 | 7 | 5 | 7 |
| Bare Soil | 12 | 21 | 18 | 15 | 15 | 12 | 16 | 11 | 18 | 18 | 22 | 22 | 28 | 10 | 14 | 19 | 21 | 5 | 13 | 20 | 8 | 7 | 19 | 26 | 15 | 8 | 15 | 18 | 20 | 20 | 21 | 17 | 7 | 13 | 27 | 12 | 27 | 24 | 14 | 23 |

Notes:
Species codes defined in Table A-5
[1] Live vegetation is the total vegetation foliar hits for the transect, NOT including noxious weeds
[2] Perennial vegetation is the total vegetation foliar hits for the transect, NOT including annuals and noxious weeds

## Table A-2: O-VMU-2 Line Point Intercept Foliar Cover Data (all hits), 2023

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRAR5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| BRTE | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | -- | 2 | 2 | -- | 1 | 5 | 4 | 11 | -- | 1 | 2 | 1 | 2 | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | -- | 6 | -- | 5 | 5 | 2 | -- | 2 | -- | 5 | 4 | -- | -- | -- | -- | -- | -- |
| AGCR | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 2 | -- | -- | 5 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 3 |
| BRIN2 | -- | 6 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELLA3 | 1 | 6 | 6 | -- | -- | -- | 3 | 2 | 4 | 1 | 5 | 6 | -- | 6 | -- | 2 | 6 | -- | -- | -- | 2 | -- | -- | 1 | 1 | -- | 1 | 1 | 3 | -- | -- | 2 | 1 | 2 | -- | 1 | 1 | 4 | -- | -- |
| ELTR7 | -- | -- | -- | 2 | -- | -- | -- | 2 | 2 | 1 | -- | -- | 2 | -- | -- | 2 | 2 | -- | -- | 8 | 1 | 2 | 1 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 9 | -- | -- | -- | 2 | 1 | -- |
| HECO26 | 2 | -- | 6 | 7 | -- | -- | 4 | -- | 1 | -- | 2 | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | 5 | -- | 1 | -- | -- | 2 | 2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| PASM | 4 | -- | 1 | -- | 3 | 6 | -- | 14 | -- | -- | 1 | 3 | -- | -- | 2 | 9 | 1 | -- | 1 | 2 | -- | -- | -- | 1 | -- | 7 | 5 | -- | 1 | 6 | 4 | 8 | -- | 1 | -- | 5 | -- | -- | 4 | -- |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | 7 | 2 | -- | -- | -- | 13 | 1 | -- | 3 | -- | -- | -- | -- | 7 | -- | 1 | -- | -- | 4 | -- | -- | -- | 2 |
| PSSP6 | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | 7 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- |
| Warm-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOSI2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOGR2 | 4 | 3 | -- | 2 | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 2 | -- | -- | -- | 1 | -- | 5 |
| PLJA | 6 | 5 | 13 | 10 | -- | -- | 9 | -- | 2 | 3 | 1 | 1 | -- | -- | 1 | -- | 2 | -- | 16 | -- | 29 | 15 | 1 | 5 | 2 | -- | 3 | -- | 1 | 13 | -- | 5 | 2 | 3 | -- | -- | 2 | 8 | 1 | 6 |
| SCPA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| SPAI | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 2 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CHGL13 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| POOL | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | 1 | -- | 1 | -- | -- | 1 | -- | -- | -- | 1 | -- |
| SATR12 | 3 | -- | -- | -- | -- | 9 | -- | -- | 1 | -- | -- | -- | 3 | -- | 2 | 1 | -- | 2 | -- | 5 | -- | 1 | -- | -- | 4 | -- | 3 | -- | -- | -- | -- | 2 | -- | 2 | -- | -- | -- | -- | -- | -- |
| SCMU6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACRE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BADI | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHER2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- |
| ERCI6 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | 1 | -- | -- | -- | -- | -- | -- | -- |
| LAOC3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| MACA2 | 1 | -- | -- | -- | -- | 1 | 1 | -- | 2 | -- | 2 | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- |
| MEOF | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MESA | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARCA13 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARFR4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARNO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCA2 | -- | 3 | -- | 1 | 4 | 5 | -- | -- | -- | 3 | 5 | 1 | 1 | 3 | 8 | 6 | 1 | -- | 2 | 5 | 2 | 1 | 2 | 5 | 4 | 5 | 1 | 3 | -- | 1 | 3 | -- | -- | 4 | 3 | 3 | 5 | 4 | 11 | 4 |
| ATCO | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| ERNA10 | 3 | -- | -- | -- | 1 | -- | 1 | 3 | -- | -- | 1 | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | 27 | -- | -- | -- | -- | 5 | -- |
| GUSA2 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | 2 | -- | -- | 6 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 9 | -- | -- | -- | -- |
| HEVI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | 3 | -- | -- | 1 | 2 | 1 | -- | -- | -- | -- | -- | 1 | 4 | -- | -- | -- | -- | -- | 7 | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| **Biocrust** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BIOCRU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |

Notes:
Species codes defined in Table A-5

## Table A-3: O-VMU-2 Line Point Intercept Species Associations, 2023

| Lower Canopy Species | Upper Canopy Species | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ACHY | ARTR2 | ATCA2 | BRTE | ELLA3 | ERNA10 | GRSQ | 6 | KRLA2 | PASM | PLJA | PSJU3 | THIN6 | **Total** |
| AGCR | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| ARNO4 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 1 |
| BADI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 |
| BRAR5 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 |
| BRIN2 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| CHER2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 |
| ELLA3 | -- | -- | 8 | -- | -- | -- | -- | 2 | -- | -- | -- | 1 | -- | 11 |
| ELTR7 | -- | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 2 |
| ERNA10 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| GUSA2 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| HECO26 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 2 | -- | -- | 3 |
| MEOF | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 1 |
| PASM | -- | -- | 5 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 6 |
| PLJA | -- | 2 | 2 | 1 | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | 7 |
| PSJU3 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| SATR12 | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 3 |
| **Total** | 2 | 2 | 22 | 1 | 1 | 5 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | **43** |

Notes:
Species codes defined in Table A-5

## Table A-4: O-VMU-2 Quadrat Canopy Cover Data (%), 2023

| Transect | T01P | | | T02P | | | T03P | | | T04P | | | T05P | | | T06P | | | T07P | | | T08P | | | T09P | | | T10P | | | T11P | | | T12P | | | T13P | | | T14P | | | T15P | | | T16P | | | T16P | | | T17P | | | T19P | | | T20P | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quadrat | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRTE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Cool-Season Perennial | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.0 | -- | -- | -- | -- | 0.5 | 11.5 | -- | 6.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.0 | -- | -- | -- | -- | 5.0 | -- | -- | -- |
| AGCR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | 2.0 | -- | -- | -- | -- | -- | -- | -- | 1.0 | 29.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4.0 | -- | -- | -- | -- | -- | -- | -- | -- | 6.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELLA3 | -- | -- | 0.3 | 0.8 | 25.0 | 25.0 | 12.0 | 0.5 | 25.0 | 0.3 | 0.3 | 3.0 | -- | -- | -- | -- | -- | -- | 22.0 | -- | -- | 1.0 | -- | 3.0 | 3.0 | -- | 5.0 | 2.0 | -- | -- | -- | 11.0 | 17.0 | -- | -- | -- | -- | -- | -- | 8.0 | 12.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELTR7 | 4.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.0 | 9.0 | 15.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.0 | -- | -- | -- | -- | -- | 8.0 | 8.0 | 8.0 |
| HECO26 | -- | -- | -- | -- | -- | -- | 0.8 | -- | 2.0 | 7.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 40.0 | -- | 25.0 | -- | -- | 0.0 | -- | 5.0 | 2.0 | 0.5 | -- | -- | -- | 7.0 | -- | 42.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | 1.0 | -- | 0.1 | -- | -- | 0.0 | -- | -- | -- | -- | -- | -- | 3.0 | 5.0 | -- | 2.0 | 2.0 | 0.0 | 0.1 | 25.0 | -- | 3.0 | 40.0 | 12.0 | -- | -- | -- | -- | -- | -- | -- | 0.0 | -- | -- | 3.0 | -- | -- | -- | 3.0 | -- | -- | -- | -- | -- | 0.0 | 3.0 | 0.0 | 0.3 | -- | -- | 30.0 | -- | -- | 0.2 | 0.3 | 3.0 | -- | 0.3 | -- |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12.0 | 0.5 | -- | -- | -- | -- | -- | -- | -- |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOBA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.0 | -- |
| BOSI2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7.0 | 0.4 | 0.5 |
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| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Non Vascular Plants** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation Cover | 21.0 | 5.0 | 35.0 | 0.8 | 70.0 | 95.0 | 40.0 | 55.0 | 26.5 | 22.0 | 7.0 | 16.0 | 15.0 | 13.0 | 32.0 | 11.0 | 28.0 | 22.0 | 26.0 | 53.0 | 25.0 | 5.8 | 40.0 | 17.5 | 14.5 | 70.0 | 45.0 | 45.0 | 27.0 | 30.0 | 37.0 | 16.0 | 19.0 | 16.0 | 55.0 | 2.0 | 45.0 | 30.0 | 5.0 | 15.0 | 12.0 | 42.0 | 30.0 | 22.0 | 10.0 | 28.0 | 1.3 | 4.0 | 5.0 | 20.0 | 70.0 | 17.0 | 5.0 | 3.0 | 63.0 | 30.0 | 25.0 | 25.0 | 10.5 | 17.0 |
| Rock | 3.0 | 3.0 | 1.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 4.0 | 6.0 | 5.0 | 8.0 | 4.0 | 3.0 | 0.5 | 3.0 | 3.0 | 3.0 | 2.0 | 1.0 | 0.2 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.5 | 2.0 | 0.5 | 0.0 | 0.8 | 0.0 | 14.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.8 | 0.0 | 44.0 | 30.0 | 3.0 | 1.0 | 3.0 | 1.5 | 2.0 | 0.5 | 5.0 | 20.0 | 0.0 | 0.5 | 5.0 | 3.0 | 0.3 | 0.1 | 0.2 | 0.1 | 0.5 | 0.1 |
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| Bare Soil | 70.0 | 90.0 | 57.0 | 96.2 | 5.0 | 0.0 | 59.9 | 45.0 | 73.5 | 67.0 | 82.0 | 74.0 | 67.0 | 73.0 | 50.0 | 61.5 | 60.0 | 72.0 | 61.0 | 27.0 | 60.0 | 92.1 | 54.0 | 77.5 | 84.6 | 29.2 | 45.0 | 45.5 | 59.0 | 56.5 | 53.0 | 73.3 | 81.0 | 66.0 | 15.0 | 43.0 | 54.0 | 60.0 | 94.0 | 25.0 | 44.0 | 27.5 | 52.0 | 42.0 | 81.0 | 60.5 | 96.0 | 94.5 | 90.0 | 54.0 | 30.0 | 12.5 | 57.0 | 44.0 | 35.8 | 49.9 | 72.8 | 70.9 | 83.0 | 75.0 |

## Table A-4: O-VMU-2 Quadrat Canopy Cover Data (%), 2023 (cont'd)

| Transect | T21P | | | T22P | | | T23P | | | T24P | | | T25P | | | T26P | | | T27P | | | T28P | | | T29P | | | T30P | | | T33P | | | T32P | | | T33P | | | T34P | | | T35P | | | T36P | | | T36P | | | T37P | | | T39P | | | T40P | | |
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| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Cool-Season Perennial [1] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Non Vascular Plants** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation Cover[1] | 12.0 | 75.0 | 25.9 | 55.0 | 32.0 | 20.0 | 15.5 | 15.0 | 20.0 | 33.0 | 21.6 | 25.5 | 32.0 | 43.0 | 23.0 | 60.0 | 15.0 | 12.0 | 30.0 | 9.0 | 35.0 | 5.0 | 31.0 | 4.0 | 23.0 | 3.0 | 1.3 | 35.0 | 60.0 | 23.3 | 32.0 | 6.0 | 26.0 | 32.0 | 35.5 | 88.0 | 40.0 | 27.0 | 65.0 | 10.6 | 49.0 | 15.0 | 0.0 | 10.0 | 11.0 | 6.0 | 27.0 | 65.0 | 0.0 | 2.0 | 21.0 | 26.0 | 40.0 | 1.5 | 2.0 | 12.3 | 0.8 | 50.0 | 73.0 | 70.0 |
| Rock | 15.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.3 | 0.1 | 0.1 | 0.9 | 0.0 | 0.1 | 0.5 | 5.0 | 3.0 | 1.0 | 0.0 | 1.0 | 5.0 | 0.3 | 3.0 | 0.1 | 0.0 | 0.1 | 0.3 | 1.0 | 12.0 | 4.0 | 0.0 | 0.0 | 1.0 | 12.0 | 18.0 | 5.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 1.0 | 0.0 | 0.5 | 0.5 | 0.0 | 0.1 | 3.0 | 12.0 | 1.0 | 0.5 | 40.0 | 30.0 | 0.5 | 0.0 | 0.1 | 0.0 | 3.0 | 0.3 | 90.0 | 0.1 | 0.0 | 0.0 |
| Litter | 8.0 | 2.0 | 2.5 | 7.0 | 5.0 | 3.0 | 3.0 | 0.1 | 0.0 | 0.0 | 0.0 | 3.0 | 3.0 | 2.0 | 25.0 | 40.0 | 35.0 | 2.0 | 35.0 | 6.0 | 5.0 | 0.1 | 0.0 | 50.0 | 6.0 | 7.0 | 25.0 | 6.0 | 7.0 | 0.5 | 45.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.5 | 59.5 | 8.0 | 5.0 | 45.0 | 25.0 | 2.5 | 95.0 | 10.0 | 0.1 | 15.0 | 38.0 | 18.0 | 1.0 | 0.1 | 6.0 | 0.0 | 0.0 | 0.1 | 15.0 | 53.0 | 0.6 | 3.0 | 10.0 | 25.0 |
| Bare Soil | 65.0 | 23.0 | 71.6 | 37.9 | 63.0 | 76.7 | 81.5 | 84.9 | 79.1 | 67.0 | 78.4 | 71.0 | 60.0 | 52.0 | 51.0 | 0.0 | 49.0 | 81.0 | 34.8 | 82.0 | 59.9 | 94.9 | 69.0 | 45.8 | 70.0 | 78.0 | 69.8 | 59.0 | 33.0 | 75.2 | 11.0 | 75.5 | 69.0 | 68.0 | 64.4 | 11.5 | 0.5 | 64.9 | 29.0 | 44.4 | 25.5 | 82.0 | 5.0 | 79.9 | 85.9 | 67.0 | 34.0 | 16.5 | 59.0 | 68.0 | 72.5 | 74.0 | 60.0 | 98.4 | 80.0 | 34.5 | 8.7 | 47.0 | 17.0 | 5.0 |

Notes:
Species codes defined in Table A-5
[1]Total vegetation canopy cover for the transect by the quadrat canopy cover estimate method

## Table A-5: O-VMU-2 Air-dry Aboveground Annual Forage Production Data, 2023

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Perennial Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | -- | -- | -- | -- | -- | 6 | 6 | 67 | -- | -- | -- | -- | -- | -- | -- | -- | 5 | 15 | -- | -- | -- | -- | 40 | 26 | -- | -- | 17 | -- | -- | -- | -- | 32 | -- | -- | -- | -- | -- | 2 | -- |
| AGCR | -- | -- | -- | -- | -- | -- | -- | -- | -- | 26 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 49 | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- |
| BRIN2 | -- | 39 | -- | -- | 30 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | 4 | -- | -- | -- | -- | 1 | -- | -- | 2 | -- | -- | -- | -- | 4 | 11 | -- | 25 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| ELLA3 | 0 | 34 | 33 | 9 | -- | -- | 27 | 12 | 27 | 3 | 48 | -- | -- | 22 | -- | 1 | -- | -- | -- | -- | 7 | -- | -- | 21 | -- | -- | 5 | 5 | 68 | -- | -- | 3 | -- | 6 | -- | -- | -- | 21 | -- | -- |
| ELTR7 | 16 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 44 | -- | -- | -- | -- | 3 | -- | -- | 54 | 45 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- |
| HECO26 | -- | -- | 8 | 9 | -- | -- | -- | -- | 18 | 36 | 3 | 15 | -- | 36 | -- | -- | -- | -- | -- | -- | 14 | 2 | -- | 102 | -- | -- | 13 | 23 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | -- | 17 | -- | -- | 6 | 6 | 6 | 67 | -- | -- | -- | 7 | 2 | -- | 1 | 10 | 44 | -- | 15 | 0 | -- | -- | -- | -- | 0 | 1 | -- | 1 | -- | 35 | -- | 25 | -- | 3 | -- | 6 | -- | -- | -- | -- |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 30 | -- | -- | -- | -- | 63 | -- | -- | 53 | -- | -- | -- | -- | 103 | -- | -- | -- | -- | -- | -- | -- | 79 |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 99 | -- | -- | -- | -- |
| Warm-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BODA2 | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | 5 | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 26 | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | 15 | -- | -- | -- | -- | 57 |
| PLJA | 25 | -- | 129 | 36 | -- | -- | 52 | -- | -- | -- | 83 | 12 | -- | -- | 18 | -- | 36 | -- | 168 | -- | 112 | 199 | 51 | 3 | -- | -- | 57 | -- | 4 | 96 | -- | -- | -- | 54 | 1 | -- | -- | 74 | -- | 54 |
| SCPA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- | -- | -- | -- | -- |
| SPAI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- |
| SPCR | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 32 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Perennial/Biennial Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BADI | -- | -- | -- | -- | 11 | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| DEPI | -- | -- | -- | -- | -- | -- | 16 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERDI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| GAAR | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 109 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LAOC3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LASE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MACA2 | -- | -- | -- | -- | -- | -- | 7 | -- | 62 | -- | 6 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEOF | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- |
| SPCO | 6 | -- | -- | -- | -- | -- | -- | 5 | -- | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| TRDU | -- | -- | -- | -- | -- | -- | 13 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| TRPR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARFR4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- | -- |
| ATCA2 | -- | 74 | -- | -- | 1 | 0 | -- | -- | -- | 129 | -- | -- | -- | -- | 59 | 18 | -- | 10 | -- | 0 | -- | -- | -- | -- | -- | 110 | 30 | -- | -- | 8 | -- | -- | 1 | -- | -- | -- | 27 | -- | 31 | 143 |
| ATCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 303 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | 48 | -- | 53 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 150 | -- | -- | -- | -- | -- | -- | -- | -- |
| GUSA2 | -- | 21 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 27 | -- | 137 | -- | -- | 15 | -- | -- | -- | -- | 47 | -- | -- | -- | -- | 24 | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | 5 | -- | -- | -- | 6 | -- | 62 | -- | -- | -- | -- | 9 | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- |
| **Total Air-dry Aboveground Annual Forage Production** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total (g) | 109 | 196 | 223 | 58 | 50 | 11 | 132 | 91 | 173 | 198 | 146 | 391 | 7 | 57 | 78 | 32 | 87 | 45 | 271 | 82 | 178 | 337 | 139 | 179 | 54 | 214 | 139 | 49 | 73 | 217 | 103 | 140 | 192 | 78 | 28 | 112 | 35 | 95 | 35 | 332 |
| Total (lbs/ac) | 646 | 1,165 | 1,324 | 343 | 300 | 66 | 786 | 543 | 1,030 | 1,175 | 870 | 2,324 | 43 | 341 | 461 | 188 | 519 | 269 | 1,614 | 488 | 1,056 | 2,004 | 828 | 1,064 | 322 | 1,272 | 823 | 291 | 434 | 1,287 | 614 | 835 | 1,146 | 466 | 165 | 667 | 206 | 564 | 206 | 1,978 |

Notes:
Species codes defined in Table A-5
Total (g) is the total of all three .5 $m^2$ quads (1.5$m^2$ total) per transect
Lbs/ac=total grams÷1.5*(4046.86/453.592)
Non-forage and forage determinations are based on the permit (e.g. plants of perennial and/or biennial duration are forage and plants of annual duration are non-forage; noxious weeds are non-forage)

## Table A-6: O-VMU-2 Shrub Belt Transect Data (frequency), 2023

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARCA13 | -- | -- | -- | -- | -- | -- | 15 | 20 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARFR4 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 16 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARNO4 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCA2 | 2 | 31 | 1 | 15 | 20 | 22 | 7 | -- | 6 | 56 | 25 | 11 | 4 | 39 | 93 | 45 | 30 | 1 | 24 | 22 | 22 | 82 | 39 | 42 | 24 | 53 | 9 | 41 | 11 | 17 | 21 | 1 | 1 | 36 | 46 | 21 | 53 | 37 | 41 | 41 |
| ATCO | -- | -- | -- | 3 | -- | -- | -- | -- | -- | 43 | -- | 8 | -- | 2 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCO4 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 8 | 1 | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CACTUS | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | 1 | -- | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 19 | -- | -- | -- |
| EPVI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | 16 | 4 | 1 | 1 | 12 | 1 | 8 | 19 | 3 | 1 | 13 | 3 | 11 | 4 | -- | -- | 13 | -- | -- | -- | -- | -- | -- | -- | 1 | 4 | -- | -- | 21 | -- | 11 | 1 | 55 | 1 | 2 | 3 | -- | 5 | 9 | -- |
| GUSA2 | 8 | 6 | -- | -- | 10 | -- | 1 | 19 | -- | 2 | 7 | -- | -- | 1 | -- | 7 | 6 | -- | 24 | 24 | 3 | 37 | -- | -- | 114 | 22 | 4 | -- | -- | 10 | -- | 19 | 4 | -- | 219 | 1 | 4 | -- | 10 | 1 |
| JUMO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | 44 | 2 | -- | 37 | 22 | 13 | 1 | -- | -- | -- | 17 | 25 | 117 | 24 | -- | -- | 7 | -- | 73 | -- | 14 | -- | -- | 1 | -- | -- | -- | 20 | -- | 11 | -- | -- | -- | 1 | 2 | -- | -- | 25 | -- | -- |
| LYPA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- |
| OPUNT | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 1 |
| PIED | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 16 | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| PUTR2 | 2 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 4 | -- | 15 | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | 6 | -- | -- | -- | 1 | 4 | -- | -- | -- | -- |
| SEFL3 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Total** | 74 | 44 | 2 | 57 | 64 | 38 | 34 | 59 | 19 | 105 | 83 | 58 | 154 | 71 | 95 | 52 | 63 | 1 | 121 | 46 | 43 | 119 | 40 | 43 | 139 | 79 | 13 | 77 | 47 | 47 | 32 | 24 | 62 | 39 | 273 | 25 | 76 | 67 | 72 | 43 |

Notes:
Species codes defined in Table A-5
The shrub belt transect area is 100m$^2$ (2mx50m); shrubs rooted in the belt transect were counted on an individual basi

## Table A-7: Species Observed 2019-2023, O-VMU-2

| Common Name | Scientific Name | Code |
|---|---|---|
| **Cool-Season Grasses (20)** | | |
| **Annuals (3)** | | |
| Field brome | *Bromus arvensis* | BRAR5 |
| Cheatgrass | *Bromus tectorum* | BRTE |
| Common barley | *Hordeum vulgare* | HOVU |
| **Perennials (17)** | | |
| Indian ricegrass | *Achnatherum hymenoides* | ACHY |
| Crested wheatgrass | *Agropyron cristatum* | AGCR |
| Smooth brome | *Bromus inermis* | BRIN2 |
| Canada wildrye | *Elymus canadensis* | ELCA4 |
| Bottlebrush squirreltail | *Elymus elymoides* | ELEL5 |
| Thickspike wheatgrass | *Elymus lanceolatus* | ELLA3 |
| Slender wheatgrass | *Elymus trachycaulus* | ELTR7 |
| Arizona fescue | *Festuca arizonica* | FEAR2 |
| Needle and thread | *Hesperostipa comata* | HECO26 |
| Foxtail barley | *Hordeum jubatum* | HOJU |
| Colorado wildrye | *Leymus ambiguus* | LEAM |
| Basin wildrye | *Leymus cinereus* | LECI4 |
| Western wheatgrass | *Pascopyrum smithii* | PASM |
| Bluegrass | *Poa* sp. | POA |
| Russian wildrye | *Psathyrostachys juncea* | PSJU3 |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | PSSP6 |
| Intermediate wheatgrass | *Thinopyrum intermedium* | THIN6 |
| **Warm-Season Grasses (13)** | | |
| **Annuals (5)** | | |
| Sixweeks grama | *Bouteloua barbata* | BOBA2 |
| Matted grama | *Bouteloua simplex* | BOSI2 |
| Mat sandbur | *Cenchrus longispinus* | CELO3 |
| Stinkgrass | *Eragrostis cilianensis* | ERCI |
| False buffalograss | *Munroa squarrosa* | MUSQ3 |
| **Perennials (8)** | | |
| Purple threeawn | *Aristida purpurea* | ARPU9 |
| Sideoats grama | *Bouteloua curtipendula* | BOCU |
| Buffalograss | *Bouteloua dactyloides* | BODA2 |
| Blue grama | *Bouteloua gracilis* | BOGR2 |
| James' galleta | *Pleuraphis jamesii* | PLJA |
| Tumblegrass | *Schedonnardus paniculatus* | SCPA |
| Alkali sacaton | *Sporobolus airoides* | SPAI |
| Sand dropseed | *Sporobolus cryptandrus* | SPCR |
| **Forbs (84)** | | |
| **Annuals (28)** | | |
| Desert madwort | *Alyssum desertorum* | ALDE |
| Alyssum | *Alyssum simplex* | ALSI8 |
| Redroot amaranth | *Amaranthus retroflexus* | AMRE |
| Burningbush | *Bassia scoparia* | BASC5 |
| Lambsquarters | *Chenopodium album* | CHAL7 |
| Ribseed sandmat | *Chamaesyce glyptosperma* | CHGL13 |
| Mealy goosefoot | *Chenopodium incanum* | CHIN2 |
| Narrowleaf goosefoot | *Chenopodium leptophyllum* | CHLE4 |
| Spotted sandmat | *Chamaesyce maculata* | CHMA15 |
| **Threadstem sandmat** | ***Chamaesyce revoluta*** | **CHRE4** |
| **Thymeleaf sandmat** | ***Chamaesyce serpyllifolia*** | **CHSE6** |
| Rocky Mountain beeplant | *Cleome serrulata* | CLSE |
| Wright's bird's beak | *Cordylanthus wrightii* | COWR2 |
| Fetid marigold | *Dyssodia papposa* | DYPA |
| Nodding buckwheat | *Eriogonum cernuum* | ERCE2 |
| Divergent buckwheat | *Eriogonum divaricatum* | ERDI5 |
| Common sunflower | *Helianthus annuus* | HEAN3 |
| Longleaf false goldeneye | *Heliomeris longifolia* | HELO6 |
| Prairie sunflower | *Helianthus petiolaris* | HEPE |
| King's lupine | *Lupinus kingii* | LUKI |
| Fendler's desertdandelion | *Malacothrix fendleri* | MAFE |
| Erect knotweed | *Polygonum erectum* | POER2 |
| Little hogweed | *Portulaca oleracea* | POOL |
| Prickly Russian thistle | *Salsola tragus* | SATR12 |
| Manyflower false threadleaf | *Schkuhria multiflora* | SCMU6 |
| Unknown Annual Forb | Unknown Annual Forb | UNKAF |
| Golden crownbeard | *Verbesina encelioides* | VEEN |
| Rough cocklebur | *Xanthium strumarium* | XAST |

## Table A-7: Species Observed 2019-2023, O-VMU-2

| Common Name | Scientific Name | Code |
|---|---|---|
| **Perennials/Biennials (56)** | | |
| Common yarrow | *Achillea millefolium* | ACMI2 |
| Russian knapweed | *Acroptilon repens* | ACRE3 |
| Nodding onion | *Allium cernuum* | ALCE2 |
| Ragweed sagebrush | *Artemisia franserioides* | ARFR3 |
| Ragleaf bahia | *Bahia dissecta* | BADI |
| Wyoming Indian paintbrush | *Castilleja linariifolia* | CALI4 |
| Sego lily | *Calochortus nuttallii* | CANU3 |
| Musk thistle | *Carduus nutans* | CANU4 |
| Whitemargin sandmat | *Chamaesyce albomarginata* | CHAL11 |
| Chenopod | Chenopodiaceae | CHENOP |
| Rose heath | *Chaetopappa ericoides* | CHER2 |
| Greenleaf five eyes | *Chamaesaracha coronopus* | CHCO2 |
| Canadian horseweed | *Conyza canadensis* | COCA5 |
| White prairie clover | *Dalea candida* | DACA7 |
| Purple prairie clover | *Dalea purpurea* | DAPU5 |
| Mountain tansymustard | *Descurainia incana* | DEIN5 |
| Western tansymustard | *Descurainia pinnata* | DEPI |
| Flixweed | *Descurainia sophia* | DESO |
| Redstem stork's bill | *Erodium cicutarium* | ERCI6 |
| Spreading fleabane | *Erigeron divergens* | ERDI4 |
| **Blanketflower** | ***Gaillardia aristata*** | **GAAR** |
| Indian blanket | *Gaillardia pulchella* | GAPU |
| Hairy gumweed | *Grindelia hirsutula* | GRHI |
| Curlytop gumweed | *Grindelia nuda* var. *aphanactis* | GRNUA |
| Curlycup gumweed | *Grindelia squarrosa* | GRSQ |
| Showy goldeneye | *Heliomeris multiflora* | HEMU3 |
| Scarlet gilia | *Ipomopsis aggregata* | IPAG |
| Flaxflowered ipomopsis | *Ipomopsis longiflora* | IPLO2 |
| Manyflowered ipomopsis | *Ipomopsis multiflora* | IPMU3 |
| Flatspine stickseed | *Lappula occidentalis* | LAOC3 |
| Prickly lettuce | *Lactuca serriola* | LASE |
| **Mesa pepperwort** | ***Lepidium alyssoides*** | **LEAL4** |
| Lewis flax | *Linum lewisii* | LILE3 |
| Hoary tansyaster | *Machaeranthera canescens* | MACA2 |
| Tanseyleaf tansyaster | *Machaeranthera tanacetifolia* | MATA2 |
| Horehound | *Marrubium vulgare* | MAVU |
| Sweetclover | *Melilotus officinalis* | MEOF |
| Alfalfa | *Medicago sativa* | MESA |
| Colorado four o'clock | *Mirabilis multiflora* | MIMU |
| Beardlip penstemon | *Penstemon barbatus* | PEBA2 |
| Palmer's penstemon | *Penstemon palmeri* | PEPA8 |
| Prostrate knotweed | *Polygonum aviculare* | POAV |
| Upright prairie coneflower | *Ratibida columnifera* | RACO3 |
| Curly dock | *Rumex crispus* | RUCR |
| Tall tumblemustard | *Sisymbrium altissimum* | SIAL2 |
| **Nightshade** | ***Solanum* sp.** | **SOLAN** |
| Scarlet globemallow | *Sphaeralcea coccinea* | SPCO |
| Fendler's globemallow | *Sphaeralcea fendleri* | SPFE |
| Gooseberryleaf globemallow | *Sphaeralcea grossulariifolia* | SPGR2 |
| Spear globemallow | *Sphaeralcea hastulata* | SPHA |
| Gray globemallow | *Sphaeralcea incana* | SPIN2 |
| Ives' fournerved daisy | *Tetraneuris ivesiana* | TEIV |
| Wright's thelypody | *Thelypodium wrightii* | THWR |
| Yellow salsify | *Tragopogon dubius* | TRDU |
| Salsify | *Tragopogon porrifolius* | TRPO |
| **Jack-go-to-bed-at-noon** | ***Tragopogon pratensis*** | **TRPR** |

## Table A-7: Species Observed 2019-2023, O-VMU-2

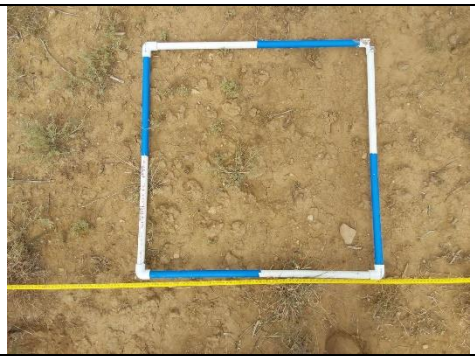
| Common Name | Scientific Name | Code |
|---|---|---|
| **Shrubs, Trees, and Cacti (42)** | | |
| Silver sagebrush | *Artemisia cana* | ARCA13 |
| Prairie sagewort | *Artemisia frigida* | ARFR4 |
| White sagebrush | *Artemisia ludoviciana* | ARLU |
| Black sagebrush | *Artemisia nova* | ARNO4 |
| Big sagebrush | *Artemisia tridentata* | ARTR2 |
| Mountain big sagebrush | *Artemisia tridentata* ssp. *vaseyana* | ARTRV |
| Tubercled saltbush | *Atriplex acanthocarpa* | ATAC |
| Fourwing saltbush | *Atriplex canescens* | ATCA2 |
| Shadscale saltbush | *Atriplex confertifolia* | ATCO |
| Mat saltbush | *Atriplex corrugata* | ATCO4 |
| Gardner's saltbush | *Atriplex gardneri* | ATGA |
| Mound saltbush | *Atriplex obovata* | ATOB |
| Longflower rabbitbrush | *Chrysothamnus depressus* | CHDE2 |
| **Greene's rabbitbrush** | ***Chrysothamnus greenei*** | **CHGR6** |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | CHVI8 |
| Russian olive | *Elaeagnus angustifolia* | ELAN |
| Mormon tea | *Ephedra viridis* | EPVI |
| Rubber rabbitbrush | *Ericameria nauseosa* | ERNA10 |
| Slenderleaf buckwheat | *Eriogonum leptophyllum* | ERLE10 |
| Broom snakeweed | *Gutierrezia sarothrae* | GUSA2 |
| Hairy false goldenaster | *Heterotheca villosa* | HEVI4 |
| Oneseed juniper | *Juniperus monosperma* | JUMO |
| Winterfat | *Krascheninnikovia lanata* | KRLA2 |
| Pale desert-thorn | *Lycium pallidum* | LYPA |
| Plains pricklypear | *Opuntia polyacantha* | OPPO |
| Twoneedle pinyon | *Pinus edulis* | PIED |
| Narrowleaf cottonwood | *Populus angustifolia* | POAN3 |
| Eastern cottonwood | *Populus deltoides* | PODE3 |
| Mexican cliffrose | *Purshia mexicana* | PUME |
| Antelope bitterbrush | *Purshia tridentata* | PUTR2 |
| Fragrant sumac | *Rhus aromatica* | RHAR4 |
| Skunkbush sumac | *Rhus trilobata* | RHTR |
| Woods' rose | *Rosa woodsii* | ROWO |
| White willow | *Salix alba* | SAAL2 |
| Narrowleaf willow | *Salix exigua* | SAEX |
| Greasewood | *Sarcobatus vermiculatus* | SAVE4 |
| Threadleaf ragwort | *Senecio flaccidus* | SEFL3 |
| Saltcedar | *Tamarix ramosissima* | TARA |
| Spineless horsebrush | *Tetradymia canescens* | TECA2 |
| Siberian elm | *Ulmus pumila* | ULPU |
| Banana yucca | *Yucca baccata* | YUBA |
| Soapweed yucca | *Yucca glauca* | YUGL |

Notes:

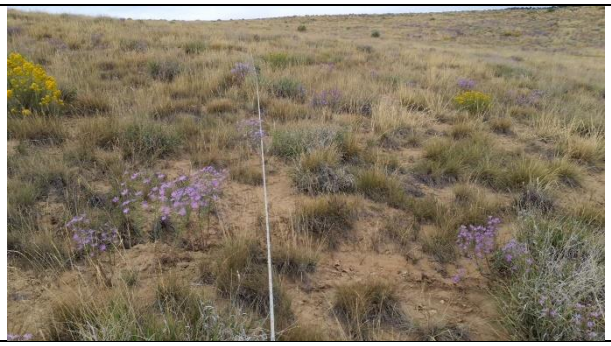
Bold species are newly observed on O-VMU-2 in 2023

**APPENDIX B**

# Quadrat Photographs

| | |
|---|---|
|  |  |
| O-VMU2-T01P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU2-T02P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU2-T03P



Q1



Q2



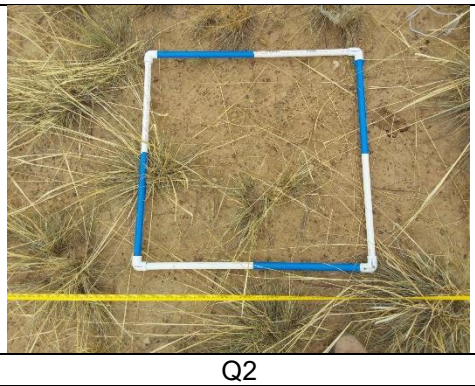
Q3



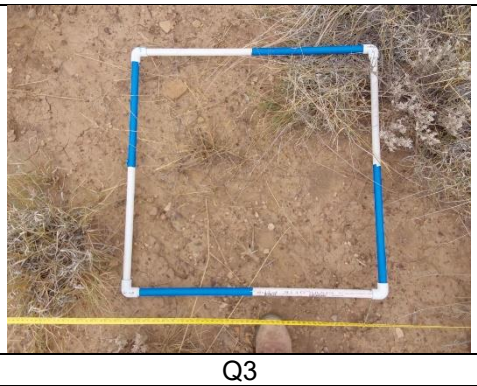
O-VMU2-T04P



Q1



Q2



Q3



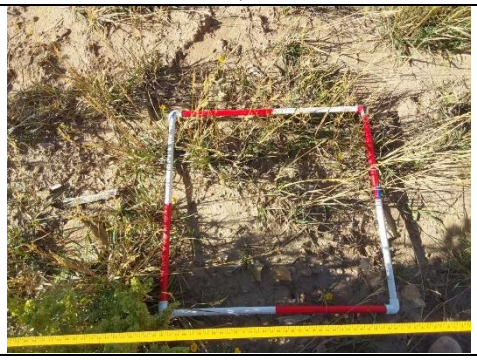
O-VMU2-T05P



Q1



Q2



Q3



O-VMU2-T06P



Q1



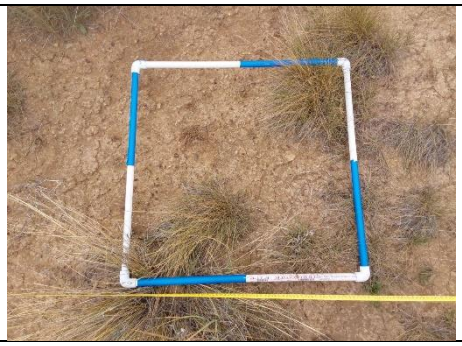
Q2



Q3



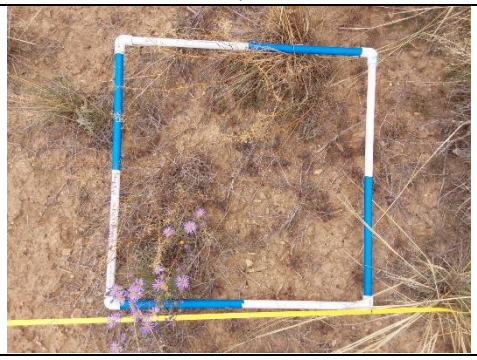
O-VMU2-T07P



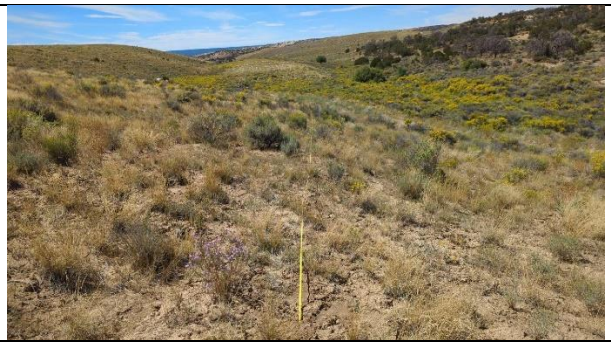
Q1



Q2



Q3



O-VMU2-T08P



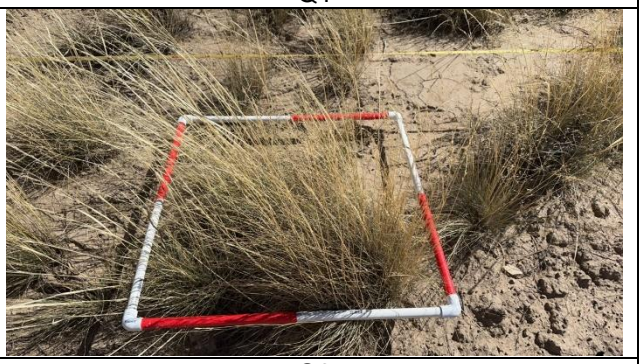
Q1

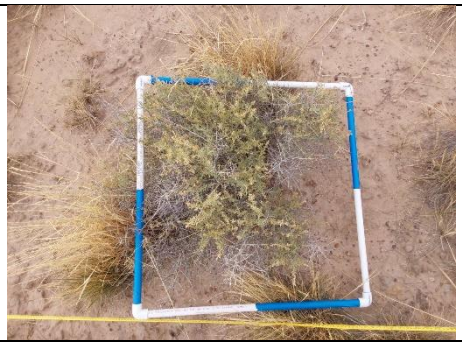
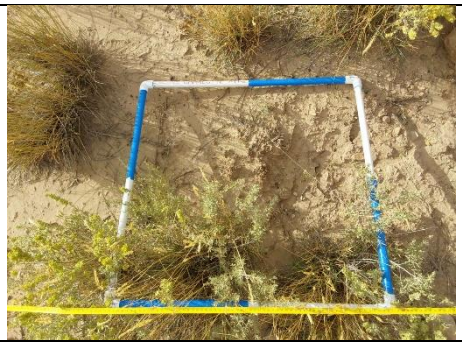


Q2



Q3

| | |
|---|---|
|  |  |
| O-VMU2-T09P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU2-T10P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU2-T11P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU2-T12P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU2-T13P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU2-T14P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU2-T15P



Q1



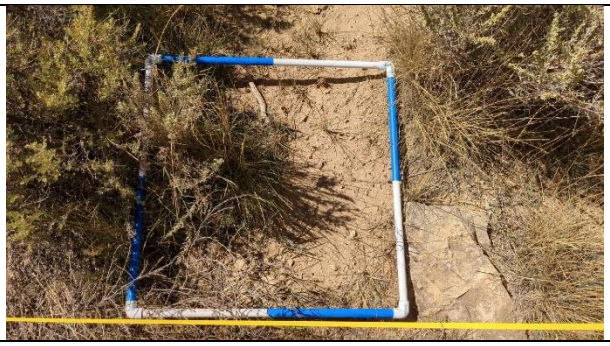
Q2



Q3



O-VMU2-T16P



Q1



Q2



Q3



O-VMU2-T17P



Q1



Q2



Q3



O-VMU2-T18P



Q1



Q2



Q3



O-VMU2-T19P



Q1



Q2



Q3



O-VMU2-T20P



Q1



Q2



Q3



O-VMU2-T21P



Q1



Q2



Q3



O-VMU2-T22P



Q1



Q2



Q3



O-VMU2-T23P



Q1



Q2



Q3



O-VMU2-T24P



Q1

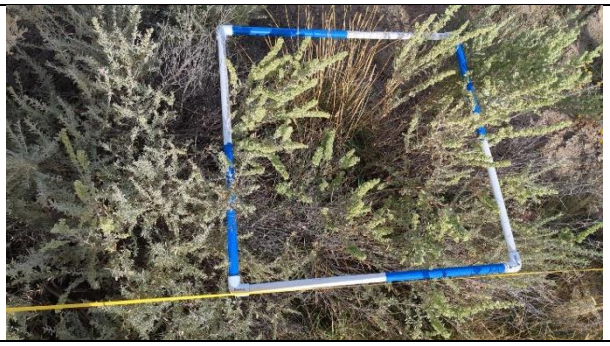
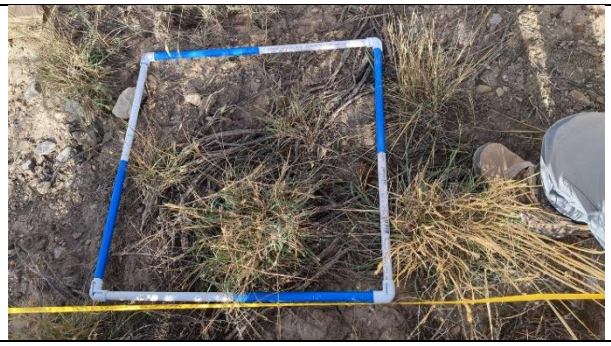


Q2



Q3

| | |
|---|---|
|  |  |
| O-VMU2-T25P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU2-T26P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU2-T27P



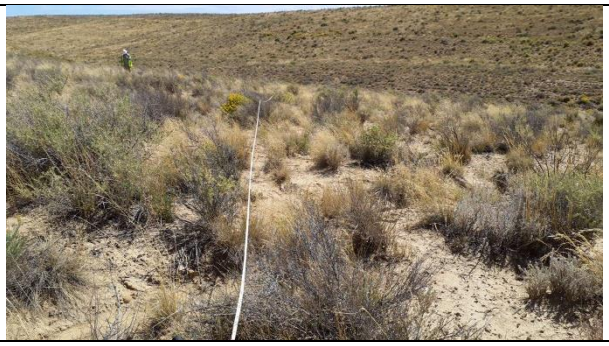
Q1



Q2



Q3



O-VMU2-T28P



Q1



Q2



Q3



O-VMU2-T29P



Q1



Q2



Q3



O-VMU2-T30P



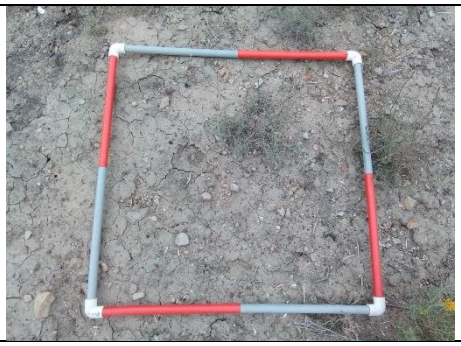
Q1



Q2



Q3

| | |
|---|---|
|  |  |
| O-VMU2-T31P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU2-T32P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU2-T33P



Q1



Q2



Q3



O-VMU2-T34P



Q1

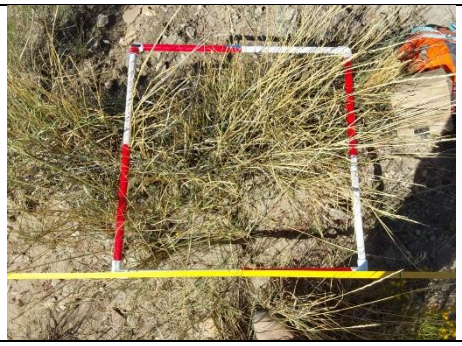


Q2



Q3

| | |
|---|---|
|  |  |
| O-VMU2-T35P | Q1 |
|  |  |
| Q2 | Q3 |

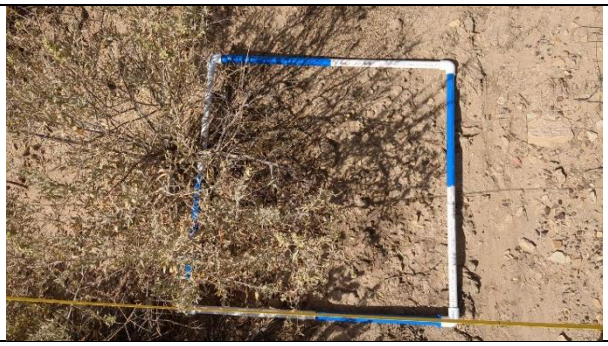
| | |
|---|---|
|  |  |
| O-VMU2-T36P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU2-T37P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU2-T38P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU2-T39P



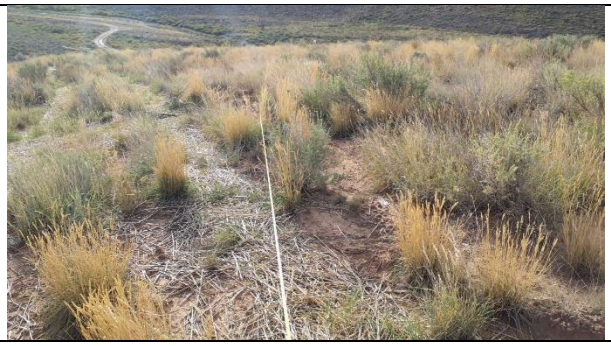
Q1



Q2



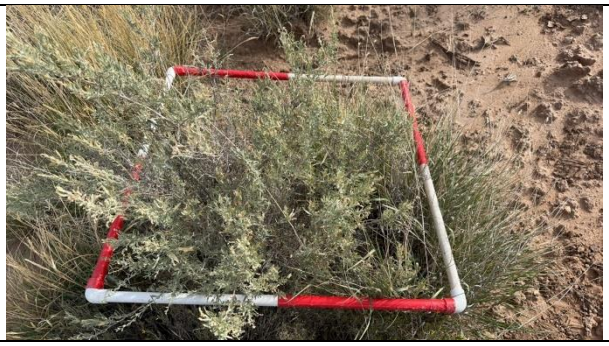
Q3



O-VMU2-T40P



Q1



Q2



Q3

**APPENDIX C**

# Vegetation Statistical Analysis

**Table C1: Equations for Vegetation Data Analysis**

| Attribute | Equation | Where |
|---|---|---|
| Sample Size / Count | $n = \sum samples$ | n = number of samples<br>∑ = sum |
| Mean | $\bar{x} = \frac{\sum x}{n}$ | $\bar{x}$ = sample mean<br>∑x = sum of values for variable<br>n = number of samples |
| Standard Deviation | $s = \sqrt{\frac{\sum(\bar{x} - x)^2}{n-1}}$ | s = standard deviation<br>∑ = sum<br>$\bar{x}$ = sample mean<br>n = number of samples |
| Variance (population) | $s^2 = \frac{\sum_{(x_i - \bar{x})^2}}{n-1}$ | $s^2$ = variance<br>∑ = sum<br>$x_i$ = Value of variable for sample *i*<br>$\bar{x}$ = sample mean<br>n = number of samples |
| t-distribution | t = 1-α, v | t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom<br>α = significance level (0.10)<br>v = degrees of freedom (n-1) |
| 90% Confidence Interval | $\bar{x} \pm z\frac{s}{\sqrt{n}}$ | $\bar{x}$ = sample mean<br>z = the critical value from the normal distribution with α/2 in each tail<br>s = standard deviation<br>n = number of samples |
| $N_{min}$ (Sample Adequacy - Normal Data) | $N_{min} = \frac{t^2 s^2}{(\bar{x}D)^2}$ | $N_{min}$ = number of samples required<br>t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom<br>s = standard deviation ($s^2$ = variance)<br>$\bar{x}$ = sample mean<br>D = the desired level of accuracy, which is 10 percent of the mean |
| Logarithmic Transformation | Y' = log(Y + k) | log = logarithmic function<br>Y = attribute value<br>k = constant, here we use 1 |
| one-sample, one-sided t test | $t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$ | t* = calculated t-statistic<br>$\bar{x}$ = sample mean<br>s = standard deviation<br>n = sample size |
| one-sample, one-sided sign test | $z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$ | z = sign test statistic<br>k = test statistic resulting from the number of values falling below 90% of the technical standard<br>n = sample size |
| Relative Cover (Perennial/Biennial Species) | Rp/b-cvr = Cvrp/b-sp. / Cvrp/b-abs. | $R_{p/b\text{-}cvr}$ = Calculated Relative Cover for a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}sp.}$ = Mean Absolute Cover of a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}abs.}$ = Mean Absolute Perennial/Biennial Cover |
| Relative Cover (All Species) | Rcvr = Cvrsp. / CvrAbs. | $R_{cvr}$ = Calculated Relative Cover for a species<br>$Cvr_{sp.}$ = Mean Absolute Cover of ANY species<br>$Cvr_{abs.}$ = Mean Absolute Cover for All Species |

Notes:
All Appendix C analysis, tables, and figures computed using R software: (R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

**Table C-2: Data for Normal Distribution and Variance Analysis, O-VMU-2, 2023**

| Transect | Raw Data | | | | Transformed Data |
|---|---|---|---|---|---|
| | Total Ground Cover (%) | Perennial Vegetation Cover (%) | Annual Forage Production (lbs/ac) | Woody Plant Density (#/ac) | Box Cox - Annual Forage Production |
| O-VMU-2-T01P | 74 | 50 | 647 | 2,995 | 23.98 |
| O-VMU-2-T02P | 56 | 44 | 1,164 | 1,781 | 29.98 |
| O-VMU-2-T03P | 62 | 48 | 1,324 | 81 | 31.47 |
| O-VMU-2-T04P | 62 | 54 | 344 | 2,307 | 18.72 |
| O-VMU-2-T05P | 50 | 36 | 300 | 2,590 | 17.75 |
| O-VMU-2-T06P | 58 | 32 | 65 | 1,538 | 9.29 |
| O-VMU-2-T07P | 66 | 56 | 788 | 1,376 | 25.85 |
| O-VMU-2-T08P | 78 | 56 | 543 | 2,388 | 22.40 |
| O-VMU-2-T09P | 56 | 44 | 1,031 | 769 | 28.64 |
| O-VMU-2-T10P | 64 | 42 | 1,175 | 4,249 | 30.08 |
| O-VMU-2-T11P | 52 | 42 | 871 | 3,359 | 26.86 |
| O-VMU-2-T12P | 56 | 40 | 2,325 | 2,347 | 38.80 |
| O-VMU-2-T13P | 42 | 16 | 43 | 6,232 | 7.69 |
| O-VMU-2-T14P | 54 | 34 | 341 | 2,873 | 18.66 |
| O-VMU-2-T15P | 62 | 22 | 461 | 3,845 | 21.02 |
| O-VMU-2-T16P | 54 | 40 | 188 | 2,104 | 14.69 |
| O-VMU-2-T17P | 44 | 34 | 520 | 2,550 | 22.02 |
| O-VMU-2-T18P | 76 | 16 | 269 | 40 | 16.97 |
| O-VMU-2-T19P | 72 | 62 | 1,614 | 4,897 | 33.89 |
| O-VMU-2-T20P | 60 | 32 | 488 | 1,862 | 21.50 |
| O-VMU-2-T21P | 80 | 68 | 1,056 | 1,740 | 28.90 |
| O-VMU-2-T22P | 84 | 54 | 2,003 | 4,816 | 36.72 |
| O-VMU-2-T23P | 58 | 36 | 829 | 1,619 | 26.36 |
| O-VMU-2-T24P | 48 | 30 | 1,063 | 1,740 | 28.97 |
| O-VMU-2-T25P | 64 | 48 | 322 | 5,625 | 18.24 |
| O-VMU-2-T26P | 60 | 42 | 1,271 | 3,197 | 30.99 |
| O-VMU-2-T27P | 68 | 42 | 823 | 526 | 26.29 |
| O-VMU-2-T28P | 56 | 32 | 290 | 3,116 | 17.50 |
| O-VMU-2-T29P | 58 | 28 | 433 | 1,902 | 20.52 |
| O-VMU-2-T30P | 58 | 46 | 1,288 | 1,902 | 31.14 |
| O-VMU-2-T31P | 56 | 30 | 614 | 1,295 | 23.49 |
| O-VMU-2-T32P | 62 | 42 | 835 | 971 | 26.43 |
| O-VMU-2-T33P | 78 | 74 | 1,145 | 2,509 | 29.80 |
| O-VMU-2-T34P | 72 | 52 | 466 | 1,578 | 21.10 |
| O-VMU-2-T35P | 40 | 26 | 166 | 11,048 | 13.93 |
| O-VMU-2-T36P | 56 | 38 | 667 | 1,012 | 24.26 |
| O-VMU-2-T37P | 34 | 16 | 206 | 3,076 | 15.25 |
| O-VMU-2-T38P | 52 | 38 | 565 | 2,711 | 22.75 |
| O-VMU-2-T39P | 56 | 42 | 206 | 2,914 | 15.24 |
| O-VMU-2-T40P | 52 | 38 | 1,977 | 1,740 | 36.55 |
| Mean | 59.75 | 40.6 | 768.1 | 2630.5 | 23.9 |
| Standard Deviation | 11.1 | 13.1 | 551.7 | 1940.2 | 7.3 |
| Count | 40 | 40 | 40 | 40 | 40 |
| Variance | 120 | 167 | 296,745 | 3,670,430 | 52.108 |
| 90% Confidence Interval | 3 | 3 | 143 | 505 | 1.901 |
| Technical Standard | 52% | 24% | 550 | 400 | 16.98 |
| **90% of Standard** | 46.8% | 21.6% | 495 | 360 | 16.34 |

Notes:
2023 Data are found in Appendix A
Annual forage production box cox transformation = (#^λ-1)/λ), where λ (lambda) = 0.34343

**Table C-3: Total Ground Cover, one-sample, one-sided t-test - classical null (left-sided), O-VMU-2, 2023**

| Total Ground Cover (%) | |
|---|---|
| Mean (%) | 59.8 |
| Standard Deviation (%) | 11.1 |
| Sample Size | 40 |
| Technical Standard (%) | 52 |
| t* | 7.381 |
| 1-tail t (0.1, 39) | -1.304 |

Notes:
Data is from Table C-2
Decision Rules (the Permit - Appendix 6.5-B):
t* < t (α; n-1), failure to meet standard
t* ≥ t (α; n-1), performance standard met
t from Section 3, Table 1 (WDEQ, 2012)
Test Statistic:

$$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

t*(7.381) ≥ t (-1.304), **performance standard is met**

**Table C-4: Perennial Vegetaion Foliar Cover, one-sample, one-sided t-test - classical null (left-sided), O-VMU-2, 2023**

| Total Perennial Cover (%) | |
|---|---|
| Mean (%) | 40.6 |
| Standard Deviation (%) | 13.1 |
| Sample Size | 40 |
| Technical Standard (%) | 24 |
| t* | 9.158 |
| 1-tail t (0.1, 40) | -1.304 |

Notes:
Data is from Table C-2
Decision Rules (the Permit - Appendix 6.5-B):
t* < t (α; n-1), failure to meet standard
t* ≥ t (α; n-1), performance standard met
t from Section 3, Table 1 (WDEQ, 2012)
Test Statistic: $$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

t*(9.158) ≥ t (-1.304), **performance standard is met**

**Table C-5: Annual Forage Production, one-sample, one-sided sign test- reverse null, O-VMU-2, 2023**

| Transect | Annual Forage Production | 90% of Technical Standard | Difference |
|---|---|---|---|
| O-VMU1-T01P | 647 | 495 | 152 |
| O-VMU1-T02P | 1,164 | 495 | 669 |
| O-VMU1-T03P | 1,324 | 495 | 829 |
| O-VMU1-T04P | 344 | 495 | -151 |
| O-VMU1-T05P | 300 | 495 | -195 |
| O-VMU1-T06P | 65 | 495 | -430 |
| O-VMU1-T07P | 788 | 495 | 293 |
| O-VMU1-T08P | 543 | 495 | 48 |
| O-VMU1-T09P | 1,031 | 495 | 536 |
| O-VMU1-T10P | 1,175 | 495 | 680 |
| O-VMU1-T11P | 871 | 495 | 376 |
| O-VMU1-T12P | 2,325 | 495 | 1,830 |
| O-VMU1-T13P | 43 | 495 | -452 |
| O-VMU1-T14P | 341 | 495 | -154 |
| O-VMU1-T15P | 461 | 495 | -34 |
| O-VMU1-T16P | 188 | 495 | -307 |
| O-VMU1-T17P | 520 | 495 | 25 |
| O-VMU1-T18P | 269 | 495 | -226 |
| O-VMU1-T19P | 1,614 | 495 | 1,119 |
| O-VMU1-T20P | 488 | 495 | -7 |
| O-VMU1-T21P | 1,056 | 495 | 561 |
| O-VMU1-T22P | 2,003 | 495 | 1,508 |
| O-VMU1-T23P | 829 | 495 | 334 |
| O-VMU1-T24P | 1,063 | 495 | 568 |
| O-VMU1-T25P | 322 | 495 | -173 |
| O-VMU1-T26P | 1,271 | 495 | 776 |
| O-VMU1-T27P | 823 | 495 | 328 |
| O-VMU1-T28P | 290 | 495 | -205 |
| O-VMU1-T29P | 433 | 495 | -62 |
| O-VMU1-T30P | 1,288 | 495 | 793 |
| O-VMU1-T31P | 614 | 495 | 119 |
| O-VMU1-T32P | 835 | 495 | 340 |
| O-VMU1-T33P | 1,145 | 495 | 650 |
| O-VMU1-T34P | 466 | 495 | -29 |
| O-VMU1-T35P | 166 | 495 | -329 |
| O-VMU1-T36P | 667 | 495 | 172 |
| O-VMU1-T37P | 206 | 495 | -289 |
| O-VMU1-T38P | 565 | 495 | 70 |
| O-VMU1-T39P | 206 | 495 | -289 |
| O-VMU1-T40P | 1,977 | 495 | 1,482 |
| | | k | 16 |
| | | n | 40 |
| | | z | -1.1068 |
| | | Standard one-tailed normal curve area (Table C-3; MMD, 1999) | 0.36580919 |
| | | P | 0.134 |

Notes:
Data is from Table C-2
*When k exceeds 50% of n-observations, the performance standard has not been mei*
P = 0.5-Area = prob of observing z; ≤0.1 performance standard met

**z value calculation:**

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

k (16) ≤ 20, P 0.1341908) > 0.1, **performance standard is not met**

**Table C-6: Woody Plant Density, one-sample, one-sided sign test- reverse null, O-VMU-2, 2023**

| Transect | Woody Plant Density | 90% of Technical Standard | Difference |
|---|---|---|---|
| O-VMU1-T01P | 2,995 | 360 | 2,635 |
| O-VMU1-T02P | 1,781 | 360 | 1,421 |
| O-VMU1-T03P | 81 | 360 | -279 |
| O-VMU1-T04P | 2,307 | 360 | 1,947 |
| O-VMU1-T05P | 2,590 | 360 | 2,230 |
| O-VMU1-T06P | 1,538 | 360 | 1,178 |
| O-VMU1-T07P | 1,376 | 360 | 1,016 |
| O-VMU1-T08P | 2,388 | 360 | 2,028 |
| O-VMU1-T09P | 769 | 360 | 409 |
| O-VMU1-T10P | 4,249 | 360 | 3,889 |
| O-VMU1-T11P | 3,359 | 360 | 2,999 |
| O-VMU1-T12P | 2,347 | 360 | 1,987 |
| O-VMU1-T13P | 6,232 | 360 | 5,872 |
| O-VMU1-T14P | 2,873 | 360 | 2,513 |
| O-VMU1-T15P | 3,845 | 360 | 3,485 |
| O-VMU1-T16P | 2,104 | 360 | 1,744 |
| O-VMU1-T17P | 2,550 | 360 | 2,190 |
| O-VMU1-T18P | 40 | 360 | -320 |
| O-VMU1-T19P | 4,897 | 360 | 4,537 |
| O-VMU1-T20P | 1,862 | 360 | 1,502 |
| O-VMU1-T21P | 1,740 | 360 | 1,380 |
| O-VMU1-T22P | 4,816 | 360 | 4,456 |
| O-VMU1-T23P | 1,619 | 360 | 1,259 |
| O-VMU1-T24P | 1,740 | 360 | 1,380 |
| O-VMU1-T25P | 5,625 | 360 | 5,265 |
| O-VMU1-T26P | 3,197 | 360 | 2,837 |
| O-VMU1-T27P | 526 | 360 | 166 |
| O-VMU1-T28P | 3,116 | 360 | 2,756 |
| O-VMU1-T29P | 1,902 | 360 | 1,542 |
| O-VMU1-T30P | 1,902 | 360 | 1,542 |
| O-VMU1-T31P | 1,295 | 360 | 935 |
| O-VMU1-T32P | 971 | 360 | 611 |
| O-VMU1-T33P | 2,509 | 360 | 2,149 |
| O-VMU1-T34P | 1,578 | 360 | 1,218 |
| O-VMU1-T35P | 11,048 | 360 | 10,688 |
| O-VMU1-T36P | 1,012 | 360 | 652 |
| O-VMU1-T37P | 3,076 | 360 | 2,716 |
| O-VMU1-T38P | 2,711 | 360 | 2,351 |
| O-VMU1-T39P | 2,914 | 360 | 2,554 |
| O-VMU1-T40P | 1,740 | 360 | 1,380 |
| | | k | 2 |
| | | n | 40 |
| | | z | -5.53 |
| | | Standard one-tailed normal curve area (Table C-3; MMD, 1999) | 0.499999984 |
| | | P | 0.00000002 |

Notes:

Data is from Table C-2

*When k exceeds 50% of n-observations, the performance standard has not been mei*

P = 0.5-Area = prob of observing z; ≤0.1 performance standard met

**z value calculation:**

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

k (2) ≤ 20, P (0.00000002) ≤ 0.1, **performance standard is met**

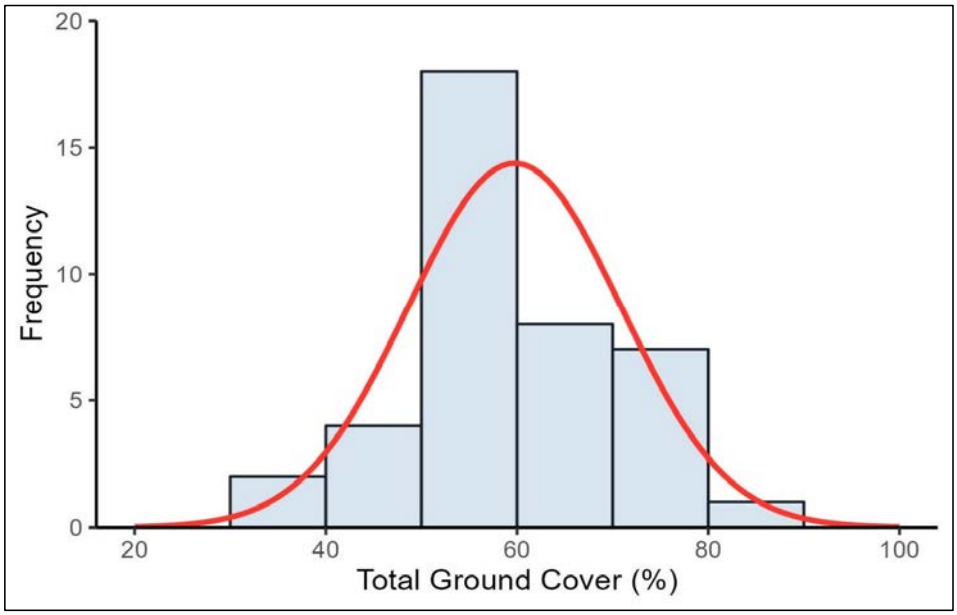
**Table C-7: Box Cox Annual Forage Production, one-sample, one-sided t-test - reverse null (right-sided), O-VMU 2, 2023**

| Box Cox Annual Forage Production (lbs/ac) | |
|---|---|
| Mean (%) | 23.9 |
| Standard Deviation (%) | 7.3 |
| Sample Size | 40 |
| Technical Standard (%) | 22.51 |
| t* | 1.952 |
| 1-tail t (0.1, 40) | 1.304 |

Notes:
Data is from Table C-2
Decision Rules (the Permit - Appendix 6.5-B):
t* < t (1-α; n-1), failure to meet standard
t* ≥ t (1-α; n-1), performance standard met
t from Section 3, Table 1 (WDEQ, 2012)
Test Statistic: $$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$
t*(1.952) ≥ t (1.304), **performance standard is met**

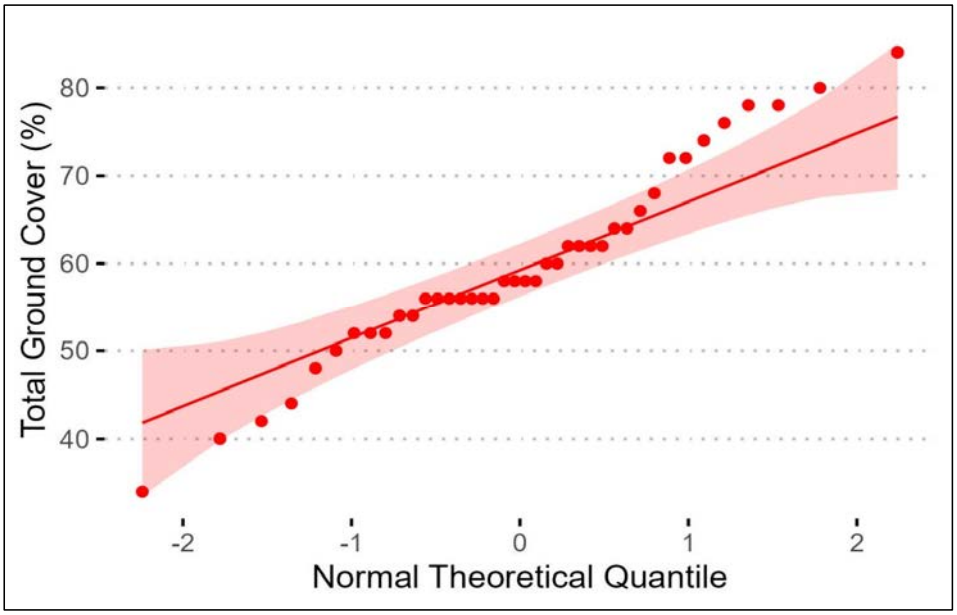
**Figure C-1: Total Ground Cover (%), O-VMU-2, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 59.75 | 56.86 | 62.64 | 2 | 11 | 0.14 | -0.21 | 54.00 | 58.00 | 64.50 |

**Normality**



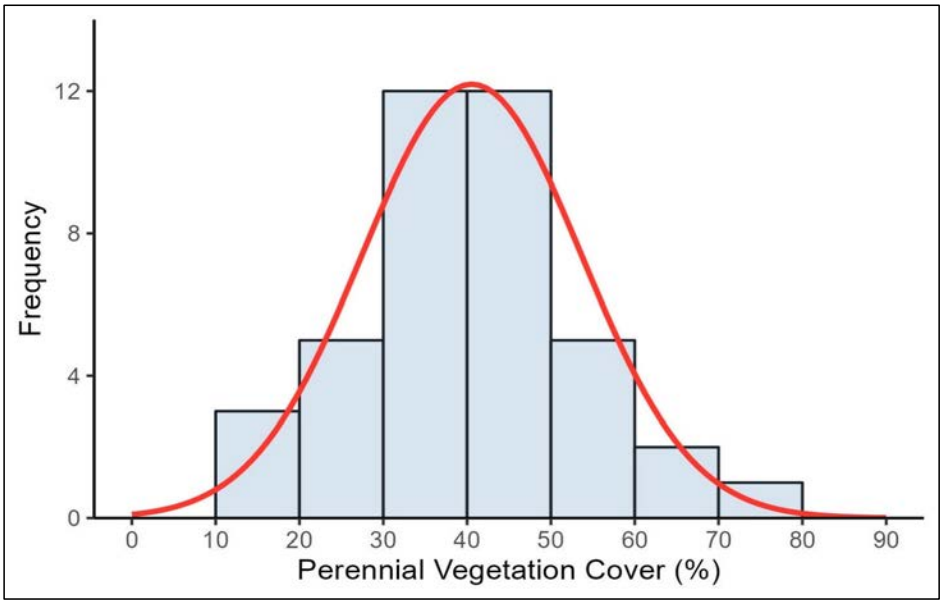

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.97107 | 0.388976 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Fail to reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P > 0.1**
*(Data are normally distributed)*

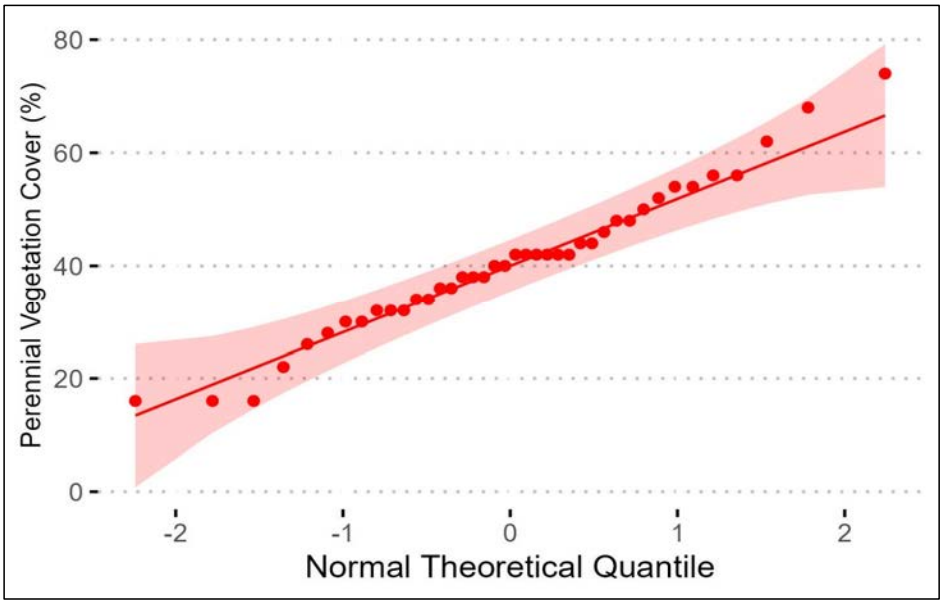
**Figure C-2: Perennial Vegetation Foliar Cover (%), O-VMU-2, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 40.55 | 37.15 | 43.95 | 2 | 13 | 0.25 | 0.04 | 32.00 | 41.00 | 48.00 |

**Normality**



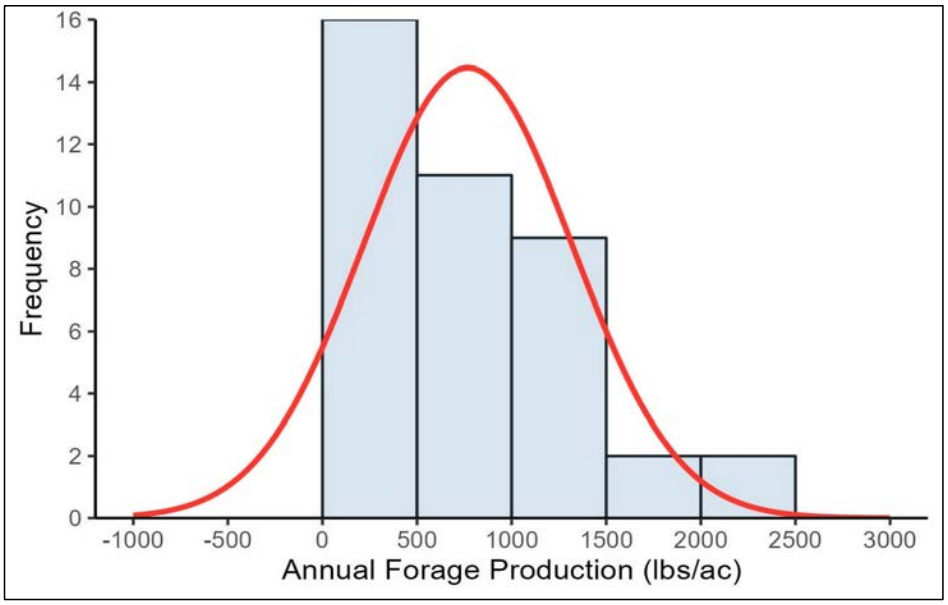

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.97679 | 0.571992 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Fail to reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P > 0.1)**
*(Data are normally distributed)*

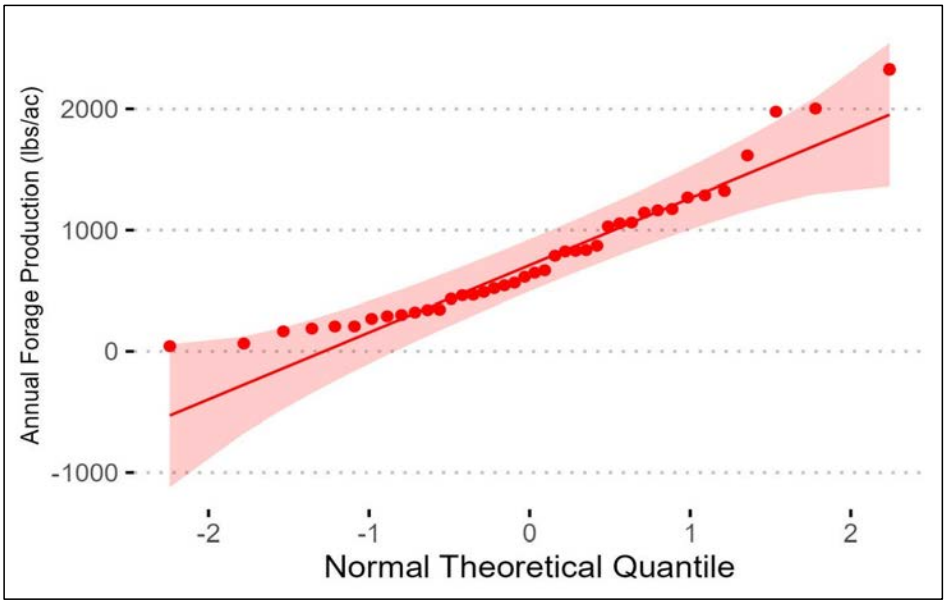
**Figure C-3: Annual Forage Production (lbs/ac), O-VMU-2, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 768.1 | 624.65 | 911.63 | 87.23 | 551.68 | 0.97 | 0.36 | 336.18 | 630.45 | 1083.54 |

**Normality**



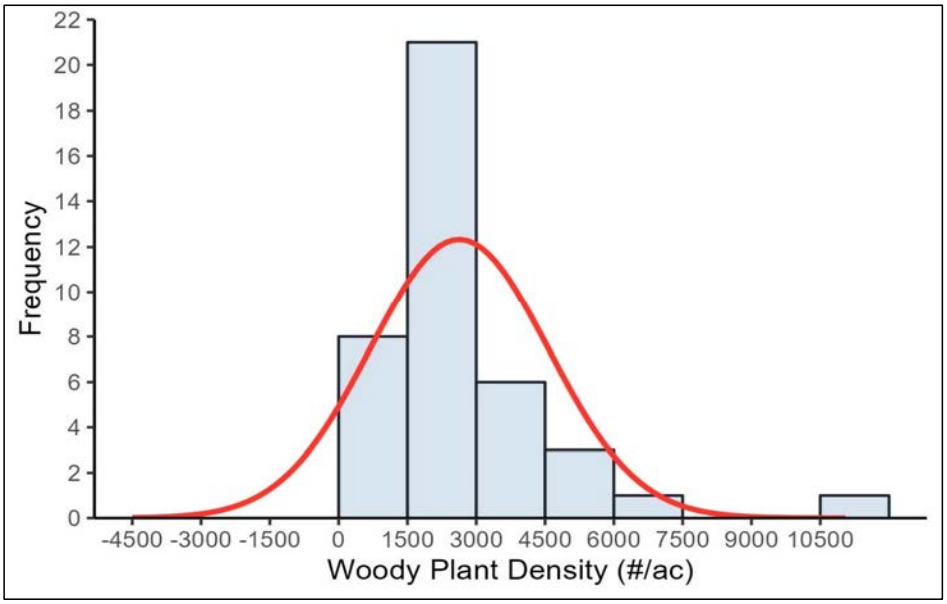

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.91397 | 0.005002 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P < 0.1)**
*(Data are not normally distributed)*

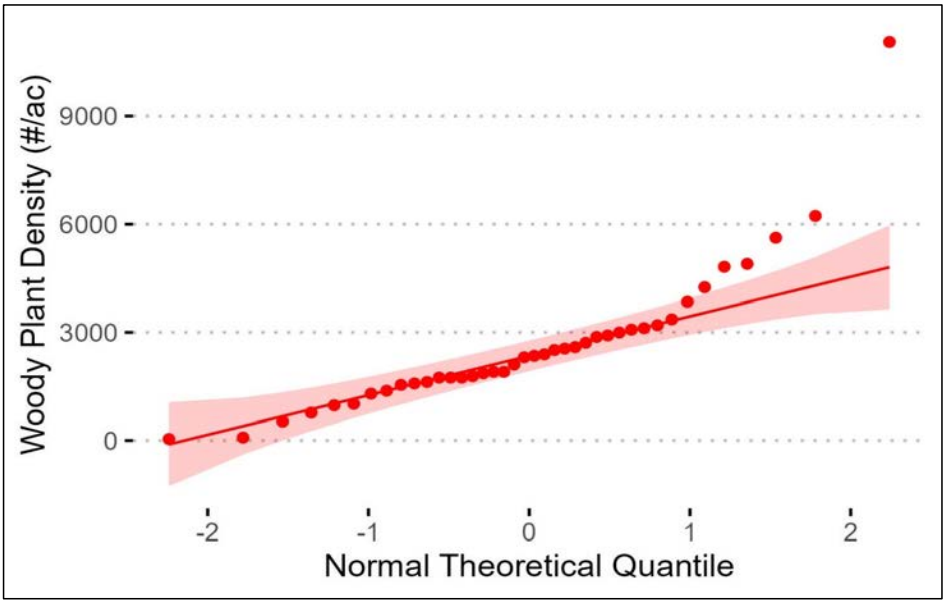
**Figure C-4: Woody Plant Density (st/ac), O-VMU-2, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 2630 | 2125.81 | 3135.11 | 306.78 | 1940.24 | 2.15 | 6.66 | 1608.63 | 2326.94 | 3085.73 |

**Normality**



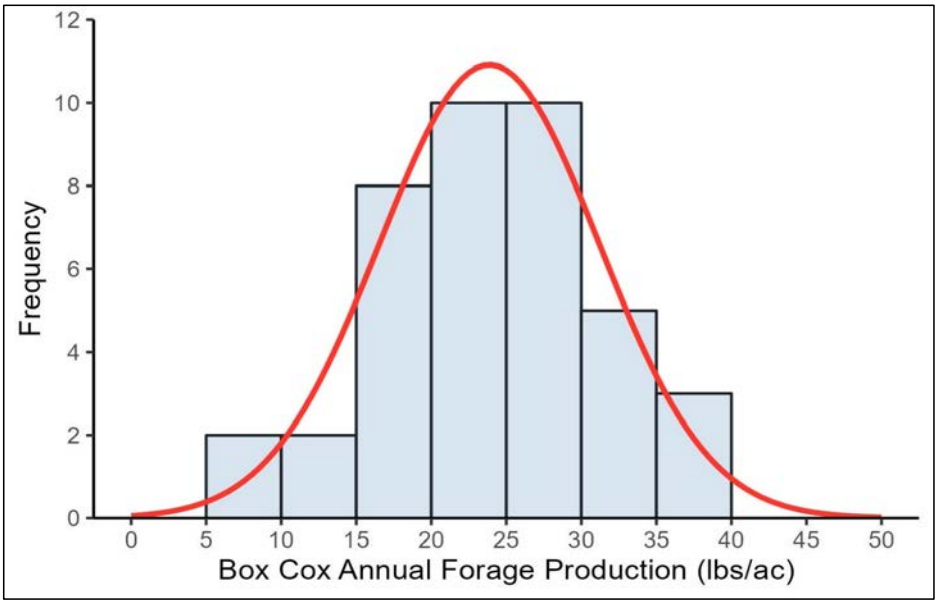

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.80999 | 0.000011 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P < 0.1)**
*(Data are not normally distributed)*

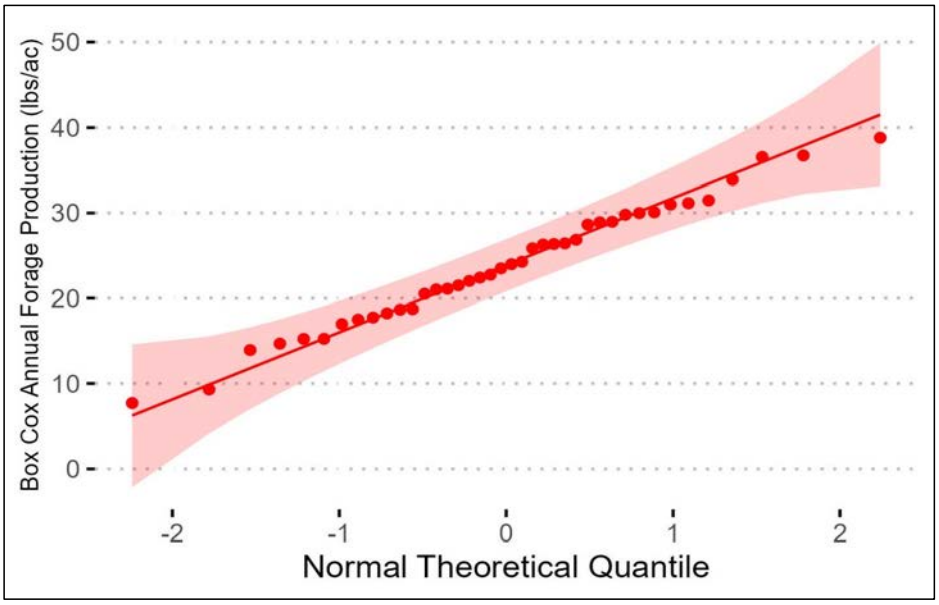
**Figure C-5: Box Cox Annual Forage Production (lbs/ac), O-VMU-2, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 23.87 | 21.97 | 25.77 | 1.16 | 7.31 | -0.06 | -0.57 | 18.56 | 23.73 | 29.18 |

**Normality**




**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.98849 | 0.951225 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Fail to reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P > 0.1)**
*(Data are normally distributed)*



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REPORT

# Vegetation Management Unit 3
# Vegetation Success Monitoring, 2023

Submitted to:

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March 2024



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# 1.0 INTRODUCTION

Mining at the McKinley Mine ceased in 2009 and reclamation of remaining support facilities (e.g., impoundments, roads, etc.) is nearing completion. Reclamation practices have been applied at the McKinley Mine under various programs since at least the early 1970s. Chevron Mining Inc. (CMI) is assessing the vegetation in reclaimed areas in anticipation of future bond and liability release. CMI understands the importance of returning the mined lands to productive traditional uses in a timely manner. To qualify for release, the increment, or permit area as a whole, must meet the Permit No. NM-0001K (2016) (the Permit) permanent-program revegetation-success criteria as shown in Table 1 of this report. In general, the lands must be in a condition that is as good as or better than the pre-mine conditions, stable, and capable of supporting the designated postmining land uses of grazing and wildlife. WSP USA, Inc. (WSP) was retained to monitor and assess the vegetation relative to the established vegetation success standards.

This report documents the vegetation community attributes collected in 2023 in O-VMU-3 and compares them to the Permit's vegetation-success criteria. Section 1 includes the introduction and a general overview. Section 2 describes the vegetation monitoring methods that were used in 2023. Section 3 presents the results of the assessment with respect to total ground cover, perennial vegetation cover, forage production, woody plant density (shrub density), and composition and diversity. Section 4 is a summary of the results for O-VMU-3 with emphasis on vegetation success.

The 2023 sampling program was conducted and evaluated in accordance with the updated monitoring methods and revegetation success standards contained in Permit Modification Number 23-03. More details beyond what is already discussed throughout this report may be found in the Permit.

## 1.1 Vegetation Management Unit 3

This report presents results from 2023 quantitative vegetation monitoring conducted in Vegetation Management Unit 3 (O-VMU-3), which is in the western portion of Area 2 and minor portions of Areas 1 and 10 (Figure 1). The configuration of the vegetation monitoring units within the U.S. Department of the Interior – Office of Surface Mining Reclamation and Enforcement (OSMRE) Permit Area, were developed in consultation with OSMRE. Undisturbed lands included within the VMU were not part of the sampling program. O-VMU-3 encompasses about 959 acres, comprised of permanent program lands (PPL), prelaw, and initial program lands (IPL). All program land, as one unit, must meet the PPL success criteria as discussed in the Permit in Section 6.5.1.2. The 10-year period of extended responsibility, however, only applies to PPL.

The elevation of O-VMU-3 ranges from about 6,950 to 7,100 feet above mean sea level. Reclamation started in 1975 with the vast majority seeded by 2003. Thus, the reclamation in the majority of O-VMU-3 ranges from 21 to almost 50 years old. This section provides a general description of the reclamation activities that were implemented. Additional details of the reclamation for specific areas can be obtained through review of the McKinley Mine annual reports.

## 1.2 Reclamation and Revegetation Procedures

Reclamation of permanent program lands included grading of the spoils to achieve a stable configuration, positive drainage, and approximate original contour. After grading, graded spoil monitoring was conducted to determine the suitability of the materials. A minimum of 6 inches of topdressing (topsoil or topsoil substitute) were then applied over suitable spoils.

After topdressing placement, the seedbed was scarified or ripped on the contour to a depth of about 8 to 12 inches. Seeding was done using various implements that drilled and/or broadcast the seed. After the seeding, certified weed-free, long-stem, hay mulch, or straw was applied at a rate of about 2 tons per acre. The mulch was anchored 3 to 4 inches into the cover with a tractor-drawn straight coulter disc. The seeding was generally performed in the fall, which tends to favor the establishment of cool-season grasses and shrubs. The approved seed mixes used at McKinley have varied over time but included both warm-season grasses, and introduced and native cool-season grasses, introduced and native forbs, and shrubs. The early seed mixes tended to emphasize the use the alfalfa and cool-season grasses. The majority of seed mixes planted on IPL consisted of native and introduced cool season grasses, limited warm-season grasses, some shrubs, but no forbs. Over time the seed mixes on PPL shifted to include more warm-season grasses, more shrub species, and a variety of forbs.

Initial program lands were typically graded so they were no steeper than 3:1 and topsoiled. Seeding practices were like those done on permanent program lands. Prelaw lands were generally graded to be no steeper than 3:1 but were not top-dressed before seeding.

## 1.3 Prevailing Climate Conditions

The amount and distribution of precipitation are important determinants for vegetation establishment and performance. Once vegetation is established, the precipitation dynamics affect the amount of vegetation cover and biomass on a year-to-year basis with grasses and forbs showing the most immediate response. Precipitation has been monitored at the McKinley Mine throughout most of its life at two primary precipitation stations (Bluff and South Tipple). The mine added a system of 8 additional seasonal precipitation gauges to better capture more representative data from the various mining areas in 2011-2012 (gauges named by area). Data from the Rain 12 and Bluff gauges were used to evaluate precipitation in O-VMU-3 (Figure 2).

Table 2 contains a summary of precipitation recorded at all the rain gauges in the North Mine Area. Total annual precipitation measured at the Bluff gauge near the mine entrance was 8.59 inches, below the regional average of 11.8 inches at Window Rock. Rain 12 gauge recorded 3.98 inches of precipitation from late April to mid-November (the period these stations operate), whereas the Bluff gauge recorded approximately 5.24 inches of rain for the same period with data throughout all of November. Mine wide, the precipitation recorded in 2023 between April and November at the other eight gauges indicate below average precipitation, on a scale of about 2-3 inches below average, with variation both spatially and temporally.

Growing season precipitation provides additional context to evaluate vegetation performance in O-VMU-3. The departure of growing season precipitation (April through September) between Rain 12 and Bluff gauges and the Window Rock (1937-1999) long-term seasonal mean is illustrated in Figure 2. Growing season precipitation in O--VMU-3 was well below the long-term seasonal mean from 2018 to 2023, with the exception of the 2022 growing season wherein both the Rain 12 and Bluff gauges were above the seasonal mean, measuring approximately 3.22 and 3.73 inches above the mean, respectively. Growing season precipitation from the Rain 12 and Bluff gauges in 2023 were 2.67 and 2.35 inches below average, respectively.

## 1.4 Livestock

CMI has been aggressively managing trespass livestock and as a result evidence of trespass horses was less apparent in 2023 in O-VMU-3. The combination of past grazing pressure with exceptional drought, however, may in some years adversely affect the ability to demonstrate that the vegetation is meeting or can meet the revegetation success standards.

# 2.0 VEGETATION STANDARDS AND MONITORING METHODS

Vegetation attributes in O-VMU-3 were quantified using the methods described in Section 6.5 of the Permit as modified in Permit Modification 23-03. Vegetation monitoring in O-VMU-3 was conducted from September 19 through October 5, 2023.

## 2.1 Vegetation Success Standards

The vegetation success standards for the Permit Area consist of five vegetative parameters: total cover, perennial cover, forage production, woody plant density, and diversity (Table 1). The total ground cover requirement, or the combined means for live vegetation cover and litter cover on the reclamation is 52%. The perennial vegetation cover requirement is 24%. Both total ground and perennial vegetation cover use absolute cover. The annual forage production requirement is 550 air-dry pounds per acre (lbs/ac). The shrub density success standard is 400 live woody stems per acre. In accordance with 30 CFR 816.116 (a)(2), success for total cover, perennial cover, forage production, and shrub density shall be ≥ 90% of the standard.

Cover is defined in three ways for accurate evaluation of diversity according to Table 1.

1) Absolute cover utilizes first-hit line point intercept (LPI) data and is used to assess the perennial grass diversity standard.
2) Relative perennial cover, the metric used to assess some grass, forb, and shrub standards, compares the cover of perennial species relative to the sum of perennial plants calculated from all-hit LPI data (excluding noxious weeds) within the VMU.
3) Relative total cover, the metric used to assess the any-single-species diversity standard, is calculated by dividing the percent cover of each perennial/biennial species by the total live vegetative cover from all-hit LPI data (excluding noxious weeds) within a VMU.

Biennial forbs are included in the vegetation cover analyses and biennial forb diversity standards because they are important to long term ecological success of the reclamation. As monocarpic, or single flowering species, these forbs produce a high number of seeds, and as a result, persist long-term in the reclamation plant community. Future mention of “perennial” in this report thus includes biennial species.

Relative shrub density, the metric used to assess the single shrub species standard, is calculated using belt-transect data by dividing the density of each species by the total density within a sampling unit. Relative calculations are valuable to determine whether a species or functional group is excessively dominant. The number of species requirement for the various diversity standard components (e.g., ≥ 2 species cool-season grasses) is calculated by adding the total number of unique species captured in the LPI surveys.

Diversity is evaluated against numerical guidelines for different vegetation types. In summary, the diversity guideline is met if perennial grasses contribute 7% or more absolute vegetation cover; at least two cool-season perennial grasses have individual relative perennial vegetation covers of 5% and 1.5% or more; at least two warm-season perennial grasses species with the highest cover species 5% or more relative perennial vegetation cover and the remaining species combining to contribute 1.5% or more relative perennial vegetation cover, at least three non-annual non-noxious forbs combining to contribute 1% or more relative total vegetation cover; shrubs combining to 6% or more relative perennial vegetation cover and no single shrub species with greater than 70% relative shrub density, and no single species of any functional group with 40% or more relative total vegetation cover. Diversity is also demonstrated by evidence of colonization or recruitment of native (not-seeded) plants from adjacent undisturbed native areas.

## 2.2 Sampling Design

All lands (PPL, Prelaw and IPL) were included in the vegetation-sampling pool for unbiased random sampling. The transect locations were reviewed with OSMRE in advance of sampling. A 100-meter (m) by 100 m square grid was superimposed over the entire VMU to delineate vegetation sample plots. Random points were created in a geographic information system and the locations including the program land (IPL or PPL) designations are shown in Figure 3. In the field, the randomly selected transect locations were assessed in numerical order with 40 primary transects accompanied by 10 alternate transects. If a transect location was determined to be unsuitable, the next alternative location was assessed for suitability. Transects that fell on or would intersect roads, drainage ways, wildlife rock piles, or prairie dog colonies were considered unsuitable.

Figure 4 shows the 100 m by 100 m vegetation plot with the cover transect orientation, and the location of the production quadrats and belt transect. The origin of the LPI transect is situated at the grid centroid and transect orientation (from 0° to 360°) is chosen randomly beginning from the transect origin, the point navigated to. LPI points are traversed to on transect left with the laser pointed towards transect right, to limit disturbance from walking on the quad and belt survey areas located on transect right. Each LPI transect is 50 m long with three half square meter (½ $m^2$) production quadrats placed flush with the meter tape with the bottom left corner at the 10, 25, and 40 m mark to the right of the transect. The belt transect corridor is 2 m by 50 m along the transect's right side.

## 2.3 Foliar, Canopy and Ground Cover

The LPI method is used to collect cover measurements required by the Permit to evaluate total cover, perennial cover, and diversity. Prior to production clipping, a 50 m measuring tape is suspended between two metal pins to extend the tape fully. A tripod mounted laser is then held along the edge of the tape, and readings are taken every meter for living plants, plant litter, rock fragments, and bare ground. When a live plant is encountered as a direct foliar hit, the species is recorded, and direct lower canopy live plant hits are also recorded that are observed down the profile. The LPI-derived data were evaluated against the permit area vegetation success standards for vegetation cover and diversity provided in Table 1, with first hits used in absolute cover calculations and all hits (upper and lower canopy hits) used in relative cover calculations.

Additional cover measurements were estimated from each production quadrat including relative cover for each species and total canopy cover, surface litter, rock fragments, and bare soil. Quadrat canopy cover data is not analyzed for success and is only briefly discussed in this report as additional support information (Table A-4). Canopy cover estimates include the foliage and foliage interspaces of all individual plant species rooted in the quadrat. Canopy cover is defined as the percentage of quadrat area included in the vertical projection of the canopy. The canopy cover estimates made on a species basis may exceed 100 percent in individual quadrats where the vegetation has multi-layered canopies. In contrast, the sum of the total canopy cover, surface litter, rock fragments, and bare soil does not exceed 100 percent. All cover estimates were made in 0.05 percent increments. Percent area cards were used to increase the accuracy and consistency of the cover estimates.

Not all plant species are expected to occur in the sampling transects and quadrats. Plants observed growing within the vegetation plots and across the reclaimed facility were inventoried while moving between sample locations and during formal sampling (Table A-7).

## 2.4 Annual Forage and Total Production

Forage production required by the Permit was determined by clipping and weighing all annual (current year's growth) above-ground forage biomass within the vertical confines of the three ½ $m^2$ quadrats placed systematically along the same 50 m transect used for LPI measurements. Biomass from all three quads from each transect are combined by species and the combined values for the transect (not the quads) are treated as a sampling unit. Production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. The Permit allows for excessively grazed production quadrats to be considered for exclusion from the sampling analysis in consultation with OSMRE, but no quadrats needed to be excluded in O-VMU-3 (the Permit, Section 6.5.2.2).

Grasses and forbs were clipped to within 5 centimeters (cm) of the soil surface, and the current year's growth was segregated from the previous year's growth (e.g., gray, weathered grass leaves, and dried culms). Production from shrubs was determined by clipping the current year's growth. Annuals and noxious weeds (e.g., Russian knapweed [*Acroptilon repens*]), when encountered, were not clipped. Photographs of the individual production quadrats are included in Appendix B.

The plant biomass samples of every species collected per transect were placed individually in labeled paper bags. The samples were air-dried (~ 90 days) until no weight changes were observed with repeated measurements on representative samples. The average tare weight of the empty paper bags was determined to correct the total sample weight to air-dry vegetation weights. The net weight of the air-dried vegetation was converted to a lbs/ac.

## 2.5 Shrub Density

Shrub density (as required by the Permit), or the number of stems per square meter (stems/$m^2$), was determined using the belt transect method (Bonham 1989). The belt transect was located parallel to the 50 m transect used to determine cover. Shrubs rooted in the 2 m belt transect were counted on a species basis. A 2 m folding ruler was horizontally oriented perpendicular to the tape to ensure that observations were taken within the 2 m corridor. The number and species of woody plant stems within the belt transect were recorded.

## 2.6 Statistical Analysis

The procedures for liability release and the basis for statistical analysis applied in this report may be found in the Permit, and as referenced in the Permit: the Wyoming Department of Environmental Quality (WDEQ) handbook of sampling and statistical methods (WDEQ 2012), and the New Mexico Mining and Minerals Division (MMD) Coal Mine Reclamation Program guidelines (MMD 1999). Additional resources include Evaluation and Comparison of Hypothesis Testing Techniques for Bond Release Applications (McDonald et al. 2003), which was the basis of the WDEQ handbook, and other sources referenced herein. More specifically, Figure 6.5-1 and Appendix 6.5-B of the Permit guide the statistical approach in determining vegetation success for total ground cover, perennial vegetation cover, annual forage production, and shrub density. The statistical analyses applied to the O-VMU-3 vegetation data are presented in Appendix C including equations for vegetation data analysis, vegetation attribute data with descriptive statistics, the statistical analyses comparing these attributes to the revegetation success standards, the statistical model, and descriptive statistics and normality for the vegetation attributes.

Descriptive statistics and statistical adequacy are presented for total ground cover, perennial vegetation cover, annual forage production, and shrub density in Tables 3 and C-2. Vegetation attribute data (Table C-2) was evaluated with the Shapiro-Wilk test to determine if data are normally distributed (Figures C-2 to C-6). For normally distributed data, statistical adequacy was assessed (Snedecor and Cochran 1967). Hypothesis testing

for normal data that met sample adequacy was conducted using a one-sample, one-sided t-test under the classical null hypothesis. A one-sample, one-sided t-test using the reverse null hypothesis was applied for normally distributed data which failed to meet statistical adequacy. A non-parametric one-sample, one-sided sign test using the reverse null hypothesis was applied to data that was not normally distributed and did not meet sample adequacy. While transformed data was not used in hypothesis testing for satisfying standards, as a supplemental analyses, non-normal data were log-transformed. If the transformed data resulted in a normal distribution, one of the t-tests previously described was performed depending on sample adequacy. If transformed data were also non-normal, data were analyzed using the non-parametric one-sample, one-sided sign test using the reverse null hypothesis on the non-transformed data.

The following presents the statistical approach in more detail. Descriptive statistics and statistical tests were performed using both Microsoft® Excel and R-Studio (version 4.2.2).

### 2.6.1 Normality and Statistical Adequacy

The normality of each dataset was first assessed using the Shapiro-Wilk test to determine the appropriate hypothesis test method (i.e., parametric versus non-parametric). The Shapiro-Wilk null hypothesis is that the samples (of size n) come from a normal distribution. Data were considered normal when the test statistic had a p-value > 0.10 for alpha (α) = 0.10.

The number of samples required to characterize a particular vegetation attribute depends on the uniformity of the vegetation and the desired degree of certainty required for the analysis. The number of samples necessary to meet sample adequacy ($N_{min}$) was calculated assuming the data were normally distributed using Snedecor and Cochran (1967) equation below.

$$N_{min} = \frac{t^2 s^2}{(\overline{x}D)^2}$$

Where $N_{min}$ equals the minimum number of samples required, $t$ is the two-tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom, $s$ is the standard deviation of the sample data, $\overline{x}$ is the mean, and $D$ is the desired level of accuracy, which is 10 percent of the mean in this case.

In addition to $N_{min}$, the standard deviation and the 90% confidence interval (CI) about the sample means are reported in Table 3.

It is often impractical to achieve sample adequacy in vegetation monitoring studies based on Snedecor and Cochran's equation listed above. In such cases, the Permit allows a maximum sample number approach to compare the data regardless of the distribution (WDEQ 2012, MMD 1999). Where sample adequacy cannot be met because of operational constraints or for other reasons, 40 samples is considered adequate as stated in the Permit. The 40-sample maximum is based on an estimate of the number of samples needed for a t-test under a normal distribution (Sokal and Rohlf 1981). Schulz et al. (1961) demonstrated that 30 to 40 samples provide a robust estimate for most cover and density measures with increased numbers of samples only slightly improving the precision of the estimate.

The maximum 40 samples were collected at the outset of sampling based on the guidance discussed above. Each transect is considered a unique sampling unit. Sample adequacy was calculated to determine the number of samples that would have been required for adequacy by the Snedecor and Cochran equation. Further analysis for

sample adequacy of cover, production and density attributes was also demonstrated using a graphical stabilization of the mean method (Clark 2001).

### 2.6.2 Hypothesis Testing

The emphasis on statistical adequacy assumes that parametric tests of normally distributed data will be conducted to demonstrate compliance with the vegetation success standards. Thus, if statistical adequacy is met for normally distributed data, the data would be analyzed with a one-sample, one-sided t-test using the classical null hypothesis. Non-parametric hypothesis tests have sufficient power to analyze data that are not normally distributed. Thus, if data is not-normal then it is permissible based on the Permit and technically appropriate to use one-sample, one-sided sign test using the reverse null approach as encouraged by OSMRE.

Hypothesis testing used to demonstrate compliance with the vegetation success standards for total ground cover, perennial vegetation cover, annual forage production, and shrub density were structured as follows (in accordance with Appendix 6.5-B of the Permit):

Classical Null Hypothesis:

$H_0$: Reclaim ≥ 90% of the Performance Standard

$H_a$: Reclaim < 90% of the Performance Standard

Where $H_0$ is the null hypothesis, and $H_a$ is the alternative hypothesis.

The one-sample, one-sided t-test using the classical null hypothesis decision rules based on the test statistic are:

If $t^* \geq t_{(\alpha; n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha; n-1)}$, conclude failure to meet the performance standard.

Test Statistic:

$$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

Where t* is the calculated t-statistic, $\bar{x}$ is the sample mean, s is the standard deviation, n is the sample size, and α = 0.10.

Reverse Null Hypothesis:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

One-sample, one-sided sign test using the reverse null hypothesis decision rules are:

If P < 0.10 or $z < z_\alpha$ (for α = 0.10, $z_\alpha$ = -1.282), conclude that the performance standard was met (i.e., $H_o$ is rejected, the revegetation values tend to be statistically greater than 90% of the technical standard).

If P ≥ 0.10 or z ≥ $z_\alpha$ (α = 0.10, $z_\alpha$ = -1.282), conclude failure to meet the performance standard (i.e., $H_o$ is NOT rejected, the revegetation values tend to be statistically less than or equal to 90% of the technical standard).

The z critical values of the normal distribution can be found in WDEQ, Table 1(2012)

Sign Test Statistic:

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

Where z is the sign test statistic (Daniel 1990), k is the test statistic resulting from the number of measurements that were less than 90% of the technical standard, and n is the sample size.

All hypothesis tests were performed with a 90% level of confidence. Hypothesis testing was not conducted for parameters where the mean or median did not exceed the minimum permit requirements.

# 3.0 RESULTS

The vegetation in O-VMU-3 is well established and dominated by perennial plants and the vegetation community achieved full compliance with the vegetation success standards in 2023. Table 3 summarizes the results for total ground cover, perennial vegetation cover, annual forage production and woody plant density (shrub density) along with their corresponding technical standard.

Field data for LPI foliar cover, quadrat canopy cover, annual forage production and shrub density by the belt transect are included in Appendix A (Tables A1-A7). Photographs of the individual production quadrats are included in Appendix B and a representative photograph of the vegetation and topography is shown in Figure 5.

Table 4 summarizes the attributes for plants recorded in the LPI transects and production quadrats and Table A-7 summarizes all species observed within belt and quadrat surveys as well as those recorded opportunistically between survey areas during monitoring. Recruitment of additional native plant species is indicative of ecological succession and the capacity of the site to support a self-sustaining ecosystem.

Field data results and statistics are discussed by parameter in the sections that follow.

## 3.1 Total Ground and Perennial Vegetation Cover

Total ground cover exceeded the revegetation success standard and met the required statistical demonstration. Total ground cover based on first hit LPI data in O-VMU-3 in 2023 had a mean of 59.4 ± 3.0% and a median of 62% (Table 3), exceeding the revegetation success standard. This was composed of live vegetation cover (42.4 ± 2.7%) and litter cover (17.0 ± 1.9%). Live vegetation foliar cover in individual transects ranged from 11 to 32 hits (22 to 64% cover) and litter cover ranged from 0 to 17 hits (0 to 34% cover) calculated from first hit LPI data (Table A-1).

Perennial vegetation cover, based on first hit LPI data, was calculated by summing the perennial and biennial species vegetation cover of the sampling unit excluding annuals and noxious weeds. The average perennial cover was 37.1 ± 3.2% and the median cover was 38% (Table 3), exceeding the revegetation success standard. Perennial vegetation cover in the individual transects varied from 8 to 32 hits (16 to 64% cover) (Table A-1). For quadrat cover data (not used in evaluating standards), the mean total vegetation canopy cover was 28.8%, ranging from 1 to 87% among individual quadrats (Table A-4).

For O-VMU-3, total ground cover data were not normally distributed but perennial vegetation cover data was normally distributed (Figures C-1 and C-2 respectively). Sample adequacy, estimated using the Snedecor and Cochran (1967) equation, was 11 samples for total ground cover and 31 samples for perennial vegetation cover, the minimum sample sizes needed to meet sample adequacy ($N_{min}$) at the 90% confidence level (Table 3). Both met sample adequacy with a sample size of 40.

Total ground cover data were not normally distributed (Figure C-1), so the one-sample, one-sided sign test with the reverse null hypothesis was used to test the mean against 90% of the technical standard of 52%. Of the 40 transects, 33 exceeded 90% of the technical standard (Table C-3) resulting in a probability (P) of 0.00004 of observing a z-value less than -3.95. Therefore, under the reverse null hypothesis we conclude that the total ground cover performance standard was met in 2023.

Perennial vegetation cover data were normally distributed and met sample adequacy, so data were statistically analyzed using a one-sample, one-sided t-test using the classical null hypothesis. The resulting t*-statistic for perennial vegetation cover was 8.061, with a sample mean of 37.1%, a standard deviation of 12.2%, measured against a one-tail $t_{(0.1, 39)}$ value of -1.304. So, under the classical null hypothesis ($t^* \geq t_{(\alpha; n-1)}$), we conclude that the performance standard of 24% perennial vegetation cover was met (Table C-4).

## 3.2 Production

Forage production exceeded the revegetation success standard and met the required statistical demonstration. Forage production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. Annual forage production in O-VMU-3 in 2023 was 816 ± 123 lbs/ac (median of 708 lbs/ac) (Table 3). Annual forage production in individual transects ranged from 142 to 1,953 pounds per acre (Table A-5). Perennial grasses (18 species) contributed the most forage with 604 lbs/ac, while shrubs (seven species) contributed 188 lbs/ac and ten perennial forbs contributed 24 lbs/ac (Table 4).

Annual forage production data for O-VMU-3 were not normally distributed (Figure C-3), though the log-transformed values were (Figure C-5). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for annual forage production was 96 samples (Table 3). Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean method (Clark 2001) with 90% CI (Figure 6). While the mean mostly increases with increasing sample numbers, the confidence levels show little change after sixteen samples. The analysis suggests that improvements in variability around the mean would likely not have improved with additional samples beyond the 40 samples collected for annual forage production.

The one-sample, one-sided sign test with the reverse null hypothesis was used to test the mean against 90% of the technical standard of 550 lbs/ac. Of the 40 transects, 30 exceeded 90% of the technical standard (Table C-5) resulting in a probability (P) of 0.001 of observing a z-value less than -3.00. Therefore, under the reverse null hypothesis we conclude that the annual forage production performance standard is met in 2023.

## 3.3 Shrub Density

Shrub density exceeded the revegetation success standard and met the required statistical demonstration. In 2023 shrub density in O-VMU-3 substantially exceeded the vegetation success standard of 400 stems/ac from belt transect data with an average of 1,911 ± 273 stems/ac and a median of 1,639 stems/ac (Table 3). Eighteen woody plant species were encountered in the belt and LPI transect sampling. Fourwing saltbush (*Atriplex canescens*) was the most common shrub encountered in both methods (Tables 5, A-1 and A-4).

The shrub density data for O-VMU-3 were not normally distributed (Figure C-4) but the log transformed data were normal (Figure C-6). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for shrub density was 86 samples (Table 3). Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean method (Clark 2001) showing 90% CI (Figure 7). The mean remains stable from four samples onward, and the 90% CI shows very little change after 24 samples. This analysis suggests that 40 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of shrub density.

The one-sample, one-sided sign test with the reverse null hypothesis was used to test the mean against the 90% of the technical standard of 400 stems per acre. Of the 40 transects, 39 exceeded 90% of the technical standard (Table C-6) resulting in a probability (P) of <0.001 of observing a z-value less than -5.85. Therefore, under the reverse null hypothesis we conclude that the woody plant density performance standard is met in 2023.

## 3.4 Composition and Diversity

In 2023, the standards were met for all of the individual diversity standards in O-VMU-3 (Table 6a). The revegetation diversity standards are based on a “lifeform statement” for grasses, forbs, and shrubs (Table 1) that consists of 12 individual parameters. The results for composition and diversity are discussed below by parameter. Relative perennial values of individual species and functional groups are calculated relative to the total perennial vegetation cover of 37.1% reported in Section 3.1. This data is calculated from all-hit LPI data (Table A-2). Relative perennial vegetation cover of individual species is listed in Table 4.

Grasses dominated the perennial vegetation cover with James’ galleta (*Pleuraphis jamesii*) representing the highest cover of the warm-season grasses by far (Table 4). Cool-season grasses also dominated the vegetation reflecting the past seed mixes, season of seeding, and the site’s continued ability to support a diverse group of cool-season grasses. Western wheatgrass (*Pascopyrum smithii*) and crested wheatgrass (*Agropyron cristatum*) represented the highest cover of the cool-season grasses. Shrubs are important components of the reclamation due to their persistence and tolerance to harsh conditions. The woody plant component is dominated primarily by fourwing saltbush, with rubber rabbitbrush (*Ericameria nauseosa*) and broom snakeweed (*Gutierrezia sarothrae*) subdominant. Perennial forb species occurred on the LPI transects, though they are minor contributors to vegetation cover, accounting for 1.6% absolute vegetation cover with scarlet globemallow (*Sphaeralcea coccinea*) contributing the highest cover.

The perennial grass diversity standard requires a total absolute vegetation cover of at least 7%, which was achieved in 2023 with 26.5%. The diversity standard for cool-season perennial grasses was achieved with 11 total species, and two species that represent at least 5 and 2.5% relative perennial vegetation cover (western wheatgrass [17.8%] and crested wheatgrass [6.4%]). The diversity standard for warm-season grasses is achieved with five total species, one species representing at least 5% (James’ galleta [22.1%]) and all remaining species representing over 1.5% relative perennial vegetation cover at 4.9%.

The perennial forb diversity standard requires at least three perennial/biennial forbs (not including noxious weeds) combining to at least 1% relative perennial vegetation cover (calculated based on the percent foliar cover of perennial species excluding annuals and noxious weeds). This standard was achieved in 2023 with 11 species totaling 4.1% relative perennial vegetation cover with the greatest contributions from scarlet globemallow (1.7 %), curlycup gumweed (0.9%, *Grindelia squarrosa*), and flatspine stickseed (0.4%, *Lappula occidentalis*).

The diversity standard for shrubs requires the relative perennial vegetation cover for all shrub species to total at least 6% with no single shrub exceeding or equal to 70% relative shrub density. Both of these standards were

achieved with 19.2% relative perennial vegetation cover of all shrubs and 69.7% relative shrub density of fourwing saltbush – the most dominant shrub.

Lastly, the diversity standards require that no single species of any functional group represent greater than 40% relative total vegetative cover. Relative total vegetative here is defined as the percent foliar cover of any recorded species divided by the total foliar cover for all live vegetation of the sampling unit, including annuals and noxious weeds. James' galleta represented the highest relative total vegetation cover at 19.2%, thus the reclamation achieved the single species diversity standard.

From 2019 through 2023, 148 plant species have been observed within reclaimed areas in O-VMU-3 including 33 grasses, 75 forbs, and 40 shrubs, trees, and cacti (Table A-7). Of the 33 grasses,19 are cool-season perennials, three are cool-season annuals, nine are warm-season perennials and two are warm-season annuals. Of the 75 forbs, 28 are annuals and the remaining 47 are perennials and/or biennials. Cacti (four species), succulents (two species), and trees (five species) were rare on the reclamation but provide diverse habitat or browse for wildlife. Shrubs and subshrubs were the most common woody plants observed (29 species). The recruitment of native plants and establishment of seeded species within is indicative of ecological succession and the capacity of the site to support a diverse and self-sustaining ecosystem.

Multi-hit LPI data provide an opportunity to investigate faciliatory relationships among plants (Table A-3). This summary suggests that fourwing saltbush is a common upper canopy species in O-VMU-3, most commonly harboring western wheatgrass and James' galleta in its understory. While these grass species are common outside of shrub canopies as well, cheatgrass (*Bromus tectorum*), a noxious weed, was hit five times beneath fourwing saltbush, one third of its total hits. This suggests that encroachment of this species may be aided by the presence of fourwing saltbush or other shrubs. Associations such as this may be informative in future management activities.

## 3.5 Noxious Weeds

During the 2023 monitoring program, Class C noxious weeds (NMDA 2020) were rarely encountered in O-VMU-3. Class C noxious weeds are generally widespread in the state and managed at the local level based on feasibility of control and level of infestation. Cheatgrass was encountered infrequently in LPI surveys and production quadrats. Noxious weeds are not used in the assessment of revegetation success but are included in the single species cover standard (Table 1). Noxious trees observed on O-VMU-3 in past years include saltcedar (*Tamarix ramosissima*) and Siberian elm (*Ulmus pumila*) but their presence in the reclaimed vegetation community is insignificant with densities much lower than native rangeland beyond the permit boundary. CMI continues to monitor for noxious weeds and actively controls them through husbandry practices that include annual services for weed management. Further, competition from desirable seeded and native species is expected to inhibit any substantial increase of noxious weeds in the reclamation.

# 4.0 SUMMARY

McKinley Mine's vegetation success standards for the post-mining land uses of grazing and wildlife are based on total ground cover, perennial vegetation cover, annual forage production, shrub density, and diversity. The technical standards (Table 1) were developed through negotiations with OSMRE based on the analysis of historical vegetation data, interpretation of the ecological site potential, and the anticipated post-mining land uses. The vegetation monitoring results for the past five years indicate that the vegetation community in O-VMU-3 is progressing well having met the shrub density standard in every year and the total ground cover and perennial vegetation cover standards in all but one year (Table 3). A summary of the findings from the past five years are:

1. Vegetation Cover: The total ground cover standard and perennial vegetation cover standard have been met every year except 2021, a year following two years of below normal growing season precipitation.
2. Forage Production: In 2020 and 2021, O-VMU-3 only received 30% and 76% of normal growing season precipitation, respectively, that led to a significant decline in forage production. In 2022, with above normal precipitation, average forage production recovered, and the average was well above the performance standard, but variability among samples was high. As such, hypothesis testing could not demonstrate the standard was met. In 2023, average annual forage production both exceeded the performance standard and passed hypothesis testing with reduced variability compared to 2022. Improved field methodology likely aided in reducing variability and enhanced the ability of the data to accurately capture the inherent variation in the landscape while achieving the performance standard.
3. Shrub Density: O-VMU-3 has exceeded the success parameters for shrub density in all five monitoring years.
4. Diversity: All plant diversity standards were met in 2019, 2022, and 2023. In 2021 fourwing saltbush comprised more than 70% relative shrub cover (based on the LPI method). In 2023, relative shrub density derived from belt transect data were used to evaluate this standard instead of LPI relative shrub cover, a change which more accurately represents the shrub community and reduces bias towards larger canopied shrubs. In 2020 and 2021, years that received below average precipitation, grass standards were not met by small margins.

Overall, vegetation performance in O-VMU-3 over the past five years is encouraging considering below-average precipitation for four of the past five years including the exceptional drought in 2020 and 2021. The performance of the vegetation under these conditions suggests that the reclaimed plant communities are resilient and capable of sustaining themselves under adverse conditions that are characteristic of this region. The reclamation in O-VMU-3 has demonstrated the capability of meeting and sustaining the post-mining land use.

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# Tables

## Table 1: Revegetation Success Standards in the McKinley Mine OSMRE Permit

| Vegetative Parameter | Components | | Success Standards | |
|---|---|---|---|---|
| | | | 2019-2022 | 2023 |
| Cover | Total Ground Cover | | ≥ 52% | ≥ 52% |
| | Perennial Vegetation Cover | | ≥ 24% | ≥ 24% |
| Diversity "Lifeform Statement" | Perennial Grasses | All Grasses | ≥ 7% absolute cover | ≥ 7% absolute cover |
| | | Cool-Season | ≥ 2 species, each ≥ 1.5% cover | ≥ 2 species, **1st species ≥ 5% relative perennial cover, 2nd species ≥ 2.5% relative perennial cover** |
| | | Warm-Season | ≥ 2% contribution, ≥ 2 species, each ≥ 0.5% cover | ≥ 2 species, **1st species ≥ 5% relative perennial cover, all other species combined ≥ 1.5% relative perennial cover** |
| | Perennial Forbs | | ≥ 3 species, combining for ≥ 1% relative | ≥ 3 species, combining for ≥ 1% relative perennial cove |
| | Shrubs | All Shrubs | ≥ 3% absolute cover | **≥ 6% relative total perennial cover** |
| | | Any Single Species | ≤ 70% relative total shrub cover | ≤ 70% relative total **shrub density** |
| | Any Single Species (including weeds) | | ≤ 40% relative total vegetative cover | ≤ 40% relative total vegetative cover |
| Production | Pounds/acre (air dry) | | ≥ 550 lbs/ac | ≥ 550 lbs/ac |
| Woody Plant Density | Stems/acre | | ≥ 400/acre | ≥ 400/acre |

Notes:
Success for cover, production, and stocking shall be ≥ 90% of the standard in accordance with 30 CFR 816.116 (a)(2).
Total ground cover does not include noxious weeds.
Perennial vegetation cover is foliar cover from LPI, not including annuals and noxious weeds.
Relative cover is the percent cover of a species or functional group divided by the total vegetation cover including annuals and noxious weeds.
Relative perennial cover is the total cover of a perennial species or perennial functional group divided by the total perennial cover (see below).
Total perennial cover includes shrubs, cactus, trees, perennial grasses and perennial forbs not including noxious species.
Relative total shrub density is the density of each woody species divided by the total woody plant density not including noxious weeds.
Production includes above-ground biomass of forage species only.
Bolded standards are those that changed in 2023

## Table 2: North Mine Seasonal and Annual Precipitation, 2015-2023

| Year | Station | Area | Precipitation (inches) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | January | February | March | April | May | June | July | August | September | October | November | December | Annual Total | Growing Season Total |
| 2015 | Rain Bluff | North Shop | 1.39 | 1.21 | 0.11 | 0.35 | 1.54 | 1.15 | 2.81 | 1.91 | 0.51 | 1.18 | 1.16 | 0.74 | 14.06 | *8.27* |
| | Rain 2 | 2 | NA | NA | NA | 0.52 | 1.51 | 1.98 | 3.17 | 1.39 | 0.50 | 1.08 | 0.92 | NA | NA | *9.07* |
| | Rain 3 | 3 | NA | NA | NA | 0.57 | 1.80 | 1.77 | 3.61 | 3.06 | 0.44 | 1.36 | 0.86 | NA | NA | *11.25* |
| | Rain 6 | 6 | NA | NA | NA | 0.54 | 0.71 | 2.12 | 2.66 | 2.12 | 0.00 | 0.92 | 0.70 | NA | NA | *8.15* |
| | Rain 10 | 10 | NA | NA | NA | 0.42 | 1.32 | 1.11 | 2.59 | 1.39 | 0.30 | 1.10 | 0.78 | NA | NA | *7.13* |
| | Rain 12 | 12 | NA | NA | NA | 0.49 | 1.59 | 1.39 | 2.88 | 2.14 | 0.47 | 1.17 | 1.29 | NA | NA | *8.96* |
| | Rain 15 | 15 | NA | NA | NA | 0.46 | 1.90 | 1.62 | 3.17 | 2.88 | 0.32 | 0.94 | 0.69 | NA | NA | *10.35* |
| 2016 | Rain Bluff | North Shop | 0.39 | 0.25 | 0.03 | 1.28 | 0.70 | 0.19 | 1.15 | 1.85 | 1.79 | 0.69 | 1.18 | 1.98 | 11.48 | *6.96* |
| | Rain 2 | 2 | NA | NA | NA | 0.17 | 0.58 | 0.14 | 2.22 | 0.71 | 0.87 | 0.21 | 0.02 | NA | NA | *4.69* |
| | Rain 3 | 3 | NA | NA | NA | 0.20 | 0.72 | 0.45 | 1.62 | 0.11 | 0.50 | 0.33 | 0.02 | NA | NA | *3.60* |
| | Rain 6 | 6 | NA | NA | NA | 0.20 | 0.75 | 0.29 | 2.00 | 0.40 | 1.19 | 0.19 | 0.02 | NA | NA | *4.83* |
| | Rain 10 | 10 | NA | NA | NA | 0.13 | 0.55 | 0.20 | 2.75 | 0.38 | 0.99 | 0.14 | 0.02 | NA | NA | *5.00* |
| | Rain 12 | 12 | NA | NA | NA | 0.30 | 0.78 | 0.36 | 1.34 | 0.49 | 1.16 | 0.18 | 0.05 | NA | NA | *4.43* |
| | Rain 15 | 15 | NA | NA | NA | 0.31 | 0.85 | 0.04 | 1.95 | 0.35 | 1.31 | 0.18 | 0.05 | NA | NA | *4.81* |
| 2017 | Rain Bluff | North Shop | 0.81 | 0.04 | 0.70 | 0.32 | 0.41 | 0.16 | 3.71 | 0.37 | 0.62 | 0.54 | 0.05 | 0.02 | 7.75 | *5.59* |
| | Rain 2 | 2 | NA | NA | NA | 1.28 | 0.66 | 0.22 | 0.78 | 2.08 | 1.46 | 0.63 | 0.44 | NA | NA | *6.48* |
| | Rain 3 | 3 | NA | NA | NA | 1.04 | 1.16 | 0.06 | 0.99 | 2.71 | 1.63 | 0.56 | 0.44 | NA | NA | *7.59* |
| | Rain 6 | 6 | NA | NA | NA | 0.86 | 1.50 | 0.02 | 0.96 | 2.04 | 1.52 | 0.38 | 0.51 | NA | NA | *6.90* |
| | Rain 10 | 10 | NA | NA | NA | 1.00 | 0.67 | 0.08 | 0.94 | 1.63 | 1.36 | 0.34 | 0.81 | NA | NA | *5.68* |
| | Rain 12 | 12 | NA | NA | NA | 1.17 | 0.91 | 0.05 | 0.88 | 1.89 | 1.77 | 0.47 | 0.46 | NA | NA | *6.67* |
| | Rain 15 | 15 | NA | NA | NA | 1.15 | 1.36 | 0.02 | 0.68 | 1.91 | 1.56 | 0.40 | 0.41 | NA | NA | *6.68* |
| 2018 | Rain Bluff | North Shop | 0.23 | 0.48 | 0.44 | 0.08 | 0.22 | 0.28 | 2.17 | 0.00 | 1.00 | 1.51 | 0.14 | 0.43 | 6.98 | *3.75* |
| | Rain 2 | 2 | NA | NA | NA | 0.06 | 0.26 | 0.30 | 1.10 | 0.90 | 1.40 | 1.48 | 0.00 | NA | NA | *4.02* |
| | Rain 3 | 3 | NA | NA | NA | 0.04 | 0.30 | 0.35 | 0.92 | 0.91 | 1.27 | 1.69 | 0.00 | NA | NA | *3.79* |
| | Rain 6 | 6 | NA | NA | NA | 0.03 | 0.21 | 0.46 | 0.97 | 0.56 | 1.02 | 1.45 | 0.00 | NA | NA | *3.25* |
| | Rain 10 | 10 | NA | NA | NA | 0.08 | 0.20 | 0.27 | 3.05 | 1.15 | 0.92 | 1.51 | 0.00 | NA | NA | *5.67* |
| | Rain 12 | 12 | NA | NA | NA | 0.06 | 0.37 | 0.26 | 1.08 | 1.36 | 1.09 | 1.54 | 0.00 | NA | NA | *4.22* |
| | Rain 15 | 15 | NA | NA | NA | 0.05 | 0.32 | 0.28 | 1.16 | 0.63 | 1.31 | 1.31 | 0.00 | NA | NA | *3.75* |
| 2019 | Rain Bluff | North Shop | 0.95 | 0.98 | 1.10 | 0.24 | 0.17 | 0.03 | 0.03 | 1.14 | 0.10 | 0.04 | 1.15 | 0.97 | 6.90 | *1.71* |
| | Rain 2 | 2 | NA | NA | NA | 0.22 | 1.41 | 0.15 | 0.35 | 0.73 | 1.35 | 0.04 | 0.05 | NA | NA | *4.21* |
| | Rain 3 | 3 | NA | NA | NA | 0.39 | 1.50 | 0.32 | 0.70 | 0.11 | 1.72 | 0.06 | 0.06 | NA | NA | *4.74* |
| | Rain 6 | 6 | NA | NA | NA | 0.36 | 1.20 | 0.00 | 0.01 | 0.34 | 1.82 | 0.04 | 0.03 | NA | NA | *3.73* |
| | Rain 10 | 10 | NA | NA | NA | 0.20 | 1.49 | 0.37 | 0.19 | 0.27 | 1.34 | 0.03 | 0.05 | NA | NA | *3.86* |
| | Rain 12 | 12 | NA | NA | NA | 0.20 | 1.59 | 0.28 | 0.35 | 0.14 | 1.38 | 0.07 | 0.04 | NA | NA | *3.94* |
| | Rain 15 | 15 | NA | NA | NA | 0.22 | 1.17 | 0.14 | 0.78 | 0.15 | 1.60 | 0.05 | 0.05 | NA | NA | *4.06* |
| 2020 | Rain Bluff | North Shop | 1.00 | 1.35 | 1.15 | 0.26 | 0.02 | 0.14 | 0.89 | 0.26 | 0.21 | 0.33 | 0.28 | 0.32 | 6.21 | *1.78* |
| | Rain 2 | 2 | NA | NA | NA | 0.26 | 0.09 | 0.05 | 1.65 | 0.20 | 0.17 | 0.31 | 0.16 | NA | NA | *2.42* |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.01 | 0.05 | 1.06 | 0.62 | 0.16 | 0.27 | 0.19 | NA | NA | *1.90* |
| | Rain 6 | 6 | NA | NA | NA | 0.05 | 0.02 | 0.02 | 0.82 | 0.55 | 0.14 | 0.08 | 0.16 | NA | NA | *1.60* |
| | Rain 10 | 10 | NA | NA | NA | 0.11 | 0.02 | 0.13 | 0.79 | 0.14 | 0.14 | 0.16 | 0.09 | NA | NA | *1.33* |
| | Rain 12 | 12 | NA | NA | NA | 0.25 | 0.08 | 0.06 | 0.97 | 0.47 | 0.35 | 0.29 | 0.28 | NA | NA | *2.18* |
| | Rain 15 | 15 | NA | NA | NA | 0.32 | 0.01 | 0.05 | 0.65 | 0.87 | 0.28 | 0.09 | 0.44 | NA | NA | *2.18* |
| 2021 | Rain Bluff | North Shop | 1.13 | 0.21 | 0.46 | 0.04 | 0.04 | 0.20 | 2.17 | 1.31 | 1.13 | 0.86 | 0.20 | 0.92 | 8.67 | *4.89* |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.03 | 0.16 | 0.99 | 1.09 | 1.04 | 0.93 | 0.00 | NA | NA | *3.31* |
| | Rain 3 | 3 | NA | NA | NA | 0.03 | 0.09 | 0.05 | 0.69 | 1.04 | 1.64 | 1.16 | 0.00 | NA | NA | *3.54* |
| | Rain 6 | 6 | NA | NA | NA | 0.02 | 0.06 | 0.03 | 0.83 | 0.19 | 0.47 | 1.05 | 0.00 | NA | NA | *1.60* |
| | Rain 10 | 10 | NA | NA | NA | 0.01 | 0.06 | 0.24 | 2.48 | 1.80 | 0.96 | 0.80 | 0.00 | NA | NA | *5.55* |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.08 | 0.22 | 1.58 | 2.08 | 1.24 | 1.01 | 0.00 | NA | NA | *5.20* |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.07 | 0.05 | 1.04 | 2.58 | 1.47 | 1.00 | 0.00 | NA | NA | *5.21* |
| 2022 | Rain Bluff | North Shop | -- | -- | 0.59 | 0.03 | 0.00 | 1.24 | 3.13 | 4.66 | 1.27 | 1.40 | 0.48 | 0.58 | 13.38 | *10.33* |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 3.00 | 3.77 | 1.22 | 1.14 | 0.39 | NA | NA | *9.02* |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 2.99 | 3.07 | 1.18 | 1.19 | 0.54 | NA | NA | *8.27* |
| | Rain 6 | 6 | NA | NA | NA | 0.01 | 0.00 | 0.66 | 2.55 | 3.05 | 0.69 | 0.28 | 0.47 | NA | NA | *6.96* |
| | Rain 10 | 10 | NA | NA | NA | 0.00 | 0.00 | 0.69 | 3.57 | 4.27 | 1.02 | 1.83 | 0.33 | NA | NA | *9.55* |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.00 | 0.91 | 3.76 | 4.07 | 1.08 | 1.57 | 0.52 | NA | NA | *9.82* |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.01 | 0.91 | 4.06 | 3.84 | 1.12 | 1.68 | 0.50 | NA | NA | *9.94* |
| 2023 | Rain Bluff | North Shop | 1.21 | 0.50 | 1.64 | 0.05 | 0.55 | 0.13 | 0.03 | 3.16 | 0.33 | 0.57 | 0.42 | NA | 8.59 | *4.25* |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.48 | 0.09 | 0.08 | 3.08 | 0.44 | 0.09 | 0.09 | NA | NA | *4.17* |
| | Rain 3 | 3 | NA | NA | NA | 0.01 | 0.84 | 0.22 | 0.26 | 2.93 | 0.54 | 0.08 | 0.08 | NA | NA | *4.80* |
| | Rain 6 | 6 | NA | NA | NA | 0.00 | 1.49 | 0.22 | 0.07 | 1.97 | 0.49 | 0.05 | 0.00 | NA | NA | *4.24* |
| | Rain 10 | 10 | NA | NA | NA | 0.03 | 0.53 | 0.13 | 0.06 | 2.61 | 0.51 | 0.03 | 0.00 | NA | NA | *3.87* |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.74 | 0.21 | 0.10 | 2.47 | 0.41 | 0.05 | 0.00 | NA | NA | *3.93* |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.79 | 0.21 | 0.43 | 2.67 | 0.56 | 0.05 | 0.00 | NA | NA | *4.66* |
| Window Rock, Long | | | 0.72 | 0.68 | 0.88 | 0.61 | 0.49 | 0.47 | 1.75 | 2.05 | 1.23 | 1.14 | 0.83 | 0.95 | 11.80 | *6.60* |

Notes:
Long-term averages are from Window Rock, Arizona Station (029410), 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season total precipitation is between April and September
NA=rain gauges taken offline due to freezing conditions, data unavailable.
-- Rain gauge malfunction
In 2017 Rain Bluff experienced power issues in the summer that may have resulted in inaccurate precipitation readings.
data incomplete

**Table 3: Summary Statistics, O-VMU-3, 2019-2023**

| | 2019 | 2020 | 2021 | 2022 | 2023 | Technical Standard |
|---|---|---|---|---|---|---|
| **Total Ground Cover (%)[1]** | | | | | | |
| Mean | 56.3 | 56.7 | 47.9 | 49.8 | 59.4 | ≥ 52% |
| Standard Deviatior | 10.8 | 10.3 | 13 | 11.9 | 11.4 | |
| 90% Confidence Interva | 2.7 | 2.7 | 3.4 | 3.1 | 3.0 | |
| Median | -- | 56 | 44 | 52 | 62 | |
| Nmin[2] | 10 | 9.3 | 19 | 17 | 11 | |
| **Live Vegetation Cover (%)[3]** | | | | | | |
| Mean | 37.4 | 32.2 | 21.5 | 35.9 | 42.4 | None |
| Standard Deviatior | 11.8 | 9.8 | 13 | 11.7 | 10.4 | |
| 90% Confidence Interva | 3 | 3 | 3 | 3.0 | 2.7 | |
| Nmin[2] | 28 | 26 | 104 | 31 | 17 | |
| **Litter Cover (%)** | | | | | | |
| Mean | 18.9 | 24.5 | 26.4 | 13.9 | 17.0 | None |
| Standard Deviatior | 7.3 | 7.8 | 7.5 | 7.1 | 7.1 | |
| 90% Confidence Interva | 1.9 | 2 | 3.4 | 1.9 | 1.9 | |
| Nmin[2] | 43 | 29 | 23 | 75 | 50 | |
| **Perennial Vegetation Cover (%)[4]** | | | | | | |
| Mean | 33 | 31.9 | 19.5 | 27.7 | 37.1 | ≥ 24% |
| Standard Deviatior | 12.5 | 10.1 | 11.6 | 12.8 | 12.2 | |
| 90% Confidence Interva | 3.2 | 2.6 | 3 | 3.3 | 3.2 | |
| Median | -- | 31 | 18 | 26 | 38 | |
| Nmin[2] | 41 | 29 | 100 | 61 | 31 | |
| **Annual Forage Production (lbs/ac)[5]** | | | | | | |
| Mean | 939 | 263 | 208 | 569 | 816 | ≥ 550 lbs/ac |
| Standard Deviatior | 1061 | 312 | 242 | 515 | 472 | |
| 90% Confidence Interva | 269 | 81 | 63 | 134 | 123 | |
| Median | -- | 156 | 132 | 509 | 708 | |
| Nmin[2] | 361 | 399 | 387 | 232 | 96 | |
| **Woody Plant Density (stems/acre) from Belt Transec** | | | | | | |
| Mean | 2,756 | 2,194 | 1,874 | 1,807 | 1,911 | ≥ 400/ac |
| Standard Deviatior | 1,825 | 1,347 | 1,404 | 866 | 1,049 | |
| 90% Confidence Interva | 463 | 350 | 365 | 228 | 273 | |
| Median | -- | 2,064 | 1,639 | 1,659 | 1,639 | |
| Nmin[2] | 124 | 107 | 159 | 65 | 86 | |

Notes:

[1] Mean foliar cover of live vegetation and litter

[2] Minimum number of samples to obtain 90% probability that the sample mean is within 10% of the population mean

[3] Mean vegetation foliar cover not including noxious weeds

[4] Mean foliar cover not including annuals and noxious weeds

[5] Annual forage production in air dry pounds per acre (lbs/ac) not including annuals or noxious weeds

Hypothesis testing found the success standard was not met

**Table 4: Average and Relative Foliar Cover and Production by Species, O-VMU-3, 2023**

| Scientific Name | Common Name | Code | Mean Vegetation Cover (% | | | | Mean Annual Production (lbs/ac) |
|---|---|---|---|---|---|---|---|
| | | | All Hit Foliar | First Hit Foliar | Relative Perennial[1] | Relative Total[2] | |
| **Cool-Season Grasses (13** | | | | | | | |
| **Annuals (1)** | | | | | | | |
| *Bromus tectorum* | Cheatgrass | BRTE | 0.70 | 0.45 | -- | 1.6 | NA |
| **Perennials (12)** | | | | | | | |
| *Achnatherum hymenoides* | Indian ricegrass | ACHY | 2.40 | 2.30 | 6.1 | 5.3 | 73.2 |
| *Agropyron cristatum* | Crested wheatgrass | AGCR | 2.50 | 2.30 | 6.4 | 5.5 | 55.9 |
| *Bromus inermis* | Smooth brome | BRIN2 | 0.90 | 0.80 | 2.3 | 2.0 | 13 |
| *Elymus elymoides* | Bottlebrush squirreltai | ELEL5 | 0.05 | 0.05 | 0.1 | 0.1 | 3.5 |
| *Elymus lanceolatus* | Thickspike wheatgrass | ELLA3 | 1.25 | 1.10 | 3.2 | 2.8 | 11.5 |
| *Elymus trachycaulus* | Slender wheatgrass | ELTR7 | 0.35 | 0.35 | 0.9 | 0.8 | 3.2 |
| *Hesperostipa comata* | Needle and threac | HECO26 | 1.65 | 1.60 | 4.2 | 3.7 | 21.6 |
| ***Koeleria macrantha*** | **Prairie Junegrass** | **KOMA** | **NA** | **NA** | **NA** | **NA** | **2.1** |
| *Pascopyrum smithii* | Western wheatgrass | PASM | 6.95 | 6.35 | 17.8 | 15.4 | 104.6 |
| *Psathyrostachys juncea* | Russian wildrye | PSJU3 | 1.00 | 1.00 | 2.6 | 2.2 | 35.1 |
| *Pseudoroegneria spicata* | Bluebunch wheatgrass | PSSP6 | 0.60 | 0.55 | 1.5 | 1.3 | 8.3 |
| *Thinopyrum intermedium* | Intermediate wheatgrass | THIN6 | 0.20 | 0.20 | 0.5 | 0.4 | 4.3 |
| **Warm-Season Grasses (6)** | | | | | | | |
| **Perennials (6)** | | | | | | | |
| *Bouteloua curtipendula* | Sideoats grama | BOCU | NA | NA | NA | NA | 0.8 |
| *Bouteloua dactyloides* | Buffalograss | BODA2 | 0.15 | 0.15 | 0.4 | 0.3 | 1.4 |
| *Bouteloua gracilis* | Blue grama | BOGR2 | 0.75 | 0.75 | 1.9 | 1.7 | 5.8 |
| *Pleuraphis jamesii* | James' galleta | PLJA | 8.65 | 8.10 | 22.1 | 19.2 | 244.3 |
| *Sporobolus airoides* | Alkali sacaton | SPAI | 0.45 | 0.45 | 1.2 | 1.0 | 7.7 |
| *Sporobolus cryptandrus* | Sand dropseec | SPCR | 0.55 | 0.45 | 1.4 | 1.2 | 7.5 |
| **Forbs (16)** | | | | | | | |
| **Annuals (3)** | | | | | | | |
| *Eriogonum divaricatum* | Divergent buckwheat | ERDI5 | 0.20 | 0.20 | -- | 0.4 | NA |
| *Portulaca oleracea* | Little hogweed | POOL | 0.15 | 0.15 | -- | 0.3 | NA |
| *Salsola tragus* | Prickly Russian thistle | SATR12 | 5.00 | 4.90 | -- | 11.1 | NA |
| **Perennials/Biennials (13)** | | | | | | | |
| *Bahia dissecta* | Ragleaf bahia | BADI | 0.05 | 0.05 | 0.1 | 0.1 | 3.0 |
| *Chaetopappa ericoides* | Rose heath | CHER2 | 0.05 | 0.05 | 0.1 | 0.1 | 1.6 |
| *Erigeron divergens* | Spreading fleabane | ERDI4 | 0.05 | 0.05 | 0.1 | 0.1 | 6.2 |
| ***Erigeron flagellaris*** | **Trailing fleabane** | **ERFL** | **NA** | **NA** | **NA** | **NA** | **<0.1** |
| *Grindelia squarrosa* | Curlycup gumweed | GRSQ | 0.35 | 0.35 | 0.9 | 0.8 | 0.4 |
| *Heliomeris multiflora* | Showy goldeneye | HEMU3 | 0.05 | 0.05 | 0.1 | 0.1 | 0.3 |
| *Lappula occidentalis* | Flatspine stickseed | LAOC3 | 0.15 | 0.15 | 0.4 | 0.3 | 0.7 |
| *Linum lewisii* | Lewis flax | LILE3 | NA | NA | NA | NA | <0.1 |
| *Machaeranthera canescens* | Hoary tansyaste | MACA2 | 0.10 | 0.10 | 0.3 | 0.2 | NA |
| *Melilotus officinalis* | Sweetclover | MEOF | 0.05 | 0.05 | 0.1 | 0.1 | NA |
| *Ratibida columnifera* | Upright prairie coneflowe | RACO3 | 0.05 | 0.05 | 0.1 | 0.1 | NA |
| *Sphaeralcea coccinea* | Scarlet globemallow | SPCO | 0.65 | 0.65 | 1.7 | 1.4 | 10.9 |
| ***Tragopogon pratensis*** | **Jack-go-to-bed-at-noor** | **TRPR** | **0.05** | **0.05** | **0.1** | **0.1** | **0.4** |

**Table 4: Average and Relative Foliar Cover and Production by Species, O-VMU-3, 2023**

| Scientific Name | Common Name | Code | Mean Vegetation Cover (% | | | | Mean Annual Production (lbs/ac) |
|---|---|---|---|---|---|---|---|
| | | | All Hit Foliar | First Hit Foliar | Relative Perennial[1] | Relative Total[2] | |
| **Shrubs, Trees, and Cacti (11)** | | | | | | | |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.10 | 0.10 | 0.3 | 0.2 | 0.1 |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 7.25 | 7.15 | 18.5 | 16.1 | 156.0 |
| *Atriplex confertifolia* | Shadscale saltbush | ATCO | NA | NA | NA | NA | 1.3 |
| *Atriplex corrugata* | Mat saltbush | ATCO4 | 0.10 | 0.10 | 0.3 | 0.2 | 2.3 |
| *Chrysothamnus greenei* | Greene's rabbitbrush | CHGR6 | 0.05 | 0.05 | 0.1 | 0.1 | NA |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 0.80 | 0.80 | 2.0 | 1.8 | 17.3 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 0.40 | 0.40 | 1.0 | 0.9 | 10.6 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 0.30 | 0.30 | 0.8 | 0.7 | NA |
| *Purshia mexicana* | Mexican cliffrose | PUME | NA | NA | NA | NA | 0.4 |
| *Sarcobatus vermiculatus* | Greasewood | SAVE4 | 0.10 | 0.10 | 0.3 | 0.2 | NA |
| **Cover Components** | | | | | | | |
| Total Ground Cover[3] | | | 59.4 | | | | |
| *Live Vegetation Foliar Cover* | | | 42.4 | | | | |
| *Perennial Vegetation Cover* | | | 37.1 | | | | |
| Rock | | | 6.5 | | | | |
| Litter | | | 17.1 | | | | |
| Bare Soil | | | 33.7 | | | | |

Notes:

[1] Relative % perennial/biennial foliar cover divided by mean foliar cover NOT including annuals and noxious weeds using all hits

[2] Relative % foliar cover for a species divided by the mean foliar cover for all live vegetation including noxious weeds using all hits

[3] % live vegetation foliar cover plus litter using first hits

Growing season for grasses from Allred (2005)

Plant duration from USDA Plants Database

NA = species captured in either LPI or quadrats but not both

"--" = annuals not included in relative perennial cover calculations

Bolded species are newly observed on O-VMU-3 in 2023

## Table 5: Relative Shrub, Tree, and Cacti Density, O-VMU-3, 2023

| Scientific Name | Common Name | Code | Relative Density (%) |
|---|---|---|---|
| *Artemisia frigida* | Prairie sagewor | ARFR4 | 0.16 |
| ***Artemisia nova*** | **Black sagebrush** | **ARNO4** | **0.05** |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.85 |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 69.67 |
| *Atriplex confertifolia* | Shadscale saltbush | ATCO | 0.48 |
| *Atriplex corrugata* | Mat saltbush | ATCO4 | 2.22 |
| *Atriplex gardneri* | Gardner's saltbush | ATGA | 0.05 |
| *Chrysothamnus greenei* | Greene's rabbitbrush | CHGR6 | 0.48 |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 5.56 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 13.71 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 4.71 |
| *Opuntia polyacantha* | Plains pricklypear | OPPO | 0.11 |
| *Opuntia* sp. | Pricklypear | OPUNT | 0.11 |
| *Purshia mexicana* | Mexican cliffrose | PUME | 0.32 |
| *Purshia tridentata* | Antelope bitterbrush | PUTR2 | 0.26 |
| *Sarcobatus vermiculatus* | Greasewood | SAVE4 | 1.11 |
| *Senecio flaccidus* | Threadleaf ragwor | SEFL3 | 0.11 |
| *Yucca baccata* | Banana yucca | YUBA | 0.05 |

Notes:
Relative density derived from belt method

Relative Density = (avg density per species per VMU ÷ avg total shrub density per VMU) * 100
Bolded species are newly observed on O-VMU-1 in 2023

**Table 6: Results for Diversity, O-VMU-3, 2023**

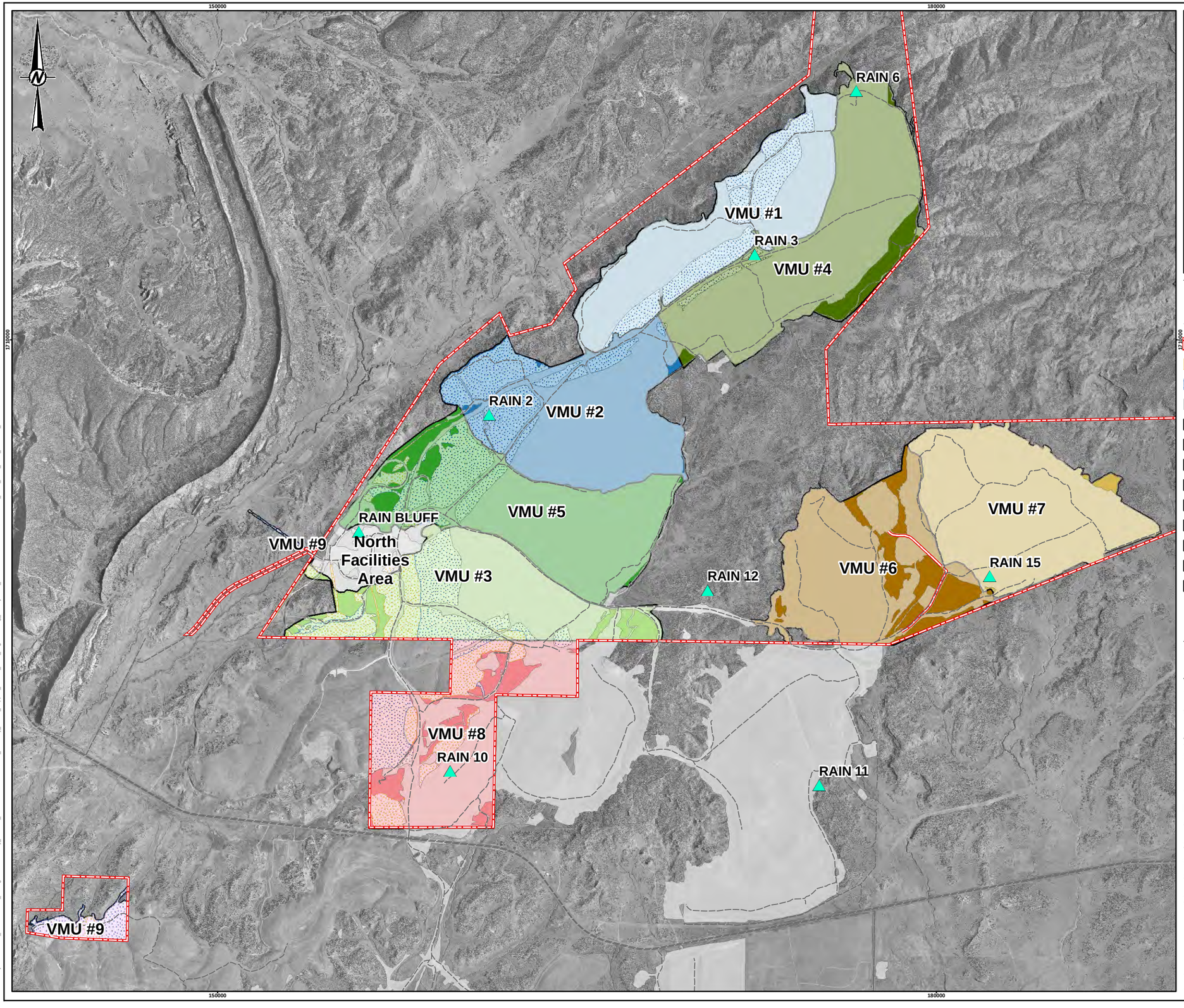
| Diversity Component | Metric | Standard | 2023 | |
|---|---|---|---|---|
| | | | Result | Species |
| **Perennial Grasses** | Absolute cover | ≥ 7% | 26.5% | -- |
| Cool-season Grasses | # Species | ≥ 2 | 11 | -- |
| Grass 1 | Relative perennial cove | ≥ 5% | 17.8% | Western wheatgrass |
| Grass 2 | Relative perennial cove | ≥ 2.5% | 6.4% | Crested wheatgrass |
| Warm-season Grasses | # Species | ≥ 2 | 5 | -- |
| Grass 1 | Relative perennial cove | ≥ 5% | 22.1% | James' galleta |
| All remaining species | Relative perennial cover | ≥ 1.5% | 4.9% | -- |
| **Perennial Forbs** | # Species | ≥3 | 11 | -- |
| | Relative perennial cover | ≥ 1% | 4.1% | -- |
| **Shrubs or Subshrubs** | Relative perennial cover | ≥ 6% | 23.3% | -- |
| Single Shrub Species | Relative shrub density | ≤ 70% | 69.7% | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 19.2% | James' galleta |

**Table 7: Results for Diversity, O-VMU-3, 2019-2022**

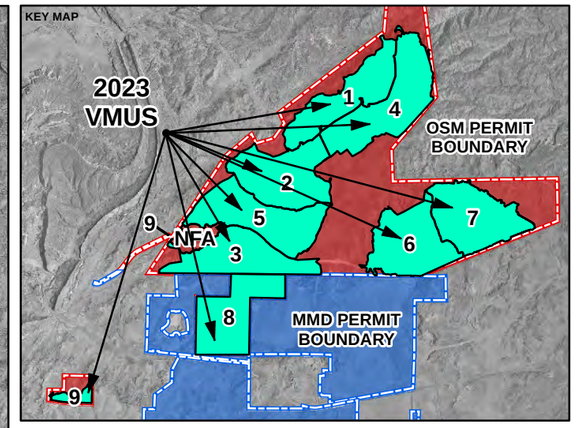
| Diversity Component | Metric | Standard | 2019 | | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Result | Species | Result | Species | Result | Species | Result | Species |
| **Perennial Grasses** | Total absolute cover | ≥ 7% | 20.7% | -- | 23.7% | -- | 11.4% | -- | 18.9% | -- |
| Cool-season Grasses | # Species | ≥ 2 | 11 | -- | 14 | -- | 10 | -- | 9 | -- |
| Grass 1 | Absolute cover | ≥ 1.5% | 6.2% | Western wheatgrass | 6.8% | Western wheatgrass | 2.6% | Western wheatgrass | 1.5% | Western wheatgrass |
| Grass 2 | Absolute cover | ≥ 1.5% | 3.8% | Thickspike wheatgrass | 2.8% | Bluebunchwheatgrass | 1.0% | Russian wildrye | 1.5% | Russian wildrye |
| Warm-season Grasses | # Species | ≥ 2 | 4 | -- | 4 | -- | 4 | -- | 5 | -- |
| | Total absolute cover | ≥ 2.0% | 2.7% | -- | 4.5% | -- | 5.2% | -- | 10.5% | -- |
| Grass 1 | Absolute cover | ≥ 0.5% | 2.1% | James' galleta | 3.8% | James' galleta | 3.9% | James galleta | 8.2% | James' galleta |
| Grass 2 | Absolute cover | ≥ 0.5% | 0.5% | Alkali sacaton | 0.4% | Blue grama | 0.5% | Blue grama | 1.7% | Blue grama |
| **Perennial Forbs** | # Species | ≥ 3 | 8 | -- | 4 | -- | 8 | -- | 7 | -- |
| | Relative perennial cover | ≥ 1% | 5.0% | -- | 1.1% | -- | 13.4% | -- | 4.2% | -- |
| **Shrubs or Subshrubs** | Total absolute cover | ≥ 3% | 10.4% | -- | 8.1% | -- | 5.5% | -- | 7.7% | -- |
| Single Shrub Species | Relative shrub cover | ≤ 70% | 67.9% | Fourwing saltbush | 55.1% | Fourwing saltbush | 78.5% | Fourwing saltbush | 68.8% | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 18.6% | Fourwing saltbush | 20.2% | Western wheatgrass | 20.0% | Fourwing saltbush | 22.8% | James' galleta |

Notes:
Diversity calculated in accordance with Table 1 in either absolute or relative % cover
Success standard was not met

# Figures




KEY MAP




LEGEND

- Rain Gauges
- Mine Site Roads
- OSM Permit Boundary
- Prelaw (~ 387 acres)
- Initial Program (~ 1,248 acres)
- Permanent Program (~ 11,327 acres)
- OSM VMU 1 (~ 934 acres)
- OSM VMU 2 (~ 1,085 acres)
- OSM VMU 3 (~ 959 acres)
- OSM VMU 4 (~ 1,242 acres)
- OSM VMU 5 (~ 1,129 acres)
- OSM VMU 6 (~ 1,024 acres)
- OSM VMU 7 (~ 1,045 acres)
- OSM VMU 8 (~ 953 acres)
- OSM VMU 9 (~ 96 acres)

0 4,000 8,000

1 inch = 4,000 feet FEET

**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT

CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT

MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2023 VEGETATION MONITORING

TITLE

**GENERAL OVERVIEW OF THE MCKINLEY OSMRE PERMIT AREA VEGETATION MANAGEMENT UNITS (VMU), 2023**

CONSULTANT

wsp

| | |
|---|---|
| YYYY-MM-DD | 2023-11-29 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MR |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | B003 | 0 | 1 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

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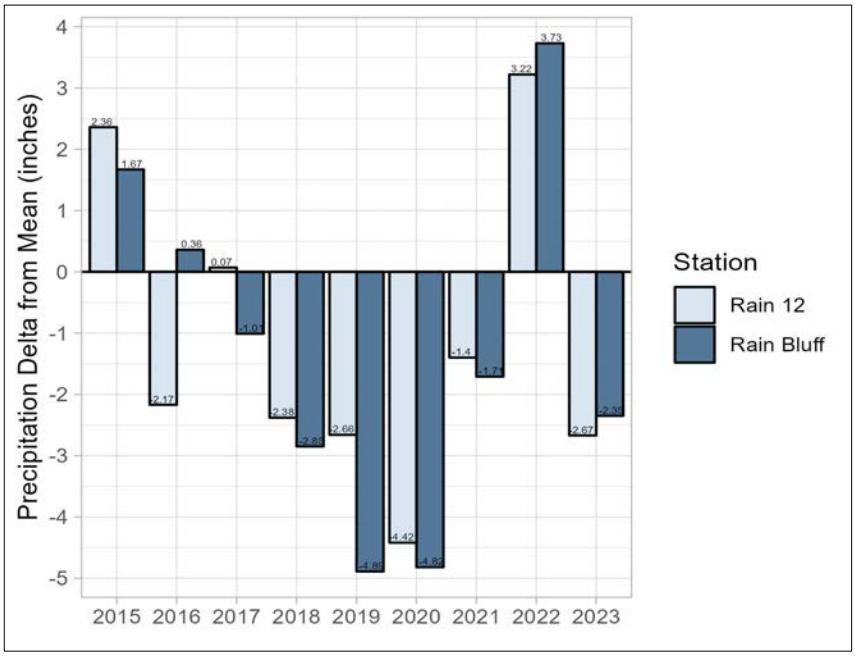
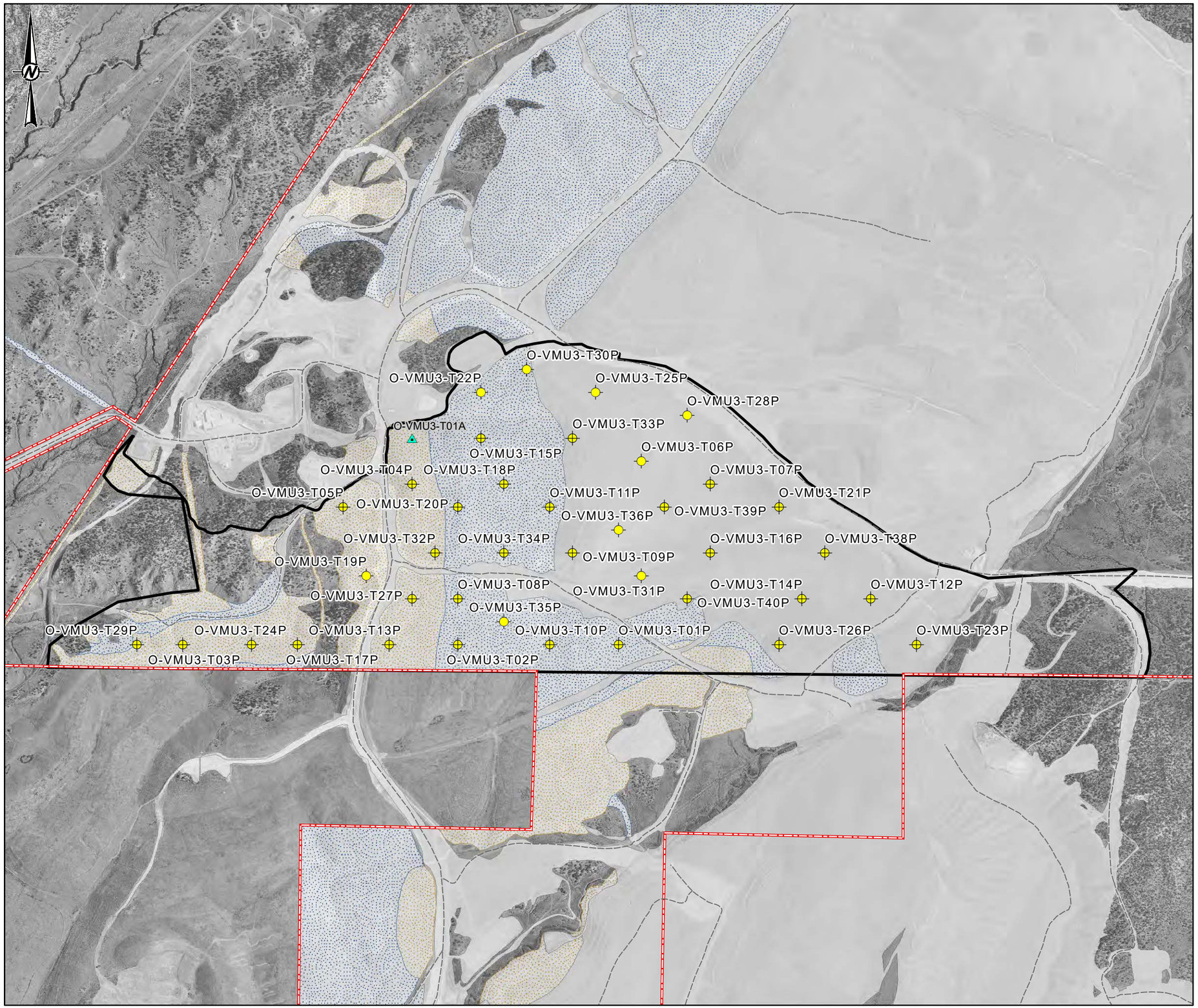
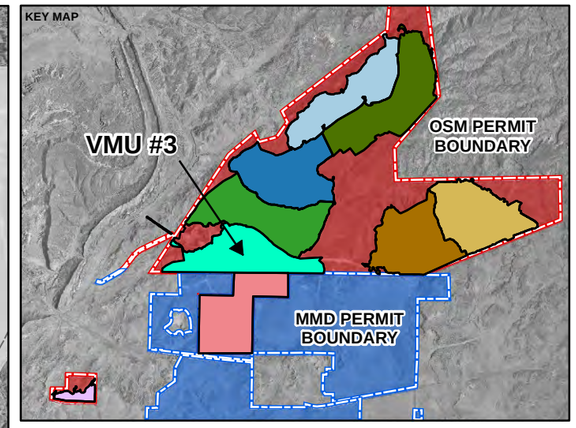
**Figure 2: Departure of Growing Season Precipitation from Long-Term Mean at Window Rock: Rain 12 and Bluff Gauges**




Notes:
Long-term seasonal mean is from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season precipitation is April through September
Source data is in Table 1




KEY MAP




**LEGEND**

- Primary Transect
- Alternate Transect
- Mine Site Roads
- OSM VMU 3 (~ 959 acres)
- Prelaw (~ 169 acres)
- Initial Program (~ 218 acres)
- Permanent Program (~ 458 acres)
- OSM Permit Boundary

**TRANSECT LABEL EXPLANATION**

O-VMU-1-T1P

| OSM Permit Area | Vegetation Management Unit (VMU-#) | Transect Number | Primary (P) or Alternate (A) |
|---|---|---|---|

0 1,400 2,800

1 inch = 1,400 feet FEET

**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN
2. KEY MAP SCALE IS DIFFERENT FROM OVERVIEW OF VMUS
3. TRANSECT LOCATIONS WERE CREATED IN ACCORDANCE WITH THE METHODS OUTLINED IN THE PERMIT

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT
CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT
MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2023 VEGETATION MONITORING

TITLE
**VEGETATION MONITORING TRANSECTS 2023, VEGETATION MANAGEMENT UNIT 3**

CONSULTANT

wsp

| | |
|---|---|
| YYYY-MM-DD | 2023-11-29 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MR |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
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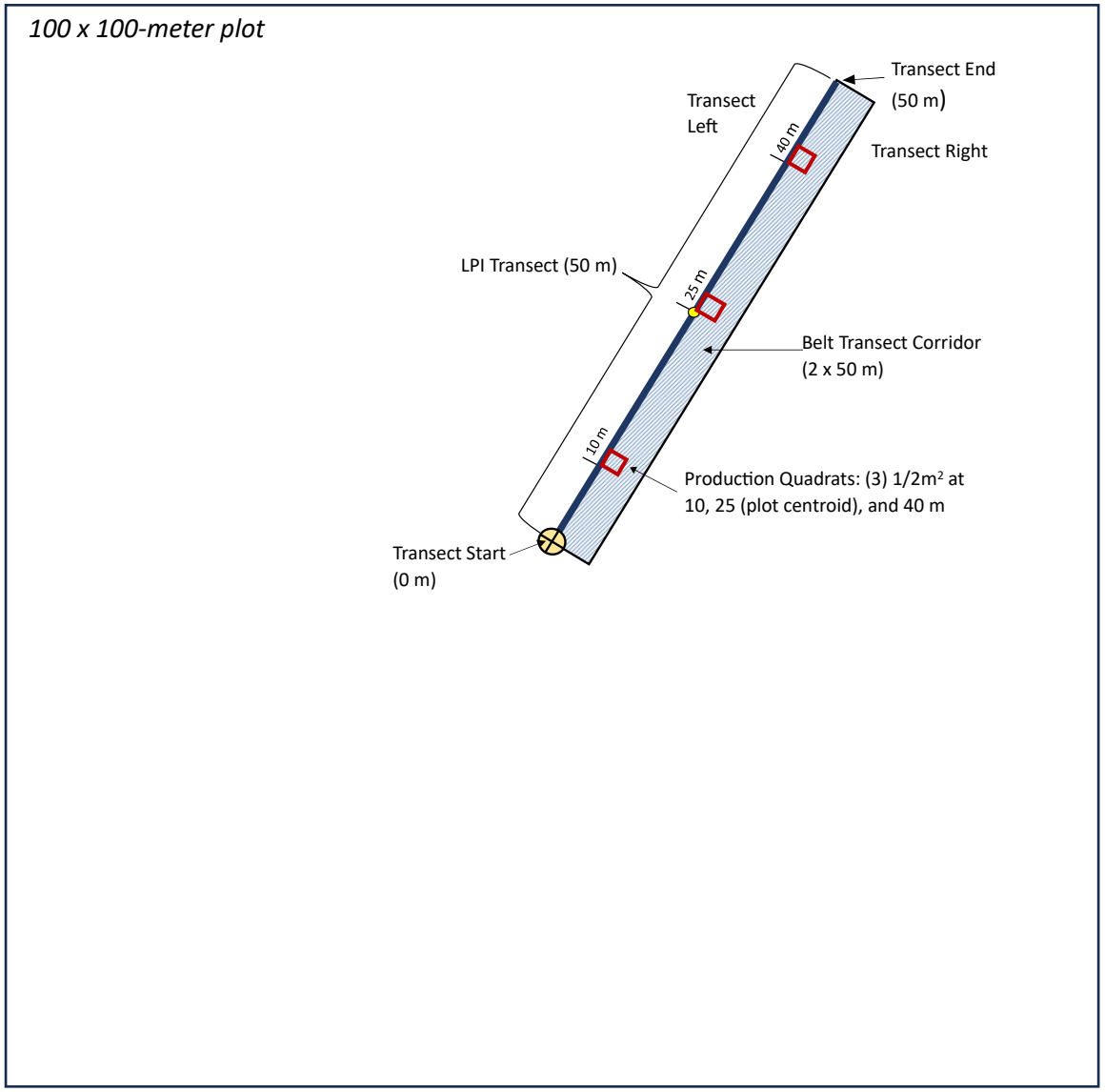
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

**Figure 4: Vegetation Plot and Transect Layout**




**Transect start placed on plot centroid and oriented randomly (0-360 degrees)* **Not to Scale**

**Figure 5: Typical Grass-Shrubland Vegetation in O-VMU-3, October 2023**



**Figure 6: Stabilization of the Annual Forage Production, O-VMU-3, 2023**

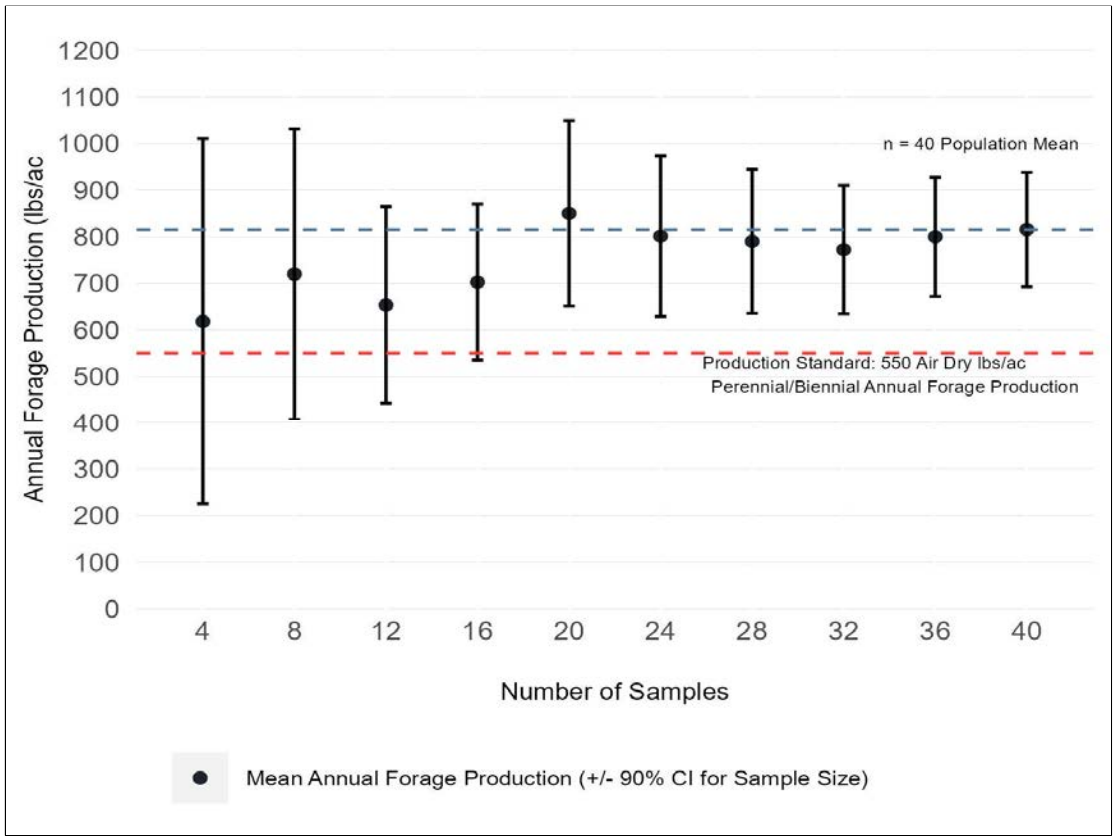
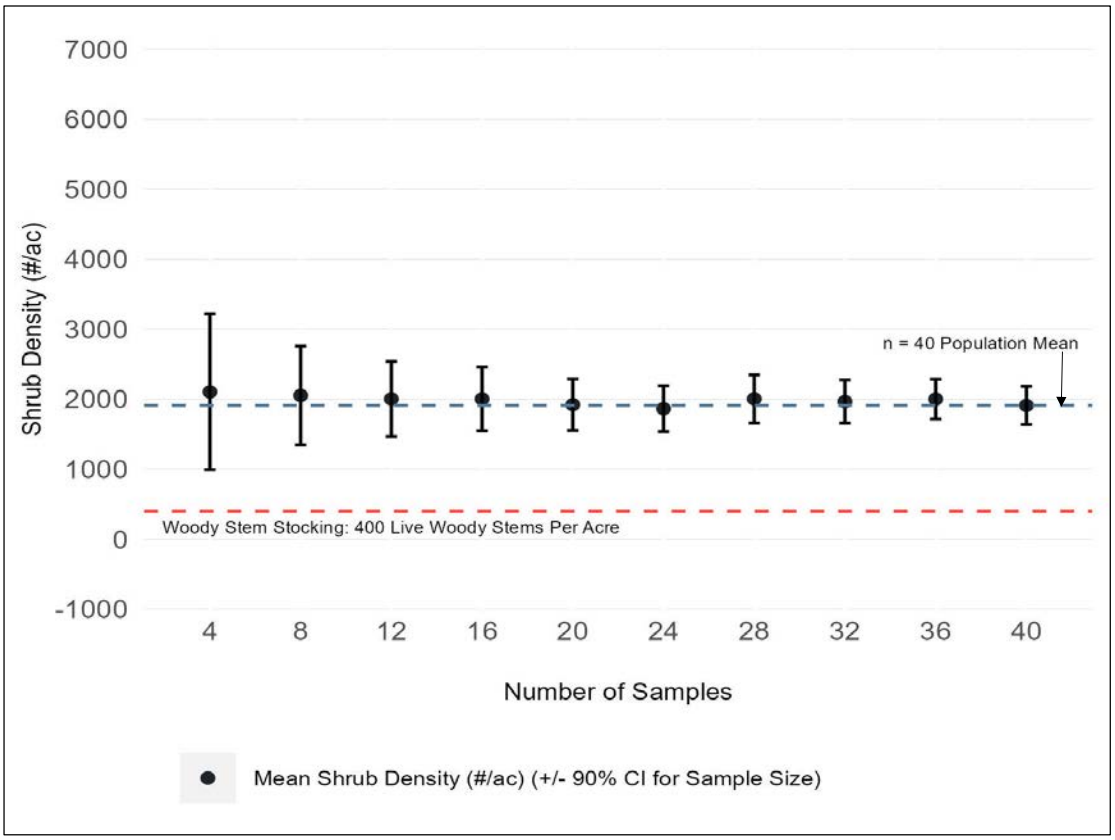


**Figure 7: Stabilization of the Mean for Shrub Density, O-VMU-3, 2023**



**APPENDIX A**

# Vegetation Data Summary

## Table A-1: O-VMU-3 Line Point Intercept Foliar Cover Data (first hits), 2023

| Transect | T01A | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRTE | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | 1 | 1 | -- | -- | -- | -- | -- | 2 | 9 | 1 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 1 | 1 | 3 | 3 | 1 | 5 | 1 | -- | 1 | 2 | 3 | -- | 4 | 1 | -- | 1 | -- | 2 | 1 |
| AGCR | 16 | -- | -- | -- | 4 | 2 | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 | 1 | -- | -- | 2 | 3 | -- | -- | -- | -- | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 9 | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| ELLA3 | -- | -- | -- | -- | -- | -- | 3 | 1 | -- | 2 | -- | -- | -- | -- | 1 | 3 | 2 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | 1 | 5 | -- | -- |
| ELTR7 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HECO26 | 1 | -- | -- | -- | -- | -- | 3 | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 15 | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | 1 |
| PASM | -- | 3 | 6 | -- | -- | 6 | -- | 4 | 5 | 2 | 2 | 1 | 3 | -- | 1 | 1 | 6 | 13 | 2 | 1 | 3 | -- | 12 | 3 | -- | 11 | -- | -- | 1 | 3 | 3 | 4 | 10 | 9 | 5 | 7 | -- | -- | -- | -- |
| PSJU3 | -- | -- | -- | 2 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | 3 | -- | -- | -- | -- | 5 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | 1 | -- | -- | 5 | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | -- |
| THIN6 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BODA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 3 | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | 4 | 2 | -- |
| PLJA | 2 | -- | 9 | 3 | 3 | -- | 11 | 3 | 1 | 2 | 4 | 3 | 16 | 3 | 2 | 3 | 8 | -- | 3 | -- | 1 | 1 | -- | 1 | -- | -- | 3 | -- | 13 | -- | -- | 3 | 9 | 2 | 3 | 2 | 8 | 18 | 13 | 9 |
| SPAI | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 4 | -- | -- | -- |
| SPCR | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ERDI5 | -- | -- | -- | -- | -- | 2 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| POOL | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| SATR12 | -- | 7 | 11 | 2 | 6 | 3 | -- | -- | 6 | 1 | -- | 4 | 2 | 11 | -- | 10 | -- | -- | 2 | -- | 7 | -- | 10 | 3 | -- | 4 | -- | 1 | -- | -- | -- | -- | 1 | -- | 6 | 1 | -- | -- | -- | -- |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BADI | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHER2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERDI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | 1 | -- | 2 | -- | -- | -- | -- | -- |
| HEMU3 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LAOC3 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MACA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEOF | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| RACO3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 2 |
| TRPR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| ATCA2 | 1 | 5 | 2 | 5 | 3 | 9 | 5 | 1 | 2 | -- | 1 | 3 | -- | 1 | 6 | 2 | 1 | 2 | 2 | 3 | 1 | 3 | 3 | 1 | 4 | 4 | 9 | 3 | -- | 2 | 7 | 1 | 4 | 6 | 7 | 15 | 7 | 3 | 5 | 4 |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | 3 | -- | -- | -- | 3 | 1 | 1 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GUSA2 | -- | -- | -- | -- | -- | -- | 2 | -- | 1 | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| SAVE4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation | 20 | 19 | 32 | 12 | 18 | 23 | 27 | 21 | 20 | 18 | 13 | 12 | 25 | 22 | 22 | 20 | 22 | 18 | 11 | 24 | 16 | 20 | 27 | 19 | 16 | 23 | 25 | 19 | 30 | 15 | 16 | 28 | 29 | 21 | 26 | 26 | 23 | 32 | 24 | 22 |
| Live Vegetation[1] | 20 | 19 | 31 | 12 | 18 | 23 | 27 | 21 | 20 | 18 | 13 | 12 | 24 | 22 | 21 | 20 | 22 | 18 | 11 | 24 | 16 | 20 | 27 | 19 | 16 | 23 | 22 | 19 | 30 | 15 | 16 | 28 | 29 | 21 | 26 | 26 | 23 | 32 | 24 | 19 |
| Perennial Vegetation[2] | 20 | 12 | 20 | 10 | 12 | 18 | 27 | 21 | 12 | 17 | 13 | 8 | 22 | 10 | 21 | 10 | 22 | 18 | 9 | 24 | 9 | 20 | 16 | 16 | 16 | 19 | 22 | 18 | 30 | 15 | 16 | 28 | 27 | 21 | 20 | 25 | 23 | 32 | 24 | 19 |
| Rock | 4 | 7 | 4 | 1 | 4 | 15 | 0 | 3 | 7 | 6 | 3 | 2 | 1 | 5 | 0 | 3 | 1 | 1 | 2 | 1 | 13 | 0 | 1 | 1 | 14 | 0 | 0 | 7 | 2 | 1 | 2 | 1 | 3 | 4 | 2 | 2 | 1 | 2 | 1 | 2 |
| Litter | 11 | 10 | 4 | 11 | 7 | 6 | 9 | 15 | 11 | 15 | 9 | 5 | 11 | 6 | 17 | 7 | 9 | 11 | 11 | 10 | 5 | 15 | 10 | 3 | 0 | 10 | 4 | 10 | 5 | 9 | 9 | 7 | 7 | 7 | 8 | 8 | 5 | 4 | 8 | 12 |
| Bare Soil | 15 | 14 | 10 | 26 | 21 | 6 | 14 | 11 | 12 | 11 | 25 | 31 | 13 | 17 | 11 | 20 | 18 | 20 | 26 | 15 | 16 | 15 | 12 | 27 | 20 | 17 | 21 | 14 | 13 | 25 | 23 | 14 | 11 | 18 | 14 | 14 | 21 | 12 | 17 | 14 |

Notes:
Species codes defined in Table A-5
[1] Live vegetation is the total vegetation foliar hits for the transect, NOT including noxious weeds
[2] Perennial vegetation is the total vegetation foliar hits for the transect, NOT including annuals and noxious weeds

## Table A-2: O-VMU-3 Line Point Intercept Foliar Cover Data (all hits), 2023

| Transect | T01A | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRTE | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | 1 | 1 | -- | -- | -- | -- | -- | 2 | 9 | 1 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 1 | 1 | 3 | 3 | 1 | 5 | 1 | -- | 1 | 2 | 3 | -- | 5 | 1 | -- | 1 | -- | 3 | 1 |
| AGCR | 16 | -- | -- | -- | 4 | 3 | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 13 | 1 | -- | -- | 2 | 4 | -- | -- | -- | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 11 | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| ELLA3 | -- | -- | -- | -- | -- | -- | 3 | 1 | -- | 2 | -- | -- | -- | -- | 1 | 3 | 2 | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | 4 | -- | -- | -- | -- | 1 | 6 | -- | -- |
| ELTR7 | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HECO26 | 1 | -- | -- | -- | -- | -- | 3 | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 15 | -- | 1 | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | 1 |
| PASM | -- | 4 | 6 | -- | -- | 6 | -- | 4 | 5 | 2 | 2 | 1 | 3 | -- | 1 | 1 | 6 | 14 | 2 | 1 | 3 | -- | 14 | 3 | -- | 12 | -- | -- | 1 | 3 | 7 | 4 | 11 | 11 | 6 | 9 | -- | -- | -- |
| PSJU3 | -- | -- | -- | 2 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | 3 | -- | -- | -- | -- | 5 | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | 1 | -- | -- | 5 | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | -- |
| THIN6 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BODA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 3 | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | 4 | 2 | -- |
| PLJA | 2 | -- | 10 | 3 | 3 | -- | 13 | 3 | 1 | 2 | 4 | 4 | 18 | 3 | 2 | 3 | 9 | -- | 3 | -- | 1 | 1 | -- | 1 | -- | -- | 3 | -- | 13 | -- | -- | 3 | 9 | 2 | 3 | 2 | 9 | 18 | 17 | 9 |
| SPAI | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 4 | -- | -- | -- |
| SPCR | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 1 |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ERDI5 | -- | -- | -- | -- | -- | 2 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| POOL | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| SATR12 | -- | 7 | 13 | 2 | 6 | 3 | -- | -- | 6 | 1 | -- | 4 | 2 | 11 | -- | 10 | -- | -- | 2 | -- | 7 | -- | 10 | 3 | -- | 4 | -- | 1 | -- | -- | -- | -- | 1 | -- | 6 | 1 | -- | -- | -- | -- |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BADI | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHER2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERDI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | 2 | -- | -- | -- | -- |
| HEMU3 | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LAOC3 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MACA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEOF | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| RACO3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 2 |
| TRPR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| ATCA2 | 1 | 5 | 2 | 6 | 3 | 9 | 5 | 1 | 2 | -- | 1 | 3 | -- | 1 | 7 | 2 | 1 | 2 | 2 | 3 | 1 | 3 | 3 | 1 | 4 | 4 | 9 | 3 | -- | 2 | 7 | 1 | 4 | 6 | 7 | 15 | 7 | 3 | 5 | 4 |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | 3 | -- | -- | -- | 3 | 1 | 1 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GUSA2 | -- | -- | -- | -- | -- | -- | 2 | -- | 1 | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| SAVE4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

Notes:
Species codes defined in Table A-5

## Table A-3: O-VMU-3 Line Point Intercept Species Associations, 2023

| Lower Canopy Species | Upper Canopy Species: ACHY | ATCA2 | BOGR2 | BRTE | ERNA10 | GRSQ | PLJA | PSJU3 | SATR12 | SPCR | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ACHY | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| AGCR | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | 4 |
| ATCA2 | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 2 |
| BODA2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 |
| BRIN2 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | 2 |
| BRTE | -- | 5 | -- | -- | -- | -- | -- | -- | -- | 1 | 6 |
| ELLA3 | -- | 2 | -- | -- | 1 | -- | -- | -- | -- | -- | 3 |
| ELTR7 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| HECO26 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| HEMU3 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| PASM | 3 | 11 | -- | -- | -- | 1 | -- | -- | -- | -- | 15 |
| PLJA | -- | 9 | 1 | 1 | -- | -- | -- | -- | 1 | -- | 12 |
| PSSP6 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 |
| SATR12 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | 2 |
| SPCR | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| **Total** | 5 | 38 | 1 | 1 | 5 | 1 | 2 | 1 | 1 | 1 | **56** |

Notes:
Species codes defined in Table A-5

## Table A-4: O-VMU-3 Quadrat Canopy Cover Data (%), 2023

| Transect | T01A | | | T01P | | | T02P | | | T03P | | | T04P | | | T05P | | | T06P | | | T07P | | | T08P | | | T09P | | | T10P | | | T11P | | | T12P | | | T13P | | | T14P | | | T15P | | | T16P | | | T16P | | | T17P | | | T19P | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quadrat | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRTE | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.1 | 0.3 | 2.0 | 0.1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.3 | -- | -- |
| Cool-Season Perennial Grasses | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | 2.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10.0 | -- | 0.5 | 2.0 | 12.0 | -- | -- | -- | 0.5 | -- | -- | -- | -- | -- | -- | -- | -- | 8.0 | -- | -- | -- | -- | -- | -- | -- | 3.0 | -- | 30.0 | -- | -- | -- | -- | -- | -- |
| AGCR | -- | -- | 27.5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.0 | -- | 1.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7.0 | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.0 | -- | -- | -- | -- | -- | -- | 3.0 | -- | -- | -- | -- | -- | 5.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELLA3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.0 | -- | -- | -- | -- | -- | 4.0 | -- | -- | -- | -- | -- | -- |
| ELTR7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.0 | 1.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HECO26 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| KOMA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | 3.0 | 2.0 | 0.1 | 1.0 | 1.0 | -- | 7.0 | -- | 0.3 | -- | -- | -- | 0.1 | 1.5 | -- | 5.0 | -- | -- | -- | -- | -- | 3.0 | -- | 1.0 | -- | 5.0 | -- | 3.0 | 1.5 | 0.1 | 0.3 | 1.0 | 10.0 | -- | -- | -- | -- | -- | 18.0 | -- | -- | 9.0 | 1.0 | 2.0 | -- | 4.0 | -- | 2.0 | -- | 5.0 | -- | 45.0 | 35.0 | 4.5 | 3.0 | -- | 3.0 | 4.0 | -- | -- |
| PSJU3 | -- | 0.8 | -- | -- | -- | -- | -- | -- | -- | 1.5 | -- | 3.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 19.0 | -- | 32.0 |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MUSQ3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Total Vegetation Cove | 7.0 | 5.0 | 27.5 | 19.0 | 7.0 | 10.0 | 47.0 | 56.0 | 26.0 | 31.5 | 27.0 | 25.0 | 1.0 | 4.2 | 18.5 | 25.0 | 13.3 | 1.0 | 82.0 | 32.0 | 50.0 | 12.6 | 47.0 | 17.0 | 5.0 | 16.5 | 11.0 | 11.0 | 5.5 | 35.0 | 25.5 | 7.0 | 12.0 | 27.0 | 8.5 | 38.0 | 29.0 | 40.0 | 38.0 | 17.3 | 11.5 | 29.0 | 35.0 | 8.0 | 48.0 | 40.0 | 8.4 | 79.0 | 50.0 | 54.5 | 42.0 | 49.0 | 29.0 | 39.0 | 15.5 | 16.0 | 15.0 | 50.6 | 87.0 | 32.0 |
| Rock | 11.0 | 18.0 | 4.0 | 7.0 | 0.5 | 4.0 | 0.5 | 0.5 | 0.0 | 0.0 | 0.1 | 1.0 | 5.0 | 0.5 | 25.0 | 5.0 | 30.0 | 10.0 | 0.0 | 1.0 | 2.0 | 6.0 | 2.0 | 45.0 | 11.0 | 3.0 | 0.0 | 12.0 | 17.0 | 3.0 | 0.0 | 0.0 | 2.0 | 1.5 | 2.0 | 0.0 | 4.0 | 4.0 | 1.0 | 6.0 | 1.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.5 | 1.5 | 0.3 | 0.3 | 2.0 | 0.5 | 0.0 | 0.3 | 1.5 | 1.0 | 2.0 | 0.5 | 2.0 | 0.0 | 4.0 |
| Litter | 2.0 | 5.0 | 7.0 | 20.0 | 5.0 | 3.0 | 5.0 | 12.0 | 2.0 | 8.0 | 7.0 | 5.0 | 4.0 | 3.0 | 5.0 | 4.0 | 8.0 | 3.0 | 18.0 | 10.0 | 15.0 | 14.0 | 14.0 | 8.0 | 2.0 | 9.0 | 17.0 | 14.0 | 12.0 | 13.0 | 8.0 | 6.0 | 21.0 | 1.0 | 1.0 | 25.0 | 17.0 | 13.0 | 20.0 | 1.0 | 16.0 | 3.0 | 25.0 | 5.0 | 14.0 | 2.0 | 1.0 | 10.0 | 18.0 | 6.0 | 9.0 | 5.0 | 10.0 | 9.0 | 2.5 | 10.0 | 4.0 | 15.0 | 11.0 | 14.0 |
| Bare Soil | 80.0 | 72.0 | 61.5 | 54.0 | 87.5 | 83.0 | 47.5 | 31.5 | 72.0 | 60.5 | 66.0 | 69.0 | 90.0 | 92.3 | 51.5 | 66.0 | 48.8 | 86.0 | 0.0 | 57.0 | 33.0 | 67.4 | 37.0 | 30.0 | 82.0 | 71.5 | 72.0 | 63.0 | 65.5 | 49.0 | 66.5 | 87.0 | 65.0 | 70.5 | 88.5 | 37.0 | 50.0 | 43.0 | 41.0 | 75.8 | 71.5 | 67.0 | 40.0 | 87.0 | 38.0 | 57.5 | 89.2 | 10.8 | 31.8 | 37.5 | 48.5 | 46.0 | 60.8 | 50.5 | 81.0 | 72.0 | 80.5 | 32.4 | 2.0 | 50.0 |

## Table A-4: O-VMU-3 Quadrat Canopy Cover Data (%), 2023 (cont'd)

| Transect | T20P | | | T21P | | | T22P | | | T23P | | | T24P | | | T25P | | | T26P | | | T27P | | | T28P | | | T29P | | | T30P | | | T33P | | | T32P | | | T33P | | | T34P | | | T35P | | | T36P | | | T36P | | | T39P | | | T40P | | |
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| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Cool-Season Perennial [1] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Shrubs, Trees, and Cact** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation Cover[1] | 12.5 | 15.5 | 5.0 | 15.0 | 38.5 | 48.0 | 48.0 | 35.2 | 36.3 | 21.0 | 18.5 | 65.0 | 67.0 | 34.0 | 25.0 | 34.0 | 1.5 | 21.0 | 47.0 | 66.0 | 7.0 | 14.0 | 25.0 | 7.0 | 39.0 | 17.0 | 6.0 | 12.0 | 1.9 | 85.0 | 35.0 | 15.5 | 50.0 | 38.0 | 20.0 | 11.0 | 12.3 | 55.0 | 23.0 | 17.2 | 40.5 | 32.0 | 15.1 | 30.0 | 52.0 | 10.0 | 36.0 | 9.0 | 60.0 | 1.0 | 14.0 | 34.0 | 75.0 | 67.0 | 47.0 | 15.3 | 11.0 | 41.0 | 45.0 | 18.0 |
| Rock | 4.0 | 6.0 | 10.0 | 5.0 | 0.0 | 0.3 | 2.0 | 3.0 | 2.0 | 2.0 | 3.0 | 0.0 | 0.0 | 0.0 | 0.5 | 4.0 | 4.0 | 5.0 | 0.3 | 0.0 | 3.0 | 5.0 | 3.0 | 8.0 | 0.5 | 4.0 | 4.0 | 7.0 | 1.5 | 0.0 | 0.5 | 5.0 | 0.3 | 0.0 | 2.0 | 1.0 | 0.0 | 0.0 | 0.5 | 2.0 | 0.3 | 1.0 | 11.0 | 0.1 | 1.0 | 2.0 | 0.0 | 1.0 | 2.0 | 0.0 | 1.0 | 0.5 | 0.0 | 2.0 | 0.0 | 4.0 | 2.0 | 0.0 | 1.0 | 0.0 |
| Litter | 7.0 | 2.0 | 3.0 | 11.0 | 14.0 | 10.0 | 10.0 | 4.0 | 18.0 | 1.0 | 5.5 | 25.0 | 0.1 | 5.0 | 4.0 | 23.0 | 6.0 | 17.0 | 25.0 | 28.0 | 6.0 | 12.0 | 4.0 | 13.0 | 16.0 | 8.0 | 4.0 | 15.0 | 10.0 | 2.0 | 25.0 | 15.0 | 27.0 | 6.0 | 10.0 | 13.0 | 12.0 | 38.0 | 7.0 | 8.0 | 17.0 | 13.0 | 4.0 | 8.0 | 11.0 | 3.0 | 25.0 | 55.0 | 17.0 | 25.0 | 3.0 | 9.0 | 10.0 | 10.0 | 23.0 | 27.0 | 17.0 | 7.0 | 15.0 | 68.0 |
| Bare Soil | 76.5 | 76.5 | 82.0 | 69.0 | 47.5 | 41.8 | 40.0 | 57.9 | 43.8 | 76.0 | 73.0 | 10.0 | 33.0 | 61.0 | 70.5 | 39.0 | 88.5 | 57.0 | 27.8 | 6.0 | 84.0 | 69.0 | 68.0 | 72.0 | 44.5 | 71.0 | 86.0 | 66.0 | 86.6 | 13.0 | 39.5 | 64.5 | 22.8 | 56.0 | 68.0 | 75.0 | 75.7 | 7.0 | 69.5 | 72.8 | 42.3 | 54.0 | 69.9 | 61.9 | 36.0 | 85.0 | 39.0 | 35.0 | 21.0 | 71.0 | 77.0 | 56.5 | 15.0 | 21.0 | 30.0 | 53.8 | 70.0 | 52.0 | 39.0 | 14.0 |

Notes:

Species codes defined in Table A-5

[1]Total vegetation canopy cover for the transect by the quadrat canopy cover estimate method

## Table A-5: O-VMU-3 Air-dry Aboveground Annual Forage Production Data, 2023

| Transect | T01A | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T38P | T39P | T40P |
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| **Perennial Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | 3 | -- | -- | -- | -- | -- | -- | -- | 17 | 31 | -- | 1 | -- | -- | 16 | -- | -- | 66 | -- | -- | 42 | 48 | -- | -- | 29 | -- | 48 | 4 | -- | -- | -- | 55 | -- | 66 | -- | -- | -- | -- | 14 | 51 |
| AGCR | 30 | -- | -- | -- | 7 | 2 | -- | -- | -- | -- | -- | -- | -- | 45 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 80 | -- | -- | -- | 211 | -- | -- | -- | -- | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 31 | -- | -- | -- | 13 | 32 | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | 6 | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 |
| ELLA3 | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | 5 | -- | -- | -- | 5 | -- | 2 | -- | -- | -- | -- | 27 | 0 | -- | 19 | -- | -- | -- | -- | 5 | -- | -- |
| ELTR7 | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HECO26 | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 91 | -- | -- | 2 | -- | -- | -- | 20 | -- | -- | 1 | -- | -- | -- | -- | -- | 21 | -- |
| KOMA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | 7 | 7 | 28 | -- | 4 | 13 | -- | 9 | 12 | 4 | 13 | -- | 22 | 3 | 4 | 15 | 9 | 127 | 9 | 5 | 1 | -- | 73 | 47 | -- | 16 | -- | 2 | -- | 1 | 104 | 28 | 6 | 8 | 78 | 50 | -- | -- | -- | -- |
| PSJU3 | 2 | -- | -- | 35 | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | 54 | -- | -- | -- | -- | 97 | -- | -- | -- | -- | 41 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 33 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | 18 | -- | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | 29 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOCU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
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| PLJA | -- | -- | 121 | 66 | 12 | 97 | 62 | 79 | -- | -- | 28 | 65 | 151 | -- | 112 | -- | 119 | 99 | 54 | -- | -- | -- | -- | 1 | -- | -- | 11 | -- | 30 | -- | -- | 23 | 35 | 36 | 22 | 26 | 25 | 279 | 59 | 34 |
| SPAI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 50 | -- | 2 | -- |
| SPCR | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- | -- | 22 | -- | -- | -- | 1 | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 16 |
| **Perennial/Biennial Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BADI | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | 2 | -- | 1 | 1 | -- | -- | -- |
| CHER2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- |
| ERDI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 17 | -- | -- | 17 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- |
| ERFL | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HEMU3 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- |
| LAOC3 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| LILE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | 3 | 1 | -- | -- | -- | 1 | -- | 4 | 1 | 36 | -- | 1 | -- | 2 | -- | -- | 2 | -- | -- | 1 | -- | -- | -- | -- | -- | 9 | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | -- | -- | 10 |
| TRPR | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| ATCA2 | -- | 10 | -- | 87 | -- | 23 | 193 | -- | -- | 57 | -- | 36 | 2 | -- | 2 | 83 | 1 | 3 | -- | 203 | -- | -- | 1 | -- | 51 | 7 | 72 | -- | -- | 2 | 39 | 0 | -- | 41 | 67 | 20 | 47 | 3 | -- | -- |
| ATCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 16 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 116 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GUSA2 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 3 | 0 | -- | -- | 41 | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | 15 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- |
| **Total Air-dry Aboveground Annual Forage Production** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total (g) | 44 | 29 | 150 | 193 | 24 | 134 | 284 | 111 | 61 | 98 | 77 | 114 | 190 | 91 | 163 | 128 | 271 | 329 | 77 | 293 | 44 | 144 | 74 | 112 | 212 | 40 | 150 | 85 | 89 | 56 | 161 | 129 | 252 | 161 | 167 | 106 | 122 | 308 | 98 | 116 |
| Total (lbs/ac) | 259 | 173 | 893 | 1,148 | 142 | 797 | 1,691 | 657 | 365 | 585 | 456 | 677 | 1,130 | 538 | 969 | 764 | 1,610 | 1,953 | 458 | 1,740 | 264 | 855 | 441 | 665 | 1,263 | 236 | 891 | 509 | 532 | 331 | 958 | 764 | 1,498 | 958 | 994 | 632 | 725 | 1,830 | 581 | 691 |

Notes:
Species codes defined in Table A-5
Total (g) is the total of all three .5 $m^2$ quads (1.5$m^2$ total) per transect
Lbs/ac=total grams÷1.5*(4046.86/453.592)
Non-forage and forage determinations are based on the permit (e.g. plants of perennial and/or biennial duration are forage and plants of annual duration are non-forage; noxious weeds are non-forage)

## Table A-6: O-VMU-3 Shrub Belt Transect Data (frequency), 2023

| Transect | T01A | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARFR4 | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARNO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 |
| ATCA2 | 18 | 46 | 25 | 96 | 28 | 33 | 19 | 14 | 20 | 38 | 7 | 82 | 22 | 11 | 34 | 23 | 18 | 37 | 39 | 26 | 7 | 43 | 61 | 6 | 122 | 21 | 32 | 27 | 2 | 25 | 43 | 9 | 29 | 40 | 43 | 81 | 48 | 15 | 12 | 14 |
| ATCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 26 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATGA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | 1 | -- | -- | 1 | 2 | 4 | 1 | 4 | 4 | -- | 7 | 1 | -- | -- | -- | 1 | 10 | -- | 3 | 17 | -- | -- | -- | 9 | 2 | 6 | -- | 1 | -- | 1 | 2 | 16 | 2 | -- | 2 | 8 | -- | -- | -- | -- | -- |
| GUSA2 | 3 | 7 | 5 | -- | 2 | -- | 73 | 4 | 5 | 12 | 8 | -- | -- | 13 | 42 | -- | 5 | -- | 2 | -- | -- | 6 | -- | 12 | 5 | -- | 1 | 10 | -- | 3 | 10 | 6 | -- | 18 | 1 | 1 | 2 | 1 | -- | 2 | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 28 | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | 21 | -- | 22 | -- | -- | -- | -- | -- | -- | 4 | 5 | -- | -- | -- |
| OPPO | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| OPUNT | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | 2 | -- | -- | -- | -- |
| PUTR2 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SAVE4 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SEFL3 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| YUBA | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Total** | 26 | 53 | 30 | 99 | 32 | 37 | 96 | 33 | 29 | 51 | 24 | 84 | 59 | 24 | 87 | 28 | 34 | 37 | 44 | 43 | 7 | 50 | 61 | 38 | 129 | 60 | 54 | 38 | 24 | 53 | 56 | 35 | 31 | 58 | 46 | 90 | 56 | 21 | 12 | 20 |

Notes:
Species codes defined in Table A-5
The shrub belt transect area is 100m$^2$ (2mx50m); shrubs rooted in the belt transect were counted on an individual basis

## Table A-7 : Species Observed 2019-2023, O-VMU-3

| Common Name | Scientific Name | Code |
|---|---|---|
| **Cool-Season Grasses (22)** | | |
| **Annuals (3)** | | |
| Field brome | *Bromus arvensis* | BRAR5 |
| Cheatgrass | *Bromus tectorum* | BRTE |
| Common barley | *Hordeum vulgare* | HOVU |
| **Perennials (19)** | | |
| Indian ricegrass | *Achnatherum hymenoides* | ACHY |
| Crested wheatgrass | *Agropyron cristatum* | AGCR |
| Smooth brome | *Bromus inermis* | BRIN2 |
| Bottlebrush squirreltail | *Elymus elymoides* | ELEL5 |
| Blue wildrye | *Elymus glaucus* | ELGL |
| Thickspike wheatgrass | *Elymus lanceolatus* | ELLA3 |
| Slender wheatgrass | *Elymus trachycaulus* | ELTR7 |
| Arizona fescue | *Festuca arizonica* | FEAR2 |
| Field fescue | *Festuca arvernensis* | FEAR4 |
| Needle and thread | *Hesperostipa comata* | HECO26 |
| Foxtail barley | *Hordeum jubatum* | HOJU |
| **Prairie Junegrass** | ***Koeleria macrantha*** | **KOMA** |
| Colorado wildrye | *Leymus ambiguus* | LEAM |
| Western wheatgrass | *Pascopyrum smithii* | PASM |
| Russian wildrye | *Psathyrostachys juncea* | PSJU3 |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | PSSP6 |
| Tall fescue | *Schedonorus arundinaceus* | SCAR7 |
| Intermediate wheatgrass | *Thinopyrum intermedium* | THIN6 |
| Tall wheatgrass | *Thinopyrum ponticum* | THPO7 |
| **Warm-Season Grasses (11)** | | |
| **Annuals (2)** | | |
| Matted grama | *Bouteloua simplex* | BOSI2 |
| False buffalograss | *Munroa squarrosa* | MUSQ3 |
| **Perennials (9)** | | |
| Purple threeawn | *Aristida purpurea* | ARPU9 |
| Sideoats grama | *Bouteloua curtipendula* | BOCU |
| Buffalograss | *Bouteloua dactyloides* | BODA2 |
| Blue grama | *Bouteloua gracilis* | BOGR2 |
| Saltgrass | *Distichlis spicata* | DISP |
| James' galleta | *Pleuraphis jamesii* | PLJA |
| Tumblegrass | *Schedonnardus paniculatus* | SCPA |
| Alkali sacaton | *Sporobolus airoides* | SPAI |
| Sand dropseed | *Sporobolus cryptandrus* | SPCR |
| **Forbs (75)** | | |
| **Annuals (28)** | | |
| Desert madwort | *Alyssum desertorum* | ALDE |
| Alyssum | *Alyssum simplex* | ALSI8 |
| Redroot amaranth | *Amaranthus retroflexus* | AMRE |
| Lambsquarters | *Chenopodium album* | CHAL7 |
| Ribseed sandmat | *Chamaesyce glyptosperma* | CHGL13 |
| Mealy goosefoot | *Chenopodium incanum* | CHIN2 |
| Narrowleaf goosefoot | *Chenopodium leptophyllum* | CHLE4 |
| Thymeleaf sandmat | *Chamaesyce serpyllifolia* | CHSE6 |
| Wright's bird's beak | *Cordylanthus wrightii* | COWR2 |
| Fetid marigold | *Dyssodia papposa* | DYPA |
| Nodding buckwheat | *Eriogonum cernuum* | ERCE2 |
| Divergent buckwheat | *Eriogonum divaricatum* | ERDI5 |
| **Trailing fleabane** | ***Erigeron flagellaris*** | **ERFL** |
| Common sunflower | *Helianthus annuus* | HEAN3 |
| Longleaf false goldeneye | *Heliomeris longifolia* | HELO6 |
| Burningbush | *Bassia scoparia* | BASC5 |
| Fendler's desertdandelion | *Malacothrix fendleri* | MAFE |
| Pony beebalm | *Monarda pectinata* | MOPE |
| Desert broomrape | *Orobanche cooperi* | ORCO4 |
| Lemonscent | *Pectis angustifolia* | PEAN |
| Erect knotweed | *Polygonum erectum* | POER2 |
| Little hogweed | *Portulaca oleracea* | POOL |
| Lanceleaf sage | *Salvia reflexa* | SARE3 |
| Prickly Russian thistle | *Salsola tragus* | SATR12 |
| Manyflower false threadleaf | *Schkuhria multiflora* | SCMU6 |
| **Jack-go-to-bed-at-noon** | ***Tragopogon pratensis*** | **TRPR** |
| Golden crownbeard | *Verbesina encelioides* | VEEN |
| Rough cocklebur | *Xanthium strumarium* | XAST |

## Table A-7 : Species Observed 2019-2023, O-VMU-3

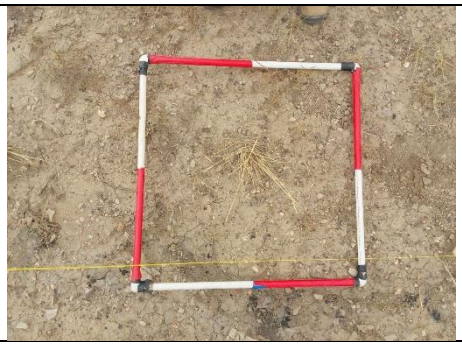
| Common Name | Scientific Name | Code |
|---|---|---|
| **Perennials/Biennials (47)** | | |
| Russian knapweed | *Acroptilon repens* | ACRE3 |
| Ragweed sagebrush | *Artemisia franserioides* | ARFR3 |
| **Silverscale saltbush** | ***Atriplex argentea*** | **ATAR2** |
| Ragleaf bahia | *Bahia dissecta* | BADI |
| Wyoming Indian paintbrush | *Castilleja linariifolia* | CALI4 |
| Sego lily | *Calochortus nuttallii* | CANU3 |
| Musk thistle | *Carduus nutans* | CANU4 |
| Whitemargin sandmat | *Chamaesyce albomarginata* | CHAL11 |
| Sandmat | *Chamaesyce* sp. | CHAMA15 |
| Rose heath | *Chaetopappa ericoides* | CHER2 |
| Canadian horseweed | *Conyza canadensis* | COCA5 |
| White prairie clover | *Dalea candida* | DACA7 |
| Purple prairie clover | *Dalea purpurea* | DAPU5 |
| Flixweed | *Descurainia sophia* | DESO |
| Redstem stork's bill | *Erodium cicutarium* | ERCI6 |
| Spreading fleabane | *Erigeron divergens* | ERDI4 |
| James' buckwheat | *Eriogonum jamesii* | ERJA |
| Bastardsage | *Eriogonum wrightii* | ERWR |
| Indian blanket | *Gaillardia pulchella* | GAPU |
| Curlycup gumweed | *Grindelia squarrosa* | GRSQ |
| Showy goldeneye | *Heliomeris multiflora* | HEMU3 |
| Scarlet gilia | *Ipomopsis aggregata* | IPAG |
| Manyflowered ipomopsis | *Ipomopsis multiflora* | IPMU3 |
| Flatspine stickseed | *Lappula occidentalis* | LAOC3 |
| Prickly lettuce | *Lactuca serriola* | LASE |
| Mesa pepperwort | *Lepidium alyssoides* | LEAL4 |
| Lewis flax | *Linum lewisii* | LILE3 |
| Hoary tansyaster | *Machaeranthera canescens* | MACA2 |
| Tanseyleaf tansyaster | *Machaeranthera tanacetifolia* | MATA2 |
| Horehound | *Marrubium vulgare* | MAVU |
| Sweetclover | *Melilotus officinalis* | MEOF |
| Alfalfa | *Medicago sativa* | MESA |
| Colorado four o'clock | *Mirabilis multiflora* | MIMU |
| Palmer's penstemon | *Penstemon palmeri* | PEPA8 |
| Rocky Mountain penstemon | *Penstemon strictus* | PEST2 |
| Prostrate knotweed | *Polygonum aviculare* | POAV |
| Upright prairie coneflower | *Ratibida columnifera* | RACO3 |
| Curly dock | *Rumex crispus* | RUCR |
| Cutleaf vipergrass | *Scorzonera laciniata* | SCLA6 |
| Tall tumblemustard | *Sisymbrium altissimum* | SIAL2 |
| Scarlet globemallow | *Sphaeralcea coccinea* | SPCO |
| Emory's globemallow | *Sphaeralcea emoryi* | SPEM |
| Gooseberryleaf globemallow | *Sphaeralcea grossulariifolia* | SPGR2 |
| Spear globemallow | *Sphaeralcea hastulata* | SPHA |
| Wright's thelypody | *Thelypodium wrightii* | THWR |
| Yellow salsify | *Tragopogon dubius* | TRDU |
| Salsify | *Tragopogon porrifolius* | TRPO |
| **Shrubs, Trees, and Cacti (40)** | | |
| Prairie sagewort | *Artemisia frigida* | ARFR4 |
| Big sagebrush | *Artemisia tridentata* | ARTR2 |
| Tubercled saltbush | *Atriplex acanthocarpa* | ATAC |
| Fourwing saltbush | *Atriplex canescens* | ATCA2 |
| Shadscale saltbush | *Atriplex confertifolia* | ATCO |
| Mat saltbush | *Atriplex corrugata* | ATCO4 |
| Gardner's saltbush | *Atriplex gardneri* | ATGA |
| **Black sagebrush** | ***Artemisia nova*** | **ARNO4** |
| Mound saltbush | *Atriplex obovata* | ATOB |
| Saltbush | *Atriplex* sp. | ATRIP |
| Longflower rabbitbrush | *Chrysothamnus depressus* | CHDE2 |
| Greene's rabbitbrush | *Chrysothamnus greenei* | CHGR6 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | CHVI8 |
| Beehive cactus | *Coryphantha* sp. | CORYP |
| Pinkflower hedgehog cactus | *Echinocereus fendleri* | ECFE |
| Kingcup cactus | *Echinocereus triglochidiatus* | ECTR |
| Russian olive | *Elaeagnus angustifolia* | ELAN |
| Longleaf jointfir | *Ephedra trifurca* | EPTR |
| Mormon tea | *Ephedra viridis* | EPVI |
| Rubber rabbitbrush | *Ericameria nauseosa* | ERNA10 |
| Slenderleaf buckwheat | *Eriogonum leptophyllum* | ERLE10 |
| Apache plume | *Fallugia paradoxa* | FAPA |
| Broom snakeweed | *Gutierrezia sarothrae* | GUSA2 |
| Hairy false goldenaster | *Heterotheca villosa* | HEVI4 |
| Oneseed juniper | *Juniperus monosperma* | JUMO |
| Winterfat | *Krascheninnikovia lanata* | KRLA2 |
| Pale desert-thorn | *Lycium pallidum* | LYPA |
| Torrey wolfberry | *Lycium torreyi* | LYTO |
| Plains pricklypear | *Opuntia polyacantha* | OPPO |
| Twoneedle pinyon | *Pinus edulis* | PIED |
| Eastern cottonwood | *Populus deltoides* | PODE3 |
| Mexican cliffrose | *Purshia mexicana* | PUME |
| Antelope bitterbrush | *Purshia tridentata* | PUTR2 |
| Skunkbush sumac | *Rhus trilobata* | RHTR |
| Greasewood | *Sarcobatus vermiculatus* | SAVE4 |
| Threadleaf ragwort | *Senecio flaccidus* | SEFL3 |
| Saltcedar | *Tamarix ramosissima* | TARA |
| Siberian elm | *Ulmus pumila* | ULPU |
| Banana yucca | *Yucca baccata* | YUBA |
| Soapweed yucca | *Yucca glauca* | YUGL |

Notes:

Bold species are newly observed on O-VMU-3 in 2023

**APPENDIX B**

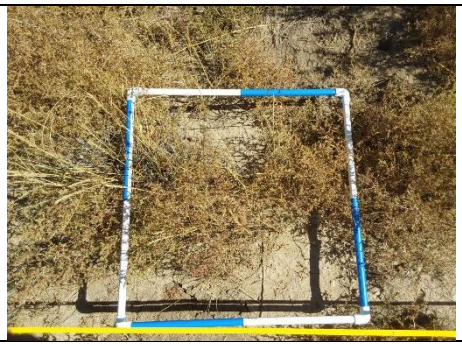
# Quadrat Photographs

| | |
|---|---|
|  |  |
| O-VMU3-T01A | Q1 |
|  |  |
| Q2 | Q3 |

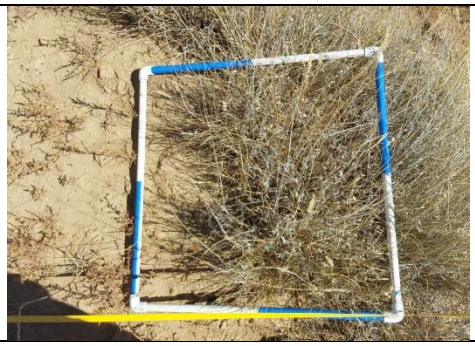
| | |
|---|---|
|  |  |
| O-VMU3-T01P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU3-T02P



Q1



Q2



Q3



O-VMU3-T03P



Q1



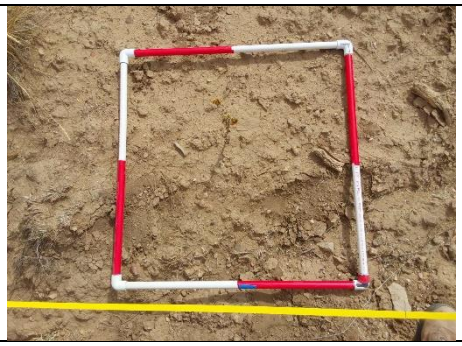
Q2



Q3



O-VMU3-T04P



Q1



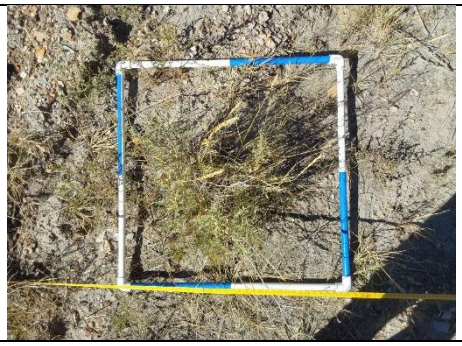
Q2



Q3



O-VMU3-T05P



Q1



Q2



Q3



O-VMU3-T06P



Q1



Q2



Q3



O-VMU3-T07P



Q1



Q2



Q3



O-VMU3-T08P



Q1



Q2



Q3



O-VMU3-T09P



Q1



Q2



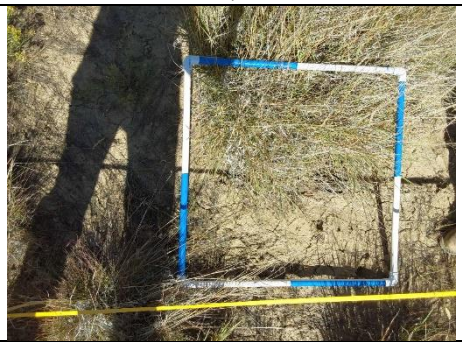
Q3

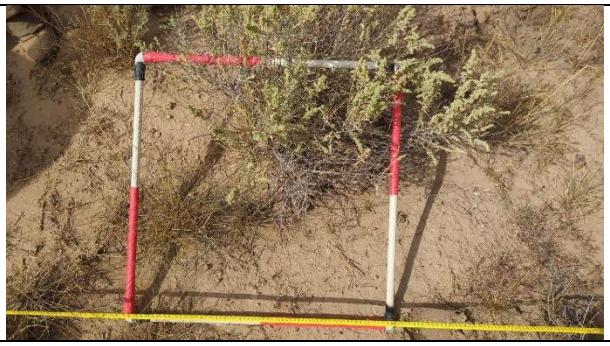
| | |
|---|---|
|  |  |
| O-VMU3-T10P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T11P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T12P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T13P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T14P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T15P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU3-T16P



Q1



Q2



Q3



O-VMU3-T17P



Q1

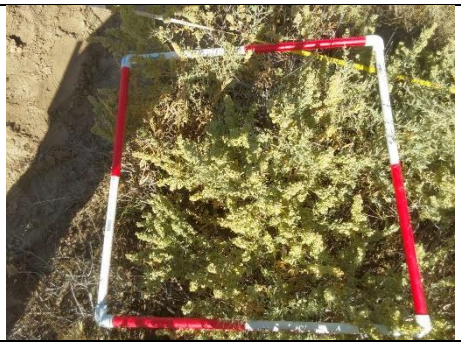


Q2



Q3

| | |
|---|---|
|  |  |
| O-VMU3-T18P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T19P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T20P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T21P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU3-T22P



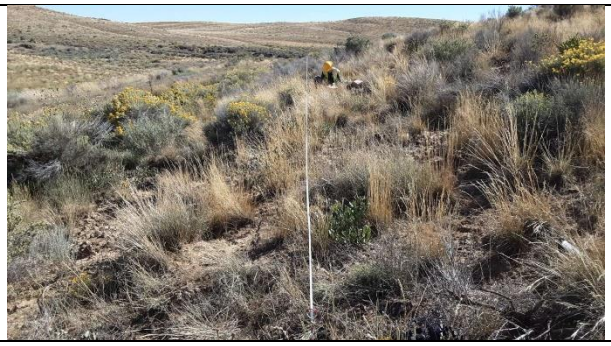
Q1



Q2



Q3



O-VMU3-T23P



Q1



Q2



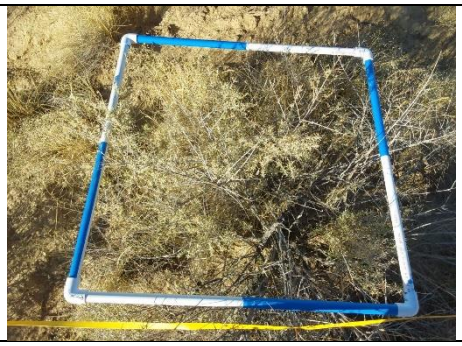
Q3

| | |
|---|---|
|  |  |
| O-VMU3-T24P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T25P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU3-T26P



Q1



Q2



Q3



O-VMU3-T27P



Q1



Q2



Q3



O-VMU3-T28P



Q1



Q2



Q3



O-VMU3-T29P



Q1



Q2



Q3



O-VMU3-T30P



Q1



Q2



Q3



O-VMU3-T31P



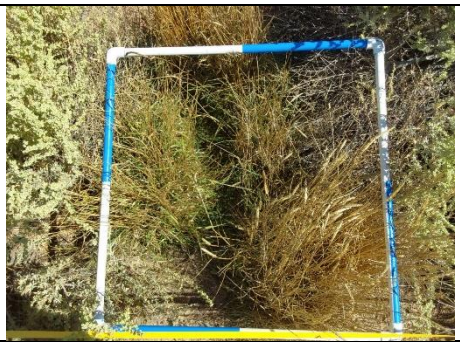
Q1

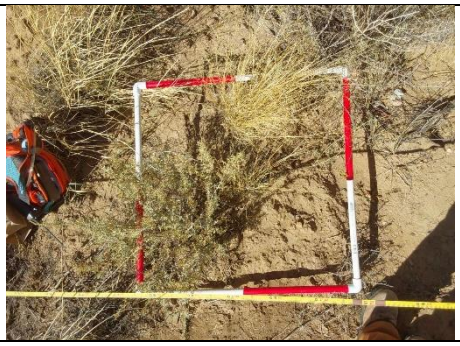


Q2

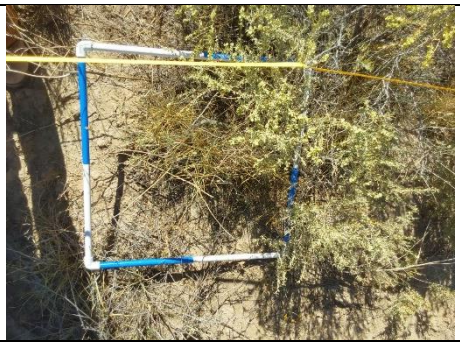


Q3

| | |
|---|---|
|  |  |
| O-VMU3-T32P | Q1 |
|  |  |
| Q2 | Q3 |

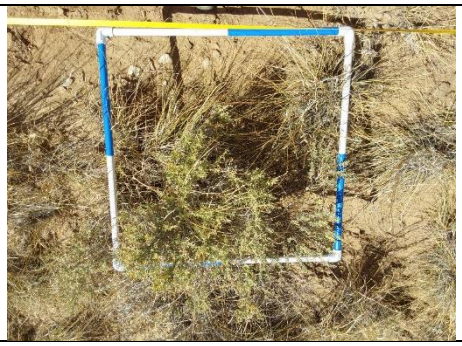
| | |
|---|---|
|  |  |
| O-VMU3-T33P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T34P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU3-T35P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU3-T36P



Q1



Q2



Q3



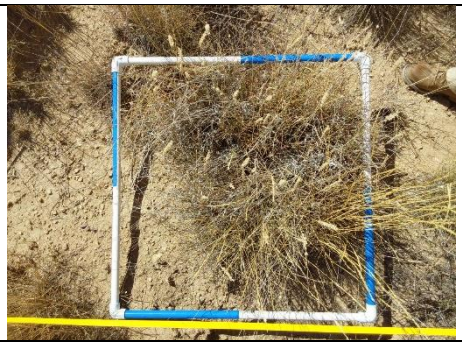
O-VMU3-T38P



Q1



Q2



Q3



O-VMU3-T39P



Q1



Q2



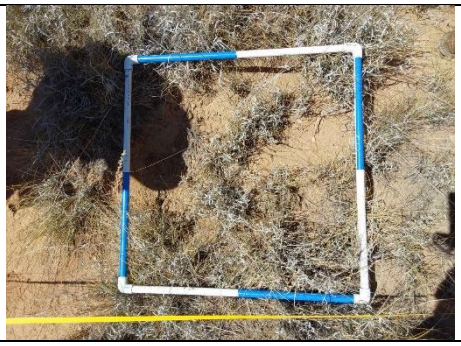
Q3



O-VMU3-T40P



Q1



Q2



Q3

**APPENDIX C**

# Vegetation Statistical Analysis

**Table C1: Equations for Vegetation Data Analysis**

| Attribute | Equation | Where |
|---|---|---|
| Sample Size / Count | $n = \sum samples$ | n = number of samples<br>∑ = sum |
| Mean | $\bar{x} = \frac{\sum x}{n}$ | $\bar{x}$ = sample mean<br>∑x = sum of values for variable<br>n = number of samples |
| Standard Deviation | $s = \sqrt{\frac{\sum(\bar{x} - x)^2}{n-1}}$ | s = standard deviation<br>∑ = sum<br>$\bar{x}$ = sample mean<br>n = number of samples |
| Variance (population) | $s^2 = \frac{\sum_{(x_i - \bar{x})^2}}{n-1}$ | $s^2$ = variance<br>∑ = sum<br>$x_i$ = Value of variable for sample *i*<br>$\bar{x}$ = sample mean<br>n = number of samples |
| t-distribution | t = 1-α, v | t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom<br>α = significance level (0.10)<br>v = degrees of freedom (n-1) |
| 90% Confidence Interval | $\bar{x} \pm z\frac{s}{\sqrt{n}}$ | $\bar{x}$ = sample mean<br>z = the critical value from the normal distribution with α/2 in each tail<br>s = standard deviation<br>n = number of samples |
| $N_{min}$ (Sample Adequacy - Normal Data) | $N_{min} = \frac{t^2 s^2}{(\bar{x}D)^2}$ | $N_{min}$ = number of samples required<br>t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom<br>s = standard deviation ($s^2$ = variance)<br>$\bar{x}$ = sample mean<br>D = the desired level of accuracy, which is 10 percent of the mean |
| Logarithmic Transformation | Y' = log(Y + k) | log = logarithmic function<br>Y = attribute value<br>k = constant, here we use 1 |
| one-sample, one-sided t test | $t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$ | t* = calculated t-statistic<br>$\bar{x}$ = sample mean<br>s = standard deviation<br>n = sample size |
| one-sample, one-sided sign test | $z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$ | z = sign test statistic<br>k = test statistic resulting from the number of values falling below 90% of the technical standard<br>n = sample size |
| Relative Cover (Perennial/Biennial Species) | Rp/b-cvr = Cvrp/b-sp. / Cvrp/b-abs. | $R_{p/b\text{-}cvr}$ = Calculated Relative Cover for a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}sp.}$ = Mean Absolute Cover of a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}abs.}$ = Mean Absolute Perennial/Biennial Cover |
| Relative Cover (All Species) | Rcvr = Cvrsp. / CvrAbs. | $R_{cvr}$ = Calculated Relative Cover for a species<br>$Cvr_{sp.}$ = Mean Absolute Cover of ANY species<br>$Cvr_{abs.}$ = Mean Absolute Cover for All Species |

Notes:
All Appendix C analysis, tables, and figures computed using R software: (R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

**Table C-2: Data for Normal Distribution and Variance Analysis, O-VMU-3, 2023**

| Transect | Raw Data | | | | | Log-Transformed Data | |
|---|---|---|---|---|---|---|---|
| | Total Ground Cover (%) | Perennial Vegetation Cover (%) | Annual Forage Production (lbs/ac) | Woody Plant Density (#/ac) | Log - Total Ground Cover | Log - Annual Forage Production | Log - Woody Plant Density |
| O-VMU3-T01A | 62 | 40 | 259 | 1,052 | 1.79 | 2.41 | 3.02 |
| O-VMU3-T01P | 58 | 24 | 173 | 2,145 | 1.76 | 2.24 | 3.33 |
| O-VMU3-T02P | 70 | 40 | 893 | 1,214 | 1.85 | 2.95 | 3.08 |
| O-VMU3-T03P | 46 | 20 | 1,148 | 4,006 | 1.66 | 3.06 | 3.60 |
| O-VMU3-T04P | 50 | 24 | 142 | 1,295 | 1.70 | 2.15 | 3.11 |
| O-VMU3-T05P | 58 | 36 | 797 | 1,497 | 1.76 | 2.90 | 3.18 |
| O-VMU3-T06P | 72 | 54 | 1,690 | 3,885 | 1.86 | 3.23 | 3.59 |
| O-VMU3-T07P | 72 | 42 | 658 | 1,335 | 1.86 | 2.82 | 3.13 |
| O-VMU3-T08P | 62 | 24 | 365 | 1,174 | 1.79 | 2.56 | 3.07 |
| O-VMU3-T09P | 66 | 34 | 585 | 2,064 | 1.82 | 2.77 | 3.31 |
| O-VMU3-T10P | 44 | 26 | 456 | 971 | 1.64 | 2.66 | 2.99 |
| O-VMU3-T11P | 34 | 16 | 677 | 3,399 | 1.53 | 2.83 | 3.53 |
| O-VMU3-T12P | 70 | 44 | 1,130 | 2,388 | 1.85 | 3.05 | 3.38 |
| O-VMU3-T13P | 56 | 20 | 539 | 971 | 1.75 | 2.73 | 2.99 |
| O-VMU3-T14P | 76 | 42 | 969 | 3,521 | 1.88 | 2.99 | 3.55 |
| O-VMU3-T15P | 54 | 20 | 763 | 1,133 | 1.73 | 2.88 | 3.05 |
| O-VMU3-T16P | 62 | 44 | 1,610 | 1,376 | 1.79 | 3.21 | 3.14 |
| O-VMU3-T17P | 58 | 36 | 1,953 | 1,497 | 1.76 | 3.29 | 3.18 |
| O-VMU3-T18P | 44 | 18 | 458 | 1,781 | 1.64 | 2.66 | 3.25 |
| O-VMU3-T19P | 68 | 48 | 1,740 | 1,740 | 1.83 | 3.24 | 3.24 |
| O-VMU3-T20P | 42 | 18 | 264 | 283 | 1.62 | 2.42 | 2.45 |
| O-VMU3-T21P | 70 | 40 | 855 | 2,023 | 1.85 | 2.93 | 3.31 |
| O-VMU3-T22P | 74 | 32 | 441 | 2,469 | 1.87 | 2.64 | 3.39 |
| O-VMU3-T23P | 44 | 32 | 665 | 1,538 | 1.64 | 2.82 | 3.19 |
| O-VMU3-T24P | 32 | 32 | 1,263 | 5,220 | 1.51 | 3.10 | 3.72 |
| O-VMU3-T25P | 66 | 38 | 236 | 2,428 | 1.82 | 2.37 | 3.39 |
| O-VMU3-T26P | 52 | 44 | 890 | 2,185 | 1.72 | 2.95 | 3.34 |
| O-VMU3-T27P | 58 | 36 | 508 | 1,538 | 1.76 | 2.71 | 3.19 |
| O-VMU3-T28P | 70 | 60 | 532 | 971 | 1.85 | 2.73 | 2.99 |
| O-VMU3-T29P | 48 | 30 | 332 | 2,145 | 1.68 | 2.52 | 3.33 |
| O-VMU3-T30P | 50 | 32 | 958 | 2,266 | 1.70 | 2.98 | 3.36 |
| O-VMU3-T31P | 70 | 56 | 765 | 1,416 | 1.85 | 2.88 | 3.15 |
| O-VMU3-T32P | 72 | 54 | 1,498 | 1,255 | 1.86 | 3.18 | 3.10 |
| O-VMU3-T33P | 56 | 42 | 959 | 2,347 | 1.75 | 2.98 | 3.37 |
| O-VMU3-T34P | 68 | 40 | 993 | 1,862 | 1.83 | 3.00 | 3.27 |
| O-VMU3-T35P | 68 | 50 | 631 | 3,642 | 1.83 | 2.80 | 3.56 |
| O-VMU3-T36P | 56 | 46 | 726 | 2,266 | 1.75 | 2.86 | 3.36 |
| O-VMU3-T38P | 72 | 64 | 1,831 | 850 | 1.86 | 3.26 | 2.93 |
| O-VMU3-T39P | 64 | 48 | 581 | 486 | 1.81 | 2.76 | 2.69 |
| O-VMU3-T40P | 62 | 38 | 690 | 809 | 1.79 | 2.84 | 2.91 |
| Mean | 59.40 | 37.1 | 815.5 | 1911.1 | 1.8 | 2.8 | 3.2 |
| Standard Deviation | 11.4 | 12.2 | 472.3 | 1048.8 | 0.1 | 0.3 | 0.2 |
| Count | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Variance | 127 | 144 | 217,522 | 1,072,411 | 0 | 0.074 | 0.061 |
| 90% Confidence Interval | 3 | 3 | 123 | 273 | 0 | 0.072 | 0.065 |
| Technical Standard | 52% | 24% | 550 | 400 | 1.72 | 2.74 | 2.60 |
| **90% of Standard** | 46.8% | 21.6% | 495 | 360 | 1.54 | 2.47 | 2.34 |

Notes:
2023 Data are found in Appendix A

**Table C-3: Total Ground Cover, one-sample, one-sided sign test- reverse null, O-VMU-3, 2023**

| Transect | Total Ground Cover | 90% of Technical Standard | Difference |
|---|---|---|---|
| O-VMU3-T01A | 62 | 46.8 | 15 |
| O-VMU3-T01P | 58 | 46.8 | 11 |
| O-VMU3-T02P | 70 | 46.8 | 23 |
| O-VMU3-T03P | 46 | 46.8 | -1 |
| O-VMU3-T04P | 50 | 46.8 | 3 |
| O-VMU3-T05P | 58 | 46.8 | 11 |
| O-VMU3-T06P | 72 | 46.8 | 25 |
| O-VMU3-T07P | 72 | 46.8 | 25 |
| O-VMU3-T08P | 62 | 46.8 | 15 |
| O-VMU3-T09P | 66 | 46.8 | 19 |
| O-VMU3-T10P | 44 | 46.8 | -3 |
| O-VMU3-T11P | 34 | 46.8 | -13 |
| O-VMU3-T12P | 70 | 46.8 | 23 |
| O-VMU3-T13P | 56 | 46.8 | 9 |
| O-VMU3-T14P | 76 | 46.8 | 29 |
| O-VMU3-T15P | 54 | 46.8 | 7 |
| O-VMU3-T16P | 62 | 46.8 | 15 |
| O-VMU3-T17P | 58 | 46.8 | 11 |
| O-VMU3-T18P | 44 | 46.8 | -3 |
| O-VMU3-T19P | 68 | 46.8 | 21 |
| O-VMU3-T20P | 42 | 46.8 | -5 |
| O-VMU3-T21P | 70 | 46.8 | 23 |
| O-VMU3-T22P | 74 | 46.8 | 27 |
| O-VMU3-T23P | 44 | 46.8 | -3 |
| O-VMU3-T24P | 32 | 46.8 | -15 |
| O-VMU3-T25P | 66 | 46.8 | 19 |
| O-VMU3-T26P | 52 | 46.8 | 5 |
| O-VMU3-T27P | 58 | 46.8 | 11 |
| O-VMU3-T28P | 70 | 46.8 | 23 |
| O-VMU3-T29P | 48 | 46.8 | 1 |
| O-VMU3-T30P | 50 | 46.8 | 3 |
| O-VMU3-T31P | 70 | 46.8 | 23 |
| O-VMU3-T32P | 72 | 46.8 | 25 |
| O-VMU3-T33P | 56 | 46.8 | 9 |
| O-VMU3-T34P | 68 | 46.8 | 21 |
| O-VMU3-T35P | 68 | 46.8 | 21 |
| O-VMU3-T36P | 56 | 46.8 | 9 |
| O-VMU3-T38P | 72 | 46.8 | 25 |
| O-VMU3-T39P | 64 | 46.8 | 17 |
| O-VMU3-T40P | 62 | 46.8 | 15 |
| | | k | 7 |
| | | n | 40 |
| | | z | -3.95 |
| | | Standard one-tailed normal curve area (Table C-3; MMD, 1999) | 0.499961387 |
| | | P | 0.00004 |

Notes:

Data is from Table C-2

*When k exceeds 50% of n-observations, the performance standard has not been met*

P = 0.5-Area = prob of observing z; ≤0.1 performance standard met

**z value calculation:**

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

k (7) ≤ 20, P (0.00004) ≤ 0.1, **performance standard is met**

**Table C-4: Perennial Vegetaion Foliar Cover, one-sample, one-sided t-test - classical null (left-sided), O-VMU-3, 2023**

| Total Perennial Cover (%) | |
|---|---|
| Mean (%) | 37.1 |
| Standard Deviation (%) | 12.2 |
| Sample Size | 40 |
| Technical Standard (%) | 24 |
| t* | 8.061 |
| 1-tail t (0.1, 40) | -1.304 |

Notes:
Data is from Table C-2
Decision Rules (the Permit - Appendix 6.5-B):
t* < t (α; n-1), failure to meet standard
t* ≥ t (α; n-1), performance standard met
t from Section 3, Table 1 (WDEQ, 2012)
Test Statistic: $t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$

t*(8.061) ≥ t (-1.304), **performance standard is met**

**Table C-5: Annual Forage Production, one-sample, one-sided sign test- reverse null, O-VMU-3, 2023**

| Transect | Annual Forage Production | 90% of Technical Standard | Difference |
|---|---|---|---|
| O-VMU3-T01A | 259 | 495 | -236 |
| O-VMU3-T01P | 173 | 495 | -322 |
| O-VMU3-T02P | 893 | 495 | 398 |
| O-VMU3-T03P | 1,148 | 495 | 653 |
| O-VMU3-T04P | 142 | 495 | -353 |
| O-VMU3-T05P | 797 | 495 | 302 |
| O-VMU3-T06P | 1,690 | 495 | 1,195 |
| O-VMU3-T07P | 658 | 495 | 163 |
| O-VMU3-T08P | 365 | 495 | -130 |
| O-VMU3-T09P | 585 | 495 | 90 |
| O-VMU3-T10P | 456 | 495 | -39 |
| O-VMU3-T11P | 677 | 495 | 182 |
| O-VMU3-T12P | 1,130 | 495 | 635 |
| O-VMU3-T13P | 539 | 495 | 44 |
| O-VMU3-T14P | 969 | 495 | 474 |
| O-VMU3-T15P | 763 | 495 | 268 |
| O-VMU3-T16P | 1,610 | 495 | 1,115 |
| O-VMU3-T17P | 1,953 | 495 | 1,458 |
| O-VMU3-T18P | 458 | 495 | -37 |
| O-VMU3-T19P | 1,740 | 495 | 1,245 |
| O-VMU3-T20P | 264 | 495 | -231 |
| O-VMU3-T21P | 855 | 495 | 360 |
| O-VMU3-T22P | 441 | 495 | -54 |
| O-VMU3-T23P | 665 | 495 | 170 |
| O-VMU3-T24P | 1,263 | 495 | 768 |
| O-VMU3-T25P | 236 | 495 | -259 |
| O-VMU3-T26P | 890 | 495 | 395 |
| O-VMU3-T27P | 508 | 495 | 13 |
| O-VMU3-T28P | 532 | 495 | 37 |
| O-VMU3-T29P | 332 | 495 | -163 |
| O-VMU3-T30P | 958 | 495 | 463 |
| O-VMU3-T31P | 765 | 495 | 270 |
| O-VMU3-T32P | 1,498 | 495 | 1,003 |
| O-VMU3-T33P | 959 | 495 | 464 |
| O-VMU3-T34P | 993 | 495 | 498 |
| O-VMU3-T35P | 631 | 495 | 136 |
| O-VMU3-T36P | 726 | 495 | 231 |
| O-VMU3-T38P | 1,831 | 495 | 1,336 |
| O-VMU3-T39P | 581 | 495 | 86 |
| O-VMU3-T40P | 690 | 495 | 195 |
| | | k | 10 |
| | | n | 40 |
| | | z | -3.00 |
| | | Standard one-tailed normal curve area (Table C-3; MMD, 1999) | 0.49866844 |
| | | P | 0.001 |

Notes:

Data is from Table C-2

*When k exceeds 50% of n-observations, the performance standard has not been met*

P = 0.5-Area = prob of observing z; ≤0.1 performance standard met

**z value calculation:**

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

k (10) ≤ 20, P (0.001) ≤ 0.1, **performance standard is met**

**Table C-6: Woody Plant Density, one-sample, one-sided sign test- reverse null, O-VMU-3, 2023**

| Transect | Annual Forage Production | 90% of Technical Standard | Difference |
|---|---|---|---|
| O-VMU3-T01A | 1,052 | 360 | 692 |
| O-VMU3-T01P | 2,145 | 360 | 1,785 |
| O-VMU3-T02P | 1,214 | 360 | 854 |
| O-VMU3-T03P | 4,006 | 360 | 3,646 |
| O-VMU3-T04P | 1,295 | 360 | 935 |
| O-VMU3-T05P | 1,497 | 360 | 1,137 |
| O-VMU3-T06P | 3,885 | 360 | 3,525 |
| O-VMU3-T07P | 1,335 | 360 | 975 |
| O-VMU3-T08P | 1,174 | 360 | 814 |
| O-VMU3-T09P | 2,064 | 360 | 1,704 |
| O-VMU3-T10P | 971 | 360 | 611 |
| O-VMU3-T11P | 3,399 | 360 | 3,039 |
| O-VMU3-T12P | 2,388 | 360 | 2,028 |
| O-VMU3-T13P | 971 | 360 | 611 |
| O-VMU3-T14P | 3,521 | 360 | 3,161 |
| O-VMU3-T15P | 1,133 | 360 | 773 |
| O-VMU3-T16P | 1,376 | 360 | 1,016 |
| O-VMU3-T17P | 1,497 | 360 | 1,137 |
| O-VMU3-T18P | 1,781 | 360 | 1,421 |
| O-VMU3-T19P | 1,740 | 360 | 1,380 |
| O-VMU3-T20P | 283 | 360 | -77 |
| O-VMU3-T21P | 2,023 | 360 | 1,663 |
| O-VMU3-T22P | 2,469 | 360 | 2,109 |
| O-VMU3-T23P | 1,538 | 360 | 1,178 |
| O-VMU3-T24P | 5,220 | 360 | 4,860 |
| O-VMU3-T25P | 2,428 | 360 | 2,068 |
| O-VMU3-T26P | 2,185 | 360 | 1,825 |
| O-VMU3-T27P | 1,538 | 360 | 1,178 |
| O-VMU3-T28P | 971 | 360 | 611 |
| O-VMU3-T29P | 2,145 | 360 | 1,785 |
| O-VMU3-T30P | 2,266 | 360 | 1,906 |
| O-VMU3-T31P | 1,416 | 360 | 1,056 |
| O-VMU3-T32P | 1,255 | 360 | 895 |
| O-VMU3-T33P | 2,347 | 360 | 1,987 |
| O-VMU3-T34P | 1,862 | 360 | 1,502 |
| O-VMU3-T35P | 3,642 | 360 | 3,282 |
| O-VMU3-T36P | 2,266 | 360 | 1,906 |
| O-VMU3-T38P | 850 | 360 | 490 |
| O-VMU3-T39P | 486 | 360 | 126 |
| O-VMU3-T40P | 809 | 360 | 449 |
| | | k | 1 |
| | | n | 40 |
| | | z | -5.85 |
| | | Standard one-tailed normal curve area (Table C-3; MMD, 1999) | 0.499999998 |
| | | P | 0.000000002 |

Notes:

Data is from Table C-2

*When k exceeds 50% of n-observations, the performance standard has not been met*

P = 0.5-Area = prob of observing z; ≤0.1 performance standard met

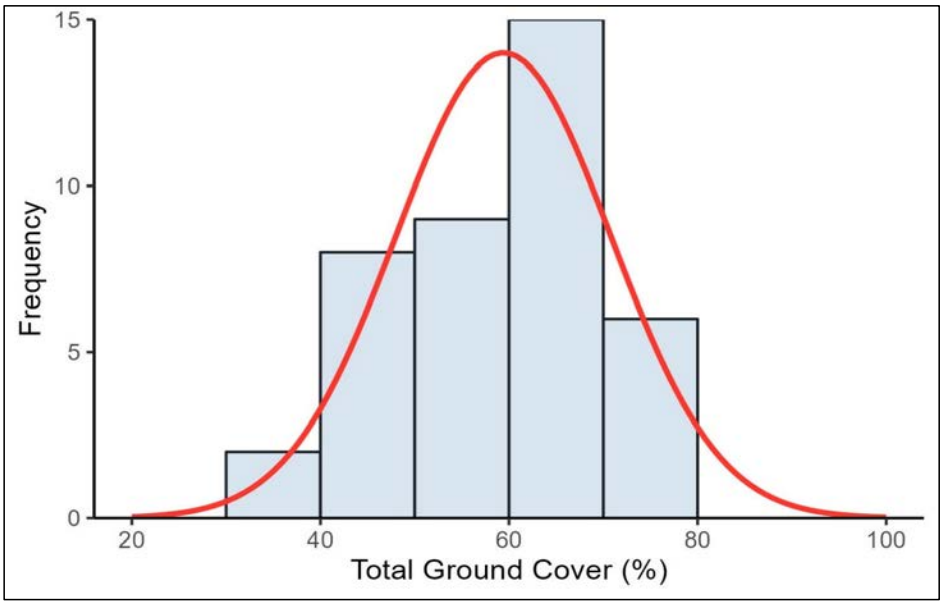
**z value calculation:**

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

k (1) ≤ 20, P (0.000000002) ≤ 0.1, **performance standard is met**

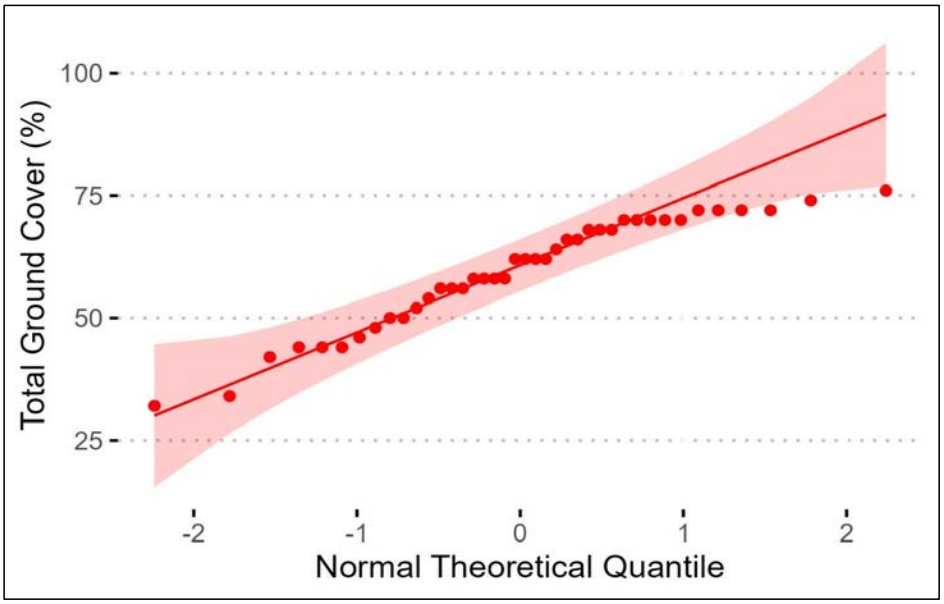
**Figure C-1: Total Ground Cover (%), O-VMU-3, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 59.4 | 56.44 | 62.36 | 2 | 11 | -0.59 | -0.61 | 51.50 | 62.00 | 70.00 |

**Normality**



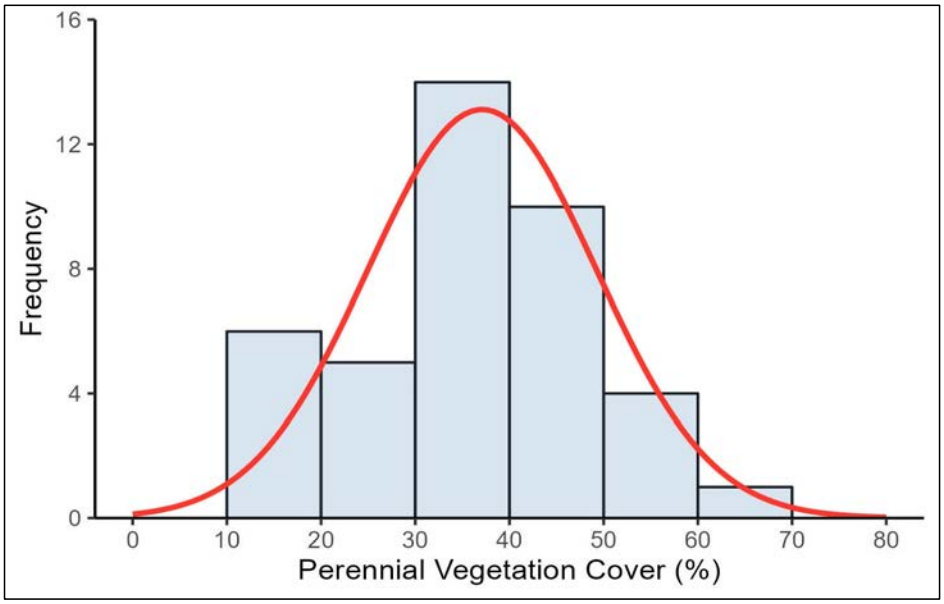

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.93775 | 0.029063 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P < 0.1)**
*(Data are not normally distributed)*

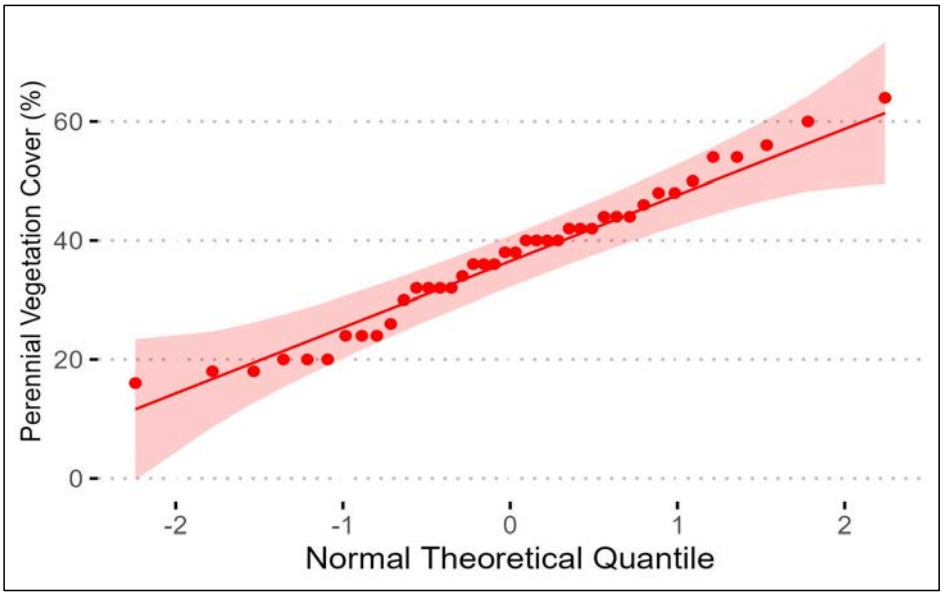
**Figure C-2: Perennial Vegetation Foliar Cover (%), O-VMU-3, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 37.1 | 33.94 | 40.26 | ## | ## | 0.10 | -0.73 | 29.00 | 38.00 | 44.00 |

**Normality**



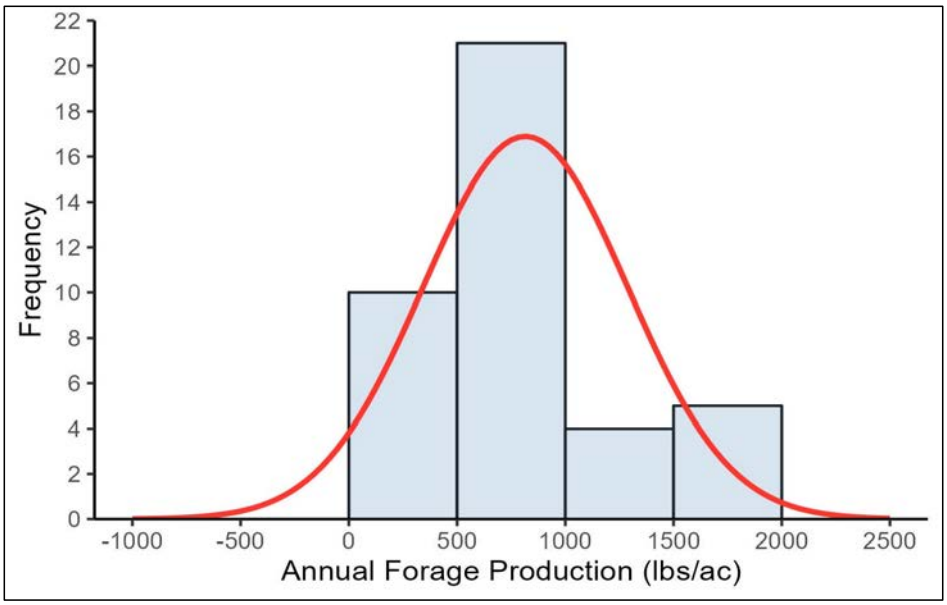

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.97464 | 0.497825 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Fail to reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P > 0.1)**
*(Data are normally distributed)*

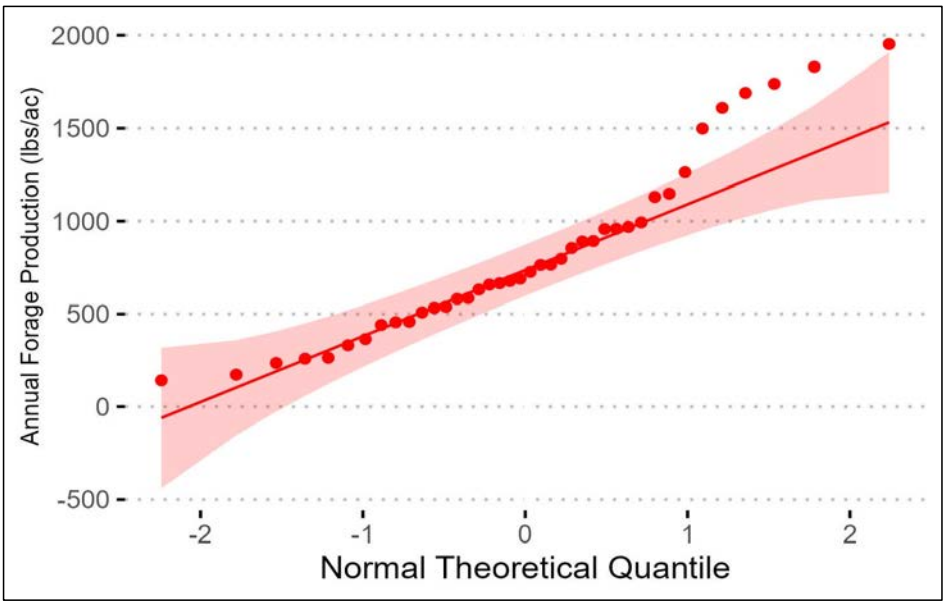
**Figure C-3: Annual Forage Production (lbs/ac), O-VMU-3, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 815.5 | 692.62 | 938.33 | 74.68 | 472.33 | 0.81 | -0.19 | 495.83 | 707.72 | 975.04 |

**Normality**



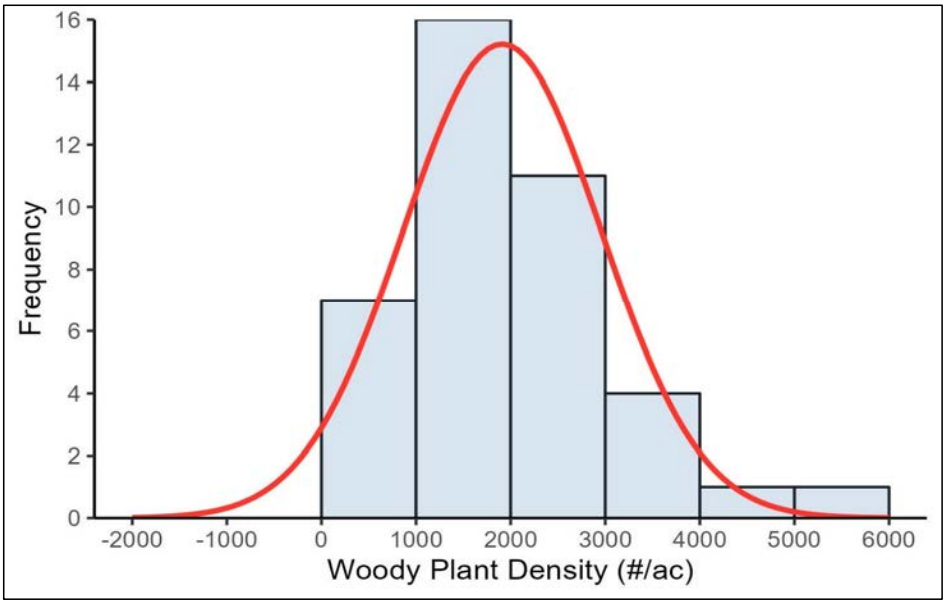

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.92331 | 0.009805 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P < 0.1)**
*(Data are not normally distributed)*

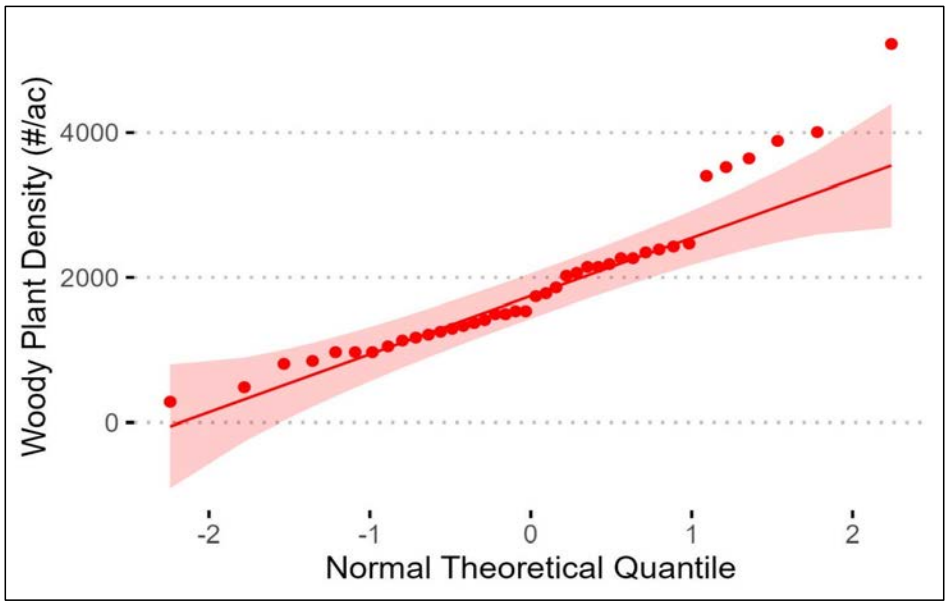
**Figure C-4: Woody Plant Density (st/ac), O-VMU-3, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 1911 | 1638.35 | 2183.91 | 165.82 | 1048.77 | 1.11 | 1.00 | 1203.94 | 1638.98 | 2286.48 |

**Normality**



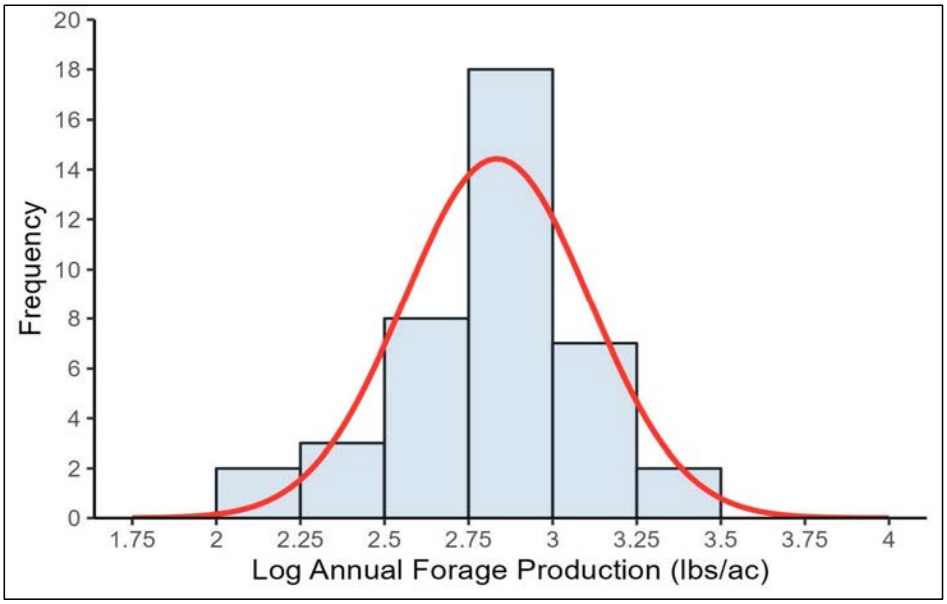

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.90737 | 0.003155 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P < 0.1)**
*(Data are not normally distributed)*

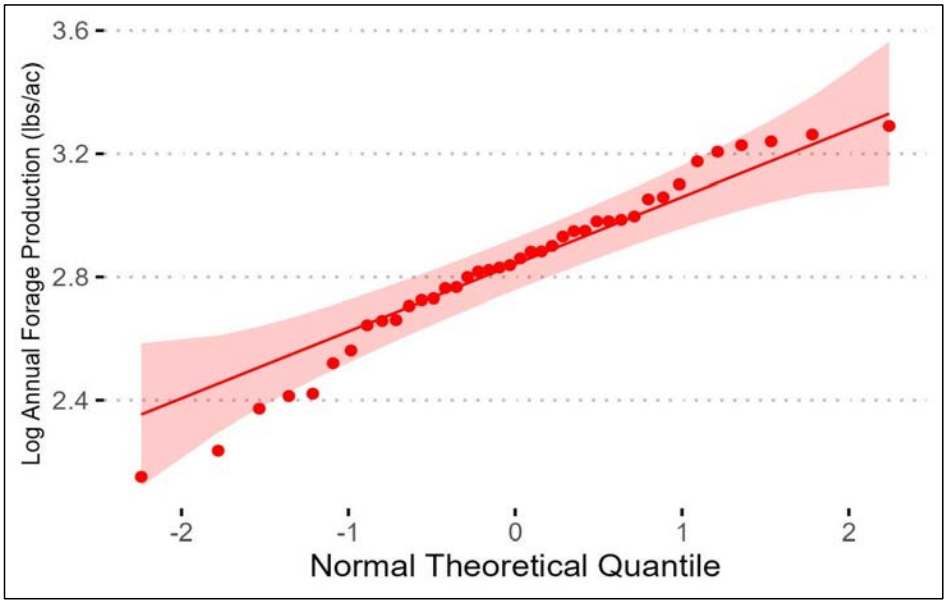
**Figure C-5: Log Annual Forage Production (lbs/acre), O-VMU-3, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 2.834 | 2.76 | 2.91 | 0.04 | 0.28 | -0.47 | -0.25 | 2.69 | 2.85 | 2.99 |

**Normality**



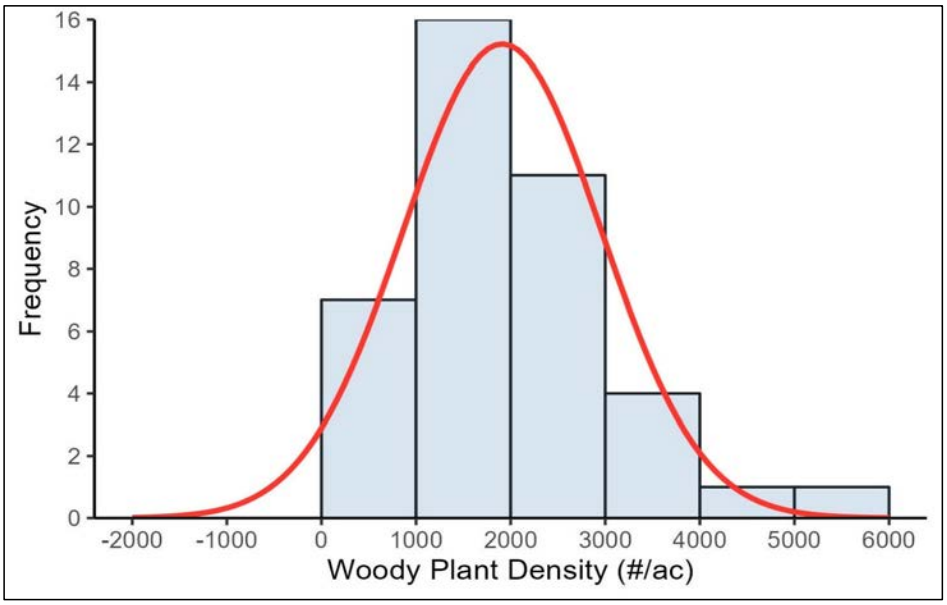

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.96877 | 0.328786 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Fail to reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P > 0.1)**
*(Data are normally distributed)*

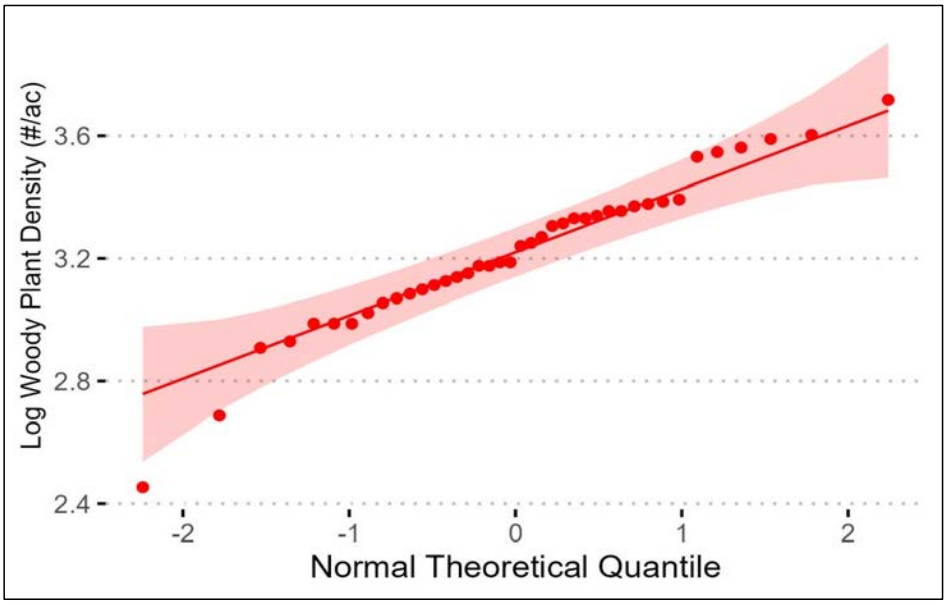
**Figure C-6: Log Woody Plant Density (st/ac), O-VMU-3, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 3.218 | 3.15 | 3.28 | 0.04 | 0.25 | -0.54 | 0.82 | 3.08 | 3.21 | 3.36 |

**Normality**




**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.96637 | 0.274488 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Fail to reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P > 0.1)**
*(Data are normally distributed)*



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REPORT

# Vegetation Management Unit 5
# Vegetation Success Monitoring, 2023

Submitted to:

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March 2024



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# 1.0 INTRODUCTION

Mining at the McKinley Mine ceased in 2009 and reclamation of remaining support facilities (e.g., impoundments, roads, etc.) is nearing completion. Reclamation practices have been applied at the McKinley Mine under various programs since at least the early 1970s. Chevron Mining Inc. (CMI) is assessing the vegetation in reclaimed areas in anticipation of future bond and liability release. CMI understands the importance of returning the mined lands to productive traditional uses in a timely manner. To qualify for release, the increment, or permit area as a whole, must meet the Permit No. NM-0001K (2016) (the Permit) permanent-program revegetation-success criteria as shown in Table 1 of this report. In general, the lands must be in a condition that is as good as or better than the pre-mine conditions, stable, and capable of supporting the designated postmining land uses of grazing and wildlife. WSP USA, Inc. (WSP) was retained to monitor and assess the vegetation relative to the established vegetation success standards.

This report documents the vegetation community attributes collected in 2023 in O-VMU-5 and compares them to the Permit's vegetation-success criteria. Section 1 includes the introduction and a general overview. Section 2 describes the vegetation monitoring methods that were used in 2023. Section 3 presents the results of the assessment with respect to total ground cover, perennial vegetation cover, forage production, woody plant density (shrub density), and composition and diversity. Section 4 is a summary of the results for O-VMU-5 with emphasis on vegetation success.

The 2023 sampling program was conducted and evaluated in accordance with the updated monitoring methods and revegetation success standards contained in Permit Modification Number 23-03. More details beyond what is already discussed throughout this report may be found in the Permit.

## 1.1 Vegetation Management Unit 5

This report presents results from 2023 quantitative vegetation monitoring conducted in Vegetation Management Unit 5 (O-VMU-5), which is in the western portion of Area 2 and minor portions of Areas 1 and 10 (Figure 1). The configuration of the vegetation monitoring units within the U.S. Department of the Interior – Office of Surface Mining Reclamation and Enforcement (OSMRE) Permit Area, were developed in consultation with OSMRE. Undisturbed lands included within the VMU were not part of the sampling program. O-VMU-5 encompasses about 1,129 acres, comprised of permanent program lands (PPL), prelaw, and initial program lands (IPL). All program land, as one unit, must meet the PPL success criteria as discussed in the Permit in Section 6.5.1.2. The 10-year period of extended responsibility, however, only applies to PPL.

The elevation of O-VMU-5 ranges from about 7,000 to 7,200 feet above mean sea level. Reclamation started in 1975 with the vast majority seeded by 2003. Thus, the reclamation in the majority of O-VMU-5 ranges from 21 to almost 50 years old. This section provides a general description of the reclamation activities that were implemented. Additional details of the reclamation for specific areas can be obtained through review of the McKinley Mine annual reports.

## 1.2 Reclamation and Revegetation Procedures

Reclamation of permanent program lands included grading of the spoils to achieve a stable configuration, positive drainage, and approximate original contour. After grading, graded spoil monitoring was conducted to determine the suitability of the materials. A minimum of 6 inches of topdressing (topsoil or topsoil substitute) were then applied over suitable spoils.

After topdressing placement, the seedbed was scarified or ripped on the contour to a depth of about 8 to 12 inches. Seeding was done using various implements that drilled and/or broadcast the seed. After the seeding, certified weed-free, long-stem, hay mulch, or straw was applied at a rate of about 2 tons per acre. The mulch was anchored 3 to 4 inches into the cover with a tractor-drawn straight coulter disc. The seeding was generally performed in the fall, which tends to favor the establishment of cool-season grasses and shrubs. The approved seed mixes used at McKinley have varied over time but included both warm-season grasses, and introduced and native cool-season grasses, introduced and native forbs, and shrubs. The early seed mixes tended to emphasize the use the alfalfa and cool-season grasses. The majority of seed mixes planted on IPL consisted of native and introduced cool season grasses, limited warm-season grasses, some shrubs, but no forbs. Over time the seed mixes on PPL shifted to include more warm-season grasses, more shrub species, and a variety of forbs.

Initial program lands were typically graded so they were no steeper than 3:1 and topsoiled. Seeding practices were like those done on permanent program lands. Prelaw lands were generally graded to be no steeper than 3:1 but were not top-dressed before seeding.

## 1.3 Prevailing Climate Conditions

The amount and distribution of precipitation are important determinants for vegetation establishment and performance. Once vegetation is established, the precipitation dynamics affect the amount of vegetation cover and biomass on a year-to-year basis with grasses and forbs showing the most immediate response. Precipitation has been monitored at the McKinley Mine throughout most of its life at two primary precipitation stations (Bluff and South Tipple). The mine added a system of 8 additional seasonal precipitation gauges to better capture more representative data from the various mining areas in 2011-2012 (gauges named by area). Data from the Rain 2 and Bluff gauges were used to evaluate precipitation in O-VMU-5 (Figure 2).

Table 2 contains a summary of precipitation recorded at all the rain gauges in the North Mine Area. Total annual precipitation measured at the Bluff gauge near the mine entrance was 8.59 inches, below the regional average of 11.8 inches at Window Rock. Rain 2 gauge recorded 4.35 inches of precipitation from late April to mid-November (the period these stations operate), whereas the Bluff gauge recorded approximately 5.24 inches of rain for the same period with data throughout all of November. Mine wide, the precipitation recorded in 2023 between April and November at the other eight gauges indicate below average precipitation, on a scale of about 2-3 inches below average, with variation both spatially and temporally.

Growing season precipitation provides additional context to evaluate vegetation performance in O-VMU-5. The departure of growing season precipitation (April through September) between Rain 2 and Bluff gauges and the Window Rock (1937-1999) long-term seasonal mean is illustrated in Figure 2. Growing season precipitation in O-VMU-5 was well below the long-term seasonal mean from 2018 to 2023, with the exception of the 2022 growing season wherein both the Rain 2 and Bluff gauges were above the seasonal mean, measuring approximately 2.42 and 3.73 inches above the mean, respectively. Growing season precipitation from the Rain 2 and Bluff gauges in 2023 were 2.43 and 2.35 inches below average, respectively.

## 1.4 Livestock

CMI has been aggressively managing trespass livestock and as a result evidence of trespass horses was less apparent in 2023 in O-VMU-5. The combination of past grazing pressure with exceptional drought, however, may in some years adversely affect the ability to demonstrate that the vegetation is meeting or can meet the revegetation success standards.

# 2.0 VEGETATION STANDARDS AND MONITORING METHODS

Vegetation attributes in O-VMU-5 were quantified using the methods described in Section 6.5 of the Permit as modified in Permit Modification 23-03. Vegetation monitoring in O-VMU-5 was conducted from September 19 through October 3, 2023.

## 2.1 Vegetation Success Standards

The vegetation success standards for the Permit Area consist of five vegetative parameters: total cover, perennial cover, forage production, woody plant density, and diversity (Table 1). The total ground cover requirement, or the combined means for live vegetation cover and litter cover on the reclamation is 52%. The perennial vegetation cover requirement is 24%. Both total ground and perennial vegetation cover use absolute cover. The annual forage production requirement is 550 air-dry pounds per acre (lbs/ac). The shrub density success standard is 400 live woody stems per acre. In accordance with 30 CFR 816.116 (a)(2), success for total cover, perennial cover, forage production, and shrub density shall be ≥ 90% of the standard.

Cover is defined in three ways for accurate evaluation of diversity according to Table 1.

1) Absolute cover utilizes first-hit line point intercept (LPI) data and is used to assess the perennial grass diversity standard.
2) Relative perennial cover, the metric used to assess some grass, forb, and shrub standards, compares the cover of perennial species relative to the sum of perennial plants calculated from all-hit LPI data (excluding noxious weeds) within the VMU.
3) Relative total cover, the metric used to assess the any-single-species diversity standard, is calculated by dividing the percent cover of each perennial/biennial species by the total live vegetative cover from all-hit LPI data (excluding noxious weeds) within a VMU.

Biennial forbs are included in the vegetation cover analyses and biennial forb diversity standards because they are important to long term ecological success of the reclamation. As monocarpic, or single flowering species, these forbs produce a high number of seeds, and as a result, persist long-term in the reclamation plant community. Future mention of “perennial” in this report thus includes biennial species.

Relative shrub density, the metric used to assess the single shrub species standard, is calculated using belt-transect data by dividing the density of each species by the total density within a sampling unit. Relative calculations are valuable to determine whether a species or functional group is excessively dominant. The number of species requirement for the various diversity standard components (e.g., ≥ 2 species cool-season grasses) is calculated by adding the total number of unique species captured in the LPI surveys.

Diversity is evaluated against numerical guidelines for different vegetation types. In summary, the diversity guideline is met if perennial grasses contribute 7% or more absolute vegetation cover; at least two cool-season perennial grasses have individual relative perennial vegetation covers of 5% and 1.5% or more; at least two warm-season perennial grasses species with the highest cover species 5% or more relative perennial vegetation cover and the remaining species combining to contribute 1.5% or more relative perennial vegetation cover, at least three non-annual non-noxious forbs combining to contribute 1% or more relative total vegetation cover; shrubs combining to 6% or more relative perennial vegetation cover and no single shrub species with greater than 70% relative shrub density, and no single species of any functional group with 40% or more relative total vegetation cover. Diversity is also demonstrated by evidence of colonization or recruitment of native (not-seeded) plants from adjacent undisturbed native areas.

## 2.2 Sampling Design

All lands (PPL, Prelaw and IPL) were included in the vegetation-sampling pool for unbiased random sampling. The transect locations were reviewed with OSMRE in advance of sampling. A 100-meter (m) by 100 m square grid was superimposed over the entire VMU to delineate vegetation sample plots. Random points were created in a geographic information system and the locations including the program land (IPL or PPL) designations are shown in Figure 3. In the field, the randomly selected transect locations were assessed in numerical order with 40 primary transects accompanied by 10 alternate transects. If a transect location was determined to be unsuitable, the next alternative location was assessed for suitability. Transects that fell on or would intersect roads, drainage ways, wildlife rock piles, or prairie dog colonies were considered unsuitable.

Figure 4 shows the 100 m by 100 m vegetation plot with the cover transect orientation, and the location of the production quadrats and belt transect. The origin of the LPI transect is situated at the grid centroid and transect orientation (from 0° to 360°) is chosen randomly beginning from the transect origin, the point navigated to. LPI points are traversed to on transect left with the laser pointed towards transect right, to limit disturbance from walking on the quad and belt survey areas located on transect right. Each LPI transect is 50 m long with three half square meter (½ $m^2$) production quadrats placed flush with the meter tape with the bottom left corner at the 10, 25, and 40 m mark to the right of the transect. The belt transect corridor is 2 m by 50 m along the transect's right side.

## 2.3 Foliar, Canopy and Ground Cover

The LPI method is used to collect cover measurements required by the Permit to evaluate total cover, perennial cover, and diversity. Prior to production clipping, a 50 m measuring tape is suspended between two metal pins to extend the tape fully. A tripod mounted laser is then held along the edge of the tape, and readings are taken every meter for living plants, plant litter, rock fragments, and bare ground. When a live plant is encountered as a direct foliar hit, the species is recorded, and direct lower canopy live plant hits are also recorded that are observed down the profile. The LPI-derived data were evaluated against the permit area vegetation success standards for vegetation cover and diversity provided in Table 1, with first hits used in absolute cover calculations and all hits (upper and lower canopy hits) used in relative cover calculations.

Additional cover measurements were estimated from each production quadrat including relative cover for each species and total canopy cover, surface litter, rock fragments, and bare soil. Quadrat canopy cover data is not analyzed for success and is only briefly discussed in this report as additional support information (Table A-4). Canopy cover estimates include the foliage and foliage interspaces of all individual plant species rooted in the quadrat. Canopy cover is defined as the percentage of quadrat area included in the vertical projection of the canopy. The canopy cover estimates made on a species basis may exceed 100 percent in individual quadrats where the vegetation has multi-layered canopies. In contrast, the sum of the total canopy cover, surface litter, rock fragments, and bare soil does not exceed 100 percent. All cover estimates were made in 0.05 percent increments. Percent area cards were used to increase the accuracy and consistency of the cover estimates.

Not all plant species are expected to occur in the sampling transects and quadrats. Plants observed growing within the vegetation plots and across the reclaimed facility were inventoried while moving between sample locations and during formal sampling (Table A-7).

## 2.4 Annual Forage and Total Production

Forage production required by the Permit was determined by clipping and weighing all annual (current year's growth) above-ground forage biomass within the vertical confines of the three ½ $m^2$ quadrats placed systematically along the same 50 m transect used for LPI measurements. Biomass from all three quads from each transect are combined by species and the combined values for the transect (not the quads) are treated as a sampling unit. Production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. The Permit allows for excessively grazed production quadrats to be considered for exclusion from the sampling analysis in consultation with OSMRE, but no quadrats needed to be excluded in O-VMU-5 (the Permit, Section 6.5.2.2).

Grasses and forbs were clipped to within 5 centimeters (cm) of the soil surface, and the current year's growth was segregated from the previous year's growth (e.g., gray, weathered grass leaves, and dried culms). Production from shrubs was determined by clipping the current year's growth. Annuals and noxious weeds (e.g., Russian knapweed [*Acroptilon repens*]), when encountered, were not clipped. Photographs of the individual production quadrats are included in Appendix B.

The plant biomass samples of every species collected per transect were placed individually in labeled paper bags. The samples were air-dried (~ 90 days) until no weight changes were observed with repeated measurements on representative samples. The average tare weight of the empty paper bags was determined to correct the total sample weight to air-dry vegetation weights. The net weight of the air-dried vegetation was converted to a lbs/ac.

## 2.5 Shrub Density

Shrub density (as required by the Permit), or the number of stems per square meter (stems/$m^2$), was determined using the belt transect method (Bonham 1989). The belt transect was located parallel to the 50 m transect used to determine cover. Shrubs rooted in the 2 m belt transect were counted on a species basis. A 2 m folding ruler was horizontally oriented perpendicular to the tape to ensure that observations were taken within the 2 m corridor. The number and species of woody plant stems within the belt transect were recorded.

## 2.6 Statistical Analysis

The procedures for liability release and the basis for statistical analysis applied in this report may be found in the Permit, and as referenced in the Permit: the Wyoming Department of Environmental Quality (WDEQ) handbook of sampling and statistical methods (WDEQ 2012), and the New Mexico Mining and Minerals Division (MMD) Coal Mine Reclamation Program guidelines (MMD 1999). Additional resources include Evaluation and Comparison of Hypothesis Testing Techniques for Bond Release Applications (McDonald et al. 2003), which was the basis of the WDEQ handbook, and other sources referenced herein. More specifically, Figure 6.5-1 and Appendix 6.5-B of the Permit guide the statistical approach in determining vegetation success for total ground cover, perennial vegetation cover, annual forage production, and shrub density. The statistical analyses applied to the O-VMU-5 vegetation data are presented in Appendix C including equations for vegetation data analysis, vegetation attribute data with descriptive statistics, the statistical analyses comparing these attributes to the revegetation success standards, the statistical model, and descriptive statistics and normality for the vegetation attributes.

Descriptive statistics and statistical adequacy are presented for total ground cover, perennial vegetation cover, annual forage production, and shrub density in Tables 3 and C-2. Vegetation attribute data (Table C-2) was evaluated with the Shapiro-Wilk test to determine if data are normally distributed (Figures C-2 to C-6). For normally distributed data, statistical adequacy was assessed (Snedecor and Cochran 1967). Hypothesis testing

for normal data that met sample adequacy was conducted using a one-sample, one-sided t-test under the classical null hypothesis. A one-sample, one-sided t-test using the reverse null hypothesis was applied for normally distributed data which failed to meet statistical adequacy. A non-parametric one-sample, one-sided sign test using the reverse null hypothesis was applied to data that was not normally distributed and did not meet sample adequacy. While transformed data was not used in hypothesis testing for satisfying standards, as a supplemental analyses, non-normal data were log-transformed. If the transformed data resulted in a normal distribution, one of the t-tests previously described was performed depending on sample adequacy. If transformed data were also non-normal, data were analyzed using the non-parametric one-sample, one-sided sign test using the reverse null hypothesis on the non-transformed data.

The following presents the statistical approach in more detail. Descriptive statistics and statistical tests were performed using both Microsoft® Excel and R-Studio (version 4.2.2).

### 2.6.1 Normality and Statistical Adequacy

The normality of each dataset was first assessed using the Shapiro-Wilk test to determine the appropriate hypothesis test method (i.e., parametric versus non-parametric). The Shapiro-Wilk null hypothesis is that the samples (of size n) come from a normal distribution. Data were considered normal when the test statistic had a p-value > 0.10 for alpha (α) = 0.10.

The number of samples required to characterize a particular vegetation attribute depends on the uniformity of the vegetation and the desired degree of certainty required for the analysis. The number of samples necessary to meet sample adequacy ($N_{min}$) was calculated assuming the data were normally distributed using Snedecor and Cochran (1967) equation below.

$$N_{min} = \frac{t^2 s^2}{(\overline{x}D)^2}$$

Where $N_{min}$ equals the minimum number of samples required, $t$ is the two-tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom, $s$ is the standard deviation of the sample data, $\overline{x}$ is the mean, and $D$ is the desired level of accuracy, which is 10 percent of the mean in this case.

In addition to $N_{min}$, the standard deviation and the 90% confidence interval (CI) about the sample means are reported in Table 3.

It is often impractical to achieve sample adequacy in vegetation monitoring studies based on Snedecor and Cochran's equation listed above. In such cases, the Permit allows a maximum sample number approach to compare the data regardless of the distribution (WDEQ 2012, MMD 1999). Where sample adequacy cannot be met because of operational constraints or for other reasons, 40 samples is considered adequate as stated in the Permit. The 40-sample maximum is based on an estimate of the number of samples needed for a t-test under a normal distribution (Sokal and Rohlf 1981). Schulz et al. (1961) demonstrated that 30 to 40 samples provide a robust estimate for most cover and density measures with increased numbers of samples only slightly improving the precision of the estimate.

The maximum 40 samples were collected at the outset of sampling based on the guidance discussed above. Each transect is considered a unique sampling unit. Sample adequacy was calculated to determine the number of samples that would have been required for adequacy by the Snedecor and Cochran equation. Further analysis for

sample adequacy of cover, production and density attributes was also demonstrated using a graphical stabilization of the mean method (Clark 2001).

### 2.6.2 Hypothesis Testing

The emphasis on statistical adequacy assumes that parametric tests of normally distributed data will be conducted to demonstrate compliance with the vegetation success standards. Thus, if statistical adequacy is met for normally distributed data, the data would be analyzed with a one-sample, one-sided t-test using the classical null hypothesis. Non-parametric hypothesis tests have sufficient power to analyze data that are not normally distributed. Thus, if data is not-normal then it is permissible based on the Permit and technically appropriate to use one-sample, one-sided sign test using the reverse null approach as encouraged by OSMRE.

Hypothesis testing used to demonstrate compliance with the vegetation success standards for total ground cover, perennial vegetation cover, annual forage production, and shrub density were structured as follows (in accordance with Appendix 6.5-B of the Permit):

Classical Null Hypothesis:

$H_0$: Reclaim ≥ 90% of the Performance Standard

$H_a$: Reclaim < 90% of the Performance Standard

Where $H_0$ is the null hypothesis, and $H_a$ is the alternative hypothesis.

The one-sample, one-sided t-test using the classical null hypothesis decision rules based on the test statistic are:

If $t^* \geq t_{(\alpha; n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha; n-1)}$, conclude failure to meet the performance standard.

Test Statistic:

$$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

Where t* is the calculated t-statistic, $\bar{x}$ is the sample mean, s is the standard deviation, n is the sample size, and α = 0.10.

Reverse Null Hypothesis:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

One-sample, one-sided sign test using the reverse null hypothesis decision rules are:

If P < 0.10 or $z < z_\alpha$ (for α = 0.10, $z_\alpha$ = -1.282), conclude that the performance standard was met (i.e., $H_o$ is rejected, the revegetation values tend to be statistically greater than 90% of the technical standard).

If P ≥ 0.10 or z ≥ $z_\alpha$ (α = 0.10, $z_\alpha$ = -1.282), conclude failure to meet the performance standard (i.e., $H_o$ is NOT rejected, the revegetation values tend to be statistically less than or equal to 90% of the technical standard).

The z critical values of the normal distribution can be found in WDEQ, Table 1 (2012)

Sign Test Statistic:

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

Where z is the sign test statistic (Daniel 1990), k is the test statistic resulting from the number of measurements that were less than 90% of the technical standard, and n is the sample size.

All hypothesis tests were performed with a 90% level of confidence. Hypothesis testing was not conducted for parameters where the mean or median did not exceed the minimum permit requirements.

# 3.0 RESULTS

The vegetation in O-VMU-5 is well established and dominated by perennial plants and the vegetation community achieved full compliance with the vegetation success standards in 2023. Table 3 summarizes the results for total ground cover, perennial vegetation cover, annual forage production and woody plant density (shrub density) along with their corresponding technical standard.

Field data for LPI foliar cover, quadrat canopy cover, annual forage production and shrub density by the belt transect are included in Appendix A (Tables A1-A7). Photographs of the individual production quadrats are included in Appendix B and a representative photograph of the vegetation and topography is shown in Figure 5.

Table 4 summarizes the attributes for plants recorded in the LPI transects and production quadrats and Table A-7 summarizes all species observed within belt and quadrat surveys as well as those recorded opportunistically between survey areas during monitoring. Recruitment of additional native plant species is indicative of ecological succession and the capacity of the site to support a self-sustaining ecosystem.

Field data results and statistics are discussed by parameter in the sections that follow.

## 3.1 Total Ground and Perennial Vegetation Cover

Total ground cover exceeded the revegetation success standard and met the required statistical demonstration. Total ground cover based on first hit LPI data in O VMU-5 in 2023 had a mean of 60.5 ± 3.1% and a median of 60% (Table 3), exceeding the revegetation success standard. This was composed of live vegetation cover (43.5 ± 3.0%) and litter cover (17.0 ± 2.6%). Live vegetation foliar cover in individual transects ranged from 12 to 32 hits (24 to 64% cover) and litter cover ranged from 1 to 22 hits (2 to 44% cover) calculated from first hit LPI data (Table A-1).

Perennial vegetation cover, based on first hit LPI data, was calculated by summing the perennial and biennial species vegetation cover of the sampling unit excluding annuals and noxious weeds. The average perennial cover was 39.5 ± 3.0% and the median cover was 36% (Table 3), exceeding the revegetation success standard. Perennial vegetation cover in the individual transects varied from 11 to 32 hits (22 to 64% cover) (Table A-1). For quadrat cover data (not used in evaluating standards), the mean total vegetation canopy cover was 30.9%, ranging from 0.2 to 94% among individual quadrats (Table A-4).

For O-VMU-5, total ground cover data were normally distributed but perennial vegetation cover data were not normally distributed (Figures C-1 and C-2 respectively). Sample adequacy, estimated using the Snedecor and Cochran (1967) equation, was 11 samples for total ground cover and 25 samples for perennial vegetation cover, the minimum sample sizes needed to meet sample adequacy ($N_{min}$) at the 90% confidence level (Table 3). Both met sample adequacy with a sample size of 40.

Total ground cover data were normally distributed (Figure C-1) and met sample adequacy, so data were statistically analyzed using a one-sample, one-sided t-test using the classical null hypothesis. The resulting t*-statistic for perennial vegetation cover was 7.365, with a sample mean of 60.5%, a standard deviation of 11.8%, measured against a one-tail $t_{(0.1, 39)}$ value of -1.304. So, under the classical null hypothesis ($t^* \geq t_{(\alpha; n-1)}$), we conclude that the performance standard of 52% perennial vegetation cover was met (Table C-3).

Perennial vegetation cover data were not normally distributed so the one-sample, one-sided sign test with the reverse null hypothesis was used to test the mean against 90% of the technical standard of 24%. Of the 40 transects, all 40 exceeded 90% of the technical standard (Table C-3) resulting in a probability (P) of <.001 of observing a z-value less than -6.17. Therefore, under the reverse null hypothesis we conclude that the total ground cover performance standard was met in 2023.

## 3.2 Production

Forage production exceeded the revegetation success standard and met the required statistical demonstration. Forage production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. Annual forage production in O-VMU-5 in 2023 was 848 ± 149 lbs/ac (median of 701 lbs/ac) (Table 3). Annual forage production in individual transects ranged from 59 to 2,646 pounds per acre (Table A-5). Perennial grasses (20 species) contributed the most forage with 585 lbs/ac, while shrubs (eight species) contributed 234 lbs/ac and 19 perennial forbs contributed 29 lbs/ac (Table 4).

Annual forage production data for O-VMU-5 were not normally distributed (Figure C-3). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for annual forage production was 130 samples (Table 3). Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean method (Clark 2001) with 90% CI (Figure 6). The mean begins to stabilize after about 16 samples and the confidence levels show little change after this. The analysis suggests that improvements in variability around the mean would likely not have improved with additional samples beyond the 40 samples collected for annual forage production.

The one-sample, one-sided sign test with the reverse null hypothesis was used to test the mean against 90% of the technical standard of 550 lbs/ac. Of the 40 transects, 28 exceeded 90% of the technical standard (Table C-5) resulting in a probability (P) of 0.009 of observing a z-value less than -2.37. Therefore, under the reverse null hypothesis we conclude that the annual forage production performance standard is met in 2023.

## 3.3 Shrub Density

Shrub density exceeded the revegetation success standard and met the required statistical demonstration. In 2023 shrub density in O-VMU-5 substantially exceeded the vegetation success standard of 400 stems/ac from belt transect data with an average of 2,180 ± 455 stems/ac and a median of 1,599 stems/ac (Table 3). Twenty-two woody plant species were encountered in the belt and LPI transect sampling. Fourwing saltbush (*Atriplex canescens*) was the most common shrub encountered in both methods (Tables 5, A-1 and A-4).

The shrub density data for O-VMU-5 were not normally distributed (Figure C-4) but the log transformed data were normal (Figure C-5). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for shrub density was 183 samples (Table 3). Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean method (Clark 2001) showing 90% CI (Figure 7). The mean remains stable from 28 samples onward, and the 90% CI shows very little change after this. This analysis suggests that 40 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of shrub density.

The one-sample, one-sided sign test with the reverse null hypothesis was used to test the mean against the 90% of the technical standard of 400 stems per acre. Of the 40 transects, 38 exceeded 90% of the technical standard (Table C-6) resulting in a probability (P) of <0.001 of observing a z-value less than -5.53. Therefore, under the reverse null hypothesis we conclude that the woody plant density performance standard is met in 2023.

## 3.4 Composition and Diversity

In 2023, the standards were met for all of the individual diversity standards in O-VMU-5 (Table 6a). The revegetation diversity standards are based on a “lifeform statement” for grasses, forbs, and shrubs (Table 1) that consists of 12 individual parameters. The results for composition and diversity are discussed below by parameter. Relative perennial values of individual species and functional groups are calculated relative to the total perennial vegetation cover of 39.5% reported in Section 3.1. This data is calculated from all-hit LPI data (Table A-2). Relative perennial vegetation cover of individual species is listed in Table 4.

Grasses dominated the perennial vegetation cover with James’ galleta (*Pleuraphis jamesii*) representing the highest cover of the warm-season grasses by far (Table 4). Cool-season grasses also dominated the vegetation reflecting the past seed mixes, season of seeding, and the site’s continued ability to support a diverse group of cool-season grasses. Western wheatgrass (*Pascopyrum smithii*) and needle and thread (*Hesperostipa comata*) represented the highest cover of the cool-season grasses. Shrubs are important components of the reclamation due to their persistence and tolerance to harsh conditions. The woody plant component is dominated primarily by fourwing saltbush, with rubber rabbitbrush (*Ericameria nauseosa*) and winterfat (*Krascheninnikovia lanata*) subdominant. Perennial forb species occurred on the LPI transects, though they are minor contributors to vegetation cover, accounting for 1.4% absolute vegetation cover with sweetclover (*Melilotus officinalis*) contributing the highest cover.

The perennial grass diversity standard requires a total absolute vegetation cover of at least 7%, which was achieved in 2023 with 28.6%. The diversity standard for cool-season perennial grasses was achieved with 17 total species, and two species that represent at least 5 and 2.5% relative perennial vegetation cover (western wheatgrass [8.0%] and needle and thread [7.4%]). The diversity standard for warm-season grasses is achieved with seven total species, one species representing at least 5% (James’ galleta [23.1%]) and all remaining species representing over 1.5% relative perennial vegetation cover at 9.1%.

The perennial forb diversity standard requires at least three perennial/biennial forbs (not including noxious weeds) combining to at least 1% relative perennial vegetation cover (calculated based on the percent foliar cover of perennial species excluding annuals and noxious weeds). This standard was achieved in 2023 with 11 species totaling 3.3% relative perennial vegetation cover with the greatest contributions from sweetclover (0.8 %) and spreading fleabane (0.7%, *Erigeron divergens*).

The diversity standard for shrubs requires the relative perennial vegetation cover for all shrub species to total at least 6% with no single shrub exceeding or equal to 70% relative shrub density. Both of these standards were

achieved with 22.8% relative perennial vegetation cover of all shrubs and 63.2% relative shrub density of fourwing saltbush – the most dominant shrub.

Lastly, the diversity standards require that no single species of any functional group represent greater than 40% relative total vegetative cover. Relative total vegetative here is defined as the percent foliar cover of any recorded species divided by the total foliar cover for all live vegetation of the sampling unit, including annuals and noxious weeds. James' galleta represented the highest relative total vegetation cover at 20.8%, thus the reclamation achieved the single species diversity standard.

From 2019 through 2023, 163 plant species have been observed within reclaimed areas in O-VMU-5 including 35 grasses, 85 forbs, and 43 shrubs, trees, and cacti (Table A-7). Of the 35 grasses,18 are cool-season perennials, five are cool-season annuals, nine are warm-season perennials and three are warm-season annuals. Of the 85 forbs, 35 are annuals and the remaining 50 are perennials and/or biennials. Cacti (four species), succulents (two species), and trees (four species) were rare on the reclamation but provide diverse habitat or browse for wildlife. Shrubs and subshrubs were the most common woody plants observed (33 species). The recruitment of native plants and establishment of seeded species within is indicative of ecological succession and the capacity of the site to support a diverse and self-sustaining ecosystem.

Multi-hit LPI data provide an opportunity to investigate faciliatory relationships among plants (Table A-3). This summary suggests that fourwing saltbush is a common upper canopy species in O-VMU-5, most commonly harboring James' galleta, which is also common outside of shrub canopies as well. Associations such as this may be informative in future management activities.

## 3.5 Noxious Weeds

During the 2023 monitoring program, Class C noxious weeds (NMDA 2020) were rarely encountered in O-VMU-5. Class C noxious weeds are generally widespread in the state and managed at the local level based on feasibility of control and level of infestation. Cheatgrass was encountered infrequently in LPI surveys and production quadrats. Noxious weeds are not used in the assessment of revegetation success but are included in the single species cover standard (Table 1). Noxious trees and shrubs observed on O-VMU-5 in past years include Siberian elm (*Ulmus pumila*), saltcedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*) but their presence in the reclaimed vegetation community is insignificant with densities much lower than native rangeland beyond the permit boundary. CMI continues to monitor for noxious weeds and actively controls them through husbandry practices that include annual services for weed management. Further, competition from desirable seeded and native species is expected to inhibit any substantial increase of noxious weeds in the reclamation.

# 4.0 SUMMARY

McKinley Mine's vegetation success standards for the post-mining land uses of grazing and wildlife are based on total ground cover, perennial vegetation cover, annual forage production, shrub density, and diversity. The technical standards (Table 1) were developed through negotiations with OSMRE based on the analysis of historical vegetation data, interpretation of the ecological site potential, and the anticipated post-mining land uses. The vegetation monitoring results for the past five years indicate that the vegetation community in O-VMU-5 is progressing well having met the total ground cover and shrub density standards in every year (Table 3). A summary of the findings from the past five years are:

1. Vegetation Cover: The total ground cover standard has been met every year and perennial vegetation cover standard has been met every year except 2021, a year following two years of below normal growing season precipitation.
2. Forage Production: In 2020 and 2021, O-VMU-5 only received 32% and 62% of normal growing season precipitation, respectively, that led to a significant decline in forage production. In 2022, with above normal precipitation, average forage production recovered, and the average was well above the performance standard, but variability among samples was high. As such, hypothesis testing could not demonstrate the standard was met. In 2023, average annual forage production both exceeded the performance standard and passed hypothesis testing. Improved field methodology enhanced the ability of the data to accurately capture the inherent variation in the landscape while achieving the performance standard.
3. Shrub Density: O-VMU-5 has exceeded the success parameters for shrub density in all five monitoring years.
4. Diversity: All plant diversity standards were met in 2020 and 2023. In 2019, 2021, and 2022 all but one diversity standard was met; fourwing saltbush comprised more than 70% relative shrub cover (based on the former LPI method). In 2023, relative shrub density derived from belt transect data were used to evaluate this standard instead of LPI relative shrub cover, a change which more accurately represents the shrub community and reduces bias towards larger canopied shrubs.

Overall, vegetation performance in O-VMU-5 over the past five years is encouraging considering below-average precipitation for four of the past five years including the exceptional drought in 2020 and 2021. The performance of the vegetation under these conditions suggests that the reclaimed plant communities are resilient and capable of sustaining themselves under adverse conditions that are characteristic of this region. The reclamation in O-VMU-5 has demonstrated the capability of meeting and sustaining the post-mining land use.

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# Tables

## Table 1: Revegetation Success Standards in the McKinley Mine OSMRE Permit

| Vegetative Parameter | Components | | Success Standards | |
|---|---|---|---|---|
| | | | 2019-2022 | 2023 |
| Cover | Total Ground Cover | | ≥ 52% | ≥ 52% |
| | Perennial Vegetation Cover | | ≥ 24% | ≥ 24% |
| Diversity "Lifeform Statement" | Perennial Grasses | All Grasses | ≥ 7% absolute cover | ≥ 7% absolute cover |
| | | Cool-Season | ≥ 2 species, each ≥ 1.5% cover | ≥ 2 species, **1st species ≥ 5% relative perennial cover, 2nd species ≥ 2.5% relative perennial cover** |
| | | Warm-Season | ≥ 2% contribution, ≥ 2 species, each ≥ 0.5% cover | ≥ 2 species, **1st species ≥ 5% relative perennial cover, all other species combined ≥ 1.5% relative perennial cover** |
| | Perennial Forbs | | ≥ 3 species, combining for ≥ 1% relative | ≥ 3 species, combining for ≥ 1% relative perennial cove |
| | Shrubs | All Shrubs | ≥ 3% absolute cover | **≥ 6% relative total perennial cover** |
| | | Any Single Species | ≤ 70% relative total shrub cover | ≤ 70% relative total **shrub density** |
| | Any Single Species (including weeds) | | ≤ 40% relative total vegetative cover | ≤ 40% relative total vegetative cover |
| Production | Pounds/acre (air dry) | | ≥ 550 lbs/ac | ≥ 550 lbs/ac |
| Woody Plant Density | Stems/acre | | ≥ 400/acre | ≥ 400/acre |

Notes:
Success for cover, production, and stocking shall be ≥ 90% of the standard in accordance with 30 CFR 816.116 (a)(2).
Total ground cover does not include noxious weeds.
Perennial vegetation cover is foliar cover from LPI, not including annuals and noxious weeds.
Relative cover is the percent cover of a species or functional group divided by the total vegetation cover including annuals and noxious weeds.
Relative perennial cover is the total cover of a perennial species or perennial functional group divided by the total perennial cover (see below).
Total perennial cover includes shrubs, cactus, trees, perennial grasses and perennial forbs not including noxious species.
Relative total shrub density is the density of each woody species divided by the total woody plant density not including noxious weeds.
Production includes above-ground biomass of forage species only.
Bolded standards are those that changed in 2023

## Table 2: North Mine Seasonal and Annual Precipitation, 2015-2023

| Year | Station | Area | Precipitation (inches) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | January | February | March | April | May | June | July | August | September | October | November | December | Annual Total | Growing Season Total |
| 2015 | Rain Bluff | North Shop | 1.39 | 1.21 | 0.11 | 0.35 | 1.54 | 1.15 | 2.81 | 1.91 | 0.51 | 1.18 | 1.16 | 0.74 | 14.06 | *8.27* |
| | Rain 2 | 2 | NA | NA | NA | 0.52 | 1.51 | 1.98 | 3.17 | 1.39 | 0.50 | 1.08 | 0.92 | NA | NA | *9.07* |
| | Rain 3 | 3 | NA | NA | NA | 0.57 | 1.80 | 1.77 | 3.61 | 3.06 | 0.44 | 1.36 | 0.86 | NA | NA | *11.25* |
| | Rain 6 | 6 | NA | NA | NA | 0.54 | 0.71 | 2.12 | 2.66 | 2.12 | 0.00 | 0.92 | 0.70 | NA | NA | *8.15* |
| | Rain 10 | 10 | NA | NA | NA | 0.42 | 1.32 | 1.11 | 2.59 | 1.39 | 0.30 | 1.10 | 0.78 | NA | NA | *7.13* |
| | Rain 12 | 12 | NA | NA | NA | 0.49 | 1.59 | 1.39 | 2.88 | 2.14 | 0.47 | 1.17 | 1.29 | NA | NA | *8.96* |
| | Rain 15 | 15 | NA | NA | NA | 0.46 | 1.90 | 1.62 | 3.17 | 2.88 | 0.32 | 0.94 | 0.69 | NA | NA | *10.35* |
| 2016 | Rain Bluff | North Shop | 0.39 | 0.25 | 0.03 | 1.28 | 0.70 | 0.19 | 1.15 | 1.85 | 1.79 | 0.69 | 1.18 | 1.98 | 11.48 | *6.96* |
| | Rain 2 | 2 | NA | NA | NA | 0.17 | 0.58 | 0.14 | 2.22 | 0.71 | 0.87 | 0.21 | 0.02 | NA | NA | *4.69* |
| | Rain 3 | 3 | NA | NA | NA | 0.20 | 0.72 | 0.45 | 1.62 | 0.11 | 0.50 | 0.33 | 0.02 | NA | NA | *3.60* |
| | Rain 6 | 6 | NA | NA | NA | 0.20 | 0.75 | 0.29 | 2.00 | 0.40 | 1.19 | 0.19 | 0.02 | NA | NA | *4.83* |
| | Rain 10 | 10 | NA | NA | NA | 0.13 | 0.55 | 0.20 | 2.75 | 0.38 | 0.99 | 0.14 | 0.02 | NA | NA | *5.00* |
| | Rain 12 | 12 | NA | NA | NA | 0.30 | 0.78 | 0.36 | 1.34 | 0.49 | 1.16 | 0.18 | 0.05 | NA | NA | *4.43* |
| | Rain 15 | 15 | NA | NA | NA | 0.31 | 0.85 | 0.04 | 1.95 | 0.35 | 1.31 | 0.18 | 0.05 | NA | NA | *4.81* |
| 2017 | Rain Bluff | North Shop | 0.81 | 0.04 | 0.70 | 0.32 | 0.41 | 0.16 | 3.71 | 0.37 | 0.62 | 0.54 | 0.05 | 0.02 | 7.75 | *5.59* |
| | Rain 2 | 2 | NA | NA | NA | 1.28 | 0.66 | 0.22 | 0.78 | 2.08 | 1.46 | 0.63 | 0.44 | NA | NA | *6.48* |
| | Rain 3 | 3 | NA | NA | NA | 1.04 | 1.16 | 0.06 | 0.99 | 2.71 | 1.63 | 0.56 | 0.44 | NA | NA | *7.59* |
| | Rain 6 | 6 | NA | NA | NA | 0.86 | 1.50 | 0.02 | 0.96 | 2.04 | 1.52 | 0.38 | 0.51 | NA | NA | *6.90* |
| | Rain 10 | 10 | NA | NA | NA | 1.00 | 0.67 | 0.08 | 0.94 | 1.63 | 1.36 | 0.34 | 0.81 | NA | NA | *5.68* |
| | Rain 12 | 12 | NA | NA | NA | 1.17 | 0.91 | 0.05 | 0.88 | 1.89 | 1.77 | 0.47 | 0.46 | NA | NA | *6.67* |
| | Rain 15 | 15 | NA | NA | NA | 1.15 | 1.36 | 0.02 | 0.68 | 1.91 | 1.56 | 0.40 | 0.41 | NA | NA | *6.68* |
| 2018 | Rain Bluff | North Shop | 0.23 | 0.48 | 0.44 | 0.08 | 0.22 | 0.28 | 2.17 | 0.00 | 1.00 | 1.51 | 0.14 | 0.43 | 6.98 | *3.75* |
| | Rain 2 | 2 | NA | NA | NA | 0.06 | 0.26 | 0.30 | 1.10 | 0.90 | 1.40 | 1.48 | 0.00 | NA | NA | *4.02* |
| | Rain 3 | 3 | NA | NA | NA | 0.04 | 0.30 | 0.35 | 0.92 | 0.91 | 1.27 | 1.69 | 0.00 | NA | NA | *3.79* |
| | Rain 6 | 6 | NA | NA | NA | 0.03 | 0.21 | 0.46 | 0.97 | 0.56 | 1.02 | 1.45 | 0.00 | NA | NA | *3.25* |
| | Rain 10 | 10 | NA | NA | NA | 0.08 | 0.20 | 0.27 | 3.05 | 1.15 | 0.92 | 1.51 | 0.00 | NA | NA | *5.67* |
| | Rain 12 | 12 | NA | NA | NA | 0.06 | 0.37 | 0.26 | 1.08 | 1.36 | 1.09 | 1.54 | 0.00 | NA | NA | *4.22* |
| | Rain 15 | 15 | NA | NA | NA | 0.05 | 0.32 | 0.28 | 1.16 | 0.63 | 1.31 | 1.31 | 0.00 | NA | NA | *3.75* |
| 2019 | Rain Bluff | North Shop | 0.95 | 0.98 | 1.10 | 0.24 | 0.17 | 0.03 | 0.03 | 1.14 | 0.10 | 0.04 | 1.15 | 0.97 | 6.90 | *1.71* |
| | Rain 2 | 2 | NA | NA | NA | 0.22 | 1.41 | 0.15 | 0.35 | 0.73 | 1.35 | 0.04 | 0.05 | NA | NA | *4.21* |
| | Rain 3 | 3 | NA | NA | NA | 0.39 | 1.50 | 0.32 | 0.70 | 0.11 | 1.72 | 0.06 | 0.06 | NA | NA | *4.74* |
| | Rain 6 | 6 | NA | NA | NA | 0.36 | 1.20 | 0.00 | 0.01 | 0.34 | 1.82 | 0.04 | 0.03 | NA | NA | *3.73* |
| | Rain 10 | 10 | NA | NA | NA | 0.20 | 1.49 | 0.37 | 0.19 | 0.27 | 1.34 | 0.03 | 0.05 | NA | NA | *3.86* |
| | Rain 12 | 12 | NA | NA | NA | 0.20 | 1.59 | 0.28 | 0.35 | 0.14 | 1.38 | 0.07 | 0.04 | NA | NA | *3.94* |
| | Rain 15 | 15 | NA | NA | NA | 0.22 | 1.17 | 0.14 | 0.78 | 0.15 | 1.60 | 0.05 | 0.05 | NA | NA | *4.06* |
| 2020 | Rain Bluff | North Shop | 1.00 | 1.35 | 1.15 | 0.26 | 0.02 | 0.14 | 0.89 | 0.26 | 0.21 | 0.33 | 0.28 | 0.32 | 6.21 | *1.78* |
| | Rain 2 | 2 | NA | NA | NA | 0.26 | 0.09 | 0.05 | 1.65 | 0.20 | 0.17 | 0.31 | 0.16 | NA | NA | *2.42* |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.01 | 0.05 | 1.06 | 0.62 | 0.16 | 0.27 | 0.19 | NA | NA | *1.90* |
| | Rain 6 | 6 | NA | NA | NA | 0.05 | 0.02 | 0.02 | 0.82 | 0.55 | 0.14 | 0.08 | 0.16 | NA | NA | *1.60* |
| | Rain 10 | 10 | NA | NA | NA | 0.11 | 0.02 | 0.13 | 0.79 | 0.14 | 0.14 | 0.16 | 0.09 | NA | NA | *1.33* |
| | Rain 12 | 12 | NA | NA | NA | 0.25 | 0.08 | 0.06 | 0.97 | 0.47 | 0.35 | 0.29 | 0.28 | NA | NA | *2.18* |
| | Rain 15 | 15 | NA | NA | NA | 0.32 | 0.01 | 0.05 | 0.65 | 0.87 | 0.28 | 0.09 | 0.44 | NA | NA | *2.18* |
| 2021 | Rain Bluff | North Shop | 1.13 | 0.21 | 0.46 | 0.04 | 0.04 | 0.20 | 2.17 | 1.31 | 1.13 | 0.86 | 0.20 | 0.92 | 8.67 | *4.89* |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.03 | 0.16 | 0.99 | 1.09 | 1.04 | 0.93 | 0.00 | NA | NA | *3.31* |
| | Rain 3 | 3 | NA | NA | NA | 0.03 | 0.09 | 0.05 | 0.69 | 1.04 | 1.64 | 1.16 | 0.00 | NA | NA | *3.54* |
| | Rain 6 | 6 | NA | NA | NA | 0.02 | 0.06 | 0.03 | 0.83 | 0.19 | 0.47 | 1.05 | 0.00 | NA | NA | *1.60* |
| | Rain 10 | 10 | NA | NA | NA | 0.01 | 0.06 | 0.24 | 2.48 | 1.80 | 0.96 | 0.80 | 0.00 | NA | NA | *5.55* |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.08 | 0.22 | 1.58 | 2.08 | 1.24 | 1.01 | 0.00 | NA | NA | *5.20* |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.07 | 0.05 | 1.04 | 2.58 | 1.47 | 1.00 | 0.00 | NA | NA | *5.21* |
| 2022 | Rain Bluff | North Shop | -- | -- | 0.59 | 0.03 | 0.00 | 1.24 | 3.13 | 4.66 | 1.27 | 1.40 | 0.48 | 0.58 | 13.38 | *10.33* |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 3.00 | 3.77 | 1.22 | 1.14 | 0.39 | NA | NA | *9.02* |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 2.99 | 3.07 | 1.18 | 1.19 | 0.54 | NA | NA | *8.27* |
| | Rain 6 | 6 | NA | NA | NA | 0.01 | 0.00 | 0.66 | 2.55 | 3.05 | 0.69 | 0.28 | 0.47 | NA | NA | *6.96* |
| | Rain 10 | 10 | NA | NA | NA | 0.00 | 0.00 | 0.69 | 3.57 | 4.27 | 1.02 | 1.83 | 0.33 | NA | NA | *9.55* |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.00 | 0.91 | 3.76 | 4.07 | 1.08 | 1.57 | 0.52 | NA | NA | *9.82* |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.01 | 0.91 | 4.06 | 3.84 | 1.12 | 1.68 | 0.50 | NA | NA | *9.94* |
| 2023 | Rain Bluff | North Shop | 1.21 | 0.50 | 1.64 | 0.05 | 0.55 | 0.13 | 0.03 | 3.16 | 0.33 | 0.57 | 0.42 | NA | 8.59 | *4.25* |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.48 | 0.09 | 0.08 | 3.08 | 0.44 | 0.09 | 0.09 | NA | NA | *4.17* |
| | Rain 3 | 3 | NA | NA | NA | 0.01 | 0.84 | 0.22 | 0.26 | 2.93 | 0.54 | 0.08 | 0.08 | NA | NA | *4.80* |
| | Rain 6 | 6 | NA | NA | NA | 0.00 | 1.49 | 0.22 | 0.07 | 1.97 | 0.49 | 0.05 | 0.00 | NA | NA | *4.24* |
| | Rain 10 | 10 | NA | NA | NA | 0.03 | 0.53 | 0.13 | 0.06 | 2.61 | 0.51 | 0.03 | 0.00 | NA | NA | *3.87* |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.74 | 0.21 | 0.10 | 2.47 | 0.41 | 0.05 | 0.00 | NA | NA | *3.93* |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.79 | 0.21 | 0.43 | 2.67 | 0.56 | 0.05 | 0.00 | NA | NA | *4.66* |
| Window Rock, Long | | | 0.72 | 0.68 | 0.88 | 0.61 | 0.49 | 0.47 | 1.75 | 2.05 | 1.23 | 1.14 | 0.83 | 0.95 | 11.80 | *6.60* |

Notes:
Long-term averages are from Window Rock, Arizona Station (029410), 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season total precipitation is between April and September
NA=rain gauges taken offline due to freezing conditions, data unavailable.
-- Rain gauge malfunction
In 2017 Rain Bluff experienced power issues in the summer that may have resulted in inaccurate precipitation readings.
data incomplete

**Table 3: Summary Statistics, O-VMU-5, 2019-2023**

| | 2019 | 2020 | 2021 | 2022 | 2023 | Technical Standard |
|---|---|---|---|---|---|---|
| **Total Ground Cover (%)[1]** | | | | | | |
| Mean | 59.7 | 59 | 53.3 | 53.0 | 60.5 | |
| Standard Deviatior | 12.8 | 13.8 | 15 | 12.2 | 11.8 | |
| 90% Confidence Interva | 3.3 | 3.6 | 4 | 3.2 | 3.1 | ≥ 52% |
| Median | -- | 58 | 52 | 54 | 60 | |
| Nmin[2] | 13 | 15 | 23 | 16 | 11 | |
| **Live Vegetation Cover (%)[3]** | | | | | | |
| Mean | 42.9 | 31.1 | 21.3 | 36.7 | 43.5 | |
| Standard Deviatior | 10.8 | 9.5 | 10.8 | 11.1 | 11.3 | |
| 90% Confidence Interva | 2.8 | 2.5 | 2.8 | 2.9 | 3.0 | None |
| Nmin[2] | 18 | 26 | 73 | 26 | 19 | |
| **Litter Cover (%)** | | | | | | |
| Mean | 16.9 | 27.9 | 32 | 16.3 | 17.0 | |
| Standard Deviatior | 7.7 | 12.2 | 10.8 | 7.1 | 9.9 | |
| 90% Confidence Interva | 2 | 3.2 | 2.8 | 1.9 | 2.6 | None |
| Nmin[2] | 60 | 55 | 73 | 55 | 97 | |
| **Perennial Vegetation Cover (%)[4]** | | | | | | |
| Mean | 37.1 | 30.3 | 20.3 | 29.8 | 39.5 | |
| Standard Deviatior | 10.9 | 10.5 | 10.5 | 11.9 | 11.6 | |
| 90% Confidence Interva | 2.8 | 2.7 | 2.8 | 3.1 | 3.0 | ≥ 24% |
| Median | -- | 30 | 20 | 31 | 36 | |
| Nmin[2] | 24 | 34 | 76 | 46 | 25 | |
| **Annual Forage Production (lbs/ac)[5]** | | | | | | |
| Mean | 975 | 358 | 422 | 473 | 848 | |
| Standard Deviatior | 899 | 400 | 1004 | 411 | 571 | |
| 90% Confidence Interva | 234 | 104 | 261 | 107 | 149 | ≥ 550 lbs/ac |
| Median | -- | 216 | 169 | 370 | 701 | |
| Nmin[2] | 242 | 354 | 1609 | 214 | 130 | |
| **Woody Plant Density (stems/acre) from Belt Transec** | | | | | | |
| Mean | 2,874 | 2,015 | 2,258 | 2,257 | 2,180 | |
| Standard Deviatior | 2,342 | 1,487 | 1,580 | 2,910 | 1,750 | |
| 90% Confidence Interva | 609 | 387 | 411 | 757 | 455 | ≥ 400/ac |
| Median | -- | 1,781 | 1,720 | 1,538 | 1,599 | |
| Nmin[2] | 188 | 155 | 139 | 472 | 183 | |

Notes:

[1] Mean foliar cover of live vegetation and litter

[2] Minimum number of samples to obtain 90% probability that the sample mean is within 10% of the population mean

[3] Mean vegetation foliar cover not including noxious weeds

[4] Mean foliar cover not including annuals and noxious weeds

[5] Annual forage production in air dry pounds per acre (lbs/ac) not including annuals or noxious weeds

Hypothesis testing found the success standard was not met

**Table 4: Average and Relative Foliar Cover and Production by Species, O-VMU-5, 2023**

| Scientific Name | Common Name | Code | Mean Vegetation Cover (% | | | | Mean Annual Production (lbs/ac) |
|---|---|---|---|---|---|---|---|
| | | | All Hit Foliar | First Hit Foliar | Relative Perennial[1] | Relative Total[2] | |
| **Cool-Season Grasses (14** | | | | | | | |
| **Annuals (2)** | | | | | | | |
| *Bromus arvensis* | Field brome | BRAR5 | 0.05 | 0.05 | -- | 0.1 | NA |
| *Bromus tectorum* | Cheatgrass | BRTE | 0.45 | 0.40 | -- | 1 | NA |
| ***Secale cereale*** | **Cereal rye** | **SECE** | **0.25** | **0.25** | **--** | **0.5** | **NA** |
| **Perennials (12)** | | | | | | | |
| *Achnatherum hymenoides* | Indian ricegrass | ACHY | 1.95 | 1.90 | 4.6 | 4.1 | 10.9 |
| *Agropyron cristatum* | Crested wheatgrass | AGCR | 1.20 | 1.20 | 2.8 | 2.6 | 34.1 |
| *Bromus inermis* | Smooth brome | BRIN2 | 0.15 | 0.15 | 0.4 | 0.3 | 4.9 |
| *Elymus elymoides* | Bottlebrush squirreltai | ELEL5 | 0.30 | 0.30 | 0.7 | 0.6 | 2.8 |
| *Elymus lanceolatus* | Thickspike wheatgrass | ELLA3 | 2.70 | 2.45 | 6.4 | 5.7 | 51 |
| *Elymus trachycaulus* | Slender wheatgrass | ELTR7 | 2.55 | 2.35 | 6.0 | 5.4 | 61.8 |
| *Hesperostipa comata* | Needle and thread | HECO26 | 3.15 | 2.90 | 7.4 | 6.7 | 27.7 |
| *Hordeum jubatum* | Foxtail barley | HOJU | NA | NA | NA | NA | <0.1 |
| *Leymus cinereus* | Basin wildrye | LECI4 | NA | NA | NA | NA | 2.5 |
| ***Nassella viridula*** | **Green needlegrass** | **NAVI4** | **0.05** | **0.05** | **0.1** | **0.1** | **NA** |
| *Pascopyrum smithii* | Western wheatgrass | PASM | 3.40 | 3.05 | 8.0 | 7.2 | 48.4 |
| *Psathyrostachys juncea* | Russian wildrye | PSJU3 | 0.75 | 0.70 | 1.8 | 1.6 | 2.2 |
| *Pseudoroegneria spicata* | Bluebunch wheatgrass | PSSP6 | 1.25 | 1.15 | 2.9 | 2.7 | 12.4 |
| *Thinopyrum intermedium* | Intermediate wheatgrass | THIN6 | 0.25 | 0.20 | 0.6 | 0.5 | 14.8 |
| **Warm-Season Grasses (5)** | | | | | | | |
| **Annauls (1)** | | | | | | | |
| *Bouteloua simplex* | Matted grama | BOSI2 | 0.20 | 0.20 | -- | 0.4 | NA |
| **Perennials (5)** | | | | | | | |
| *Aristida purpurea* | Purple threeawn | ARPU9 | NA | NA | NA | NA | 0.6 |
| *Bouteloua curtipendula* | Sideoats grama | BOCU | 0.05 | -- | 0.1 | 0.1 | <0.1 |
| *Bouteloua dactyloides* | Buffalograss | BODA2 | 0.25 | 0.25 | 0.6 | 0.5 | 0.3 |
| *Bouteloua gracilis* | Blue grama | BOGR2 | 2.25 | 2.20 | 5.3 | 4.8 | 26.9 |
| *Pleuraphis jamesii* | James' galleta | PLJA | 9.80 | 8.55 | 23.1 | 20.8 | 247.6 |
| ***Sorghastrum nutans*** | **Indiangrass** | **SONU2** | **0.05** | **0.05** | **0.1** | **0.1** | **NA** |
| *Sporobolus airoides* | Alkali sacaton | SPAI | 0.75 | 0.70 | 1.8 | 1.6 | 35.6 |
| *Sporobolus cryptandrus* | Sand dropseed | SPCR | 0.50 | 0.45 | 1.2 | 1.1 | 0.7 |
| **Forbs (13)** | | | | | | | |
| **Annuals (4)** | | | | | | | |
| *Alyssum simplex* | Alyssum | ALSI8 | 0.05 | 0.05 | -- | 0.1 | NA |
| ***Chamaesyce revoluta*** | **Threadstem sandmat** | **CHRE4** | **0.05** | **0.05** | **--** | **0.1** | **NA** |
| ***Chamaesyce serpyllifolia*** | **Thymeleaf sandmat** | **CHSE6** | **0.05** | **0.05** | **--** | **0.1** | **NA** |
| *Dysphania graveolens* | Fetid goosefoot | DYGR | 0.05 | 0.05 | -- | 0.1 | NA |
| *Eriogonum cernuum* | Nodding buckwheat | ERCE2 | 0.05 | 0.05 | -- | 0.1 | NA |
| *Helianthus annuus* | Common sunflower | HEAN3 | 0.05 | 0.05 | -- | 0.1 | NA |
| *Portulaca oleracea* | Little hogweed | POOL | 0.10 | 0.10 | -- | 0.2 | NA |
| *Salsola tragus* | Prickly Russian thistle | SATR12 | 3.20 | 3.10 | -- | 6.8 | NA |
| **Perennials/Biennials (13)** | | | | | | | |
| *Achillea millefolium* | Common yarrow | ACMI2 | NA | NA | NA | NA | <0.1 |
| *Bahia dissecta* | Ragleaf bahia | BADI | 0.05 | 0.05 | 0.1 | 0.1 | <0.1 |
| *Dalea purpurea* | Purple prairie clover | DAPU5 | NA | NA | NA | NA | 0.2 |
| ***Descurainia incana*** | **Mountain tansymustard** | **DEIN5** | **NA** | **NA** | **NA** | **NA** | **7.9** |
| *Descurainia pinnata* | Western tansymustard | DEPI | NA | NA | NA | NA | 0.1 |
| *Erigeron divergens* | Spreading fleabane | ERDI4 | 0.30 | 0.30 | 0.7 | 0.6 | 1.8 |
| ***Gaillardia aristata*** | **Blanketflower** | **GAAR** | **NA** | **NA** | **NA** | **NA** | **0.7** |
| ***Heliomeris multiflora*** | **Showy goldeneye** | **HEMU3** | **0.05** | **0.05** | **0.1** | **0.1** | **0.4** |
| *Lappula occidentalis* | Flatspine stickseed | LAOC3 | NA | NA | NA | NA | 0.7 |
| *Linum lewisii* | Lewis flax | LILE3 | 0.05 | 0.05 | 0.1 | 0.1 | 0.3 |
| *Machaeranthera canescens* | Hoary tansyaste | MACA2 | 0.15 | 0.15 | 0.4 | 0.3 | 11.2 |
| *Machaeranthera tanacetifolia* | Tanseyleaf tansyaste | MATA2 | NA | NA | NA | NA | 0.5 |
| *Medicago sativa* | Alfalfa | MESA | 0.10 | 0.10 | 0.2 | 0.2 | 1.5 |
| *Melilotus officinalis* | Sweetclover | MEOF | 0.35 | 0.35 | 0.8 | 0.7 | NA |
| ***Onobrychis viciifolia*** | **Sainfoin** | **ONVI** | **0.05** | **0.05** | **0.1** | **0.1** | **NA** |
| *Ratibida columnifera* | Upright prairie coneflower | RACO3 | NA | NA | NA | NA | 0.1 |
| *Sphaeralcea coccinea* | Scarlet globemallow | SPCO | 0.15 | 0.15 | 0.4 | 0.3 | 0.4 |
| *Sphaeralcea fendleri* | Fendler's globemallow | SPFE | NA | NA | NA | NA | 0.4 |
| *Sphaeralcea incana* | Gray globemallow | SPIN2 | 0.05 | 0.05 | 0.1 | 0.1 | 0.4 |
| *Tragopogon dubius* | Yellow salsify | TRDU | 0.10 | 0.10 | 0.2 | 0.2 | 1.7 |
| *Tragopogon pratensis* | Jack-go-to-bed-at-noor | TRPR | NA | NA | NA | NA | 0.4 |

**Table 4: Average and Relative Foliar Cover and Production by Species, O-VMU-5, 2023**

| Scientific Name | Common Name | Code | Mean Vegetation Cover (% | | | | Mean Annual Production (lbs/ac) |
|---|---|---|---|---|---|---|---|
| | | | All Hit Foliar | First Hit Foliar | Relative Perennial[1] | Relative Total[2] | |
| **Shrubs, Trees, and Cacti (11)** | | | | | | | |
| *Artemisia ludoviciana* | White sagebrush | ARLU | 0.05 | 0.05 | 0.1 | 0.1 | |
| ***Artemisia nova*** | **Black sagebrush** | **ARNO4** | **0.05** | **0.05** | **0.1** | **0.1** | **NA** |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.05 | 0.05 | 0.1 | 0.1 | NA |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 6.85 | 6.70 | 16.1 | 14.6 | 186.6 |
| *Atriplex corrugata* | Mat saltbush | ATCO4 | NA | NA | NA | NA | 0.2 |
| *Chrysothamnus greenei* | Greene's rabbitbrush | CHGR6 | NA | NA | NA | NA | 0.4 |
| *Ephedra viridis* | Mormon tea | EPVI | NA | NA | NA | NA | 0.1 |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 1.00 | 1.00 | 2.4 | 2.1 | 18.2 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 0.10 | 0.10 | 0.2 | 0.2 | 0.3 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 1.25 | 1.20 | 2.9 | 2.7 | 27.0 |
| *Pinus edulis* | Twoneedle pinyon | PIED | 0.10 | 0.10 | 0.2 | 0.2 | NA |
| *Purshia mexicana* | Mexican cliffrose | PUME | 0.20 | 0.20 | 0.5 | 0.4 | 0.7 |
| *Purshia tridentata* | Antelope bitterbrush | PUTR2 | 0.05 | 0.05 | 0.1 | 0.1 | NA |
| **Unknown Plants (1)** | | | | | | | |
| Brassicaceae sp | Unknown Brassicaceae Species | BRASSI | 0.05 | 0.05 | 0.1 | 0.1 | NA |
| **Cover Components** | | | | | | | |
| Total Ground Cover[3] | | | 60.5 | | | | |
| *Live Vegetation Foliar Cover* | | | 43.5 | | | | |
| *Perennial Vegetation Cover* | | | 39.5 | | | | |
| Rock | | | 3.1 | | | | |
| Litter | | | 17.0 | | | | |
| Bare Soil | | | 36.0 | | | | |

Notes:

[1] Relative % perennial/biennial foliar cover divided by mean foliar cover NOT including annuals and noxious weeds using all hits

[2] Relative % foliar cover for a species divided by the mean foliar cover for all live vegetation including noxious weeds using all hits

[3] % live vegetation foliar cover plus litter using first hits

Growing season for grasses from Allred (2005)

Plant duration from USDA Plants Database

NA = species captured in either LPI or quadrats but not both

"--" = annuals not included in relative perennial cover calculations

Bolded species are newly observed on O-VMU-1 in 2023

## Table 5: Relative Shrub, Tree, and Cacti Density, O-VMU-5, 2023

| Scientific Name | Common Name | Code | Relative Density (%) |
|---|---|---|---|
| ***Artemisia bigelovii*** | **Bigelow sage** | **ARBI3** | **0.05** |
| *Artemisia frigida* | Prairie sagewor | ARFR4 | 0.05 |
| *Artemisia ludoviciana* | White sagebrush | ARLU | 0.19 |
| ***Artemisia nova*** | **Black sagebrush** | **ARNO4** | **0.23** |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.42 |
| *Atriplex acanthocarpa* | Tubercled saltbush | ATAC | 0.19 |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 63.16 |
| *Atriplex confertifolia* | Shadscale saltbush | ATCO | 0.70 |
| *Atriplex corrugata* | Mat saltbush | ATCO4 | 1.11 |
| *Cactaceae sp.* | Unknown Cactaceae Species | CACTUS | 0.05 |
| *Chrysothamnus greenei* | Greene's rabbitbrush | CHGR6 | 0.09 |
| *Ephedra viridis* | Mormon tea | EPVI | 0.09 |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 6.08 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 3.34 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 23.11 |
| ***Opuntia macrorhiza*** | **Twistspine pricklypear** | **OPMA2** | **0.05** |
| ***Opuntia phaeacantha*** | **Tulip pricklypear** | **OPPH** | **0.05** |
| *Opuntia sp.* | Pricklypear | OPUNT | 0.05 |
| *Pinus edulis* | Twoneedle pinyon | PIED | 0.14 |
| *Purshia mexicana* | Mexican cliffrose | PUME | 0.60 |
| *Purshia tridentata* | Antelope bitterbrush | PUTR2 | 0.19 |
| *Sarcobatus vermiculatus* | Greasewood | SAVE4 | 0.09 |

Notes:
Relative density derived from belt method
Relative Density = (avg density per species per VMU ÷ avg total shrub density per VMU) * 100
Bolded species are newly observed on O-VMU-5 in 2023

**Table 6: Results for Diversity, O-VMU-5, 2023**

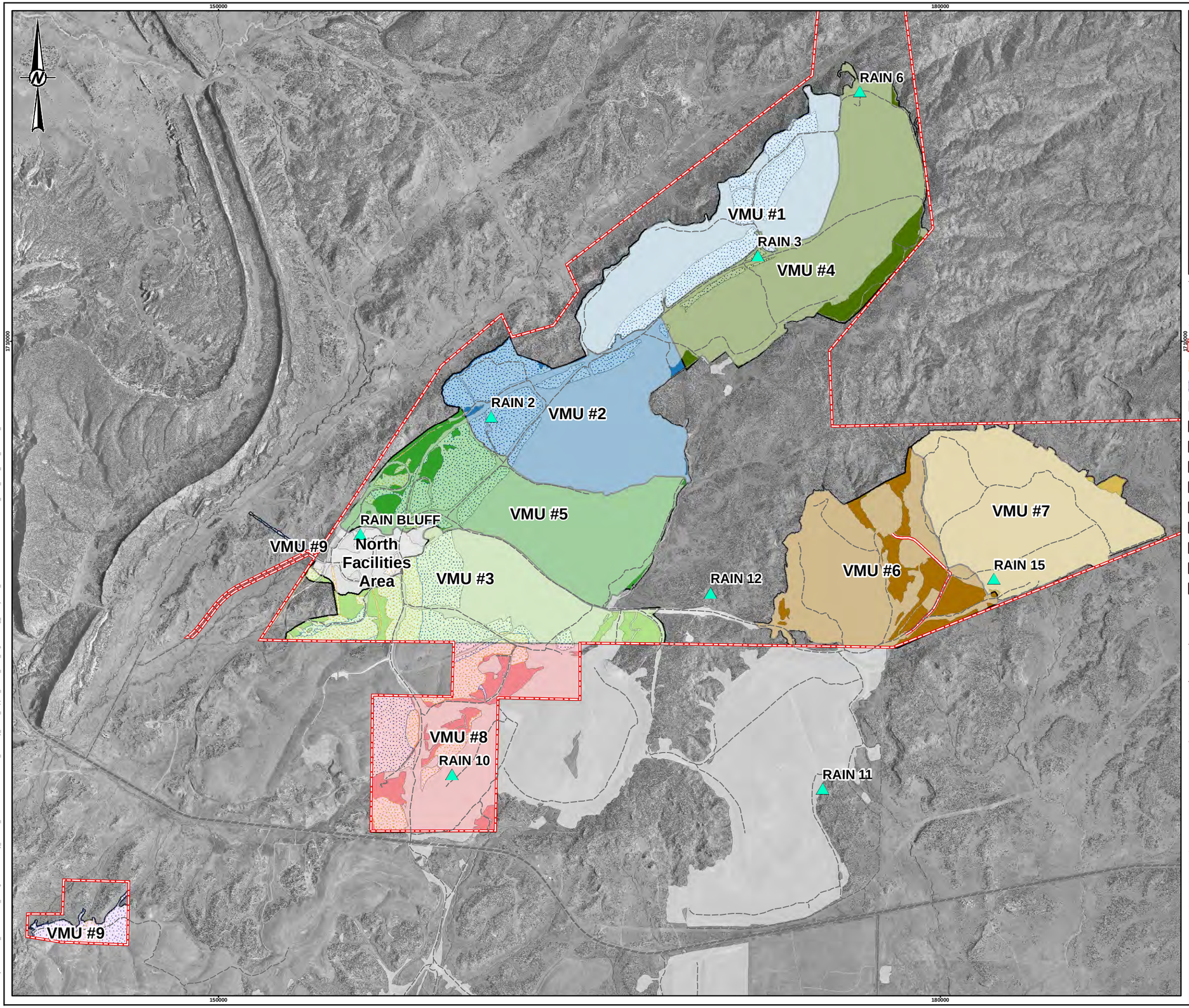
| Diversity Component | Metric | Standard | 2023 | |
|---|---|---|---|---|
| | | | Result | Species |
| **Perennial Grasses** | Absolute cover | ≥ 7% | 28.6 | -- |
| Cool-season Grasses | # Species | ≥ 2 | 17 | -- |
| Grass 1 | Relative perennial cove | ≥ 5% | 8.0 | Western wheatgrass |
| Grass 2 | Relative perennial cove | ≥ 2.5% | 7.4 | Needle and threac |
| Warm-season Grasses | # Species | ≥ 2 | 7 | -- |
| Grass 1 | Relative perennial cove | ≥ 5% | 23.1 | James' galleta |
| All remaining species | Relative perennial cover | ≥ 1.5% | 9.1 | -- |
| **Perennial Forbs** | # Species | ≥3 | 11 | -- |
| | Relative perennial cover | ≥ 1% | 3.3 | -- |
| **Shrubs or Subshrubs** | Relative perennial cover | ≥ 6% | 22.8 | -- |
| Single Shrub Species | Relative shrub density | ≤ 70% | 63.2 | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 20.8 | James' galleta |

**Table 7: Results for Diversity, O-VMU-5, 2019-2022**

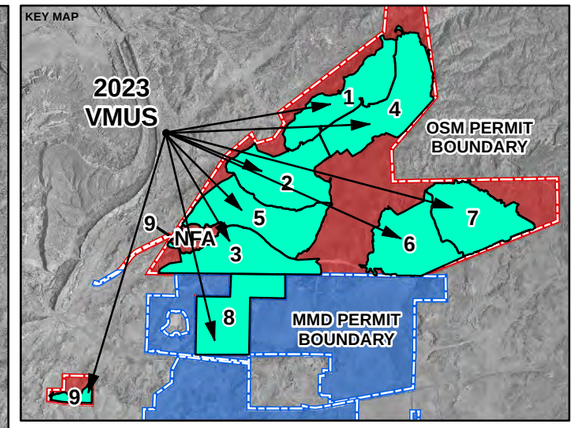
| Diversity Component | Metric | Standard | 2019 | | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Result | Species | Result | Species | Result | Species | Result | Species |
| **Perennial Grasses** | Total absolute cover | ≥ 7% | 21.0% | -- | 21.3% | -- | 10.5% | -- | 21.7% | -- |
| Cool-season Grasses | # Species | ≥ 2 | 11 | -- | 11 | -- | 14 | -- | 12 | -- |
| Grass 1 | Absolute cover | ≥ 1.5% | 7.1% | Western wheatgrass | 8.0% | Western wheatgrass | 2.3% | Western wheatgrass | 3.5% | Western wheatgrass |
| Grass 2 | Absolute cover | ≥ 1.5% | 2.3% | Thickspike wheatgrass | 3.7% | Slender wheatgrass | 1.6% | Crested wheatgrass | 1.8% | Indian ricegrass |
| Warm-season Grasses | # Species | ≥ 2 | 6 | -- | 4 | -- | 4 | -- | 6 | -- |
| | Total absolute cover | ≥ 2.0% | 5.7% | -- | 3.9% | -- | 3.0% | -- | 11.7% | -- |
| Grass 1 | Absolute cover | ≥ 0.5% | 4.3% | James' galleta | 2.8% | James' galleta | 2.4% | James' galleta | 7.4% | James' galleta |
| Grass 2 | Absolute cover | ≥ 0.5% | 0.6% | Alkali sacaton | 0.6% | Alkali sacaton | 0.5% | Alkali sacaton | 2.6% | Alkali sacaton |
| **Perennial Forbs** | # Species | ≥ 3 | 13 | -- | 4 | -- | 4 | -- | 10 | -- |
| | Relative perennial cover | ≥ 1% | 10.5% | -- | 1.3% | -- | 1.5% | -- | 2.6% | -- |
| **Shrubs or Subshrubs** | Total absolute cover | ≥ 3% | 12.2% | -- | 8.6% | -- | 9.4% | -- | 7.4% | -- |
| Single Shrub Species | Relative shrub cover | ≤ 70% | 70.9% | Fourwing saltbush | 58.7% | Fourwing saltbush | 75.0% | Fourwing saltbush | 73.0% | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 19.3% | Fourwing saltbush | 25.6% | Western wheatgrass | 33.3% | Fourwing saltbush | 20.20% | James' galleta |

Notes:
Diversity calculated in accordance with Table 1 in either absolute or relative % cover
Success standard was not met

# Figures




KEY MAP




LEGEND

- Rain Gauges
- Mine Site Roads
- OSM Permit Boundary
- Prelaw (~ 387 acres)
- Initial Program (~ 1,248 acres)
- Permanent Program (~ 11,327 acres)
- OSM VMU 1 (~ 934 acres)
- OSM VMU 2 (~ 1,085 acres)
- OSM VMU 3 (~ 959 acres)
- OSM VMU 4 (~ 1,242 acres)
- OSM VMU 5 (~ 1,129 acres)
- OSM VMU 6 (~ 1,024 acres)
- OSM VMU 7 (~ 1,045 acres)
- OSM VMU 8 (~ 953 acres)
- OSM VMU 9 (~ 96 acres)

0 4,000 8,000

1 inch = 4,000 feet FEET

**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT

CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT

MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2023 VEGETATION MONITORING

TITLE

# GENERAL OVERVIEW OF THE MCKINLEY OSMRE PERMIT AREA VEGETATION MANAGEMENT UNITS (VMU), 2023

CONSULTANT

wsp

| | |
|---|---|
| YYYY-MM-DD | 2023-11-29 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MR |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | B003 | 0 | 1 |

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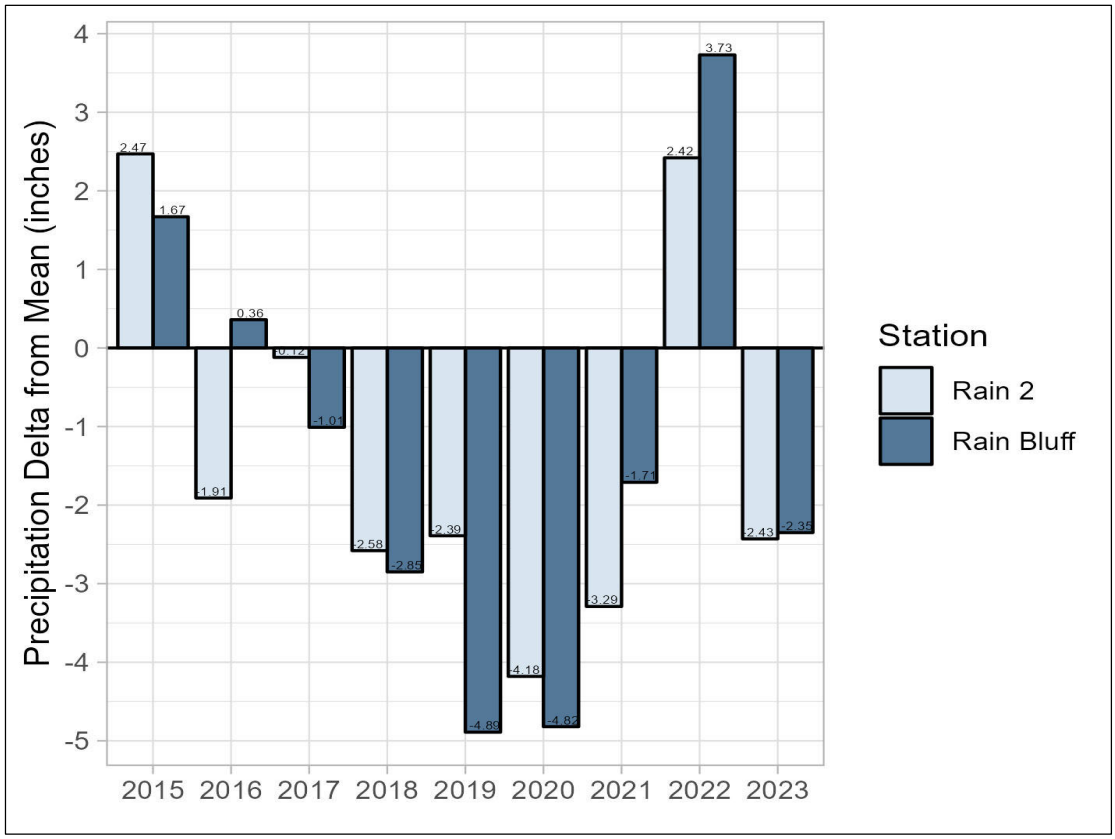
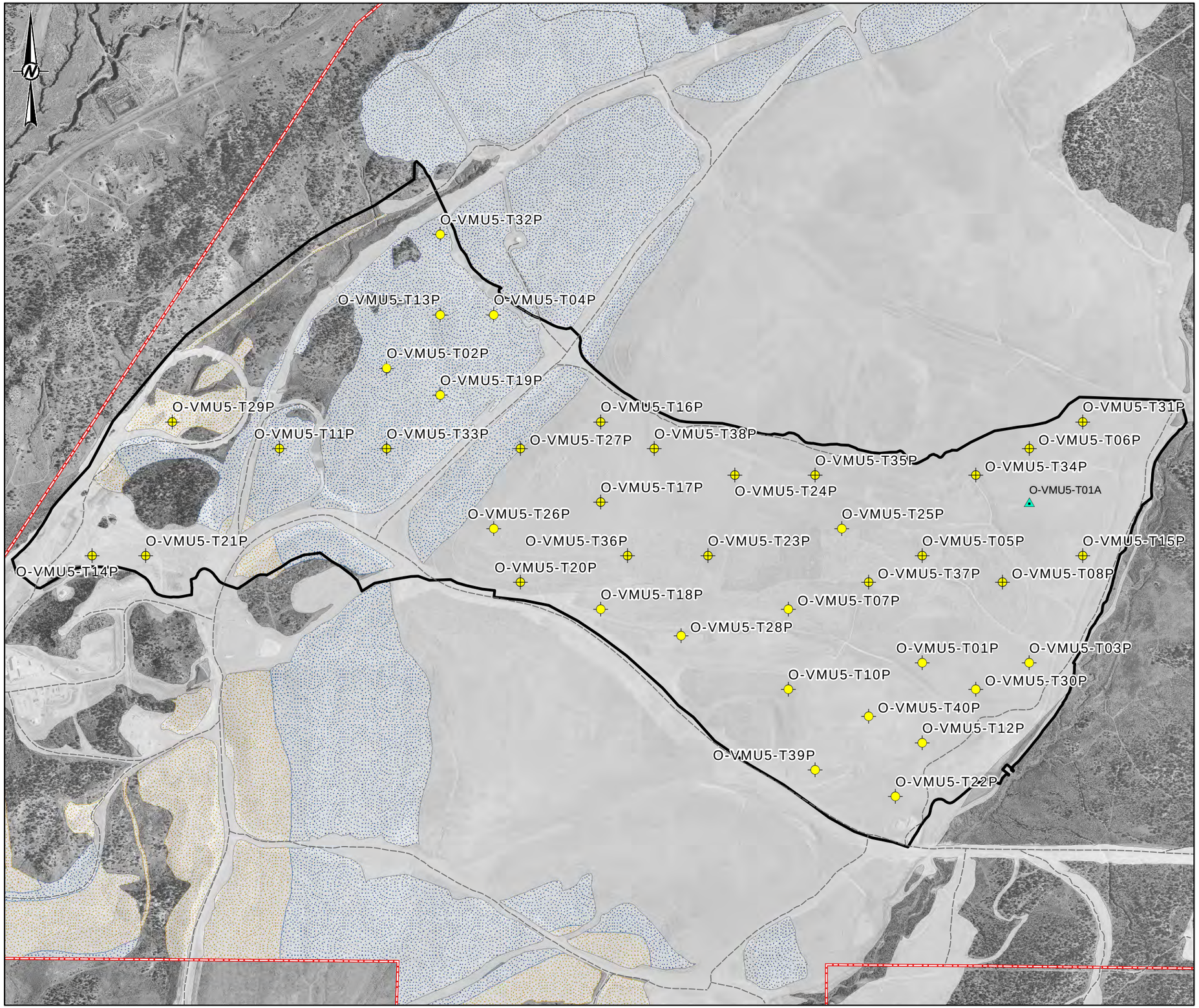
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

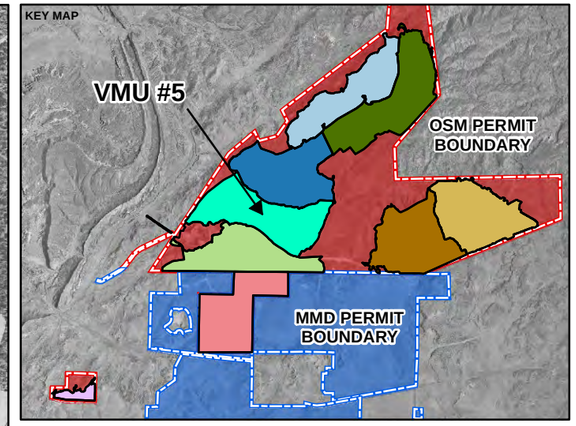
**Figure 2: Departure of Growing Season Precipitation from Long-Term Mean at Window Rock: Rain Bluff and Rain 2 Gauges**




Notes:
Long-term seasonal mean is from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season precipitation is April through September
Source data is in Table 1




KEY MAP




**LEGEND**

- Primary Transect
- Alternate Transect
- Mine Site Roads
- OSM VMU 5 (~ 1,129 acres)
- Prelaw (~ 28 acres)
- Initial Program (~ 208 acres)
- Permanent Program (~ 799 acres)
- OSM Permit Boundary

**TRANSECT LABEL EXPLANATION**

O-VMU-1-T1P

- OSM Permit Area
- Vegetation Management Unit (VMU-#)
- Transect Number
- Primary (P) or Alternate (A)

0 1,200 2,400

1 inch = 1,200 feet FEET

**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN
2. KEY MAP SCALE IS DIFFERENT FROM OVERVIEW OF VMUS
3. TRANSECT LOCATIONS WERE CREATED IN ACCORDANCE WITH THE METHODS OUTLINED IN THE PERMIT

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT
CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT
MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2023 VEGETATION MONITORING

TITLE
**VEGETATION MONITORING TRANSECTS 2023, VEGETATION MANAGEMENT UNIT 5**

CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2023-11-29 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MR |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | B008 | 0 | 3 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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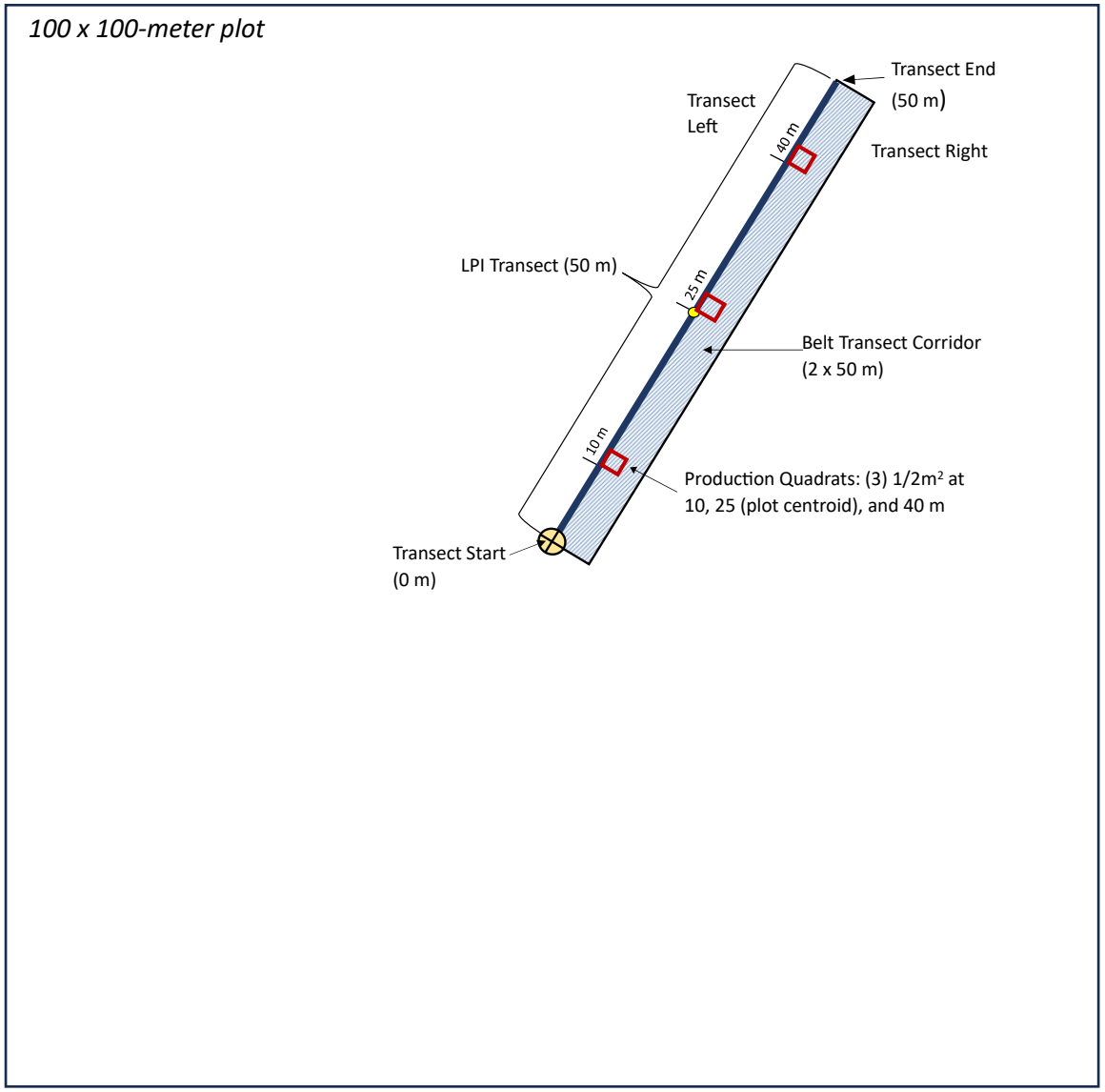
**Figure 4: Vegetation Plot and Transect Layout**




**Transect start placed on plot centroid and oriented randomly (0-360 degrees)* **Not to Scale**

**Figure 5: Typical Grass-Shrubland Vegetation in O-VMU-5, September 2023**



**Figure 6: Stabilization of the Annual Forage Production, O-VMU-5, 2023**

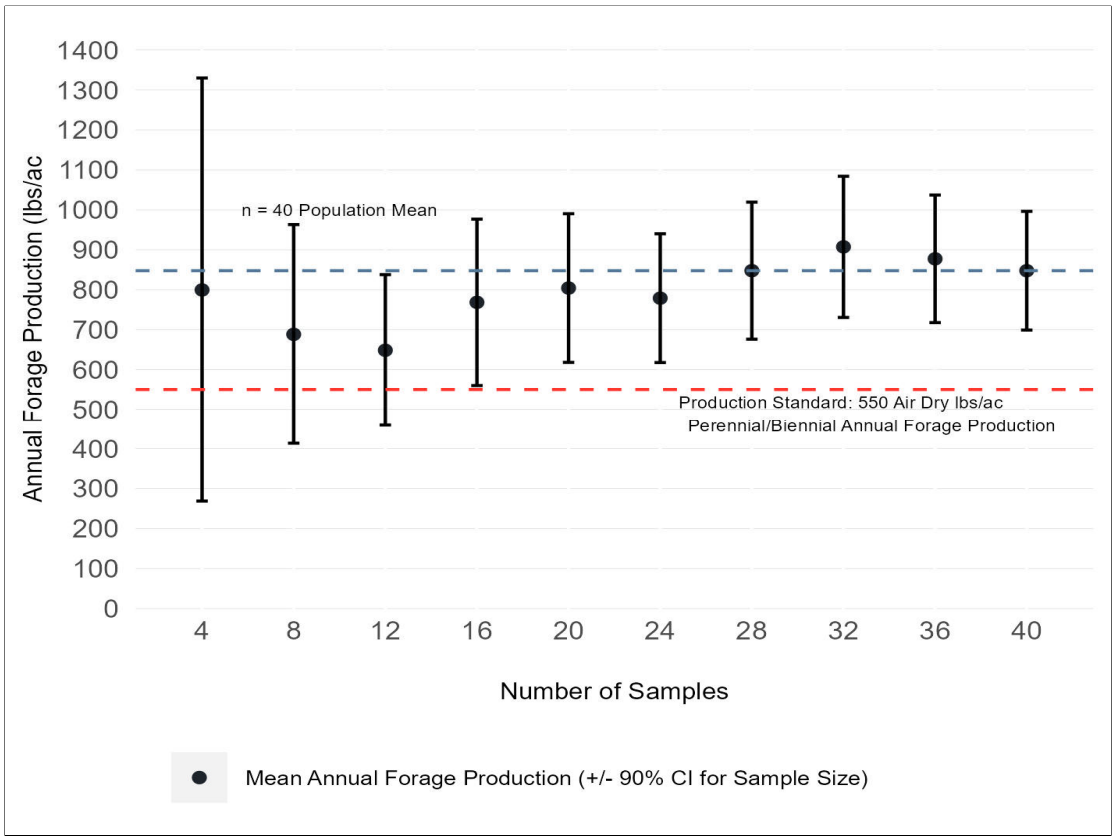
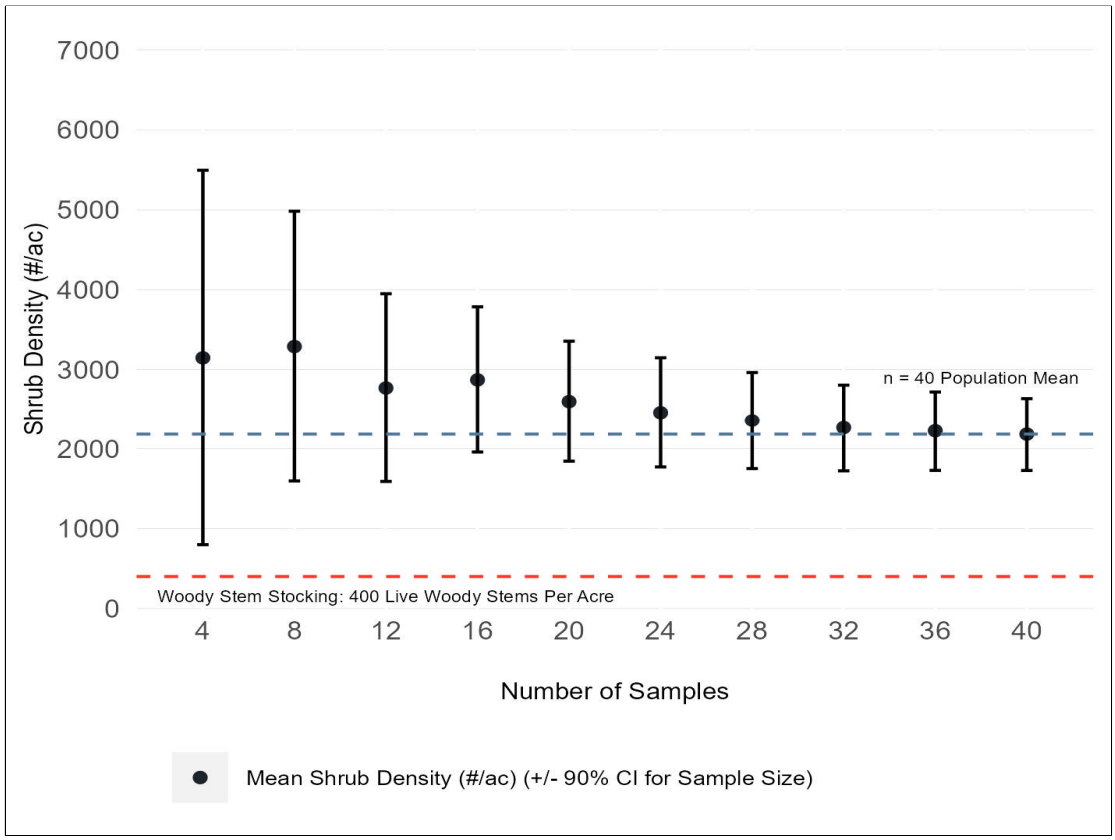


**Figure 7: Stabilization of the Mean for Shrub Density, O-VMU-5, 2023**



**APPENDIX A**

# Vegetation Data Summary

## Table A-1: O-VMU-5 Line Point Intercept Foliar Cover Data (first hits), 2023

| Transect | T01A | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRAR5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BRTE | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | 1 | -- | -- | -- | -- | -- | -- | -- |
| SECE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | 1 | -- | -- | 2 | 5 | 2 | 2 | -- | 2 | 2 | 1 | -- | -- | -- | -- | -- | -- | 5 | 1 | -- | 1 | -- | -- | 1 | 2 | -- | -- | -- | -- | 1 | 1 | -- | 1 | 2 | 3 | 1 | 1 | -- | 1 |
| AGCR | 2 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 5 | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | -- | 1 | 2 |
| ELLA3 | -- | -- | -- | -- | 1 | -- | 3 | 5 | -- | -- | -- | -- | -- | 5 | -- | -- | -- | 4 | -- | 5 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | 4 | -- | -- | 2 | -- | -- | -- | -- | 15 | -- |
| ELTR7 | 4 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 10 | -- | -- | -- | -- | -- | -- | 6 | -- | 9 | -- | 2 | -- | -- | -- | -- | -- | -- | 1 | 2 | 3 | 4 | 1 | 2 |
| HECO26 | 1 | 4 | -- | -- | -- | -- | 1 | 1 | 1 | 4 | -- | -- | -- | 2 | 1 | -- | -- | 2 | -- | -- | -- | 9 | 2 | 7 | -- | -- | -- | -- | 1 | 4 | 7 | -- | -- | 2 | -- | 1 | 1 | 6 | 1 | -- |
| NAVI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | -- | 4 | 6 | 5 | 6 | -- | -- | -- | 1 | -- | -- | -- | 1 | 6 | -- | 2 | 1 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | 5 | 2 | -- | 7 | 1 | -- | -- | 1 | 4 | 4 | -- |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | 2 | 2 | -- | -- | 1 | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| PSSP6 | -- | 2 | -- | 4 | -- | -- | 1 | -- | 3 | -- | -- | 4 | -- | 1 | 1 | -- | -- | -- | -- | -- | 1 | 3 | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOSI2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BODA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 2 | -- | -- | 1 | -- | -- |
| BOGR2 | 1 | 3 | -- | -- | -- | 1 | -- | 6 | -- | -- | -- | 3 | -- | 3 | -- | 6 | -- | -- | -- | -- | 1 | 5 | 1 | 1 | -- | 1 | -- | 4 | 5 | 1 | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- |
| PLJA | 3 | 6 | -- | -- | -- | 3 | 1 | 7 | 3 | 7 | 2 | 9 | 5 | 5 | 1 | 3 | -- | 8 | -- | 9 | 5 | 5 | 23 | 4 | -- | 3 | -- | 12 | 5 | 5 | -- | -- | 4 | 8 | 9 | 2 | 3 | 5 | 4 | 2 |
| SONU2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPAI | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 3 | -- | -- | 2 | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| SPCR | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | 1 | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ALSI8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
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| HEAN3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
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| SATR12 | -- | -- | 6 | -- | 2 | 2 | 2 | -- | 1 | -- | 3 | -- | 1 | 1 | -- | -- | 8 | -- | 2 | 6 | -- | -- | 1 | -- | -- | 2 | 3 | -- | -- | -- | -- | -- | 9 | 2 | 2 | 4 | 1 | -- | 1 | 3 |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BADI | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERDI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- |
| HEMU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| LILE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| MACA2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| MEOF | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 |
| MESA | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ONVI | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| SPIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
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| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARLU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARNO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCA2 | 7 | -- | 1 | 11 | 3 | 1 | 4 | 4 | 5 | 4 | 2 | 1 | 6 | 5 | 2 | 2 | 6 | 3 | 1 | -- | 1 | 6 | 1 | -- | 3 | 6 | -- | 1 | 12 | -- | 4 | 7 | 3 | -- | 5 | 5 | 4 | 2 | 4 | 2 |
| ERNA10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- |
| GUSA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | 9 | -- | -- | 3 | -- | -- | -- | 2 | -- | -- | 5 | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- |
| PIED | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Unknown Plant** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRASSI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation | 19 | 20 | 22 | 21 | 22 | 18 | 14 | 25 | 17 | 24 | 16 | 23 | 18 | 30 | 16 | 19 | 31 | 17 | 21 | 23 | 15 | 32 | 32 | 19 | 12 | 24 | 18 | 31 | 27 | 22 | 22 | 17 | 31 | 20 | 24 | 18 | 15 | 31 | 32 | 21 |
| Live Vegetation[1] | 19 | 20 | 22 | 21 | 19 | 18 | 14 | 25 | 17 | 24 | 16 | 23 | 18 | 29 | 16 | 19 | 31 | 17 | 21 | 23 | 15 | 32 | 32 | 19 | 12 | 24 | 17 | 31 | 27 | 22 | 22 | 15 | 30 | 20 | 24 | 18 | 15 | 31 | 32 | 21 |
| Perennial Vegetation[2] | 19 | 20 | 16 | 21 | 16 | 16 | 12 | 25 | 16 | 24 | 13 | 23 | 17 | 28 | 16 | 19 | 18 | 17 | 18 | 11 | 15 | 32 | 30 | 18 | 12 | 22 | 13 | 31 | 27 | 22 | 22 | 15 | 21 | 17 | 22 | 14 | 14 | 30 | 31 | 18 |
| Rock | 0 | 2 | 4 | 0 | 1 | 1 | 7 | 2 | 1 | 1 | 0 | 2 | 9 | 1 | 2 | 0 | 0 | 0 | 10 | 1 | 3 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 1 | 0 | 1 | 3 | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 0 |
| Litter | 8 | 7 | 9 | 9 | 22 | 8 | 6 | 1 | 8 | 2 | 18 | 1 | 8 | 9 | 9 | 16 | 7 | 12 | 9 | 17 | 8 | 2 | 1 | 15 | 5 | 7 | 17 | 6 | 9 | 10 | 8 | 13 | 5 | 3 | 2 | 10 | 8 | 11 | 4 | 9 |
| Bare Soil | 23 | 21 | 15 | 20 | 5 | 23 | 23 | 21 | 24 | 23 | 16 | 24 | 15 | 10 | 23 | 15 | 12 | 21 | 10 | 9 | 24 | 16 | 17 | 15 | 33 | 16 | 15 | 13 | 13 | 18 | 19 | 17 | 14 | 24 | 24 | 20 | 26 | 8 | 14 | 20 |

Notes:
Species codes defined in Table A-5
[1] Live vegetation is the total vegetation foliar hits for the transect, NOT including noxious weeds
[2] Perennial vegetation is the total vegetation foliar hits for the transect, NOT including annuals and noxious weeds

## Table A-2: O-VMU-5 Line Point Intercept Foliar Cover Data (all hits), 2023

| Transect | T01A | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRAR5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BRTE | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | 2 | 1 | -- | -- | -- | -- | -- | -- | -- |
| SECE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | 1 | -- | -- | 2 | 5 | 2 | 2 | -- | 2 | 2 | 1 | -- | -- | -- | -- | -- | -- | 5 | 1 | -- | 1 | -- | -- | 1 | 2 | -- | -- | -- | -- | 1 | 1 | -- | 1 | 3 | 3 | 1 | 1 | -- | 2 |
| AGCR | 2 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 5 | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | -- | 1 | 2 |
| ELLA3 | -- | -- | -- | -- | 1 | -- | 3 | 5 | -- | 1 | -- | -- | -- | 5 | -- | -- | -- | -- | 4 | -- | 6 | -- | -- | -- | 8 | -- | -- | -- | -- | -- | 4 | -- | -- | 2 | -- | -- | -- | -- | 15 | -- |
| ELTR7 | 4 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 11 | -- | -- | -- | -- | -- | -- | 6 | -- | 11 | -- | 2 | -- | -- | -- | -- | -- | 1 | 3 | 3 | 4 | 1 | 4 |
| HECO26 | 1 | 4 | -- | -- | -- | 3 | 1 | 1 | 1 | 4 | -- | -- | -- | 2 | 1 | -- | -- | 2 | -- | -- | -- | 11 | 2 | 7 | -- | -- | -- | -- | 1 | 4 | 7 | -- | -- | 2 | -- | 1 | 1 | 6 | 1 | -- |
| NAVI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | -- | 4 | 7 | 6 | 7 | -- | -- | -- | 1 | -- | -- | 1 | 1 | 6 | -- | 2 | 1 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | 1 | 5 | 2 | 1 | 8 | 1 | -- | -- | 1 | 4 | 4 | -- |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | 3 | 2 | -- | -- | 1 | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| PSSP6 | -- | 2 | -- | 4 | -- | -- | 1 | -- | 3 | -- | -- | 4 | -- | 1 | 1 | -- | -- | -- | -- | -- | 1 | 5 | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOSI2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOCU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| BODA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 2 | -- | -- | 1 | -- | -- |
| BOGR2 | 1 | 3 | -- | -- | -- | 1 | -- | 6 | -- | -- | -- | 3 | -- | 3 | -- | 8 | -- | -- | -- | -- | 1 | 5 | 1 | 1 | -- | 1 | -- | 4 | 5 | 1 | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- |
| PLJA | 3 | 6 | -- | -- | -- | 3 | 1 | 8 | 3 | 9 | 2 | 10 | 6 | 5 | 1 | 3 | -- | 10 | -- | 11 | 5 | 7 | 24 | 4 | -- | 3 | -- | 14 | 9 | 5 | -- | -- | 5 | 8 | 13 | 3 | 3 | 5 | 5 | 3 |
| SONU2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPAI | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 3 | -- | 1 | 2 | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| SPCR | 1 | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | 1 | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ALSI8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| CHRE4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHSE6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| DYGR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERCE2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HEAN3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| POOL | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| SATR12 | -- | -- | 6 | -- | 2 | 2 | 2 | -- | 1 | -- | 3 | -- | 1 | 1 | -- | -- | 8 | -- | 2 | 6 | -- | 1 | 1 | -- | -- | 2 | 3 | -- | -- | -- | -- | -- | 9 | 2 | 2 | 5 | 1 | -- | 1 | 3 |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BADI | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERDI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- |
| HEMU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| LILE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| MACA2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| MEOF | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 |
| MESA | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ONVI | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| SPIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| TRDU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARLU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARNO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCA2 | 8 | -- | 1 | 11 | 3 | 1 | 4 | 4 | 5 | 4 | 2 | 1 | 6 | 5 | 2 | 2 | 6 | 3 | 1 | -- | 1 | 7 | 1 | -- | 3 | 6 | -- | 1 | 12 | -- | 5 | 7 | 3 | -- | 5 | 5 | 4 | 2 | 4 | 2 |
| ERNA10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- |
| GUSA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | 9 | -- | -- | 4 | -- | -- | -- | 2 | -- | -- | 5 | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- |
| PIED | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Unknown Plant** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRASSI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

Notes:
Species codes defined in Table A-5

## Table A-3: O-VMU-5 Line Point Intercept Species Associations, 2023

| Lower Canopy Species | Upper Canopy Species: ACHY | AGCR | ATCA2 | BOGR2 | ELEL5 | ERDI4 | ERNA10 | GUSA2 | HECO26 | KRLA2 | MEOF | MESA | PUME | SATR12 | SECE | SPAI | SPCR | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACHY | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 2 |
| ATCA2 | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 3 |
| BOCU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 |
| BODA2 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| BOGR2 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 2 |
| BRAR5 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| BRTE | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| ELLA3 | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 5 |
| ELTR7 | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 |
| HECO26 | 3 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 |
| HOJU | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| KRLA2 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| NAVI4 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| PASM | -- | -- | 5 | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 7 |
| PLJA | 1 | -- | 12 | 1 | -- | -- | 2 | -- | 1 | 1 | 1 | -- | 2 | 1 | 2 | 1 | 1 | 26 |
| PSJU3 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| PSSP6 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| SATR12 | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| SPAI | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
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Notes:
Species codes defined in Table A-5

# Table A-4: O-VMU-5 Quadrat Canopy Cover Data (%), 2023

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| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation Cove | 50.0 | 1.8 | 35.0 | 22.0 | 0.5 | 33.0 | 0.3 | 46.0 | 15.0 | 5.0 | 35.0 | 8.0 | 35.0 | 30.0 | 52.0 | 88.0 | 28.9 | 32.5 | 8.0 | 2.0 | 14.0 | 26.1 | 23.0 | 25.0 | 55.0 | 40.0 | 5.0 | 45.0 | 31.8 | 14.5 | 22.0 | 22.0 | 11.0 | 10.0 | 20.0 | 25.0 | 47.0 | 4.0 | 28.0 | 65.0 | 78.0 | 37.0 | 18.0 | 22.0 | 10.0 | 26.5 | 42.8 | 46.0 | 29.0 | 34.0 | 30.0 | 73.5 | 58.0 | 22.0 | 40.0 | 15.0 | 65.0 | 12.0 | 48.0 | 22.1 |
| Rock | 0.0 | 0.1 | 0.0 | 0.3 | 0.4 | 0.1 | 23.0 | 2.0 | 17.0 | 4.0 | 5.0 | 1.0 | 1.0 | 6.0 | 0.0 | 0.0 | 0.3 | 0.1 | 0.8 | 4.0 | 4.0 | 0.3 | 0.1 | 0.1 | 0.0 | 3.0 | 0.5 | 0.3 | 1.3 | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 5.0 | 12.0 | 7.0 | 1.0 | 0.0 | 3.0 | 1.0 | 0.5 | 1.0 | 0.8 | 0.0 | 0.0 | 0.3 | 0.3 | 0.3 | 0.2 | 0.1 | 3.0 | 4.0 | 9.0 | 1.0 | 5.0 | 0.5 | 8.0 |
| Litter | 0.1 | 0.1 | 0.5 | 3.0 | 1.5 | 0.8 | 26.0 | 25.0 | 6.0 | 3.0 | 4.0 | 5.0 | 50.0 | 20.0 | 30.0 | 2.0 | 27.0 | 8.0 | 3.0 | 7.0 | 1.5 | 1.0 | 8.0 | 0.0 | 15.0 | 4.0 | 5.0 | 4.0 | 2.3 | 0.8 | 5.0 | 1.0 | 20.0 | 3.0 | 3.0 | 2.0 | 12.0 | 8.0 | 12.0 | 22.0 | 12.0 | 10.0 | 7.0 | 5.0 | 5.0 | 3.5 | 6.0 | 45.0 | 20.0 | 15.0 | 20.0 | 18.0 | 12.0 | 4.0 | 20.0 | 8.0 | 29.0 | 20.0 | 30.0 | 8.0 |
| Bare Soil | 50.0 | 98.2 | 64.5 | 74.8 | 97.6 | 66.2 | 50.7 | 27.0 | 62.0 | 88.0 | 56.0 | 86.0 | 14.0 | 44.0 | 18.0 | 10.0 | 43.9 | 59.4 | 88.3 | 87.0 | 80.5 | 72.7 | 68.9 | 75.0 | 30.0 | 53.0 | 89.5 | 50.8 | 64.8 | 84.8 | 72.9 | 77.0 | 68.9 | 86.9 | 77.0 | 73.0 | 36.0 | 76.0 | 53.0 | 12.0 | 10.0 | 50.0 | 74.0 | 72.5 | 84.0 | 69.2 | 51.2 | 9.0 | 50.7 | 50.7 | 49.7 | 4.3 | 29.9 | 71.0 | 36.0 | 68.0 | 5.0 | 63.0 | 21.6 | 61.9 |

## Table A-4: O-VMU-5 Quadrat Canopy Cover Data (%), 2023 (cont'd)

| Transect | T21P | | | T22P | | | T23P | | | T24P | | | T25P | | | T26P | | | T27P | | | T28P | | | T29P | | | T30P | | | T33P | | | T32P | | | T33P | | | T34P | | | T35P | | | T36P | | | T36P | | | T37P | | | T39P | | | T40P | | |
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| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Cool-Season Perennial [1] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Shrubs, Trees, and Cact** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Unknown Plan** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation Cover | 19.0 | 23.0 | 13.0 | 0.2 | 20.0 | 45.0 | 85.0 | 59.3 | 28.0 | 25.0 | 20.0 | 10.0 | 1.0 | 78.0 | 4.0 | 22.0 | 11.0 | 77.0 | 11.7 | 9.1 | 65.2 | 46.3 | 73.0 | 35.5 | 94.0 | 73.0 | 39.0 | 45.0 | 6.0 | 25.0 | 5.0 | 20.0 | 35.0 | 0.5 | 85.0 | 40.0 | 35.0 | 40.0 | 35.0 | 6.0 | 35.0 | 35.0 | 35.0 | 78.0 | 23.0 | 16.7 | 3.1 | 20.0 | 39.0 | 2.2 | 7.0 | 23.0 | 22.0 | 20.0 | 9.8 | 62.2 | 34.5 | 49.0 | 6.0 | 29.0 |
| Rock | 1.0 | 1.0 | 2.0 | 1.0 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.8 | 0.5 | 0.8 | 0.0 | 0.1 | 0.2 | 6.0 | 1.0 | 0.4 | 0.9 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.5 | 0.1 | 2.0 | 1.0 | 0.1 | 4.0 | 0.0 | 0.1 | 0.0 | 0.5 | 0.5 | 4.0 | 1.5 | 0.5 | 0.0 | 0.3 | 1.0 | 0.5 | 0.8 | 0.0 | 0.0 | 0.1 | 0.8 | 0.1 | 1.0 | 0.5 | 1.0 | 0.0 | 0.3 | 0.3 | 1.0 | 0.0 |
| Litter | 8.0 | 6.0 | 6.0 | 10.0 | 0.5 | 5.0 | 2.0 | 0.5 | 0.5 | 10.0 | 8.0 | 6.0 | 1.0 | 12.0 | 1.5 | 7.0 | 3.0 | 5.0 | 10.0 | 5.0 | 2.0 | 4.0 | 0.5 | 0.1 | 3.0 | 25.0 | 15.0 | 2.0 | 6.0 | 2.0 | 0.5 | 4.0 | 5.0 | 4.0 | 14.0 | 27.0 | 25.0 | 3.0 | 1.0 | 2.0 | 3.0 | 1.0 | 0.5 | 5.5 | 0.5 | 7.0 | 3.0 | 4.0 | 7.0 | 7.5 | 12.0 | 10.0 | 2.0 | 8.0 | 0.5 | 16.0 | 8.0 | 35.8 | 0.5 | 10.0 |
| Bare Soil | 72.0 | 70.0 | 79.0 | 88.8 | 79.2 | 49.9 | 13.0 | 40.3 | 71.5 | 64.9 | 71.3 | 83.5 | 97.3 | 10.0 | 94.4 | 70.8 | 80.0 | 17.0 | 77.9 | 85.0 | 32.8 | 49.8 | 26.3 | 64.5 | 3.0 | 2.0 | 46.0 | 53.0 | 87.5 | 73.0 | 92.5 | 75.0 | 59.9 | 91.5 | 1.0 | 33.0 | 40.0 | 56.5 | 63.5 | 88.0 | 60.5 | 63.5 | 64.5 | 16.3 | 75.5 | 75.8 | 93.1 | 76.0 | 54.0 | 90.3 | 80.3 | 67.0 | 75.0 | 71.5 | 88.7 | 21.9 | 57.3 | 15.0 | 92.5 | 61.0 |

Notes:
Species codes defined in Table A-5
[1]Total vegetation canopy cover for the transect by the quadrat canopy cover estimate method

## Table A-5: O-VMU-5 Air-dry Aboveground Annual Forage Production Data, 2023

| Transect | T01A | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
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| **Perennial Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | 32 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 12 | 1 | -- | 1 | 7 | -- | -- | -- | 7 | -- |
| AGCR | 18 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 49 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 70 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 92 | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 33 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
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| ELLA3 | 54 | -- | -- | 21 | -- | -- | 1 | -- | -- | 27 | -- | 5 | -- | 15 | 22 | -- | -- | -- | -- | -- | 26 | 2 | -- | -- | 73 | -- | -- | -- | 11 | -- | 53 | -- | -- | 14 | -- | -- | 20 | -- | -- | -- |
| ELTR7 | 18 | -- | -- | 25 | -- | -- | -- | -- | 9 | -- | -- | -- | -- | 2 | -- | 1 | 28 | 50 | -- | -- | -- | -- | -- | 44 | -- | 102 | -- | 16 | 11 | -- | -- | -- | -- | -- | 6 | 2 | 5 | 77 | -- | 20 |
| HECO26 | -- | 4 | -- | 3 | -- | -- | -- | -- | 3 | 14 | -- | -- | -- | -- | 3 | 20 | -- | -- | -- | -- | -- | 16 | -- | 60 | -- | -- | -- | 24 | 5 | 20 | -- | -- | -- | -- | -- | 8 | -- | 5 | -- | 2 |
| HOJU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LECI4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 17 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | -- | 5 | 9 | 10 | 39 | -- | -- | 31 | -- | -- | 15 | 1 | 8 | 8 | -- | -- | 34 | -- | 1 | -- | -- | 3 | -- | -- | 1 | -- | 21 | -- | 5 | 12 | -- | 3 | 66 | -- | -- | 1 | -- | 28 | 26 | -- |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 13 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PSSP6 | -- | 1 | -- | 6 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 39 | 2 | -- | -- | -- | -- | -- | 1 | 7 | -- | -- | -- | -- | -- | -- | 16 | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
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| BOGR2 | -- | 19 | -- | -- | 1 | -- | -- | 24 | 4 | -- | -- | 1 | 6 | 6 | -- | 5 | -- | 7 | -- | -- | -- | 16 | 27 | -- | -- | 2 | -- | -- | 25 | 10 | -- | -- | -- | -- | 19 | -- | -- | -- | -- | 9 |
| PLJA | 102 | 103 | -- | 1 | 5 | 125 | 12 | 34 | 71 | 32 | 28 | 40 | 38 | 62 | -- | 78 | -- | 171 | -- | 117 | 23 | 16 | 166 | -- | -- | 5 | -- | 75 | 78 | 4 | 1 | -- | 6 | 101 | 123 | -- | 30 | -- | -- | 20 |
| SPAI | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | 25 | -- | 39 | -- | 15 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 60 | 91 | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Perennial/Biennial Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACMI2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0 | -- | -- | -- | -- |
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| DEIN5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 53 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| DEPI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| ERDI4 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| GAAR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HEMU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- |
| LAOC3 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LILE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| MACA2 | -- | 34 | -- | -- | -- | -- | -- | 0 | -- | -- | 30 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | 7 |
| MATA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- |
| MESA | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| RACO3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- |
| SPFE | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| TRDU | -- | 1 | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | 0 | -- | -- | -- | -- | -- |
| TRPR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ATCA2 | 73 | -- | -- | 28 | 77 | -- | -- | 0 | 52 | -- | -- | -- | 18 | 172 | -- | 2 | 35 | 69 | -- | -- | 7 | 18 | -- | -- | -- | 305 | -- | -- | 231 | -- | 32 | 82 | -- | -- | -- | 19 | -- | 4 | 32 | 1 |
| ATCO4 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| EPVI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 57 | -- | -- | -- | -- | -- | -- | -- | 62 | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- |
| GUSA2 | -- | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | 1 | -- | 1 | 1 | 22 | -- | -- | -- | -- | -- | 44 | -- | -- | 76 | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 32 | -- | 0 | -- | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Total Air-dry Aboveground Annual Forage Production** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total (g) | 265 | 169 | 10 | 95 | 128 | 134 | 36 | 89 | 152 | 77 | 76 | 78 | 119 | 345 | 88 | 206 | 98 | 297 | 124 | 119 | 60 | 80 | 192 | 106 | 79 | 413 | 177 | 180 | 445 | 149 | 110 | 187 | 91 | 117 | 156 | 65 | 55 | 205 | 64 | 67 |
| Total (lbs/ac) | 1,576 | 1,002 | 59 | 562 | 762 | 800 | 216 | 530 | 903 | 456 | 451 | 463 | 707 | 2,054 | 524 | 1,227 | 581 | 1,768 | 735 | 705 | 358 | 478 | 1,144 | 629 | 469 | 2,455 | 1,050 | 1,069 | 2,646 | 888 | 654 | 1,112 | 538 | 698 | 926 | 389 | 327 | 1,220 | 380 | 396 |

Notes:
Species codes defined in Table A-5
Total (g) is the total of all three .5 $m^2$ quads (1.5$m^2$ total) per transect
Lbs/ac=total grams÷1.5*(4046.86/453.592)
Non-forage and forage determinations are based on the permit (e.g. plants of perennial and/or biennial duration are forage and plants of annual duration are non-forage; noxious weeds are non-forage)

## Table A-6: O-VMU-5 Shrub Belt Transect Data (frequency), 2023

| Transect | T01A | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARBI3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- |
| ARFR4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARLU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- |
| ARNO4 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- |
| ATAC | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- |
| ATCA2 | 72 | 5 | 13 | 47 | 187 | 13 | 41 | 25 | 68 | 16 | 34 | 19 | 62 | 32 | 33 | 26 | 37 | 24 | 11 | 31 | 59 | 29 | 8 | 4 | 21 | 28 | -- | 3 | 68 | 5 | 37 | 24 | 27 | 10 | 32 | 83 | 50 | 38 | 19 | 20 |
| ATCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | 7 | 1 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | 2 | -- | -- |
| ATCO4 | -- | -- | -- | 4 | -- | -- | 8 | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- |
| CACTUS | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| EPVI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- |
| ERNA10 | -- | -- | -- | -- | 10 | 2 | 1 | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | 2 | 18 | -- | -- | 1 | -- | -- | 4 | -- | -- | 78 | -- | -- | -- | 2 | 8 | -- | 2 | -- | -- | -- | -- | -- |
| GUSA2 | 2 | 2 | 2 | -- | -- | 2 | -- | -- | -- | 4 | 2 | 3 | 1 | -- | -- | -- | -- | 2 | 14 | -- | -- | 1 | -- | -- | 12 | -- | 2 | -- | -- | 4 | 1 | 10 | 4 | -- | 1 | -- | -- | 3 | -- | -- |
| KRLA2 | 3 | -- | 159 | 1 | 9 | 14 | 26 | -- | 4 | 2 | -- | -- | 28 | 28 | 4 | 92 | -- | -- | 1 | -- | 50 | -- | 6 | 2 | -- | 9 | 5 | -- | -- | 1 | 1 | -- | -- | 1 | -- | 16 | 4 | 31 | -- | 1 |
| OPMA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| OPPH | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| OPUNT | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PIED | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | 13 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SAVE4 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Total** | 78 | 7 | 174 | 52 | 206 | 31 | 77 | 25 | 72 | 40 | 36 | 23 | 91 | 64 | 40 | 119 | 37 | 28 | 46 | 38 | 122 | 32 | 14 | 6 | 39 | 41 | 10 | 82 | 69 | 10 | 39 | 41 | 39 | 14 | 36 | 99 | 56 | 80 | 21 | 21 |

Notes:
Species codes defined in Table A-5
The shrub belt transect area is 100m$^2$ (2mx50m); shrubs rooted in the belt transect were counted on an individual basis

## Table A-7: Species Observed 2019-2023, O-VMU-5

| Common Name | Scientific Name | Code |
|---|---|---|
| **Cool-Season Grasses (23)** | | |
| **Annuals (5)** | | |
| Field brome | *Bromus arvensis* | BRAR5 |
| Cheatgrass | *Bromus tectorum* | BRTE |
| Common barley | *Hordeum vulgare* | HOVU |
| **Cereal rye** | ***Secale cereale*** | **SECE** |
| **Common Wheat** | ***Triticum aestivum*** | **TRAE** |
| **Perennials (18)** | | |
| Indian ricegrass | *Achnatherum hymenoides* | ACHY |
| Crested wheatgrass | *Agropyron cristatum* | AGCR |
| Smooth brome | *Bromus inermis* | BRIN2 |
| Bottlebrush squirreltail | *Elymus elymoides* | ELEL5 |
| Blue wildrye | *Elymus glaucus* | ELGL |
| Thickspike wheatgrass | *Elymus lanceolatus* | ELLA3 |
| Slender wheatgrass | *Elymus trachycaulus* | ELTR7 |
| Arizona fescue | *Festuca arizonica* | FEAR2 |
| Needle and thread | *Hesperostipa comata* | HECO26 |
| Foxtail barley | *Hordeum jubatum* | HOJU |
| Colorado wildrye | *Leymus ambiguus* | LEAM |
| Basin wildrye | *Leymus cinereus* | LECI4 |
| **Green needlegrass** | ***Nassella viridula*** | **NAVI4** |
| Western wheatgrass | *Pascopyrum smithii* | PASM |
| Russian wildrye | *Psathyrostachys juncea* | PSJU3 |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | PSSP6 |
| Intermediate wheatgrass | *Thinopyrum intermedium* | THIN6 |
| Tall wheatgrass | *Thinopyrum ponticum* | THPO7 |
| **Warm-Season Grasses (12)** | | |
| **Annuals (3)** | | |
| Sixweeks grama | *Bouteloua barbata* | BOBA2 |
| Matted grama | *Bouteloua simplex* | BOSI2 |
| False buffalograss | *Munroa squarrosa* | MUSQ3 |
| **Perennials (9)** | | |
| Purple threeawn | *Aristida purpurea* | ARPU9 |
| Sideoats grama | *Bouteloua curtipendula* | BOCU |
| Buffalograss | *Bouteloua dactyloides* | BODA2 |
| Blue grama | *Bouteloua gracilis* | BOGR2 |
| James' galleta | *Pleuraphis jamesii* | PLJA |
| Tumblegrass | *Schedonnardus paniculatus* | SCPA |
| **Indiangrass** | ***Sorghastrum nutans*** | **SONU2** |
| Alkali sacaton | *Sporobolus airoides* | SPAI |
| Sand dropseed | *Sporobolus cryptandrus* | SPCR |
| **Forbs (85)** | | |
| **Annuals (35)** | | |
| Desert madwort | *Alyssum desertorum* | ALDE |
| Alyssum | *Alyssum simplex* | ALSI8 |
| **Redroot amaranth** | ***Amaranthus retroflexus*** | **AMRE** |
| Annual ragweed | *Ambrosia artemisiifolia* | AMAR2 |
| Burningbush | *Bassia scoparia* | BASC5 |
| Ribseed sandmat | *Chamaesyce glyptosperma* | CHGL13 |
| Spotted sandmat | *Chamaesyce maculata* | CHMA15 |
| **Prairie sandmat** | ***Chamaesyce missurica*** | **CHMI8** |
| **Threadstem sandmat** | ***Chamaesyce revoluta*** | **CHRE4** |
| **Thymeleaf sandmat** | ***Chamaesyce serpyllifolia*** | **CHSE6** |
| Mealy goosefoot | *Chenopodium incanum* | CHIN2 |
| Narrowleaf goosefoot | *Chenopodium leptophyllum* | CHLE4 |
| Lambsquarters | *Chenopodium album* | CHAL7 |
| Rocky Mountain beeplant | *Cleome serrulata* | CLSE |
| Wright's bird's beak | *Cordylanthus wrightii* | COWR2 |
| Fetid goosefoot | *Dysphania graveolens* | DYGR |
| **Fetid marigold** | ***Dyssodia papposa*** | **DYPA** |
| Nodding buckwheat | *Eriogonum cernuum* | ERCE2 |
| Divergent buckwheat | *Eriogonum divaricatum* | ERDI5 |
| Saltlover | *Halogeton glomeratus* | HAGL |
| Common sunflower | *Helianthus annuus* | HEAN3 |
| Prairie sunflower | *Helianthus petiolaris* | HEPE |
| Longleaf false goldeneye | *Heliomeris longifolia* | HELO6 |
| Coulter's horseweed | *Laennecia coulteri* | LACO13 |
| King's lupine | *Lupinus kingii* | LUKI |
| Fendler's desertdandelion | *Malacothrix fendleri* | MAFE |
| Pony beebalm | *Monarda pectinata* | MOPE |
| Erect knotweed | *Polygonum erectum* | POER2 |
| Little hogweed | *Portulaca oleracea* | POOL |
| Prickly Russian thistle | *Salsola tragus* | SATR12 |
| Manyflower false threadleaf | *Schkuhria multiflora* | SCMU6 |
| Cutleaf nightshade | *Solanum triflorum* | SOTR |
| Common sowthistle | *Sonchus oleraceus* | SOOL |
| Golden crownbeard | *Verbesina encelioides* | VEEN |
| Rough cocklebur | *Xanthium strumarium* | XAST |

## Table A-7: Species Observed 2019-2023, O-VMU-5

| Common Name | Scientific Name | Code |
|---|---|---|
| **Perennials/Biennials (50)** | | |
| Common yarrow | *Achillea millefolium* | ACMI2 |
| Horsetail milkweed | *Asclepias subverticillata* | ASSU2 |
| Fort Wingate milkvetch | *Astragalus mingatanus* | ASWI2 |
| Ragleaf bahia | *Bahia dissecta* | BADI |
| Sego lily | *Calochortus nuttallii* | CANU3 |
| Musk thistle | *Carduus nutans* | CANU4 |
| Wyoming Indian paintbrush | *Castilleja linariifolia* | CALI4 |
| Rose heath | *Chaetopappa ericoides* | CHER2 |
| Whitemargin sandmat | *Chamaesyce albomarginata* | CHAL11 |
| Canadian horseweed | *Conyza canadensis* | COCA5 |
| Purple prairie clover | *Dalea purpurea* | DAPU5 |
| **Mountain tansymustard** | ***Descurainia incana*** | **DEIN5** |
| Western tansymustard | *Descurainia pinnata* | DEPI |
| Flixweed | *Descurainia sophia* | DESO |
| Spreading fleabane | *Erigeron divergens* | ERDI4 |
| Bastardsage | *Eriogonum wrightii* | ERWR |
| Redstem stork's bill | *Erodium cicutarium* | ERCI6 |
| **Blanketflower** | ***Gaillardia aristata*** | **GAAR** |
| Curlycup gumweed | *Grindelia squarrosa* | GRSQ |
| **Showy goldeneye** | ***Heliomeris multiflora*** | **HEMU3** |
| Scarlet gilia | *Ipomopsis aggregata* | IPAG |
| Flaxflowered ipomopsis | *Ipomopsis longiflora* | IPLO2 |
| Manyflowered ipomopsis | *Ipomopsis multiflora* | IPMU3 |
| Prickly lettuce | *Lactuca serriola* | LASE |
| Flatspine stickseed | *Lappula occidentalis* | LAOC3 |
| Lewis flax | *Linum lewisii* | LILE3 |
| Hoary tansyaster | *Machaeranthera canescens* | MACA2 |
| Tanseyleaf tansyaster | *Machaeranthera tanacetifolia* | MATA2 |
| Horehound | *Marrubium vulgare* | MAVU |
| Alfalfa | *Medicago sativa* | MESA |
| Sweetclover | *Melilotus officinalis* | MEOF |
| Narrowleaf four-o'clock | *Mirabilis linearis* | MILI3 |
| Colorado four o'clock | *Mirabilis multiflora* | MIMU |
| **Sainfoin** | ***Onobrychis viciifolia*** | **ONVI** |
| Palmer's penstemon | *Penstemon palmeri* | PEPA8 |
| Prostrate knotweed | *Polygonum aviculare* | POAV |
| Upright prairie coneflower | *Ratibida columnifera* | RACO3 |
| Curly dock | *Rumex crispus* | RUCR |
| Tall tumblemustard | *Sisymbrium altissimum* | SIAL2 |
| Scarlet globemallow | *Sphaeralcea coccinea* | SPCO |
| Emory's globemallow | *Sphaeralcea emoryi* | SPEM |
| Fendler's globemallow | *Sphaeralcea fendleri* | SPFE |
| Gooseberryleaf globemallow | *Sphaeralcea grossulariifolia* | SPGR2 |
| Spear globemallow | *Sphaeralcea hastulata* | SPHA |
| Gray globemallow | *Sphaeralcea incana* | SPIN2 |
| Small-leaf globemallow | *Sphaeralcea parvifolia* | SPPA2 |
| Wright's thelypody | *Thelypodium wrightii* | THWR |
| Yellow salsify | *Tragopogon dubius* | TRDU |
| Salsify | *Tragopogon porrifolius* | TRPO |
| Jack-go-to-bed-at-noon | *Tragopogon pratensis* | TRPR |

## Table A-7: Species Observed 2019-2023, O-VMU-5

| Common Name | Scientific Name | Code |
|---|---|---|
| **Shrubs, Trees, and Cacti (43)** | | |
| **Bigelow sage** | ***Artemisia bigelovii*** | **ARBI3** |
| Silver sagebrush | *Artemisia cana* | ARCA13 |
| Prairie sagewort | *Artemisia frigida* | ARFR4 |
| White sagebrush | *Artemisia ludoviciana* | ARLU |
| **Black sagebrush** | ***Artemisia nova*** | **ARNO4** |
| Big sagebrush | *Artemisia tridentata* | ARTR2 |
| Tubercled saltbush | *Atriplex acanthocarpa* | ATAC |
| Fourwing saltbush | *Atriplex canescens* | ATCA2 |
| Shadscale saltbush | *Atriplex confertifolia* | ATCO |
| Mat saltbush | *Atriplex corrugata* | ATCO4 |
| Gardner's saltbush | *Atriplex gardneri* | ATGA |
| Mound saltbush | *Atriplex obovata* | ATOB |
| Basin saltbush | *Atriplex tridentata* | ATTR3 |
| Longflower rabbitbrush | *Chrysothamnus depressus* | CHDE2 |
| Greene's rabbitbrush | *Chrysothamnus greenei* | CHGR6 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | CHVI8 |
| Pinkflower hedgehog cactus | *Echinocereus fendleri* | ECFE |
| Russian olive | *Elaeagnus angustifolia* | ELAN |
| Longleaf jointfir | *Ephedra trifurca* | EPTR |
| Mormon tea | *Ephedra viridis* | EPVI |
| Rubber rabbitbrush | *Ericameria nauseosa* | ERNA10 |
| Slenderleaf buckwheat | *Eriogonum leptophyllum* | ERLE10 |
| Broom snakeweed | *Gutierrezia sarothrae* | GUSA2 |
| Hairy false goldenaster | *Heterotheca villosa* | HEVI4 |
| Pingue rubberweed | *Hymenoxys richardsonii* | HYRI |
| Oneseed juniper | *Juniperus monosperma* | JUMO |
| Winterfat | *Krascheninnikovia lanata* | KRLA2 |
| **Twistspine pricklypear** | ***Opuntia macrorhiza*** | **OPMA2** |
| **Tulip pricklypear** | ***Opuntia phaeacantha*** | **OPPH** |
| Plains pricklypear | *Opuntia polyacantha* | OPPO |
| Twoneedle pinyon | *Pinus edulis* | PIED |
| Mexican cliffrose | *Purshia mexicana* | PUME |
| Antelope bitterbrush | *Purshia tridentata* | PUTR2 |
| Woods' rose | *Rosa woodsii* | ROWO |
| Narrowleaf willow | *Salix exigua* | SAEX |
| Greasewood | *Sarcobatus vermiculatus* | SAVE4 |
| Threadleaf ragwort | *Senecio flaccidus* | SEFL3 |
| Broom-like ragwort | *Senecio spartioides* | SESP3 |
| Saltcedar | *Tamarix ramosissima* | TARA |
| Spineless horsebrush | *Tetradymia canescens* | TECA2 |
| Siberian elm | *Ulmus pumila* | ULPU |
| Banana yucca | *Yucca baccata* | YUBA |
| Soapweed yucca | *Yucca glauca* | YUGL |

Notes:

Bold species are newly observed on O-VMU-5 in 2023

**APPENDIX B**

# Quadrat Photographs



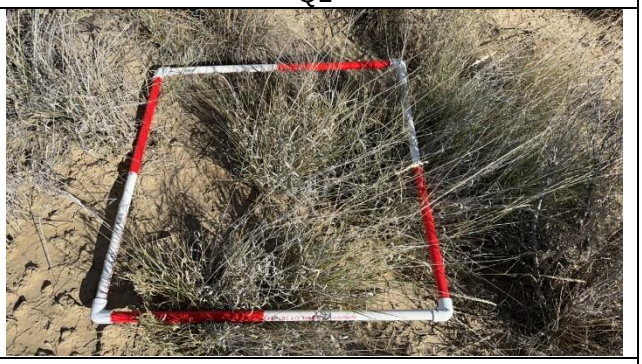
O-VMU5-T01A



Q1



Q2



Q3



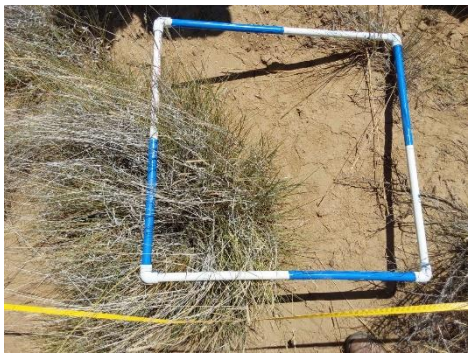
O-VMU5-T01P



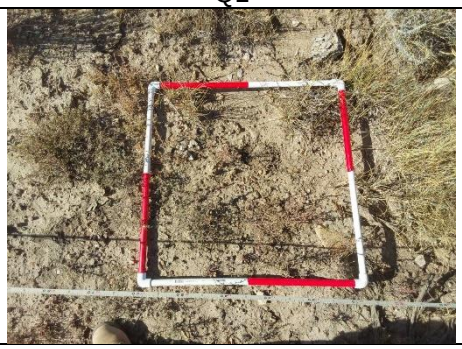
Q1



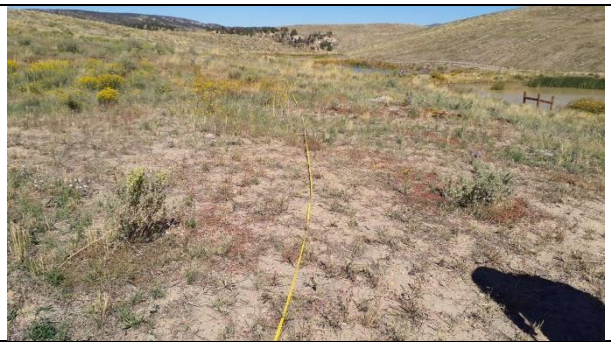
Q2



Q3

| | |
|---|---|
|  |  |
| O-VMU5-T02P | Q1 |
|  |  |
| Q2 | Q3 |

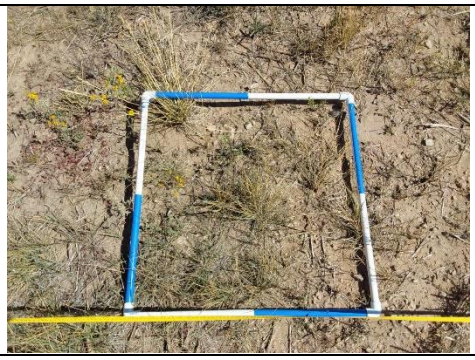
| | |
|---|---|
|  |  |
| O-VMU5-T03P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU5-T04P



Q1



Q2



Q3



O-VMU5-T05P



Q1



Q2



Q3



O-VMU5-T06P



Q1



Q2



Q3



O-VMU5-T07P



Q1



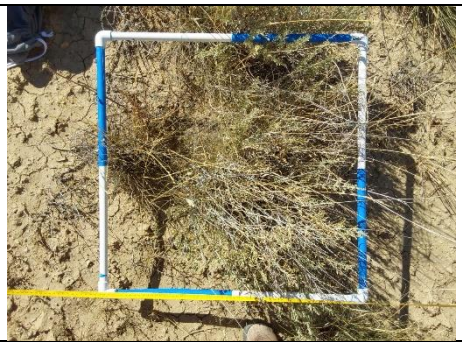
Q2



Q3



O-VMU5-T08P



Q1



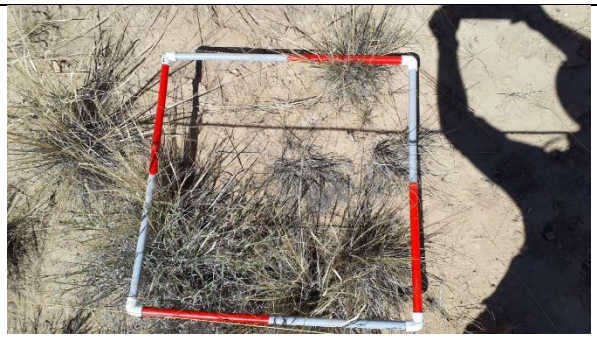
Q2



Q3



O-VMU5-T10P



Q1



Q2



Q3



O-VMU5-T11P



Q1



Q2



Q3



O-VMU5-T12P



Q1



Q2



Q3



O-VMU5-T13P



Q1



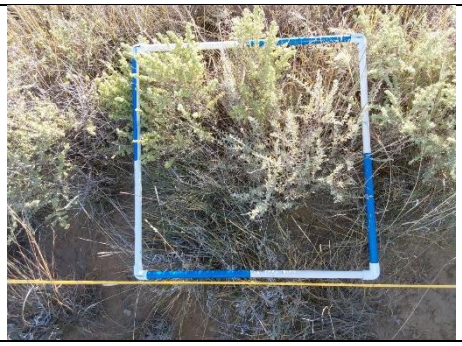
Q2



Q3



O-VMU5-T14P



Q1



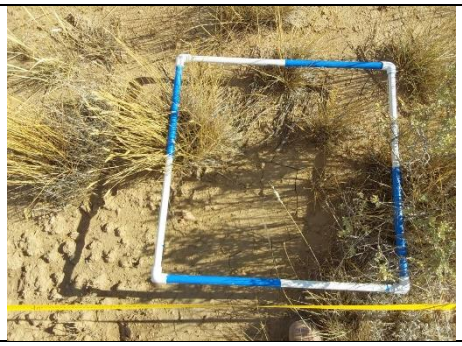
Q2



Q3



O-VMU5-T15P



Q1



Q2



Q3

vZs/>



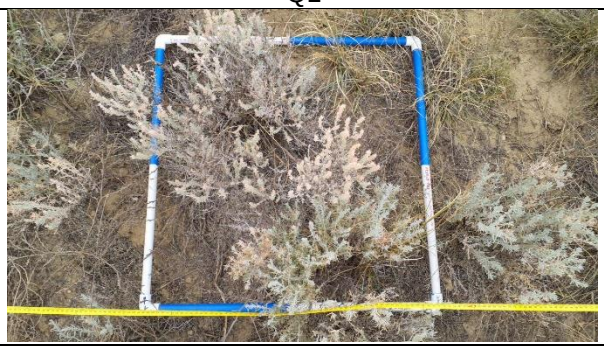
O-VMU5-T16P



Q1



Q2



Q3

| | |
|---|---|
|  |  |
| O-VMU5-T17P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU5-T18P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU5-T19P



Q1



Q2



Q3



O-VMU5-T20P



Q1



Q2



Q3



O-VMU5-T21P



Q1



Q2



Q3



O-VMU5-T22P



Q1



Q2



Q3



O-VMU5-T23P



Q1



Q2



Q3



O-VMU5-T24P



Q1



Q2



Q3



O-VMU5-T25P



Q1



Q2



Q3



O-VMU5-T26P



Q1



Q2

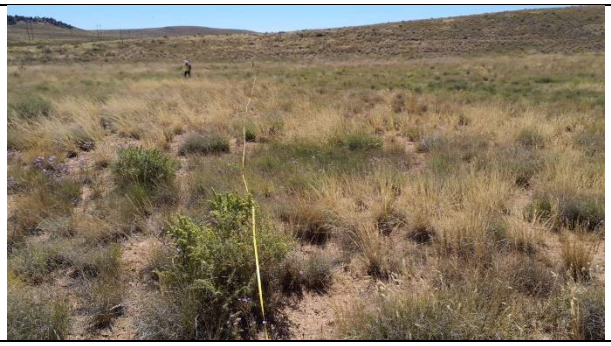


Q3

| | |
|---|---|
|  |  |
| O-VMU5-T27P | Q1 |
|  |  |
| Q2 | Q3 |

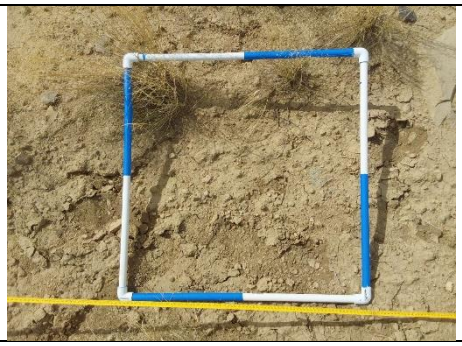
| | |
|---|---|
|  |  |
| O-VMU5-T28P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU5-T29P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU5-T30P | Q1 |
|  |  |
| Q2 | Q3 |



O-VMU5-T31P



Q1



Q2



Q3



O-VMU5-T32P



Q1



Q2



Q3



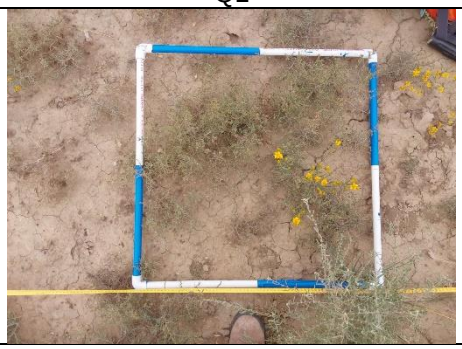
O-VMU5-T33P



Q1



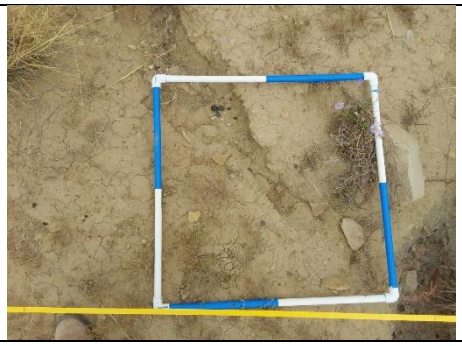
Q2



Q3



O-VMU5-T34P



Q1



Q2



Q3



O-VMU5-T35P



Q1



Q2



Q3



O-VMU5-T36P



Q1

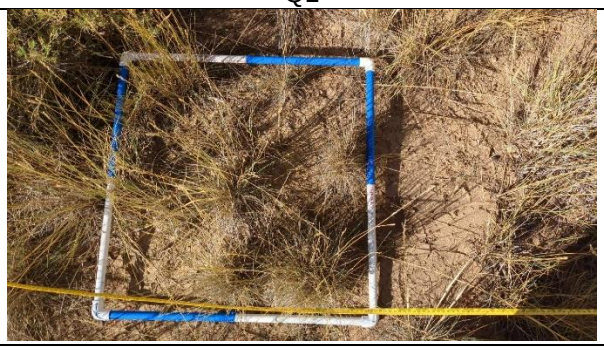


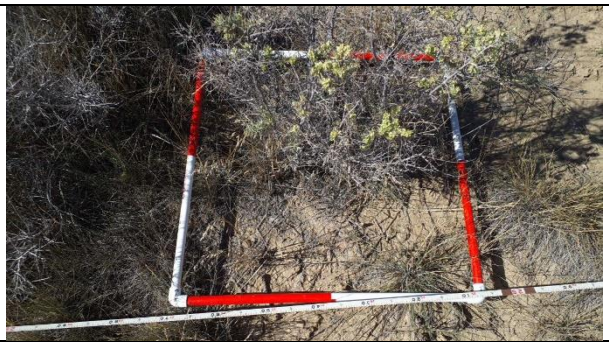
Q2



Q3

| | |
|---|---|
|  |  |
| O-VMU5-T37P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU5-T38P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU5-T39P | Q1 |
|  |  |
| Q2 | Q3 |

| | |
|---|---|
|  |  |
| O-VMU5-T40P | Q1 |
|  |  |
| Q2 | Q3 |

**APPENDIX C**

# Vegetation Statistical Analysis

**Table C1: Equations for Vegetation Data Analysis**

| Attribute | Equation | Where |
|---|---|---|
| Sample Size / Count | $n = \sum samples$ | n = number of samples<br>∑ = sum |
| Mean | $\bar{x} = \frac{\sum x}{n}$ | $\bar{x}$ = sample mean<br>∑x = sum of values for variable<br>n = number of samples |
| Standard Deviation | $s = \sqrt{\frac{\sum(\bar{x} - x)^2}{n-1}}$ | s = standard deviation<br>∑ = sum<br>$\bar{x}$ = sample mean<br>n = number of samples |
| Variance (population) | $s^2 = \frac{\sum_{(x_i - \bar{x})^2}}{n-1}$ | $s^2$ = variance<br>∑ = sum<br>$x_i$ = Value of variable for sample *i*<br>$\bar{x}$ = sample mean<br>n = number of samples |
| t-distribution | t = 1-α, v | t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom<br>α = significance level (0.10)<br>v = degrees of freedom (n-1) |
| 90% Confidence Interval | $\bar{x} \pm z\frac{s}{\sqrt{n}}$ | $\bar{x}$ = sample mean<br>z = the critical value from the normal distribution with α/2 in each tail<br>s = standard deviation<br>n = number of samples |
| $N_{min}$ (Sample Adequacy - Normal Data) | $N_{min} = \frac{t^2 s^2}{(\bar{x}D)^2}$ | $N_{min}$ = number of samples required<br>t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom<br>s = standard deviation ($s^2$ = variance)<br>$\bar{x}$ = sample mean<br>D = the desired level of accuracy, which is 10 percent of the mean |
| Logarithmic Transformation | Y' = log(Y + k) | log = logarithmic function<br>Y = attribute value<br>k = constant, here we use 1 |
| one-sample, one-sided t test | $t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$ | t* = calculated t-statistic<br>$\bar{x}$ = sample mean<br>s = standard deviation<br>n = sample size |
| one-sample, one-sided sign test | $z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$ | z = sign test statistic<br>k = test statistic resulting from the number of values falling below 90% of the technical standard<br>n = sample size |
| Relative Cover (Perennial/Biennial Species) | Rp/b-cvr = Cvrp/b-sp. / Cvrp/b-abs. | $R_{p/b\text{-}cvr}$ = Calculated Relative Cover for a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}sp.}$ = Mean Absolute Cover of a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}abs.}$ = Mean Absolute Perennial/Biennial Cover |
| Relative Cover (All Species) | Rcvr = Cvrsp. / CvrAbs. | $R_{cvr}$ = Calculated Relative Cover for a species<br>$Cvr_{sp.}$ = Mean Absolute Cover of ANY species<br>$Cvr_{abs.}$ = Mean Absolute Cover for All Species |

Notes:
All Appendix C analysis, tables, and figures computed using R software: (R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

**Table C-2: Data for Normal Distribution and Variance Analysis, O-VMU-5, 2023**

| Transect | Raw Data | | | | Log-Transformed Data | | |
|---|---|---|---|---|---|---|---|
| | Total Ground Cover (%) | Perennial Vegetation Cover (%) | Annual Forage Production (lbs/ac) | Woody Plant Density (#/ac) | Log - Annual Forage Production | Log - Perennial Vegetation Cover | Log - Woody Plant Density |
| O-VMU5-T01A | 54 | 38 | 1,575 | 3,157 | 3.20 | 1.58 | 3.50 |
| O-VMU5-T01P | 54 | 40 | 1,002 | 283 | 3.00 | 1.60 | 2.45 |
| O-VMU5-T02P | 62 | 32 | 58 | 7,042 | 1.76 | 1.51 | 3.85 |
| O-VMU5-T03P | 60 | 42 | 562 | 2,104 | 2.75 | 1.62 | 3.32 |
| O-VMU5-T04P | 82 | 32 | 761 | 8,337 | 2.88 | 1.51 | 3.92 |
| O-VMU5-T05P | 52 | 32 | 799 | 1,255 | 2.90 | 1.51 | 3.10 |
| O-VMU5-T06P | 40 | 24 | 217 | 3,116 | 2.34 | 1.38 | 3.49 |
| O-VMU5-T07P | 52 | 50 | 531 | 1,012 | 2.73 | 1.70 | 3.01 |
| O-VMU5-T08P | 50 | 32 | 903 | 2,914 | 2.96 | 1.51 | 3.46 |
| O-VMU5-T10P | 52 | 48 | 456 | 1,619 | 2.66 | 1.68 | 3.21 |
| O-VMU5-T11P | 68 | 26 | 451 | 1,457 | 2.65 | 1.41 | 3.16 |
| O-VMU5-T12P | 48 | 46 | 463 | 931 | 2.67 | 1.66 | 2.97 |
| O-VMU5-T13P | 52 | 34 | 707 | 3,683 | 2.85 | 1.53 | 3.57 |
| O-VMU5-T14P | 76 | 56 | 2,054 | 2,590 | 3.31 | 1.75 | 3.41 |
| O-VMU5-T15P | 50 | 32 | 524 | 1,619 | 2.72 | 1.51 | 3.21 |
| O-VMU5-T16P | 70 | 38 | 1,228 | 4,816 | 3.09 | 1.58 | 3.68 |
| O-VMU5-T17P | 76 | 36 | 581 | 1,497 | 2.76 | 1.56 | 3.18 |
| O-VMU5-T18P | 58 | 34 | 1,768 | 1,133 | 3.25 | 1.53 | 3.05 |
| O-VMU5-T19P | 60 | 36 | 736 | 1,862 | 2.87 | 1.56 | 3.27 |
| O-VMU5-T20P | 80 | 22 | 705 | 1,538 | 2.85 | 1.34 | 3.19 |
| O-VMU5-T21P | 46 | 30 | 358 | 4,937 | 2.55 | 1.48 | 3.69 |
| O-VMU5-T22P | 68 | 64 | 478 | 1,295 | 2.68 | 1.81 | 3.11 |
| O-VMU5-T23P | 66 | 60 | 1,143 | 567 | 3.06 | 1.78 | 2.75 |
| O-VMU5-T24P | 68 | 36 | 629 | 243 | 2.80 | 1.56 | 2.39 |
| O-VMU5-T25P | 34 | 24 | 469 | 1,578 | 2.67 | 1.38 | 3.20 |
| O-VMU5-T26P | 62 | 44 | 2,454 | 1,659 | 3.39 | 1.64 | 3.22 |
| O-VMU5-T27P | 68 | 26 | 1,051 | 405 | 3.02 | 1.41 | 2.61 |
| O-VMU5-T28P | 74 | 62 | 1,068 | 3,318 | 3.03 | 1.79 | 3.52 |
| O-VMU5-T29P | 72 | 54 | 2,645 | 2,792 | 3.42 | 1.73 | 3.45 |
| O-VMU5-T30P | 64 | 44 | 887 | 405 | 2.95 | 1.64 | 2.61 |
| O-VMU5-T31P | 60 | 44 | 654 | 1,578 | 2.82 | 1.64 | 3.20 |
| O-VMU5-T32P | 56 | 30 | 1,111 | 1,659 | 3.05 | 1.48 | 3.22 |
| O-VMU5-T33P | 70 | 42 | 538 | 1,578 | 2.73 | 1.62 | 3.20 |
| O-VMU5-T34P | 46 | 34 | 697 | 567 | 2.84 | 1.53 | 2.75 |
| O-VMU5-T35P | 52 | 44 | 925 | 1,457 | 2.97 | 1.64 | 3.16 |
| O-VMU5-T36P | 56 | 28 | 389 | 4,006 | 2.59 | 1.45 | 3.60 |
| O-VMU5-T37P | 46 | 28 | 326 | 2,266 | 2.51 | 1.45 | 3.36 |
| O-VMU5-T38P | 84 | 60 | 1,220 | 3,237 | 3.09 | 1.78 | 3.51 |
| O-VMU5-T39P | 72 | 62 | 379 | 850 | 2.58 | 1.79 | 2.93 |
| O-VMU5-T40P | 60 | 36 | 396 | 850 | 2.60 | 1.56 | 2.93 |
| Mean | 60.50 | 39.6 | 847.5 | 2180.2 | 2.8 | 1.6 | 3.2 |
| Standard Deviation | 11.8 | 11.6 | 571.4 | 1749.5 | 0.3 | 0.1 | 0.4 |
| Count | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Variance | 135 | 132 | 318,361 | 2,984,082 | 0.088 | 0.015 | 0.123 |
| 90% Confidence Interval | 3 | 3 | 149 | 455 | 0.078 | 0.032 | 0.092 |
| Technical Standard | 52% | 24% | 550 | 400 | 2.74 | 1.38 | 2.60 |
| **90% of Standard** | 46.8% | 21.6% | 495 | 360 | 2.47 | 1.33 | 2.34 |

Notes:
2023 Data are found in Appendix A

**Table C-3: Total Ground Cover, one-sample, one-sided t-test - classical null (left-sided), O-VMU-5, 2023**

| Total Ground Cover (%) | |
|---|---|
| Mean (%) | 60.5 |
| Standard Deviation (%) | 11.8 |
| Sample Size | 40 |
| Technical Standard (%) | 52 |
| t* | 7.365 |
| 1-tail t (0.1, 39) | -1.304 |

Notes:
Data is from Table C-2
Decision Rules (the Permit - Appendix 6.5-B):
t* < t (α; n-1), failure to meet standard
t* ≥ t (α; n-1), performance standard met
t from Section 3, Table 1 (WDEQ, 2012)
Test Statistic:

$$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

t*(7.365) ≥ t (-1.304), **performance standard is met**

**Table C-5: Perennial Vegetation Foliar Cover, one-sample, one-sided sign test- reverse null, O-VMU-5, 2023**

| Transect | Perennial Foliar Cover | 90% of Technical Standard | Difference |
|---|---|---|---|
| O-VMU5-T01A | 38 | 22 | 16 |
| O-VMU5-T01P | 40 | 22 | 18 |
| O-VMU5-T02P | 32 | 22 | 10 |
| O-VMU5-T03P | 42 | 22 | 20 |
| O-VMU5-T04P | 32 | 22 | 10 |
| O-VMU5-T05P | 32 | 22 | 10 |
| O-VMU5-T06P | 24 | 22 | 2 |
| O-VMU5-T07P | 50 | 22 | 28 |
| O-VMU5-T08P | 32 | 22 | 10 |
| O-VMU5-T10P | 48 | 22 | 26 |
| O-VMU5-T11P | 26 | 22 | 4 |
| O-VMU5-T12P | 46 | 22 | 24 |
| O-VMU5-T13P | 34 | 22 | 12 |
| O-VMU5-T14P | 56 | 22 | 34 |
| O-VMU5-T15P | 32 | 22 | 10 |
| O-VMU5-T16P | 38 | 22 | 16 |
| O-VMU5-T17P | 36 | 22 | 14 |
| O-VMU5-T18P | 34 | 22 | 12 |
| O-VMU5-T19P | 36 | 22 | 14 |
| O-VMU5-T20P | 22 | 22 | 0 |
| O-VMU5-T21P | 30 | 22 | 8 |
| O-VMU5-T22P | 64 | 22 | 42 |
| O-VMU5-T23P | 60 | 22 | 38 |
| O-VMU5-T24P | 36 | 22 | 14 |
| O-VMU5-T25P | 24 | 22 | 2 |
| O-VMU5-T26P | 44 | 22 | 22 |
| O-VMU5-T27P | 26 | 22 | 4 |
| O-VMU5-T28P | 62 | 22 | 40 |
| O-VMU5-T29P | 54 | 22 | 32 |
| O-VMU5-T30P | 44 | 22 | 22 |
| O-VMU5-T31P | 44 | 22 | 22 |
| O-VMU5-T32P | 30 | 22 | 8 |
| O-VMU5-T33P | 42 | 22 | 20 |
| O-VMU5-T34P | 34 | 22 | 12 |
| O-VMU5-T35P | 44 | 22 | 22 |
| O-VMU5-T36P | 28 | 22 | 6 |
| O-VMU5-T37P | 28 | 22 | 6 |
| O-VMU5-T38P | 60 | 22 | 38 |
| O-VMU5-T39P | 62 | 22 | 40 |
| O-VMU5-T40P | 36 | 22 | 14 |
| | | k | 0 |
| | | n | 40 |
| | | z | -6.17 |
| | | Standard one-tailed normal curve area (Table C-3; MMD, 1999) | 0.5000000 |
| | | P | 0.0000000003 |

Notes:
Data is from Table C-2
*When k exceeds 50% of n-observations, the performance standard has not been met*
P = 0.5-Area = prob of observing z; ≤0.1 performance standard met
**z value calculation:**

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

k (0) ≤ 20, P (0.0000000003) ≤ 0.1, **performance standard is met**

**Table C-5: Annual Forage Production, one-sample, one-sided sign test- reverse null, O-VMU-5, 2023**

| Transect | Annual Forage Production | 90% of Technical Standard | Difference |
|---|---|---|---|
| O-VMU5-T01A | 1,575 | 495 | 1,080 |
| O-VMU5-T01P | 1,002 | 495 | 507 |
| O-VMU5-T02P | 58 | 495 | -437 |
| O-VMU5-T03P | 562 | 495 | 67 |
| O-VMU5-T04P | 761 | 495 | 266 |
| O-VMU5-T05P | 799 | 495 | 304 |
| O-VMU5-T06P | 217 | 495 | -278 |
| O-VMU5-T07P | 531 | 495 | 36 |
| O-VMU5-T08P | 903 | 495 | 408 |
| O-VMU5-T10P | 456 | 495 | -39 |
| O-VMU5-T11P | 451 | 495 | -44 |
| O-VMU5-T12P | 463 | 495 | -32 |
| O-VMU5-T13P | 707 | 495 | 212 |
| O-VMU5-T14P | 2,054 | 495 | 1,559 |
| O-VMU5-T15P | 524 | 495 | 29 |
| O-VMU5-T16P | 1,228 | 495 | 733 |
| O-VMU5-T17P | 581 | 495 | 86 |
| O-VMU5-T18P | 1,768 | 495 | 1,273 |
| O-VMU5-T19P | 736 | 495 | 241 |
| O-VMU5-T20P | 705 | 495 | 210 |
| O-VMU5-T21P | 358 | 495 | -137 |
| O-VMU5-T22P | 478 | 495 | -17 |
| O-VMU5-T23P | 1,143 | 495 | 648 |
| O-VMU5-T24P | 629 | 495 | 134 |
| O-VMU5-T25P | 469 | 495 | -26 |
| O-VMU5-T26P | 2,454 | 495 | 1,959 |
| O-VMU5-T27P | 1,051 | 495 | 556 |
| O-VMU5-T28P | 1,068 | 495 | 573 |
| O-VMU5-T29P | 2,645 | 495 | 2,150 |
| O-VMU5-T30P | 887 | 495 | 392 |
| O-VMU5-T31P | 654 | 495 | 159 |
| O-VMU5-T32P | 1,111 | 495 | 616 |
| O-VMU5-T33P | 538 | 495 | 43 |
| O-VMU5-T34P | 697 | 495 | 202 |
| O-VMU5-T35P | 925 | 495 | 430 |
| O-VMU5-T36P | 389 | 495 | -106 |
| O-VMU5-T37P | 326 | 495 | -169 |
| O-VMU5-T38P | 1,220 | 495 | 725 |
| O-VMU5-T39P | 379 | 495 | -116 |
| O-VMU5-T40P | 396 | 495 | -99 |
| | | k | 12 |
| | | n | 40 |
| | | z | -2.37 |
| | | Standard one-tailed normal curve area (Table C-3; MMD, 1999) | 0.49114697 |
| | | P | 0.009 |

Notes:

Data is from Table C-2

*When k exceeds 50% of n-observations, the performance standard has not been met*

P = 0.5-Area = prob of observing z; ≤0.1 performance standard met

**z value calculation:**

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

k (12) ≤ 20, P (0.009) ≤ 0.1, **performance standard is met**

**Table C-6: Woody Plant Density, one-sample, one-sided sign test- reverse null, O-VMU-5, 2023**

| Transect | Annual Forage Production | 90% of Technical Standard | Difference |
|---|---|---|---|
| O-VMU5-T01A | 3,157 | 360 | 2,797 |
| O-VMU5-T01P | 283 | 360 | -77 |
| O-VMU5-T02P | 7,042 | 360 | 6,682 |
| O-VMU5-T03P | 2,104 | 360 | 1,744 |
| O-VMU5-T04P | 8,337 | 360 | 7,977 |
| O-VMU5-T05P | 1,255 | 360 | 895 |
| O-VMU5-T06P | 3,116 | 360 | 2,756 |
| O-VMU5-T07P | 1,012 | 360 | 652 |
| O-VMU5-T08P | 2,914 | 360 | 2,554 |
| O-VMU5-T10P | 1,619 | 360 | 1,259 |
| O-VMU5-T11P | 1,457 | 360 | 1,097 |
| O-VMU5-T12P | 931 | 360 | 571 |
| O-VMU5-T13P | 3,683 | 360 | 3,323 |
| O-VMU5-T14P | 2,590 | 360 | 2,230 |
| O-VMU5-T15P | 1,619 | 360 | 1,259 |
| O-VMU5-T16P | 4,816 | 360 | 4,456 |
| O-VMU5-T17P | 1,497 | 360 | 1,137 |
| O-VMU5-T18P | 1,133 | 360 | 773 |
| O-VMU5-T19P | 1,862 | 360 | 1,502 |
| O-VMU5-T20P | 1,538 | 360 | 1,178 |
| O-VMU5-T21P | 4,937 | 360 | 4,577 |
| O-VMU5-T22P | 1,295 | 360 | 935 |
| O-VMU5-T23P | 567 | 360 | 207 |
| O-VMU5-T24P | 243 | 360 | -117 |
| O-VMU5-T25P | 1,578 | 360 | 1,218 |
| O-VMU5-T26P | 1,659 | 360 | 1,299 |
| O-VMU5-T27P | 405 | 360 | 45 |
| O-VMU5-T28P | 3,318 | 360 | 2,958 |
| O-VMU5-T29P | 2,792 | 360 | 2,432 |
| O-VMU5-T30P | 405 | 360 | 45 |
| O-VMU5-T31P | 1,578 | 360 | 1,218 |
| O-VMU5-T32P | 1,659 | 360 | 1,299 |
| O-VMU5-T33P | 1,578 | 360 | 1,218 |
| O-VMU5-T34P | 567 | 360 | 207 |
| O-VMU5-T35P | 1,457 | 360 | 1,097 |
| O-VMU5-T36P | 4,006 | 360 | 3,646 |
| O-VMU5-T37P | 2,266 | 360 | 1,906 |
| O-VMU5-T38P | 3,237 | 360 | 2,877 |
| O-VMU5-T39P | 850 | 360 | 490 |
| O-VMU5-T40P | 850 | 360 | 490 |
| | | k | 2 |
| | | n | 40 |
| | | z | -5.53 |
| | | Standard one-tailed normal curve area (Table C-3; MMD, 1999) | 0.499999984 |
| | | P | 0.00000002 |

Notes:

Data is from Table C-2

*When k exceeds 50% of n-observations, the performance standard has not been met*

P = 0.5-Area = prob of observing z; ≤0.1 performance standard met

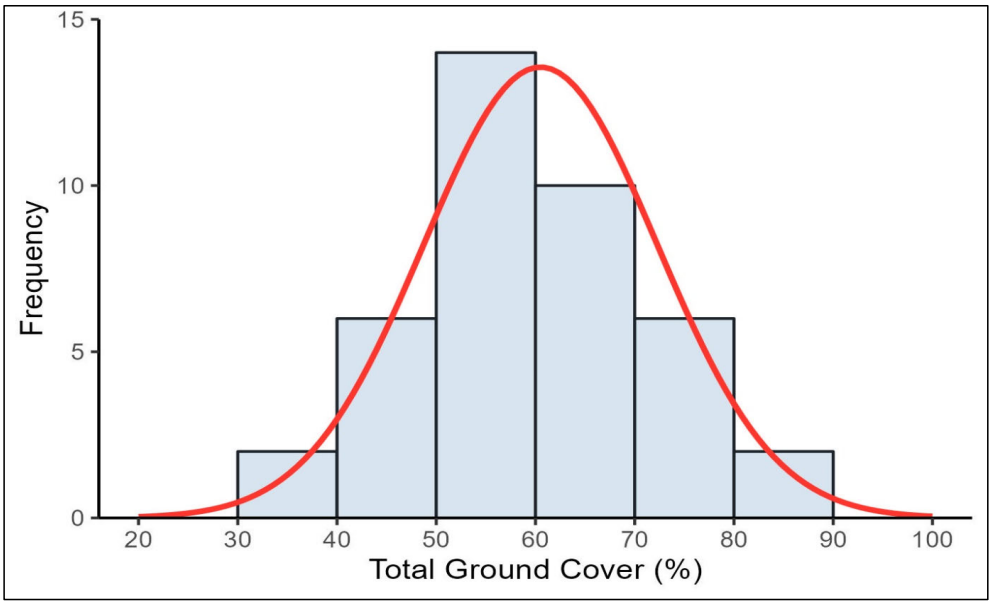
**z value calculation:**

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

k (2) ≤ 20, P (0.00000002) ≤ 0.1, **performance standard is met**

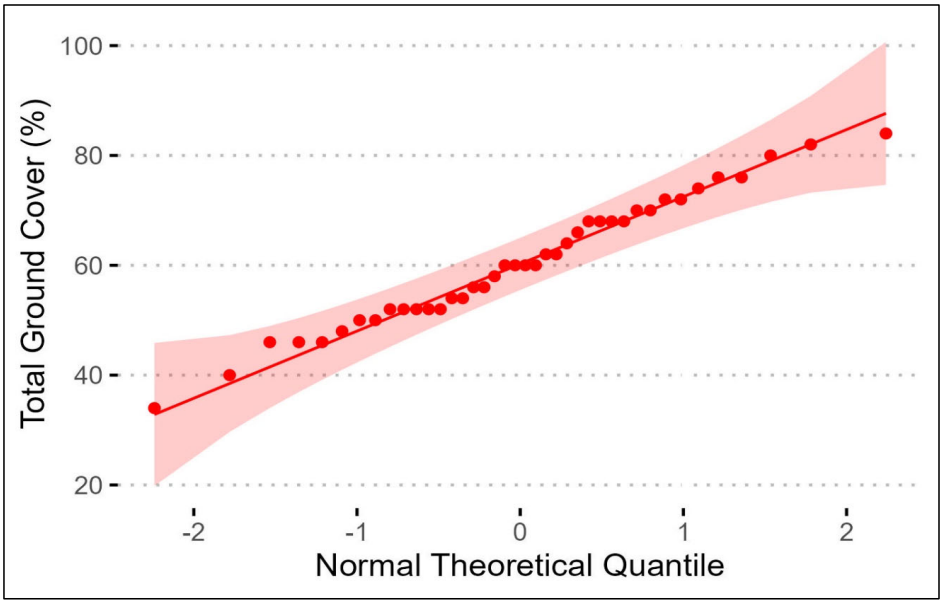
**Figure C-1: Total Ground Cover (%), O-VMU-5, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 60.5 | 57.44 | 63.56 | 2 | 12 | 0.04 | -0.71 | 52.00 | 60.00 | 68.50 |

**Normality**



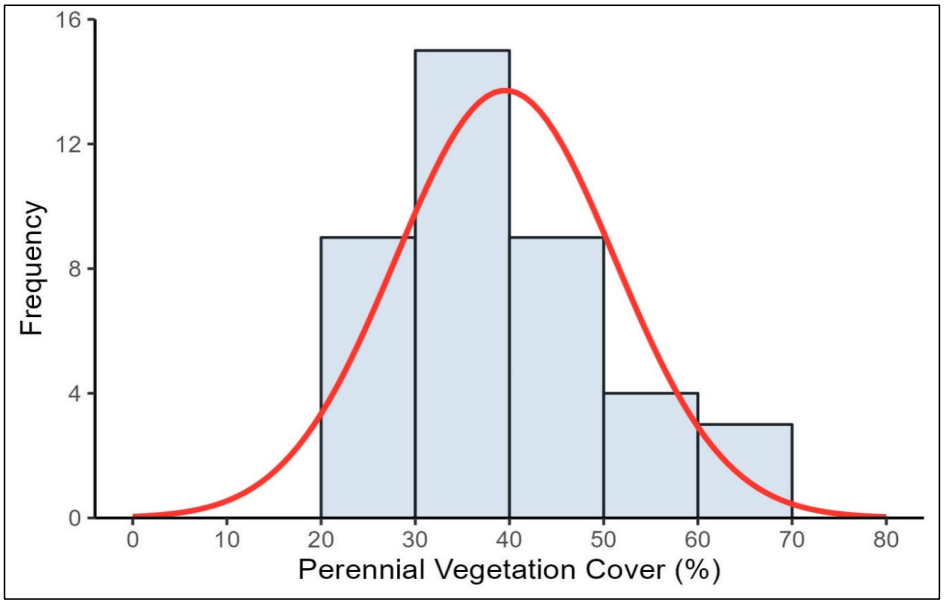

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.98359 | 0.818952 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Fail to reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P > 0.1)**
*(Data are normally distributed)*

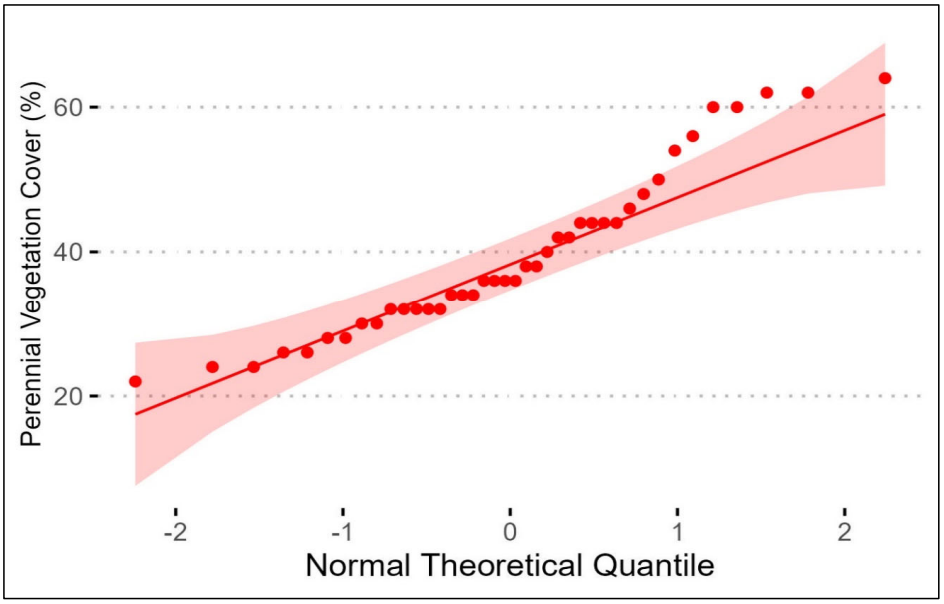
**Figure C-2: Perennial Vegetation Foliar Cover (%), O-VMU-5, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 39.55 | 36.52 | 42.58 | 2 | 12 | 0.61 | -0.67 | 32.00 | 36.00 | 44.50 |

**Normality**



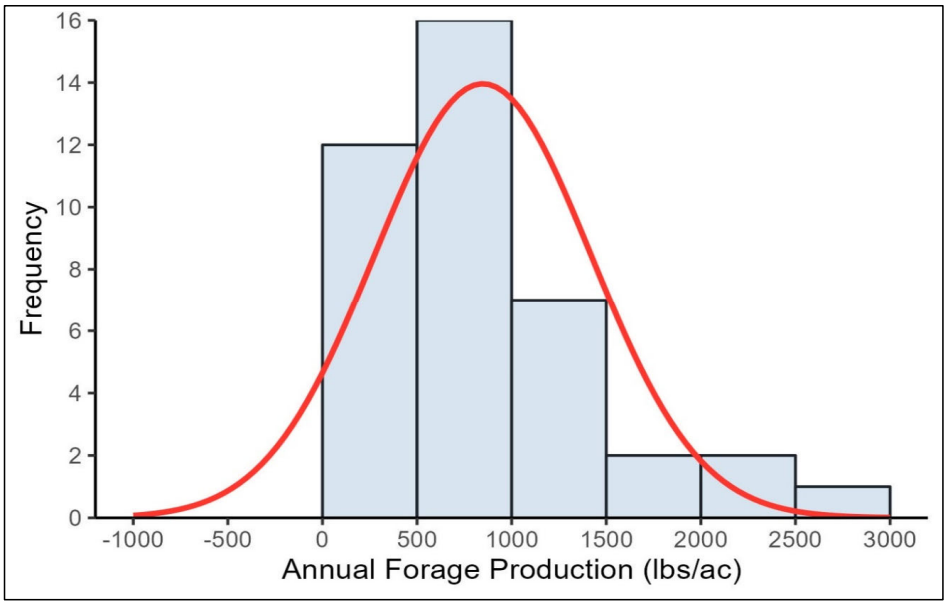

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.93098 | 0.017342 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P < 0.1)**
*(Data are not normally distributed)*

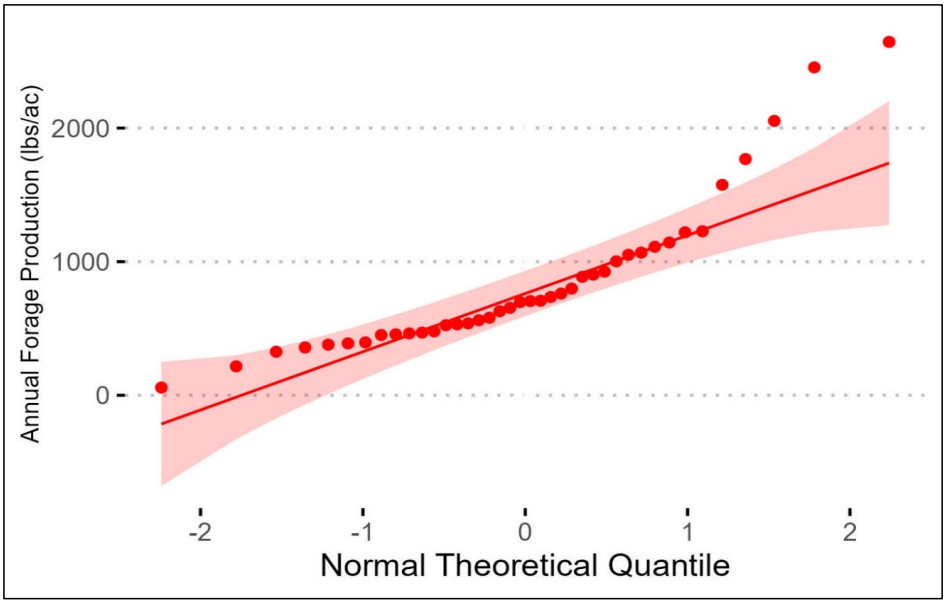
**Figure C-3: Annual Forage Production (lbs/ac), O-VMU-5, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 847.5 | 698.85 | 996.10 | 90.35 | 571.42 | 1.51 | 1.98 | 467.70 | 701.27 | 1055.41 |

**Normality**



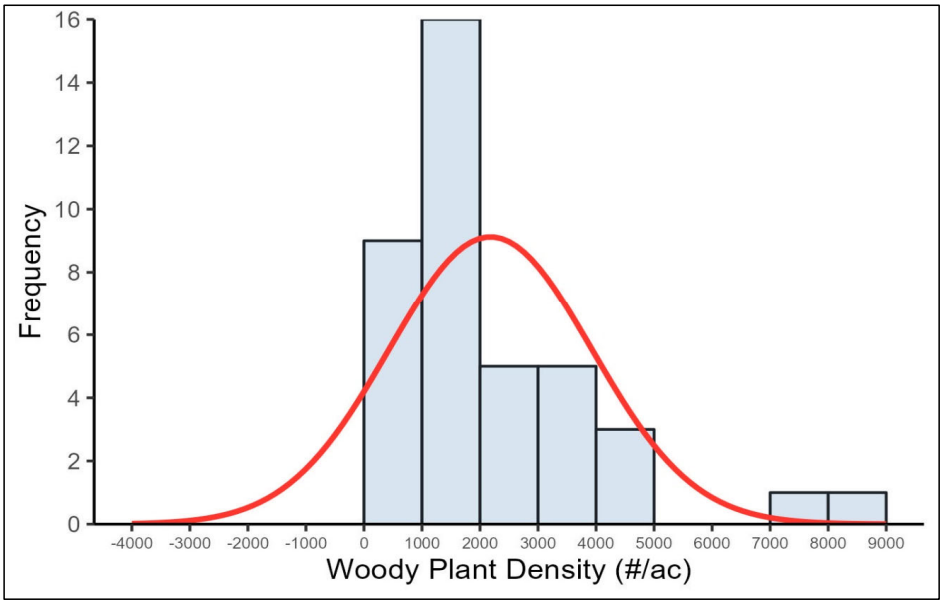

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.84216 | 0.000058 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P < 0.1)**
*(Data are not normally distributed)*

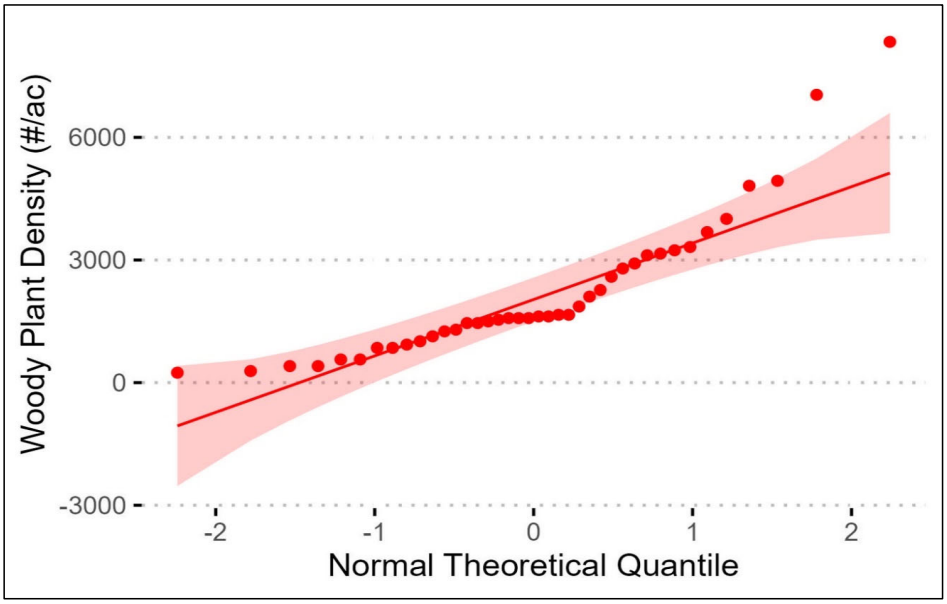
**Figure C-4: Woody Plant Density (st/ac), O-VMU-5, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 2180 | 1725.22 | 2635.27 | 276.61 | 1749.46 | 1.66 | 2.86 | 1102.77 | 1598.51 | 2964.32 |

**Normality**



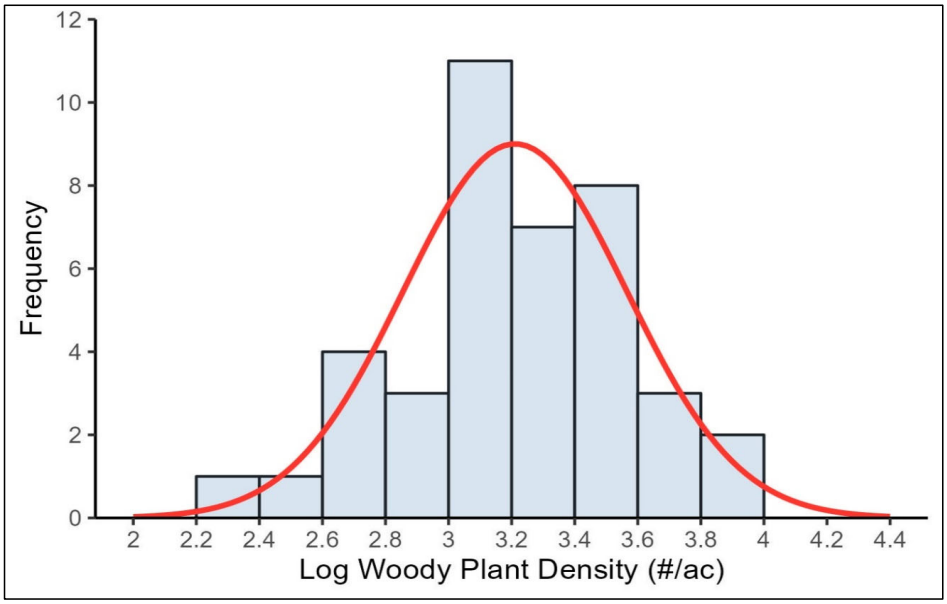

**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.83048 | 0.000031 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P < 0.1)**
*(Data are not normally distributed)*

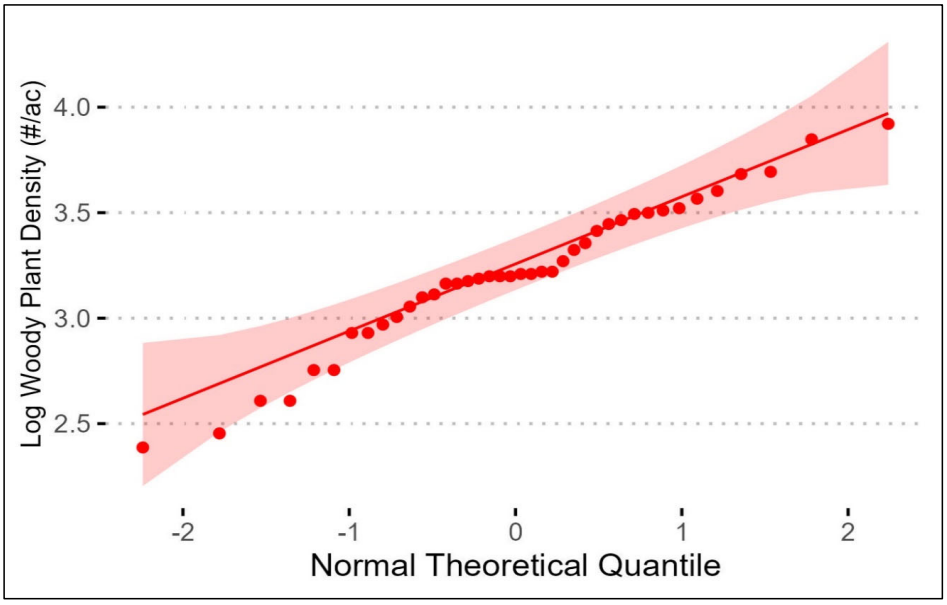
**Figure C-5: Log Woody Plant Density (st/ac), O-VMU-5, 2023**

**Descriptives**




| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 3.211 | 3.12 | 3.30 | 0.06 | 0.35 | -0.34 | -0.21 | 3.04 | 3.20 | 3.47 |

**Normality**




**Shapiro-Wilk Test**

| W statistic | P-value |
|---|---|
| 0.97299 | 0.445360 |

**H0: F(Y) = N(μ, σ)**
The population is normally distributed.
**H1: F(Y) ≠ N(μ, σ)**
The population is not normaly distributed
**Fail to reject the null hypothesis in favor of the alternative hypothesis with 90% confidence (P > 0.1)**
*(Data are normally distributed)*



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**REPORT**

# Vegetation Management Unit 2
# Vegetation Success Monitoring, 2024

Submitted to:

**Chevron Mining Inc. - McKinley Mine**

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March 2025



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# 1.0 INTRODUCTION

Mining at the McKinley Mine ceased in 2009 and reclamation of remaining support facilities (e.g., impoundments, roads, etc.) is nearing completion. Reclamation practices have been applied at the McKinley Mine under various programs since at least the early 1970s. Chevron Mining Inc. (CMI) is assessing the vegetation in reclaimed areas in anticipation of future bond and liability release. CMI understands the importance of returning the mined lands to productive traditional uses in a timely manner. To qualify for release, the increment, or permit area as a whole, must meet the Permit No. NM-0001K (2016) (the Permit) permanent-program revegetation-success criteria as shown in Table 1 of this report. In general, the lands must be in a condition that is as good as or better than the pre-mine conditions, stable, and capable of supporting the designated postmining land uses of grazing and wildlife. WSP USA, Inc. (WSP) was retained to monitor and assess the vegetation relative to the established vegetation success standards.

This report documents the vegetation community attributes collected in 2024 in O-VMU-2 and compares them to the Permit's vegetation-success criteria. Section 1 includes the introduction and a general overview. Section 2 describes the vegetation monitoring methods that were used in 2024. Section 3 presents the results of the assessment with respect to total ground cover, perennial vegetation cover, forage production, woody plant density (shrub density), and composition and diversity. Section 4 is a summary of the results for O-VMU-2 with emphasis on vegetation success.

The 2024 sampling program was conducted and evaluated in accordance with the updated monitoring methods and revegetation success standards contained in Permit Modification Number 23-03. More details beyond what is already discussed throughout this report may be found in the Permit.

## 1.1 Vegetation Management Unit 2

This report presents results from 2024 quantitative vegetation monitoring conducted in Vegetation Management Unit 2 (O-VMU-2), which is in the western portion of Area 2N and a portion of Area 3 (Figure 1). The configuration of the vegetation monitoring units within the U.S. Department of the Interior – Office of Surface Mining Reclamation and Enforcement (OSMRE) Permit Area, was developed in consultation with OSMRE. Undisturbed lands included within the VMU were not part of the sampling program. O-VMU-2 encompasses about 1,085 acres, comprised of permanent program lands (PPL), and initial program lands (IPL). Both PPL and IPL as one unit must meet the PPL revegetation success criteria as discussed in the Permit in Section 6.5.1.2. The 10-year period of extended responsibility, however, only applies to PPL.

The elevation of O-VMU-2 ranges from about 7,150 to 7,400 feet above mean sea level. Reclamation started in 1975, with the vast majority seeded by 2003. Thus, the reclamation in the majority of O-VMU-2 ranges from 21 to almost 50 years old. This section provides a general description of the reclamation activities that were implemented. Additional details of the reclamation for specific areas can be obtained through a review of the McKinley Mine annual reports.

## 1.2 Reclamation and Revegetation Procedures

Reclamation of permanent program lands included grading of the spoils to achieve a stable configuration, positive drainage, and approximate original contour. After grading, graded spoil monitoring was conducted to determine the suitability of the materials. A minimum of 6 inches of topdressing (topsoil or topsoil substitute) was then applied over suitable spoils.

After topdressing placement, the seedbed was scarified or ripped on the contour to a depth of about 8 to 12 inches. Seeding was done using various implements that drilled and/or broadcast the seed. After the seeding, certified weed-free, long-stem, hay mulch, or straw was applied at a rate of about 2 tons per acre. The mulch was anchored 3 to 4 inches into the cover with a tractor-drawn straight coulter disc. The seeding was generally performed in the fall, which tends to favor the establishment of cool-season grasses and shrubs. The approved seed mixes used at McKinley have varied over time but included both warm-season grasses, and introduced and native cool-season grasses, introduced and native forbs, and shrubs. The early seed mixes tended to emphasize the use of alfalfa and cool-season grasses. The majority of seed mixes planted on IPL consisted of native and introduced cool-season grasses, limited warm-season grasses, some shrubs, but no forbs. Over time, the seed mixes on PPL shifted to include more warm-season grasses, more shrub species, and a variety of forbs.

Initial program lands were typically graded so they were no steeper than 3:1 and topsoiled. Seeding practices were like those done on permanent program lands.

## 1.3 Prevailing Climate Conditions

The amount and distribution of precipitation are important determinants for vegetation establishment and performance. Once vegetation is established, the precipitation dynamics affect the amount of vegetation cover and biomass on a year-to-year basis, with grasses and forbs showing the most immediate response. Long term precipitation has been monitored at the McKinley North Mine at the Bluff station (Figure 1). The mine added a system of 6 additional seasonal precipitation gauges to better capture more representative data from the various mining areas in 2011-2012 (gauges named by mining area). Data from the Rain 2 gauge was used to evaluate precipitation in O-VMU-2 (Figure 1).

Table 2 contains a summary of precipitation recorded at all the rain gauges in the North Mine Area. Total annual precipitation measured at the Bluff gauge near the mine entrance was 11.97 inches in 2024, slightly exceeding the regional average of 11.8 inches at Window Rock. Total annual precipitation for the season rain gauges is unavailable as they are taken offline due to freezing conditions from December through March.

Growing season precipitation provides additional context to evaluate vegetation performance in O-VMU-2. The departure of growing season precipitation (April through September) between the Rain 2 gauge and the Window Rock (1937-1999) long-term seasonal mean is illustrated in Figure 2. Growing season precipitation in O-VMU-2 has been below the long-term seasonal mean from 2016 to 2021 with a severe drought in 2020 when the site only received 37% of the normal growing season precipitation for the region. In 2022, O-VMU-2 growing season was about 60% above the long-term-average. In 2023, the growing season was again dry with precipitation measured at the Rain 2 gauge was 60% of the long-term average. Over the past ten years, growing season precipitation measured at the Rain 2 gauge was on average 18% below regional norms.

Precipitation in 2024 was near normal for the growing season with a wetter than average June accounting for nearly 38% of the total growing season precipitation. The Rain 2 gauge recorded 6.14 inches of precipitation from April to September, slightly lower than the Bluff gauge that recorded 6.57 inches of rain for the same period. Rainfall in April, May, July and September was below their monthly long-term average with a slightly wetter than normal August. Mine wide, the precipitation recorded in 2024 between April and November at the seven gauges indicate near normal regional rainfall, with average rainfall falling just 0.12 inches below the regional norm with variation both spatially and temporally (Table 2).

## 1.4 Livestock

CMI has aggressively managed trespass livestock (horses) the past several years, resulting in less evidence of overgrazing in the reclamation in 2024 in O-VMU-2. The combination of past grazing pressure with exceptional drought, however, may in some years adversely affected the ability to demonstrate that the vegetation is meeting or can meet the revegetation success standards.

# 2.0 VEGETATION STANDARDS AND MONITORING METHODS

Vegetation attributes in O-VMU-2 were quantified using the methods described in Section 6.5 of the Permit as modified in Permit Modification 23-03. Vegetation monitoring in O-VMU-2 was conducted from September 26 through October 1, 2024.

## 2.1 Vegetation Success Standards

The vegetation success standards for the Permit Area consist of five vegetative parameters: total cover, perennial cover, forage production, woody plant density, and diversity (Table 1). The total ground cover requirement, or the combined means for live vegetation cover and litter cover on the reclamation, is 52%. The perennial vegetation cover requirement is 24%. Both total ground and perennial vegetation cover use absolute cover. The annual forage production requirement is 550 air-dry pounds per acre (lbs/ac). The shrub density success standard is 400 live woody stems per acre. In accordance with 30 CFR 816.116 (a)(2), success for total cover, perennial cover, forage production, and shrub density shall be ≥ 90% of the standard.

Cover is defined in three ways for accurate evaluation of diversity according to Table 1.

1) Absolute cover utilizes first-hit line point intercept (LPI) data and is used to assess the perennial grass diversity standard.
2) Relative perennial cover, the metric used to assess grass, forb, and shrub diversity, compares the cover of perennial species relative to the sum of perennial plants calculated from all-hit LPI data (excluding noxious weeds) within the VMU.
3) Relative total cover, the metric used to assess the any-single-species diversity standard, is calculated by dividing the percent cover of each perennial/biennial species by the total live vegetative cover from all-hit LPI data (excluding noxious weeds) within a VMU.

Biennial forbs are included in the vegetation cover analyses and biennial forb diversity standards because they are important to the long-term ecological success of the reclamation. As monocarpic, or single flowering species, these forbs produce a high number of seeds, and as a result, persist long-term in the reclamation plant community. Future mention of “perennial” in this report thus includes biennial forb species. Plant duration was derived from the USDA Plants Database.

Relative shrub density, the metric used to assess the single shrub species standard, is calculated using belt-transect data by dividing the density of each species by the total density within a sampling unit. Relative calculations are valuable to determine whether a species or functional group is excessively dominant. The number of species required for the various diversity standard components (e.g., ≥ 2 species of cool-season grasses) is calculated by adding the total number of unique species captured in the LPI surveys.

Diversity is evaluated against numerical guidelines for different vegetation types. In summary, the diversity guideline is met if perennial grasses contribute 7% or more absolute vegetation cover; at least two cool-season perennial grasses have individual relative perennial vegetation covers of 5% and 1.5% or more; at least two

warm-season perennial grasses species with the highest cover species 5% or more relative perennial vegetation cover and the remaining species combining to contribute 1.5% or more relative perennial vegetation cover, at least three non-annual non-noxious forbs combining to contribute 1% or more relative total vegetation cover; shrubs combining to 6% or more relative perennial vegetation cover and no single shrub species with greater than 70% relative shrub density, and no single species of any functional group with 40% or more relative total vegetation cover. Diversity is also demonstrated by evidence of colonization or recruitment of native (not-seeded) plants from adjacent undisturbed native areas.

## 2.2 Sampling Design

All lands (PPL, Prelaw and IPL) were included in the vegetation-sampling pool for unbiased random sampling. The transect locations were reviewed with OSMRE in advance of sampling. A 100-meter (m) by 100 m square grid was superimposed over the entire VMU to delineate vegetation sample plots. Random points were created in a geographic information system, and the locations, including the program land (IPL or PPL) designations, are shown in Figure 3. In the field, the randomly selected transect locations were assessed in numerical order with 40 primary transects accompanied by 10 alternate transects. If a transect location was determined to be unsuitable, the next alternative location was assessed for suitability. Transects that fell on or would intersect roads, drainage ways, wildlife rock piles, or prairie dog colonies were considered unsuitable.

Figure 4 shows the 100 m by 100 m vegetation plot with the cover transect orientation, and the location of the production quadrats and belt transect. The origin of the LPI transect is situated at the grid centroid and transect orientation (from 0° to 360°) is chosen randomly beginning from the transect origin, the point navigated to. LPI points are traversed on transect left with the laser pointed towards transect right, to limit disturbance from walking on the quad and belt survey areas located on transect right. Each LPI transect is 50 m long with three half square meter (½ $m^2$) production quadrats placed flush with the meter tape with the bottom left corner at the 10, 25, and 40 m mark to the right of the transect. The belt transect corridor is 2 m by 50 m along the transect's right side.

## 2.3 Foliar, Canopy and Ground Cover

The LPI method is used to collect cover measurements required by the Permit to evaluate total cover, perennial cover, and diversity. Prior to production clipping, a 50 m measuring tape is suspended between two metal pins to extend the tape fully. A tripod-mounted laser is then held along the edge of the tape, and readings are taken every meter for living plants, plant litter, rock fragments, and bare ground. When a live plant is encountered as a direct foliar hit, the species is recorded, and direct lower canopy live plant hits are also recorded that are observed down the profile. The LPI-derived data were evaluated against the permit vegetation success standards for vegetation cover and diversity provided in Table 1, with first hits used in absolute cover calculations and all hits (upper and lower canopy hits) used in relative cover calculations.

Additional cover measurements were estimated from each production quadrat, including relative cover for each species and total canopy cover, surface litter, rock fragments, and bare soil. Quadrat canopy cover data is not analyzed for success and is only briefly discussed in this report as additional support information (Table A-3). Canopy cover estimates include the foliage and foliage interspaces of all individual plant species rooted in the quadrat. Canopy cover is defined as the percentage of quadrat area included in the vertical projection of the canopy. The canopy cover estimates made on a species basis may exceed 100 percent in individual quadrats where the vegetation has multi-layered canopies. In contrast, the sum of the total canopy cover, surface litter, rock fragments, and bare soil does not exceed 100 percent. All cover estimates were made in 0.05 percent increments. Percent area cards were used to increase the accuracy and consistency of the cover estimates.

Not all plant species are expected to occur in the sampling transects and quadrats. Plants observed growing within the vegetation plots and across the reclaimed areas were inventoried while moving between transect locations and during formal sampling (Table A-6).

## 2.4 Annual Forage and Total Production

Forage production required by the Permit was determined by clipping and weighing all annual (current year's growth) above-ground forage biomass within the vertical confines of the three ½ $m^2$ quadrats placed systematically along the same 50 m transect used for LPI measurements. Biomass from all three quads from each transect are combined by species and the combined values for the transect (not the quads) are treated as a sampling unit. Production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. The Permit allows for excessively grazed production quadrats to be considered for exclusion from the sampling analysis in consultation with OSMRE, but no quadrats needed to be excluded in O-VMU-2 (the Permit, Section 6.5.2.2).

Grasses and forbs were clipped to within 5 centimeters (cm) of the soil surface, and the current year's growth was segregated from the previous year's growth (e.g., gray, weathered grass leaves, and dried culms). Production from shrubs was determined by clipping the current year's growth. Annuals and noxious weeds (e.g., Russian knapweed [*Acroptilon repens*]), when encountered, were not clipped. Photographs of the individual production quadrats are included in Appendix B.

The plant biomass samples of every species collected per transect were placed individually in labeled paper bags. The samples were air-dried (~ 90 days) until no weight changes were observed with repeated measurements on representative samples. The average tare weight of the empty paper bags was determined to correct the total sample weight to air-dry vegetation weights. The net weight of the air-dried vegetation was converted to lbs/ac.

## 2.5 Shrub Density

Shrub density (as required by the Permit), or the number of stems per square meter (stems/$m^2$), was determined using the belt transect method (Bonham 1989). The belt transect was located parallel to the 50 m transect used to determine cover. Shrubs rooted in the 2 m belt transect were counted on a species basis. A 2 m folding ruler was horizontally oriented perpendicular to the tape to ensure that observations were taken within the 2 m corridor. The number and species of woody plant stems within the belt transect were recorded.

## 2.6 Statistical Analysis

The procedures for liability release and the basis for statistical analysis applied in this report may be found in the Permit, and as referenced in the Permit: the Wyoming Department of Environmental Quality (WDEQ) handbook of sampling and statistical methods (WDEQ 2012), and the New Mexico Mining and Minerals Division (MMD) Coal Mine Reclamation Program guidelines (MMD 1999). Additional resources include *Evaluation and Comparison of Hypothesis Testing Techniques for Bond Release Applications* (McDonald et al. 2003), which was the basis of the WDEQ handbook, and other sources referenced herein. More specifically, Figure 6.5-1 and Appendix 6.5-B of the Permit guide the statistical approach in determining vegetation success for total ground cover, perennial vegetation cover, annual forage production, and shrub density. The statistical analyses applied to the O-VMU-2 vegetation data are presented in Appendix C, including equations for vegetation data analysis, vegetation attribute data with descriptive statistics, the statistical analyses comparing these attributes to the revegetation success standards, the statistical model, and descriptive statistics and normality for the vegetation attributes.

Descriptive statistics and statistical adequacy are presented for total ground cover, perennial vegetation cover, annual forage production, and shrub density in Tables 3 and C-2. Vegetation attribute data (Table C-2) was evaluated with the Shapiro-Wilk test to determine if data are normally distributed (Exhibits C-1 to C-4). For normally distributed data, statistical adequacy was assessed (Snedecor and Cochran 1967). Hypothesis testing for normal data that met sample adequacy was conducted using a one-sample, one-sided t-test under the classical null hypothesis. A one-sample, one-sided t-test using the reverse null hypothesis was applied for normally distributed data, which failed to meet statistical adequacy. A non-parametric one-sample, one-sided sign test using the reverse null hypothesis was applied to data that was not normally distributed and did not meet sample adequacy. While transformed data was not used in hypothesis testing for satisfying standards, as supplemental analyses, non-normal data were log-transformed. If the transformed data resulted in a normal distribution, a one-sample, one-sided t-test was used in accordance with the procedures described in Section 2.6.2. If a transformation is applied, the technical standard is also logarithmically transformed in congruence with the guidelines (MMD 1999, Appendix C, Section 6). This is done to be consistent with algebraic procedures where log(0.9x)=log(x)+log(0.9) and not 0.9*log(x). If transformed data were also non-normal, the original data were analyzed using the non-parametric one-sample, one-sided sign test using the reverse null hypothesis on the non-transformed data.

The following presents the statistical approach in more detail. Descriptive statistics and statistical tests were performed using both Microsoft® Excel and R-Studio (version 4.2.2).

### 2.6.1 Normality and Statistical Adequacy

The normality of each dataset was first assessed using the Shapiro-Wilk test to determine the appropriate hypothesis test method (i.e., parametric versus non-parametric). The Shapiro-Wilk null hypothesis is that the samples (of size n) come from a normal distribution. Data were considered normal when the test statistic had a p-value > 0.10 for alpha (α) = 0.10. If the data failed hypothesis testing and was not normal, a log transformation was performed, and if the transformation resulted in a normal distribution, the appropriate hypothesis test was chosen depending on sample adequacy ($N_{min}$) as outlined in Figure 6.5-1 of the Permit (2016).

The number of samples required to characterize a particular vegetation attribute depends on the uniformity of the vegetation and the desired degree of certainty required for the analysis. The number of samples necessary to meet $N_{min}$ was calculated assuming the data were normally distributed using the Snedecor and Cochran (1967) equation below.

$$N_{min} = \frac{t^2 s^2}{(\overline{x}D)^2}$$

Where $N_{min}$ equals the minimum number of samples required, $t$ is the two-tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom, $s$ is the standard deviation of the sample data, $\overline{x}$ is the mean, and $D$ is the desired level of accuracy, which is 10 percent of the mean in this case.

In addition to $N_{min}$, the standard deviation and the 90% confidence interval (CI) about the sample means are reported in Table 3.

It is often impractical to achieve sample adequacy in vegetation monitoring studies based on Snedecor and Cochran's equation listed above. In such cases, the Permit allows a maximum sample number approach to compare the data regardless of the distribution (WDEQ 2012, MMD 1999). Where sample adequacy cannot be met because of operational constraints or for other reasons, 40 samples are considered adequate as stated in the

Permit. The 40-sample maximum is based on an estimate of the number of samples needed for a t-test under a normal distribution (Sokal and Rohlf 1981). Schulz et al. (1961) demonstrated that 30 to 40 samples provide a robust estimate for most cover and density measures, with increased numbers of samples only slightly improving the precision of the estimate.

The maximum 40 samples were collected at the outset of sampling based on the guidance discussed above. Each transect is considered a unique sampling unit. Sample adequacy was calculated to determine the number of samples that would have been required for adequacy by the Snedecor and Cochran equation. Further analysis for sample adequacy of cover, production, and density attributes was also demonstrated using a graphical stabilization of the mean method (Clark 2001) when sample adequacy was not met.

### 2.6.2 Hypothesis Testing

The emphasis on statistical adequacy assumes that parametric tests of normally distributed data will be conducted to demonstrate compliance with the vegetation success standards. Thus, if statistical adequacy is met for normally distributed data, the data would be analyzed with a one-sample, one-sided t-test using the classical null hypothesis. Non-parametric hypothesis tests have sufficient power to analyze data that are not normally distributed. Thus, if data is not normal then it is permissible based on the Permit and technically appropriate to use the one-sample, one-sided sign test using the reverse null approach as encouraged by OSMRE.

Hypothesis testing used to demonstrate compliance with the vegetation success standards for total ground cover, perennial vegetation cover, annual forage production, and shrub density were structured as follows (in accordance with Appendix 6.5-B of the Permit):

Classical Null Hypothesis:

$H_0$: Reclaim ≥ 90% of the Performance Standard

$H_a$: Reclaim < 90% of the Performance Standard

Where $H_0$ is the null hypothesis, and $H_a$ is the alternative hypothesis.

The one-sample, one-sided t-test using the classical null hypothesis decision rules based on the test statistic are:

If $t^* \geq t_{(\alpha; n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha; n-1)}$, conclude failure to meet the performance standard.

Test Statistic:

$$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

Where t* is the calculated t-statistic, $\bar{x}$ is the sample mean, s is the standard deviation, n is the sample size, and α = 0.10. If this test is applied to the log transformed data, the log of the standard is added to the log of 0.9 rather than multiplying it.

Reverse Null Hypothesis:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

One-sample, one-sided sign test using the reverse null hypothesis decision rules are:

If P < 0.10 or z < $z_\alpha$ (for α = 0.10, $z_\alpha$ = -1.282), conclude that the performance standard was met (i.e., $H_o$ is rejected, the revegetation values tend to be statistically greater than 90% of the technical standard).

If P ≥ 0.10 or z ≥ $z_\alpha$ (α = 0.10, $z_\alpha$ = -1.282), conclude failure to meet the performance standard (i.e., $H_o$ is NOT rejected, the revegetation values tend to be statistically less than or equal to 90% of the technical standard).

The z critical values of the normal distribution can be found in WDEQ, Table 1 (2012)

Sign Test Statistic:

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

Where z is the sign test statistic (Daniel 1990), k is the test statistic resulting from the number of measurements that were less than 90% of the technical standard, and n is the sample size.

All hypothesis tests were performed with a 90% level of confidence. Hypothesis testing was not conducted for parameters where the mean or median did not exceed the minimum permit requirements. P-values, when reported, were calculated using R's t distribution probability function with the appropriate t* and degrees of freedom. This function allows for calculating precise p-values given the relevant parameters of a distribution, without the need for a table (R Core Team 2023).

# 3.0 RESULTS

The vegetation in O-VMU-2 is well established and dominated by perennial plants and the vegetation community statistically met all vegetation success standards in 2024 as it did in 2023. Table 3 summarizes the results for total ground cover, perennial vegetation cover, annual forage production, and woody plant density (shrub density) along with their corresponding technical standard.

Field data for LPI foliar cover, quadrat canopy cover, annual forage production, and shrub density by the belt transect are included in Appendix A (Tables A-1 through A-6). Photographs of the individual production quadrats are included in Appendix B and a representative photograph of the vegetation and topography is shown in Figure 5.

Table 4 summarizes the attributes for plants recorded in the LPI transects and production quadrats and Table A-6 summarizes all species observed within belt and quadrat surveys as well as those recorded opportunistically between transect locations during monitoring. Recruitment of additional native plant species is indicative of ecological succession and the capacity of the site to support a self-sustaining ecosystem.

Field data results and statistics for each vegetation parameter are discussed in the sections that follow.

## 3.1 Total Ground Cover

Total ground cover exceeded the revegetation success standard and met the required statistical demonstration. Total ground cover based on first hit LPI data in O VMU-2 in 2024 had a mean of 68.3 ± 2.9% (90% confidence

interval [CI]) and a median of 70% (Table 3), exceeding the revegetation success standard. Total ground cover was not normally distributed on its own, nor with a logarithmic transformation (Exhibit C-1). Sample adequacy was 7 samples, which is less than the 39 samples taken indicating sample adequacy is met.

Given the attributes of the data, total ground cover was analyzed with a one-sided sign test under the reverse null hypothesis. Two transects did not meet the standard of 90% of 52% total ground cover resulting in a z-statistic of -5.44 (less than $z_{\alpha}$ of -1.282) and a p-value less than 0.001. Therefore, we reject that null hypothesis that the reclamation is less than or equal to 90% of 52% total ground cover and conclude that the total ground cover standard has been met.

## 3.2 Perennial Vegetation Cover

Perennial vegetation cover, based on first hit LPI data, was calculated by summing the perennial and biennial species vegetation cover of the sampling unit excluding annuals and noxious weeds. The average perennial cover was 54.6 ± 3.2% and the median cover was 58% (Table 3), exceeding the revegetation success standard. Sample adequacy was met with 14 samples.

Perennial vegetation cover data were normally distributed and met sample adequacy (Exhibit C-2), data were statistically analyzed using a one-sample, one-sided t-test using the classical null hypothesis. The resulting t*-statistic for perennial vegetation cover was 16.90, with a sample mean of 54.6%, a standard deviation of 12.2%, measured against a one-tail t (0.1, 38) value of -1.304. So, under the classical null hypothesis ($t^* \geq t(\alpha; n-1)$) and a p-value of 1, we conclude that the performance standard of 24% perennial vegetation cover was met (Exhibit C-2).

## 3.3 Production

Forage production exceeded the revegetation success standard and met the required statistical demonstration. Annual forage production in O-VMU-2 in 2023 was 881.5 ± 98 lbs/ac (median of 835 lbs/ac, standard deviation was 376.3), the highest value since sampling began in 2019 (Table 3). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for annual forage production was 52 samples (Table 3).

Annual forage production data for O-VMU-2 were not normally distributed, but the logarithmically transformed values were normally distributed (Exhibit C-3). Given that $N_{min}$ was larger than the number of samples taken, the use of the reverse null hypothesis is warranted as discussed in Section 2.6.2. Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean (Clark 2001). Figure 6 illustrates the stabilization of the mean and 90% CI for production that begins to stabilize at 24 samples. This analysis suggests that 40 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of annual forage production.

Annual production data were normally distributed with a log transformation but did not meet sample adequacy, thus, data were statistically analyzed using a one-sample, one-sided t-test using the reverse null hypothesis. The resulting t*-statistic for production was 7.10, with a transformed sample mean of 2.91, and a standard deviation of 0.187, measured against a one-tail t (0.9, 39) value of 1.304. So, under the reverse null hypothesis ($t^* \geq t(1-\alpha; n-1)$) and a p-value less than 0.001, we conclude that the performance standard of 550 lbs/ac was met (Exhibit C-3).

## 3.4 Shrub Density

Shrub density exceeded the revegetation success standard and met the required statistical demonstration. In 2024, shrub density in O-VMU-2 substantially exceeded the vegetation success standard of 400 stems/ac from belt transect data with an average of 1,891 ± 247 stems/ac and a median of 1,801 stems/ac (Table 3). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for shrub density was estimated to be 71 samples (Table 3).

The shrub density data for O-VMU-2 were not normally distributed but the log transformed data were normal (Exhibit C-4). Given that $N_{min}$ was larger than the number of samples taken, the use of the reverse null hypothesis is warranted as discussed in Section 2.6.2. Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean (Clark 2001). Figure 7 illustrates the stabilization of the mean and 90% CI for shrub density that begins to stabilize at 16 samples. This analysis suggests that 39 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of shrub density.

The shrub density data were normally distributed but did not meet sample adequacy, data were statistically analyzed using a one-sample, one-sided t-test using the reverse null hypothesis. The resulting t*-statistic for shrub density was 10.21, with a sample mean of 1,891, and a standard deviation of 948, measured against a one-tail t (0.9, 39) value of 1.304. So, under the reverse null hypothesis ($t^* \geq t(1-\alpha; n-1)$) and p-value less than 0.001, we conclude that the performance standard of 400 stems/ac cover was met (Exhibit C-4).

## 3.5 Composition and Diversity

In 2024, the standards were met for all of the individual diversity standards in O-VMU-2 (Table 6). The revegetation diversity standards are based on a “lifeform statement” for grasses, forbs, and shrubs (Table 1) that consists of 12 individual parameters. The results for composition and diversity are discussed below by parameter. Relative cover values of perennial and biennial species are calculated from all LPI data (first hit and understory: Table A-2). Relative perennial vegetation cover of individual species is listed in Table 4.

Grasses dominated the perennial vegetation cover with James’ galleta (*Pleuraphis jamesii*) representing the highest cover of the warm-season grasses with blue grama (*Bouteloua gracilis*) and alkali sacaton (*Sporobolus airoides*) providing additional cover (Table 4). Cool-season grasses also dominated the vegetation reflecting the past seed mixes, season of seeding, and the site’s continued ability to support a diverse group of cool-season grasses. Western wheatgrass (*Pascopyrum smithii*), thickspike wheatgrass (*Elymus lanceolatus*), and needle and thread (*Hesperostipa comata*) represented the highest cover of the cool-season grasses. Shrubs are important components of the reclamation due to their persistence and tolerance to harsh conditions. The woody plant component is dominated primarily by fourwing saltbush, with rubber rabbitbrush (*Ericameria nauseosa*) and broom snakeweed (*Gutierrezia sarothrae*) present in significant numbers. Perennial forb species occurred on the LPI transects, though they are minor contributors to vegetation cover, with scarlet globemallow (*Sphaeralcea coccinea*) contributing the highest cover.

The perennial grass diversity standard requires a total absolute vegetation cover of at least 7%, which was achieved in 2024 with 45.9%. The diversity standard for cool-season perennial grasses was achieved with 10 total species, and two species that represent at least 5 and 2.5% relative perennial vegetation cover (western wheatgrass [13.4%] and thickspike wheatgrass [11.2%]). The diversity standard for warm-season grasses is achieved with four total species, one species representing at least 5% (James’ galleta [24.2%]) and all remaining species representing over 1.5% relative perennial vegetation cover at 6.8%.

The perennial forb diversity standard requires at least three perennial/biennial forbs (not including noxious weeds) combining to at least 1% relative perennial vegetation cover. This standard was achieved in 2024 with nine species totaling 2.8% relative perennial vegetation cover with the greatest contributions from scarlet globemallow (0.6%), curlycup gumweed (*Grindellia squarrosa*, 0.5%), and hoary tansyaster (*Machaeranthera canescens*, 0.4%).

The diversity standard for shrubs requires the relative perennial vegetation cover for all shrub species to total at least 6% with no single shrub exceeding or equal to 70% relative shrub density. Both of these standards were achieved with 18.0% relative perennial vegetation cover of all shrubs (Table 6) and 55.5% relative shrub density of fourwing saltbush – the most dominant shrub (Table 5).

Lastly, the diversity standards require that no single species of any functional group represent greater than 40% relative total vegetative cover. Relative total vegetative here is defined as the percent foliar cover of any recorded species divided by the total foliar cover for all live vegetation of the sampling unit, including annuals and noxious weeds. James' galleta represented the highest relative total vegetation cover at 23.1%, thus the reclamation achieved the single species diversity standard.

From 2019 through 2024, 160 plant species have been observed within reclaimed areas in O-VMU-2 including 33 grasses, 85 forbs, and 42 shrubs, trees, and cacti (Table A-6). Of the 33 grasses, 17 are cool-season perennials, three are cool-season annuals, eight are warm-season perennials and five are warm-season annuals. Of the 84 forbs, 28 are annuals, and the remaining 57 are perennials and/or biennials. Cacti (one species), succulents (two species), and trees (seven species) were rare on the reclamation but provide diverse habitat or browse for wildlife. Shrubs and subshrubs were the most common observed of the 42 species woody plant species. The recruitment of native plants and establishment of seeded species within is indicative of ecological succession and the capacity of the site to support a diverse and self-sustaining ecosystem.

## 3.6 Noxious Weeds

During the 2024 monitoring program, Class C noxious weeds (NMDA 2020) were rarely encountered in O-VMU-2. Class C noxious weeds are generally widespread in the state and managed at the local level based on the feasibility of control and level of infestation. Cheatgrass was encountered infrequently in LPI surveys and production quadrats. Noxious weeds are not used in the assessment of revegetation success but are included in the single species cover standard (Table 1). Noxious trees and shrubs observed on O-VMU-2 in past years include saltcedar (*Tamarix ramosissima*), Siberian elm (*Ulmus pumila*) and Russian olive (*Elaeagnus angustifolia*) but their presence in the reclaimed vegetation community is insignificant with densities much lower than native rangeland beyond the permit boundary. CMI continues to monitor for noxious weeds and actively controls them through husbandry practices that include annual services for weed management. Further, competition from desirable seeded and native species is expected to inhibit any substantial increase of noxious weeds in the reclamation.

# 4.0 SUMMARY

McKinley Mine's vegetation success standards for the post-mining land uses of grazing and wildlife are based on total ground cover, perennial vegetation cover, annual forage production, shrub density, and diversity. The technical standards (Table 1) were developed through negotiations with OSMRE based on the analysis of historical vegetation data, interpretation of the ecological site potential, and the anticipated post-mining land uses. The vegetation monitoring results for the past six years indicate that the vegetation community in O-VMU-2 has progressed and now meets the revegetation success standards despite persistent drought conditions over the

past several years. This progression is evident as the shrub density and total ground cover standards have been met every year and the perennial vegetation cover standard in all but one year (Table 3). Moreover, annual forage production has been well above the standard and passed hypothesis testing in 2023 and 2024. A summary of the findings from the past six years are:

1. Vegetation Cover: The total ground cover standard and perennial vegetation cover standard have been met every year since monitoring began in 2019 with the exception of perennial vegetation cover in 2021.
2. Forage Production: Average annual forage production met standards in both 2023 and 2024. Forage production was also above the numeric performance standards in 2019 and 2022 though hypothesis testing did not demonstrate that the standard was met due to highly variable data.
3. Shrub Density: O-VMU-2 has exceeded the success parameters for shrub density every year since 2019 when monitoring was initiated.
4. Diversity: All plant diversity standards were met in 2020, 2022, 2023, and 2024 (Tables 6 and 7). In 2021 and 2019 the second warm-season grass species fell short of the standard. Perennial forbs also fell short in 2021. With the revised diversity standards adopted to accurately represent expected vegetation composition in semi-arid shrubland/grasslands, all diversity thresholds were met in 2023 and 2024.

The reclamation in O-VMU-2 has demonstrated the capability of meeting and sustaining the post-mining land use by fully meeting the vegetation performance standard over the past two years. Long-term vegetation performance in the reclamation is encouraging considering below-average precipitation in 5 of the past 6 years including the exceptional drought in 2020 and 2021. The performance of vegetation in O-VMU-2 under these conditions show that the reclaimed plant communities are resilient and capable of sustaining themselves under the adverse conditions that are characteristic of this region.

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# Tables

**Table 1: Revegetation Success Standards in the McKinley Mine OSMRE Permit**

| Vegetative Parameter | Components | | Success Standards | |
|---|---|---|---|---|
| | | | 2019-2022 | 2023-2024 |
| Cover | Total Ground Cover | | ≥ 52% | ≥ 52% |
| | Perennial Vegetation Cover | | ≥ 24% | ≥ 24% |
| Diversity "Lifeform Statement" | Perennial Grasses | All Grasses | ≥ 7% absolute cover | ≥ 7% absolute cover |
| | | Cool-Season | ≥ 2 species, each ≥ 1.5% cover | ≥ 2 species, 1st species ≥ 5% relative perennial cover, 2nd species ≥ 2.5% relative perennial cover |
| | | Warm-Season | ≥ 2% contribution, ≥ 2 species, each ≥ 0.5% cover | ≥ 2 species, 1st species ≥ 5% relative perennial cover, all other species combined ≥ 1.5% relative perennial cover |
| | Perennial Forbs | | ≥ 3 species, combining for ≥ 1% relative perennial cover | ≥ 3 species, combining for ≥ 1% relative perennial cover |
| | Shrubs | All Shrubs | ≥ 3% absolute cover | ≥ 6% relative total perennial cover |
| | | Any Single Species | ≤ 70% relative total shrub cover | ≤ 70% relative total shrub density |
| | Any Single Species (including weeds) | | ≤ 40% relative total vegetative cover | ≤ 40% relative total vegetative cover |
| Production | Pounds/acre air dry | | ≥ 550 lbs/ac | ≥ 550 lbs/ac |
| Woody Plant Density | Stems/acre | | ≥ 400/acre | ≥ 400/acre |

Notes:
Success for cover, production, and stocking shall be ≥ 90% of the standard in accordance with 30 CFR 816.116 a)(2).
Total ground cover does not include noxious weeds.
Perennial vegetation cover is foliar cover from LPI, not including annuals and noxious weeds.
Relative cover is the percent cover of a species or functional group divided by the total vegetation cover including annuals and noxious weeds.
Relative perennial cover is the total cover of a perennial species or perennial functional group divided by the total perennial cover (see below).
Total perennial cover includes shrubs, cactus, trees, perennial grasses and perennial forbs not including noxious species.
Relative total shrub density is the density of each woody species divided by the total woody plant density not including noxious weeds.

**Table 2: North Mine Seasonal and Annual Precipitation, 2015-2024**

| Year | Station | Area | Precipitation (inches) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | January | February | March | April | May | June | July | August | September | October | November | December | Annual Total | Growing Season Total |
| 2015 | Rain Bluff | North Shop | 1.39 | 1.21 | 0.11 | 0.35 | 1.54 | 1.15 | 2.81 | 1.91 | 0.51 | 1.18 | 1.16 | 0.74 | 14.06 | 8.27 |
| | Rain 2 | 2 | NA | NA | NA | 0.52 | 1.51 | 1.98 | 3.17 | 1.39 | 0.50 | 1.08 | 0.92 | NA | NA | 9.07 |
| | Rain 3 | 3 | NA | NA | NA | 0.57 | 1.80 | 1.77 | 3.61 | 3.06 | 0.44 | 1.36 | 0.86 | NA | NA | 11.25 |
| | Rain 6 | 6 | NA | NA | NA | 0.54 | 0.71 | 2.12 | 2.66 | 2.12 | 0.00 | 0.92 | 0.70 | NA | NA | 8.15 |
| | Rain 10 | 10 | NA | NA | NA | 0.42 | 1.32 | 1.11 | 2.59 | 1.39 | 0.30 | 1.10 | 0.78 | NA | NA | 7.13 |
| | Rain 12 | 12 | NA | NA | NA | 0.49 | 1.59 | 1.39 | 2.88 | 2.14 | 0.47 | 1.17 | 1.29 | NA | NA | 8.96 |
| | Rain 15 | 15 | NA | NA | NA | 0.46 | 1.90 | 1.62 | 3.17 | 2.88 | 0.32 | 0.94 | 0.69 | NA | NA | 10.35 |
| 2016 | Rain Bluff | North Shop | 0.39 | 0.25 | 0.03 | 1.28 | 0.70 | 0.19 | 1.15 | 1.85 | 1.79 | 0.69 | 1.18 | 1.98 | 11.48 | 6.96 |
| | Rain 2 | 2 | NA | NA | NA | 0.17 | 0.58 | 0.14 | 2.22 | 0.71 | 0.87 | 0.21 | 0.02 | NA | NA | 4.69 |
| | Rain 3 | 3 | NA | NA | NA | 0.20 | 0.72 | 0.45 | 1.62 | 0.11 | 0.50 | 0.33 | 0.02 | NA | NA | 3.60 |
| | Rain 6 | 6 | NA | NA | NA | 0.20 | 0.75 | 0.29 | 2.00 | 0.40 | 1.19 | 0.19 | 0.02 | NA | NA | 4.83 |
| | Rain 10 | 10 | NA | NA | NA | 0.13 | 0.55 | 0.20 | 2.75 | 0.38 | 0.99 | 0.14 | 0.02 | NA | NA | 5.00 |
| | Rain 12 | 12 | NA | NA | NA | 0.30 | 0.78 | 0.36 | 1.34 | 0.49 | 1.16 | 0.18 | 0.05 | NA | NA | 4.43 |
| | Rain 15 | 15 | NA | NA | NA | 0.31 | 0.85 | 0.04 | 1.95 | 0.35 | 1.31 | 0.18 | 0.05 | NA | NA | 4.81 |
| 2017 | Rain Bluff | North Shop | 0.81 | 0.04 | 0.70 | 0.32 | 0.41 | 0.16 | 3.71 | 0.37 | 0.62 | 0.54 | 0.05 | 0.02 | 7.75 | 5.59 |
| | Rain 2 | 2 | NA | NA | NA | 1.28 | 0.66 | 0.22 | 0.78 | 2.08 | 1.46 | 0.63 | 0.44 | NA | NA | 6.48 |
| | Rain 3 | 3 | NA | NA | NA | 1.04 | 1.16 | 0.06 | 0.99 | 2.71 | 1.63 | 0.56 | 0.44 | NA | NA | 7.59 |
| | Rain 6 | 6 | NA | NA | NA | 0.86 | 1.50 | 0.02 | 0.96 | 2.04 | 1.52 | 0.38 | 0.51 | NA | NA | 6.90 |
| | Rain 10 | 10 | NA | NA | NA | 1.00 | 0.67 | 0.08 | 0.94 | 1.63 | 1.36 | 0.34 | 0.81 | NA | NA | 5.68 |
| | Rain 12 | 12 | NA | NA | NA | 1.17 | 0.91 | 0.05 | 0.88 | 1.89 | 1.77 | 0.47 | 0.46 | NA | NA | 6.67 |
| | Rain 15 | 15 | NA | NA | NA | 1.15 | 1.36 | 0.02 | 0.68 | 1.91 | 1.56 | 0.40 | 0.41 | NA | NA | 6.68 |
| 2018 | Rain Bluff | North Shop | 0.23 | 0.48 | 0.44 | 0.08 | 0.22 | 0.28 | 2.17 | 0.00 | 1.00 | 1.51 | 0.14 | 0.43 | 6.98 | 3.75 |
| | Rain 2 | 2 | NA | NA | NA | 0.06 | 0.26 | 0.30 | 1.10 | 0.90 | 1.40 | 1.48 | 0.00 | NA | NA | 4.02 |
| | Rain 3 | 3 | NA | NA | NA | 0.04 | 0.30 | 0.35 | 0.92 | 0.91 | 1.27 | 1.69 | 0.00 | NA | NA | 3.79 |
| | Rain 6 | 6 | NA | NA | NA | 0.03 | 0.21 | 0.46 | 0.97 | 0.56 | 1.02 | 1.45 | 0.00 | NA | NA | 3.25 |
| | Rain 10 | 10 | NA | NA | NA | 0.08 | 0.20 | 0.27 | 3.05 | 1.15 | 0.92 | 1.51 | 0.00 | NA | NA | 5.67 |
| | Rain 12 | 12 | NA | NA | NA | 0.06 | 0.37 | 0.26 | 1.08 | 1.36 | 1.09 | 1.54 | 0.00 | NA | NA | 4.22 |
| | Rain 15 | 15 | NA | NA | NA | 0.05 | 0.32 | 0.28 | 1.16 | 0.63 | 1.31 | 1.31 | 0.00 | NA | NA | 3.75 |
| 2019 | Rain Bluff | North Shop | 0.95 | 0.98 | 1.10 | 0.24 | 0.17 | 0.03 | 0.03 | 1.14 | 0.10 | 0.04 | 1.15 | 0.97 | 6.90 | 1.71 |
| | Rain 2 | 2 | NA | NA | NA | 0.22 | 1.41 | 0.15 | 0.35 | 0.73 | 1.35 | 0.04 | 0.05 | NA | NA | 4.21 |
| | Rain 3 | 3 | NA | NA | NA | 0.39 | 1.50 | 0.32 | 0.70 | 0.11 | 1.72 | 0.06 | 0.06 | NA | NA | 4.74 |
| | Rain 6 | 6 | NA | NA | NA | 0.36 | 1.20 | 0.00 | 0.01 | 0.34 | 1.82 | 0.04 | 0.03 | NA | NA | 3.73 |
| | Rain 10 | 10 | NA | NA | NA | 0.20 | 1.49 | 0.37 | 0.19 | 0.27 | 1.34 | 0.03 | 0.05 | NA | NA | 3.86 |
| | Rain 12 | 12 | NA | NA | NA | 0.20 | 1.59 | 0.28 | 0.35 | 0.14 | 1.38 | 0.07 | 0.04 | NA | NA | 3.94 |
| | Rain 15 | 15 | NA | NA | NA | 0.22 | 1.17 | 0.14 | 0.78 | 0.15 | 1.60 | 0.05 | 0.05 | NA | NA | 4.06 |
| 2020 | Rain Bluff | North Shop | 1.00 | 1.35 | 1.15 | 0.26 | 0.02 | 0.14 | 0.89 | 0.26 | 0.21 | 0.33 | 0.28 | 0.32 | 6.21 | 1.78 |
| | Rain 2 | 2 | NA | NA | NA | 0.26 | 0.09 | 0.05 | 1.65 | 0.20 | 0.17 | 0.31 | 0.16 | NA | NA | 2.42 |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.01 | 0.05 | 1.06 | 0.62 | 0.16 | 0.27 | 0.19 | NA | NA | 1.90 |
| | Rain 6 | 6 | NA | NA | NA | 0.05 | 0.02 | 0.02 | 0.82 | 0.55 | 0.14 | 0.08 | 0.16 | NA | NA | 1.60 |
| | Rain 10 | 10 | NA | NA | NA | 0.11 | 0.02 | 0.13 | 0.79 | 0.14 | 0.14 | 0.16 | 0.09 | NA | NA | 1.33 |
| | Rain 12 | 12 | NA | NA | NA | 0.25 | 0.08 | 0.06 | 0.97 | 0.47 | 0.35 | 0.29 | 0.28 | NA | NA | 2.18 |
| | Rain 15 | 15 | NA | NA | NA | 0.32 | 0.01 | 0.05 | 0.65 | 0.87 | 0.28 | 0.09 | 0.44 | NA | NA | 2.18 |
| 2021 | Rain Bluff | North Shop | 1.13 | 0.21 | 0.46 | 0.04 | 0.04 | 0.20 | 2.17 | 1.31 | 1.13 | 0.86 | 0.20 | 0.92 | 8.67 | 4.89 |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.03 | 0.16 | 0.99 | 1.09 | 1.04 | 0.93 | 0.00 | NA | NA | 3.31 |
| | Rain 3 | 3 | NA | NA | NA | 0.03 | 0.09 | 0.05 | 0.69 | 1.04 | 1.64 | 1.16 | 0.00 | NA | NA | 3.54 |
| | Rain 6 | 6 | NA | NA | NA | 0.02 | 0.06 | 0.03 | 0.83 | 0.19 | 0.47 | 1.05 | 0.00 | NA | NA | 1.60 |
| | Rain 10 | 10 | NA | NA | NA | 0.01 | 0.06 | 0.24 | 2.48 | 1.80 | 0.96 | 0.80 | 0.00 | NA | NA | 5.55 |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.08 | 0.22 | 1.58 | 2.08 | 1.24 | 1.01 | 0.00 | NA | NA | 5.20 |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.07 | 0.05 | 1.04 | 2.58 | 1.47 | 1.00 | 0.00 | NA | NA | 5.21 |
| 2022 | Rain Bluff | North Shop | -- | -- | 0.59 | 0.03 | 0.00 | 1.24 | 3.13 | 4.66 | 1.27 | 1.40 | 0.48 | 0.58 | 13.38 | 10.33 |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 3.00 | 3.77 | 1.22 | 1.14 | 0.39 | NA | NA | 9.02 |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 2.99 | 3.07 | 1.18 | 1.19 | 0.54 | NA | NA | 8.27 |
| | Rain 6 | 6 | NA | NA | NA | 0.01 | 0.00 | 0.66 | 2.55 | 3.05 | 0.69 | 0.28 | 0.47 | NA | NA | 6.96 |
| | Rain 10 | 10 | NA | NA | NA | 0.00 | 0.00 | 0.69 | 3.57 | 4.27 | 1.02 | 1.83 | 0.33 | NA | NA | 9.55 |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.00 | 0.91 | 3.76 | 4.07 | 1.08 | 1.57 | 0.52 | NA | NA | 9.82 |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.01 | 0.91 | 4.06 | 3.84 | 1.12 | 1.68 | 0.50 | NA | NA | 9.94 |
| 2023 | Rain Bluff | North Shop | 1.21 | 0.50 | 1.64 | 0.05 | 0.55 | 0.13 | 0.03 | 3.16 | 0.33 | 0.57 | 0.42 | NA | 8.59 | 4.25 |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.48 | 0.09 | 0.08 | 3.08 | 0.44 | 0.09 | 0.09 | NA | NA | 4.17 |
| | Rain 3 | 3 | NA | NA | NA | 0.01 | 0.84 | 0.22 | 0.26 | 2.93 | 0.54 | 0.08 | 0.08 | NA | NA | 4.80 |
| | Rain 6 | 6 | NA | NA | NA | 0.00 | 1.49 | 0.22 | 0.07 | 1.97 | 0.49 | 0.05 | 0.00 | NA | NA | 4.24 |
| | Rain 10 | 10 | NA | NA | NA | 0.03 | 0.53 | 0.13 | 0.06 | 2.61 | 0.51 | 0.03 | 0.00 | NA | NA | 3.87 |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.74 | 0.21 | 0.10 | 2.47 | 0.41 | 0.05 | 0.00 | NA | NA | 3.93 |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.79 | 0.21 | 0.43 | 2.67 | 0.56 | 0.05 | 0.00 | NA | NA | 4.66 |
| 2024 | Rain Bluff | North Shop | 1.06 | 0.58 | 2.22 | 0.45 | 0.03 | 2.27 | 1.17 | 2.33 | 0.32 | 1.18 | 0.36 | 0.00 | 11.97 | 6.57 |
| | Rain 2 | 2 | NA | NA | NA | 0.21 | 0.01 | 2.36 | 0.65 | 2.31 | 0.60 | 1.32 | 0.13 | NA | NA | 6.14 |
| | Rain 3 | 3 | NA | NA | NA | 0.28 | 0.01 | 2.23 | 0.87 | 2.64 | 0.48 | 1.55 | 0.15 | NA | NA | 6.51 |
| | Rain 6 | 6 | NA | NA | NA | 0.22 | 0.06 | 2.33 | 1.22 | 2.33 | 0.45 | 1.35 | 0.08 | NA | NA | 6.61 |
| | Rain 10 | 10 | NA | NA | NA | 0.16 | 0.05 | 2.65 | 0.38 | 1.92 | 0.37 | 0.98 | 0.12 | NA | NA | 5.53 |
| | Rain 12 | 12 | NA | NA | NA | 0.15 | 0.10 | 2.58 | 0.54 | 2.58 | 0.87 | 1.24 | 0.20 | NA | NA | 6.82 |
| | Rain 15 | 15 | NA | NA | NA | 0.18 | 0.05 | 3.36 | 0.48 | 2.41 | 0.72 | 1.21 | 0.29 | NA | NA | 7.20 |
| Window Rock, Long Term normals | | | 0.72 | 0.68 | 0.88 | 0.61 | 0.49 | 0.47 | 1.75 | 2.05 | 1.23 | 1.14 | 0.83 | 0.95 | 11.80 | 6.60 |

Notes:
Long-term averages are from Window Rock, Arizona Station (029410), 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season total precipitation is between April and September
NA=rain gauges taken offline due to freezing conditions, data unavailable.
-- Rain gauge malfunction
In 2017 Rain Bluff experienced power issues in the summer that may have resulted in inaccurate precipitation readings.
data incomplete

**Table 3: Summary Statistics, O-VMU-2, 2019-2024**

| | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | Technical Standard |
|---|---|---|---|---|---|---|---|
| **Total Ground Cover (%)[1]** | | | | | | | |
| Mean | 63.2 | 57.5 | 54.5 | 51.5 | 59.8 | 68.3 | ≥ 52% |
| Standard Deviation | 10.9 | 10.3 | 11.6 | 11.2 | 11.1 | 10.8 | |
| 90% Confidence Interval | 2.8 | 2.7 | 3 | 2.9 | 2.9 | 2.9 | |
| Median | -- | 58 | 54 | 54 | 58 | 70 | |
| Nmin[2] | 8.5 | 9.1 | 12.8 | 13 | 10 | 7 | |
| **Live Vegetation Cover (%)[3]** | | | | | | | |
| Mean | 46 | 32 | 18 | 36.6 | 43.0 | 56.3 | None |
| Standard Deviation | 11 | 8 | 6.5 | 10.9 | 12.9 | 10.9 | |
| 90% Confidence Interval | 2.8 | 2.1 | 1.7 | 2.8 | 3.4 | 2.8 | |
| Nmin[2] | 15 | 17 | 37 | 25 | 26 | 11 | |
| **Perennial Vegetation Cover (%)[4]** | | | | | | | |
| Mean | 40 | 32 | 17 | 31.0 | 40.5 | 54.6 | ≥ 24% |
| Standard Deviation | 12 | 8.3 | 6.2 | 10.3 | 13.1 | 12.2 | |
| 90% Confidence Interval | 3 | 2.1 | 1.6 | 2.7 | 3.4 | 3.2 | |
| Median | -- | 32 | 18 | 30 | 41 | 58 | |
| Nmin[2] | 24 | 19 | 38 | 32 | 30 | 14 | |
| **Annual Forage Production (lbs/ac)[5]** | | | | | | | |
| Mean | 656 | 472 | 210 | 560 | 768 | 881 | ≥ 550 lbs/ac |
| Standard Deviation | 561 | 461 | 207 | 416 | 552 | 376 | |
| 90% Confidence Interval | 146 | 120 | 53 | 108 | 144 | 98 | |
| Median | -- | 365 | 146 | 529 | 631 | 835 | |
| Nmin[2] | 208 | 271 | 275 | 156 | 146 | 52 | |
| **Woody Plant Density (stems/acre) from Belt Transect** | | | | | | | |
| Mean | 3,149 | 2,239 | 2,375 | 2,555 | 2,631 | 1891 | ≥ 400/ac |
| Standard Deviation | 2,617 | 1,409 | 1,799 | 1,916 | 1,940 | 948 | |
| 90% Confidence Interval | 681 | 367 | 462 | 498 | 505 | 247 | |
| Median | -- | 1,862 | 2,145 | 2,226 | 2,327 | 1801 | |
| Nmin[2] | 196 | 112 | 163 | 160 | 154 | 71 | |

Notes:

[1] Mean foliar cover of live vegetation and litter

[2] Minimum number of samples to obtain 90% probability that the sample mean is within 10% of the population mean

[3] Mean vegetation foliar cover not including noxious weeds

[4] Mean foliar cover not including annuals and noxious weeds

[5] Annual forage production in air dry pounds per acre lbs/ac not including annuals or noxious weeds

Hypothesis testing found the success standard was not met

**Table 4: Average and Relative Foliar Cover and Production by Species, O-VMU-2, 2024**

| Scientific Name | Common Name | Code | Mean Vegetation Cover (%) | | | | Mean Annual Production (lbs/ac) |
|---|---|---|---|---|---|---|---|
| | | | First Hit Foliar[1] | Under story[2] | Relative Perennial | Relative Total | |
| **Cool-Season Grasses (12)** | | | | | | | |
| **Annuals (1)** | | | | | | | |
| *Bromus tectorum* | Cheatgrass | BRTE | 0.31 | 0.26 | NA | 0.9 | -- |
| **Perennials (11)** | | | | | | | |
| *Achnatherum hymenoides* | Indian ricegrass | ACHY | 2.00 | 0.15 | 3.7 | 3.6 | 24.3 |
| *Agropyron cristatum* | Crested wheatgrass | AGCR | 1.79 | 0.15 | 3.4 | 3.2 | 60.7 |
| *Bromus inermis* | Smooth brome | BRIN2 | 0.46 | 0.05 | 0.9 | 0.8 | 2.8 |
| *Elymus elymoides* | Bottlebrush squirreltail | ELEL5 | 0.21 | 0.10 | 0.5 | 0.5 | 3.7 |
| *Elymus lanceolatus* | Thickspike wheatgrass | ELLA3 | 6.05 | 0.41 | 11.2 | 10.7 | 64.1 |
| *Elymus trachycaulus* | Slender wheatgrass | ELTR7 | -- | -- | -- | -- | 6.9 |
| *Hesperostipa comata* | Needle and thread | HECO26 | 2.67 | 0.05 | 4.7 | 4.5 | 42.8 |
| *Pascopyrum smithii* | Western wheatgrass | PASM | 7.03 | 0.77 | 13.5 | 12.9 | 129.0 |
| *Psathyrostachys juncea* | Russian wildrye | PSJU3 | 1.18 | 0.05 | 2.1 | 2.0 | 13.5 |
| *Pseudoroegneria spicata* | Bluebunch wheatgrass | PSSP6 | 3.13 | 0.31 | 5.9 | 5.7 | 19.1 |
| *Thinopyrum intermedium* | Intermediate wheatgrass | THIN6 | 1.28 | 0.05 | 2.3 | 2.2 | 14.2 |
| **Warm-Season Grasses (5)** | | | | | | | |
| **Perennials (5)** | | | | | | | |
| *Bouteloua dactyloides* | Buffalograss | BODA2 | 0.31 | -- | 0.5 | 0.5 | 9.0 |
| *Bouteloua gracilis* | Blue grama | BOGR2 | 2.36 | -- | 4.1 | 3.9 | 34.8 |
| *Pleuraphis jamesii* | James' galleta | PLJA | 13.18 | 0.82 | 24.2 | 23.1 | 194.1 |
| *Sporobolus airoides* | Alkali sacaton | SPAI | 1.28 | 0.05 | 2.3 | 2.2 | 7.4 |
| *Sporobolus cryptandrus* | Sand dropseed | SPCR | -- | -- | -- | -- | 4.1 |
| **Forbs (20)** | | | | | | | |
| **Annuals (3)** | | | | | | | |
| *Alyssum desertorum* | Desert madwort | ALDE | 0.15 | 0.05 | NA | 0.3 | -- |
| *Helianthus annuus* | Common sunflower | HEAN3 | 0.21 | -- | NA | 0.3 | -- |
| *Salsola tragus* | Prickly Russian thistle | SATR12 | 1.38 | -- | NA | 2.3 | -- |
| **Perennials/Biennials (22)** | | | | | | | |
| *Acroptilon repens* | Russian knapweed | ACRE3 | 0.10 | -- | -- | 0.2 | -- |
| *Asclepias subverticillata* | Horsetail milkweed | ASSU2 | 0.10 | 0.05 | 0.3 | 0.3 | 1.8 |
| *Bahia dissecta* | Ragleaf bahia | BADI | -- | -- | -- | -- | 3.4 |
| *Boerhavia gracillima* | Slimstalk spiderling | BOGR | -- | 0.05 | 0.1 | 0.1 | -- |
| *Chaetopappa ericoides* | Rose heath | CHER2 | -- | -- | -- | -- | 2.4 |
| *Convolvulus* sp. | Bindweed | CONVO | 0.05 | -- | -- | 0.1 | -- |
| *Erigeron flagellaris* | Trailing fleabane | ERFL | -- | -- | -- | -- | 1.7 |
| *Grindelia squarrosa* | Curlycup gumweed | GRSQ | 0.31 | -- | 0.5 | 0.5 | 12.4 |
| *Heliomeris multiflora* | Showy goldeneye | HEMU3 | -- | -- | -- | -- | 1.2 |
| *Lactuca serriola* | Prickly lettuce | LASE | -- | -- | -- | -- | 1.6 |
| *Machaeranthera canescens* | Hoary tansyaster | MACA2 | 0.26 | -- | 0.4 | 0.4 | 21.3 |
| *Medicago sativa* | Alfalfa | MESA | 0.10 | -- | 0.2 | 0.2 | 2.0 |
| *Melilotus officinalis* | Sweetclover | MEOF | 0.21 | -- | 0.4 | 0.3 | 2.8 |
| *Penstemon palmeri* | Palmer's penstemon | PEPA8 | -- | -- | -- | -- | 2.5 |
| *Ratibida columnifera* | Upright prairie coneflower | RACO3 | 0.10 | -- | 0.2 | 0.2 | -- |
| *Sisymbrium altissimum* | Tall tumblemustard | SIAL2 | -- | -- | -- | -- | 3.6 |
| *Sphaeralcea coccinea* | Scarlet globemallow | SPCO | 0.36 | -- | 0.6 | 0.6 | 4.7 |
| *Sphaeralcea fendleri* | Fendler's globemallow | SPFE | -- | -- | -- | -- | 0.9 |
| *Sphaeralcea incana* | Gray globemallow | SPIN2 | -- | -- | -- | -- | 1.5 |
| *Tragopogon dubius* | Yellow salsify | TRDU | 0.10 | -- | 0.2 | 0.2 | 2.6 |
| *Tragopogon pratensis* | Jack-go-to-bed-at-noon | TRPR | -- | -- | -- | -- | 8.1 |

**Table 4: Average and Relative Foliar Cover and Production by Species, O-VMU-2, 2024**

| Scientific Name | Common Name | Code | Mean Vegetation Cover (%) | | | | Mean Annual Production (lbs/ac) |
|---|---|---|---|---|---|---|---|
| | | | First Hit Foliar[1] | Under story[2] | Relative Perennial | Relative Total | |
| **Shrubs, Trees, and Cacti (13)** | | | | | | | |
| *Artemisia frigida* | Prairie sagewort | ARFR4 | 0.05 | -- | 0.1 | 0.1 | -- |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.62 | -- | 1.1 | 1.0 | 6.6 |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 5.74 | 0.10 | 10.1 | 9.7 | 122.1 |
| *Atriplex confertifolia* | Shadscale saltbush | ATCO | 0.21 | -- | 0.4 | 0.3 | 14.9 |
| *Atriplex corrugata* | Mat saltbush | ATCO4 | 0.05 | -- | 0.1 | 0.1 | 5.3 |
| *Elaeagnus angustifolia* | Russian olive | ELAN | 0.05 | -- | -- | 0.1 | -- |
| *Eriogonum leptophyllum* | Slenderleaf buckwheat | ERLE10 | -- | -- | -- | -- | 0.8 |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 0.92 | -- | 1.6 | 1.5 | 7.8 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 1.03 | 0.10 | 1.9 | 1.9 | 12.2 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 0.82 | 0.05 | 1.5 | 1.4 | 6.0 |
| *Opuntia phaeacantha* | Tulip pricklypear | OPPH | -- | 0.05 | 0.1 | 0.1 | -- |
| *Purshia mexicana* | Mexican cliffrose | PUME | 0.46 | -- | 0.8 | 0.8 | -- |
| *Sarcobatus vermiculatus* | Greasewood | SAVE4 | 0.21 | -- | 0.4 | 0.3 | 0.7 |
| **Cover Components** | | | | | | | |
| Total Ground Cover | | | 68.77 | | | | |
| *Live Vegetation Foliar Cover* | | | 56.82 | | | | |
| *Perennial Vegetation Cover* | | | 54.77 | | | | |
| Rock | | | 7.33 | | | | |
| Litter | | | 11.95 | | | | |
| Bare Soil | | | 23.90 | | | | |

Notes:

[1] First hit foliar is calculated from first hits only

[2] Understory cover is calculated from second and lower hits

"--" species captured in either LPI or quadrats but not both

NA annuals not included in relative perennial cover calculations

**Table 5: Relative Shrub, Tree, and Cacti Density, O-VMU-2, 2024**

| Scientific Name | Common Name | Code | Relative Density (%) |
|---|---|---|---|
| *Artemisia caruthii* | Carruth's Sagewort | ARCA13 | 2.14 |
| *Artemisia dracunculus* | Tarragon | ARDR4 | 0.05 |
| *Artemsia frigida* | Prairie sagewort | ARFR4 | 0.54 |
| *Artemisia ludoviciana* | White sagebrush | ARLU | 0.32 |
| *Artemisia nova* | Black sagebrush | ARNO4 | 0.32 |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 1.82 |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 55.54 |
| *Atriplex confertifolia* | Shadscale saltbush | ATCO | 1.23 |
| *Atriplex corrugata* | Mat saltbush | ATCO4 | 2.35 |
| *Chrysothamnus greeneii* | Greene's rabbitbrush | CHGR6 | 0.59 |
| *Cylindropuntia spinosior* | Walkingstick cactus | CYSP8 | 0.16 |
| *Elaeagnus angustifolia* | Russian olive | ELAN | 0.05 |
| *Ephedra viridis* | Mormon tea | EPVI | 0.05 |
| *Eriogonum leptophyllum* | Slenderleaf buckwheat | ERLE10 | 1.82 |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 6.85 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 10.91 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 12.20 |
| *Opuntia phaeacantha* | Tulip pricklypear | OPPH | 0.16 |
| *Pinus edulis* | Twoneedle pinyon | PIED | 0.05 |
| *Purshia mexicana* | Mexican cliffrose | PUME | 1.82 |
| *Purshia tridentata* | Antelope bitterbrush | PUTR2 | 0.16 |
| *Sarcobatus vermiculatus* | Greasewood | SAVE4 | 0.86 |

Notes:

Relative density derived from belt method

Relative Density avg density per species per VMU ÷ avg total shrub density per VMU * 100

**Table 6: Results for Diversity, O-VMU-2, 2023-2024**

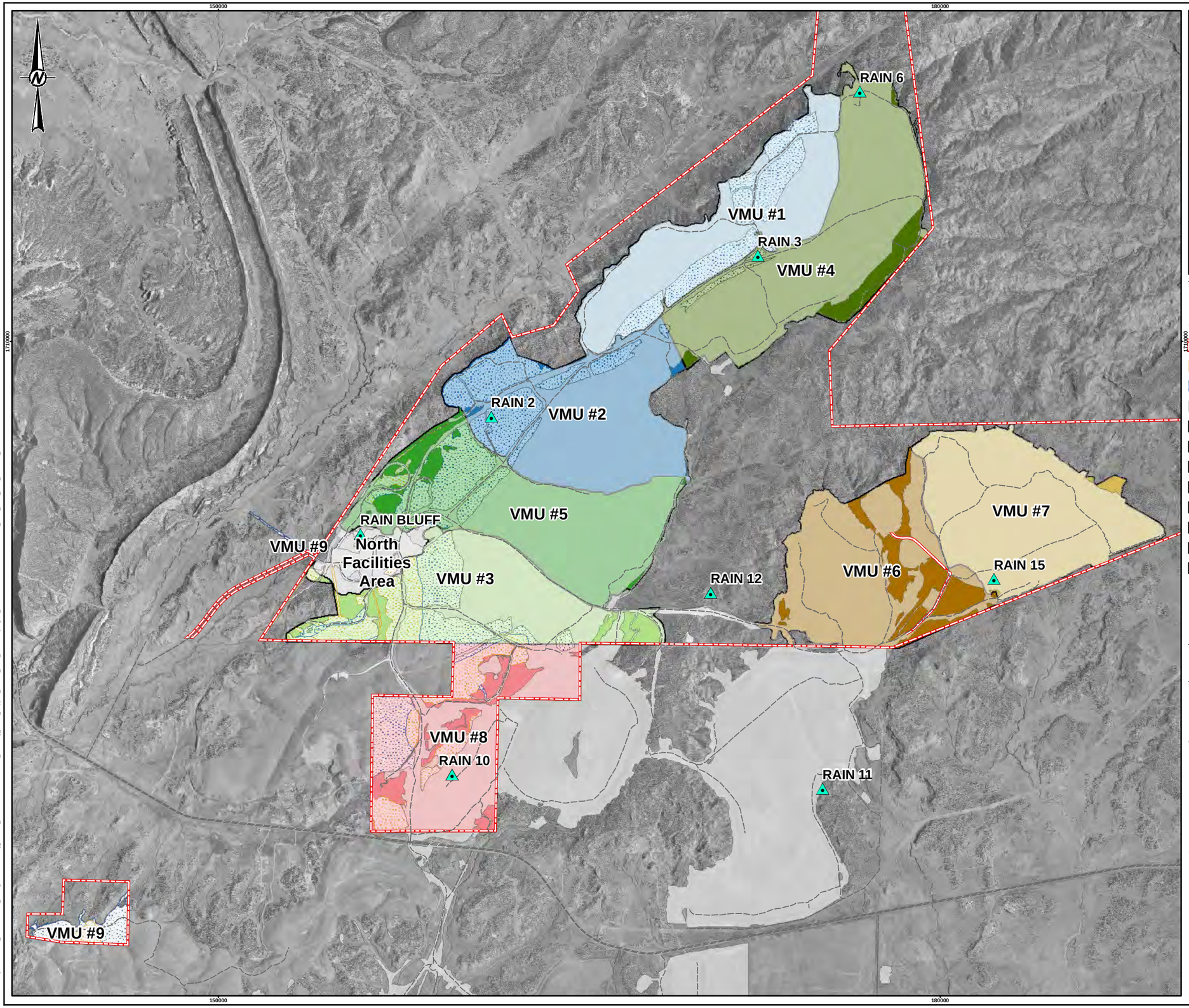
| Diversity Component | Metric | Standard | 2023 | | 2024 | |
|---|---|---|---|---|---|---|
| | | | Result | Species | Result | Species |
| **Perennial Grasses** | Absolute cover | ≥ 7% | 27.8% | -- | 45.9% | -- |
| Cool-season Grasses | # Species | ≥ 2 | 11 | -- | 10 | -- |
| Grass 1 | Relative perennial cover | ≥ 5% | 10.2% | Western wheatgrass | 13.4% | Western wheatgrass |
| Grass 2 | Relative perennial cover | ≥ 2.5% | 7.7% | Thickspike wheatgrass | 11.2% | Thickspike wheatgrass |
| Warm-season Grasses | # Species | ≥ 2 | 4 | -- | 4 | -- |
| Grass 1 | Relative perennial cover | ≥ 5% | 19.5% | James galleta | 24.2% | James galleta |
| All remaining species | Relative perennial cover | ≥ 1.5% | 3.7% | -- | 6.8% | -- |
| **Perennial Forbs** | # Species | ≥3 | 10 | -- | 9 | -- |
| | Relative perennial cover | ≥ 1% | 4.3% | -- | 2.8% | -- |
| **Shrubs or Subshrubs** | Relative perennial cover | ≥ 6% | 26.7% | -- | 18.0% | -- |
| Single Shrub Species | Relative shrub density | ≤ 70% | 42.0% | Fourwing saltbush | 55.5% | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 18.2% | James galleta | 23.1% | James galleta |

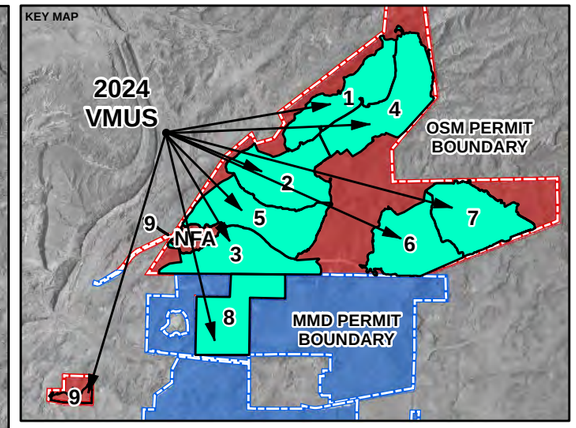
**Table 7: Results for Diversity, O-VMU-2, 2019-2022**

| Diversity Component | Metric | Standard | 2019 | | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Result | Species | Result | Species | Result | Species | Result | Species |
| **Perennial Grasses** | Total absolute cover | ≥ 7% | 20.8% | -- | 21.8% | -- | 11.4% | -- | 20.7% | -- |
| Cool-season Grasses | # Species | ≥ 2 | 12 | -- | 11 | -- | 11 | -- | 11 | -- |
| Grass 1 | Absolute cover | ≥ 1.5% | 7.6% | Western wheatgrass | 7.3% | Western wheatgrass | 1.8% | Western wheatgrass | 3.7% | Western wheatgrass |
| Grass 2 | Absolute cover | ≥ 1.5% | 2.8% | Thickspike wheatgrass | 2.0% | Slender wheatgrass | 1.5% | Thickspike wheatgrass | 1.9% | Slender wheatgrass |
| Warm-season Grasses | # Species | ≥ 2 | 4 | -- | 4 | -- | 4 | -- | 3 | -- |
| | Total absolute cover | ≥ 2.0% | 4.5% | -- | 5.7% | -- | 4.6% | -- | 9.5% | -- |
| Grass 1 | Absolute cover | ≥ 0.5% | 3.5% | James galleta | 3.8% | James galleta | 4.0% | James' galleta | 6.6% | James galleta |
| Grass 2 | Absolute cover | ≥ 0.5% | 0.4% | Blue grama | 1.0% | Blue grama | 0.3% | Alkali sacaton | 1.5% | Blue grama |
| **Perennial Forbs** | # Species | ≥ 3 | 19 | -- | 5 | -- | 1 | -- | 14 | -- |
| | Relative perennial cover | ≥ 1% | 20.4% | -- | 2.2% | -- | 0.3% | -- | 5.6% | -- |
| **Shrubs or Subshrubs** | Total absolute cover | ≥ 3% | 11.0% | -- | 9.4% | -- | 5.2% | -- | 8.1% | -- |
| Single Shrub Species | Relative shrub cover | ≤ 70% | 68.0% | Fourwing saltbush | 58.5% | Fourwing saltbush | 66.0% | Fourwing saltbush | 67.3% | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 15.7% | Western wheatgrass | 21.8% | Western wheatgrass | 22.1% | James galleta | 0.18 | James' galleta |

Notes:
Diversity calculated in accordance with Table 1 in either absolute or relative % cover
Success standard was not met

# Figures




**LEGEND**

- Rain Gauges
- Mine Site Roads
- OSM Permit Boundary
- Prelaw (~ 387 acres)
- Initial Program (~ 1,248 acres)
- Permanent Program (~ 11,327 acres)
- OSM VMU 1 (~ 934 acres)
- OSM VMU 2 (~ 1,085 acres)
- OSM VMU 3 (~ 959 acres)
- OSM VMU 4 (~ 1,242 acres)
- OSM VMU 5 (~ 1,129 acres)
- OSM VMU 6 (~ 1,024 acres)
- OSM VMU 7 (~ 1,045 acres)
- OSM VMU 8 (~ 953 acres)

0 4,000 8,000

1 inch = 4,000 feet FEET

**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT
CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT
MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2024 VEGETATION MONITORING

TITLE
**GENERAL OVERVIEW OF THE MCKINLEY OSMRE PERMIT AREA VEGETATION MANAGEMENT UNITS (VMU), 2024**

CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2025-02-14 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MT |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| US-WSP-31406184.000 | D003 | 0 | 1 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

1in

0

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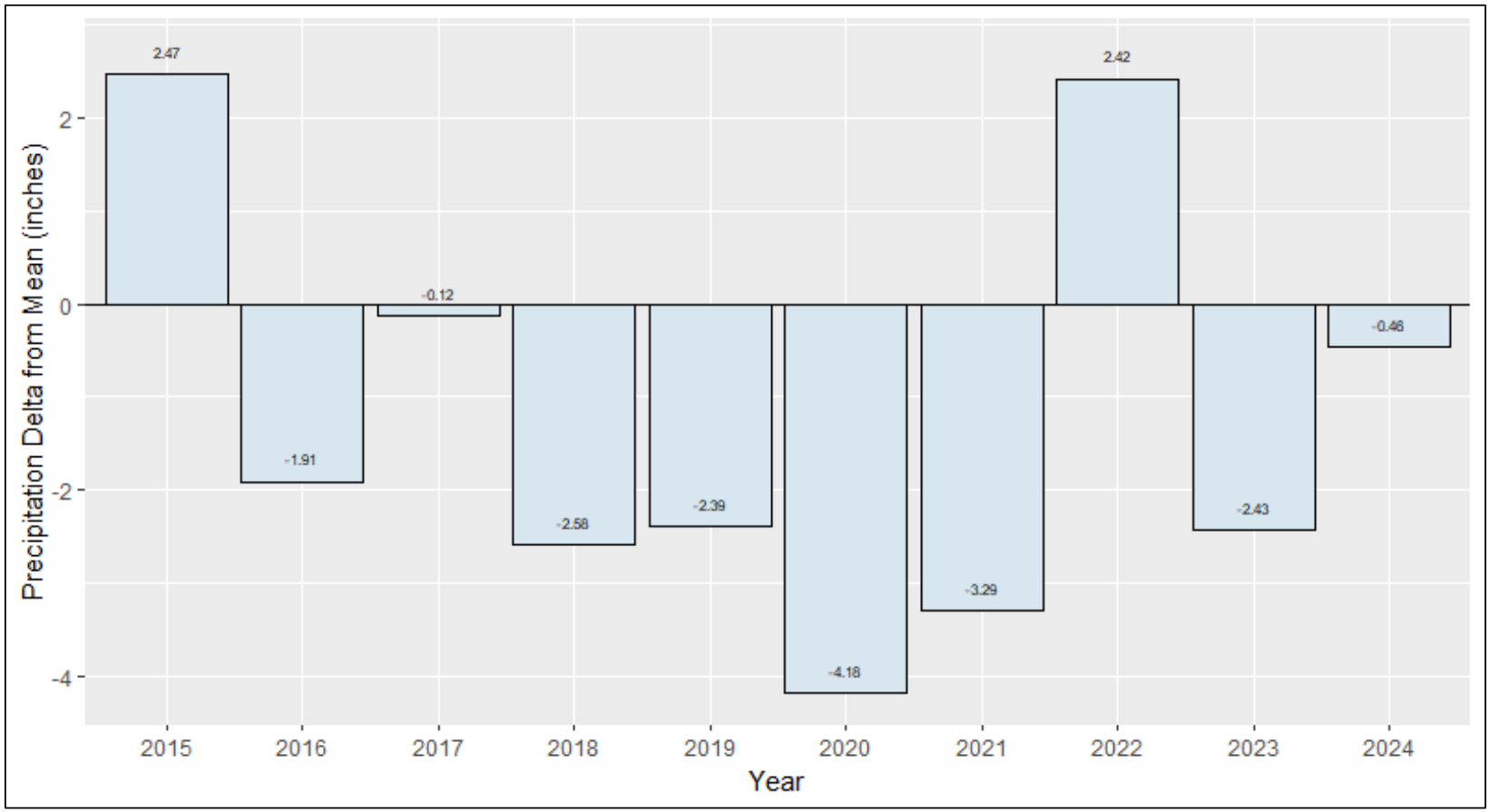
**Figure 2: Departure of Growing Season Precipitation from Long-Term Mean at Window Rock: Rain 2 Gauge**




Notes:

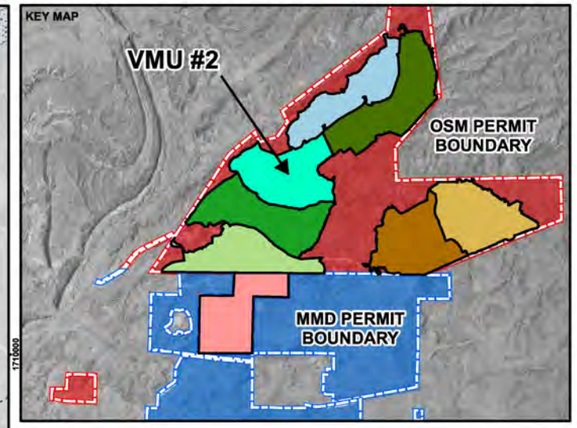
Long-term seasonal mean is from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2020).

Growing season precipitation is April through September

Source data is in Table 2

O-VMU2-T39P
O-VMU2-T11P
O-VMU2-T32P
O-VMU2-T03P
O-VMU2-T37P
O-VMU2-T25P
O-VMU2-T13P
O-VMU2-T23P
O-VMU2-T12P
O-VMU2-T18P
O-VMU2-T22P
O-VMU2-T38P
O-VMU2-T30P
O-VMU2-T08P
O-VMU2-T06P
O-VMU2-T40P
O-VMU2-T16P
O-VMU2-T31P
O-VMU2-T10P
O-VMU2-T20P
O-VMU2-T04P
O-VMU2-T33P
O-VMU2-T14P
O-VMU2-T27P
O-VMU2-T09P
O-VMU2-T34P
O-VMU2-T01P
O-VMU2-T24P
O-VMU2-T05P
O-VMU2-T28P
O-VMU2-T35P
O-VMU2-T15P
O-VMU2-T07P
O-VMU2-T17P
O-VMU2-T29P
O-VMU2-T21P
O-VMU2-T19P
O-VMU2-T26P
O-VMU2-T02P
O-VMU2-T36P

KEY MAP




**LEGEND**

- Primary Transect
- Alternate Transect
- Mine Site Roads
- OSM VMU 2 (~ 1,085 acres)
- Prelaw
- Initial Program
- Permanent Program
- Native Areas
- OSM Permit Boundary

**TRANSECT LABEL EXPLANATION**

O-VMU-1-T1P

- OSM Permit Area
- Vegetation Management Unit (VMU-#)
- Transect Number
- Primary (P) or Alternate (A)

0 970 1,940

1 inch = 940 feet FEET

**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN
2. KEY MAP SCALE IS DIFFERENT FROM OVERVIEW OF VMUS
3. TRANSECT LOCATIONS WERE CREATED IN ACCORDANCE WITH THE METHODS OUTLINED IN THE PERMIT

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT
CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT
MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2024 VEGETATION MONITORING

TITLE
**SURVEYED VEGETATION MONITORING TRANSECTS, 2024 VEGETATION MANAGEMENT UNIT 2**

CONSULTANT
WSP

| | |
|---|---|
| YYYY-MM-DD | 2025-02-14 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MT |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| US-WSP-31406184.000 | D002 | 0 | 3 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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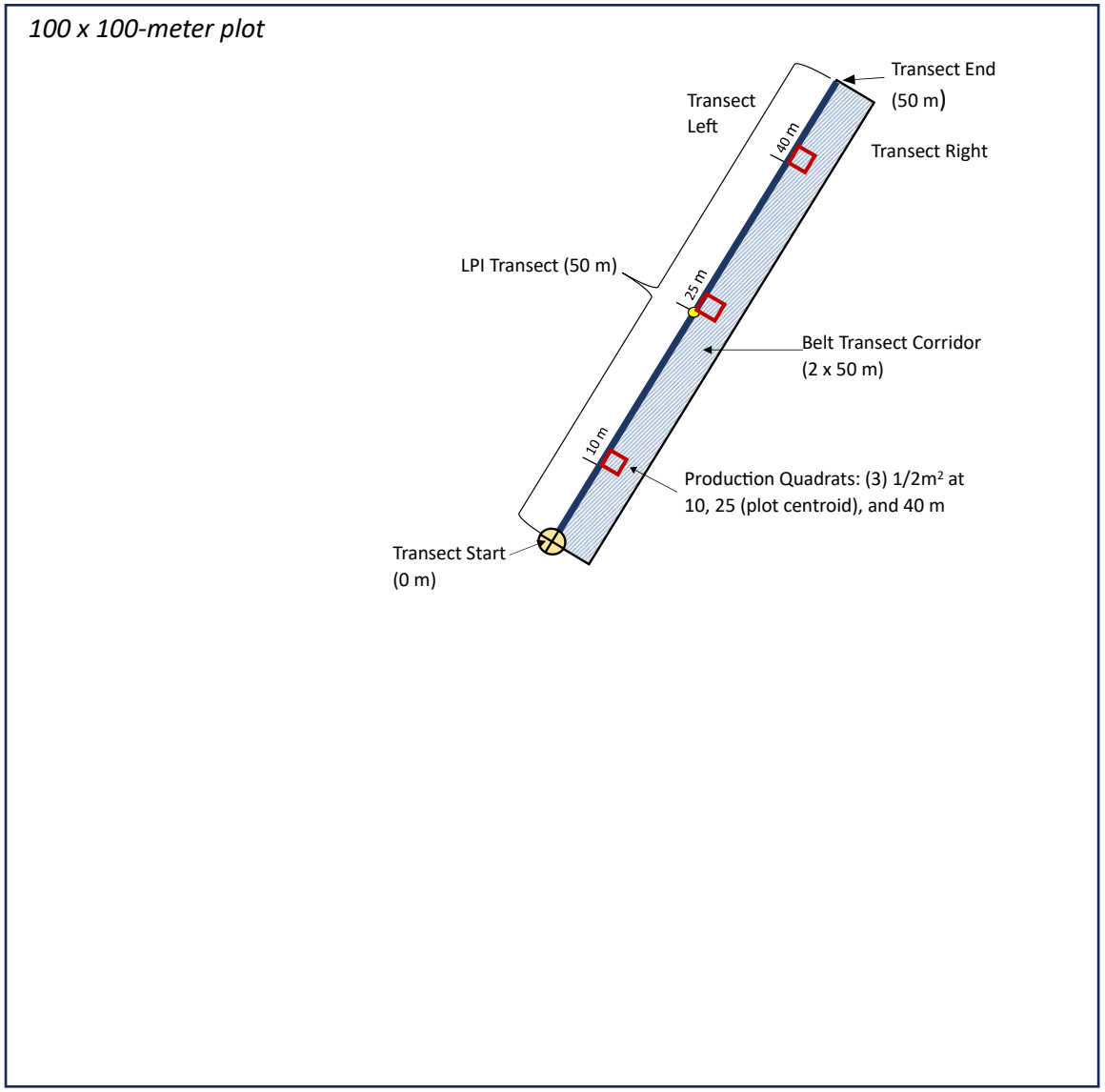
**Figure 4: Vegetation Plot and Transect Layout**




**Transect start placed on plot centroid and oriented randomly (0-360 degrees)* **Not to Scale**

**Figure 5: Typical Grass-Shrubland Vegetation in O-VMU-2, September 2024**

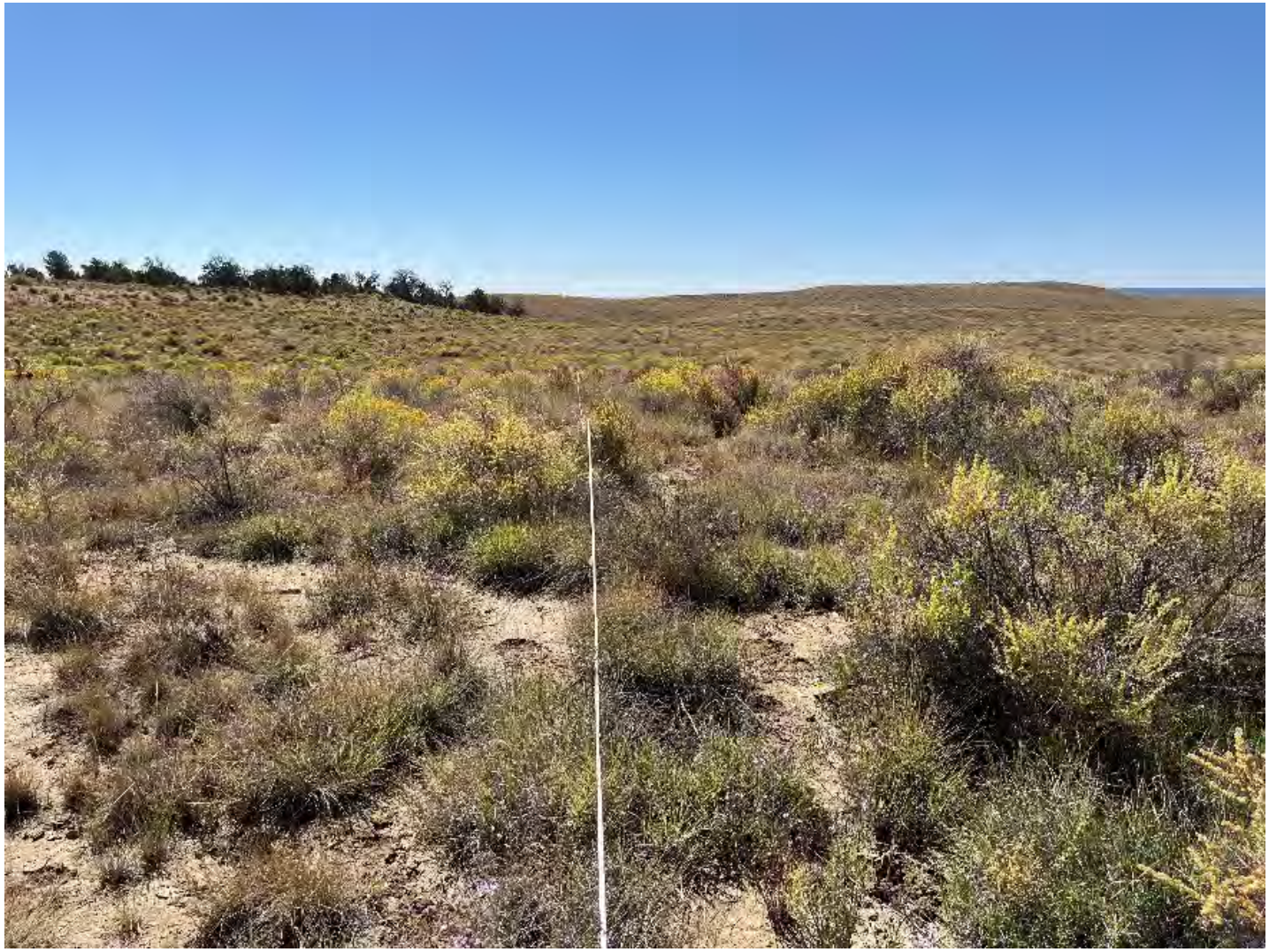


**Figure 6: Stabilization of the Annual Forage Production Mean and 90% Confidence Interval, O-VMU-2, 2024**

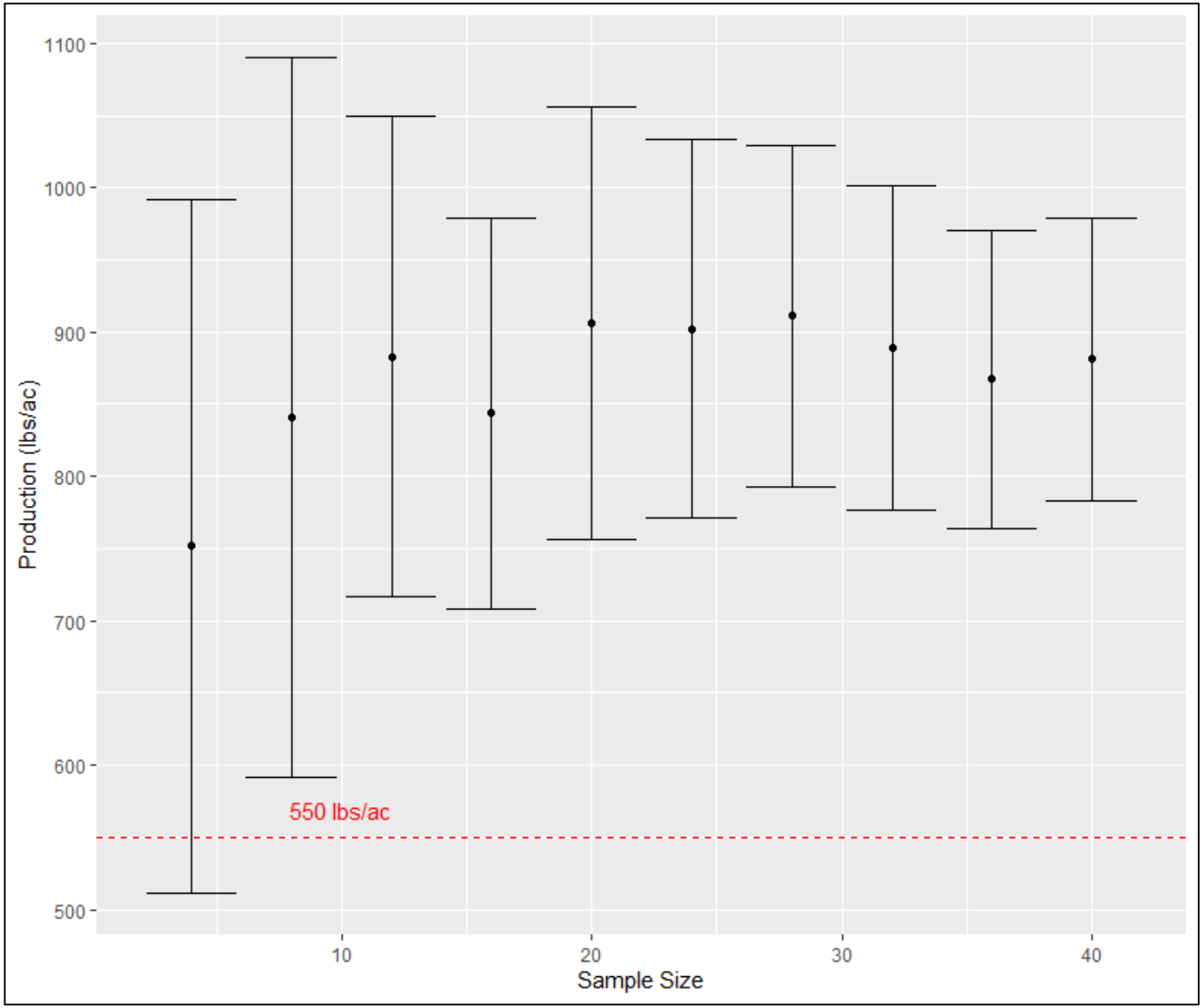
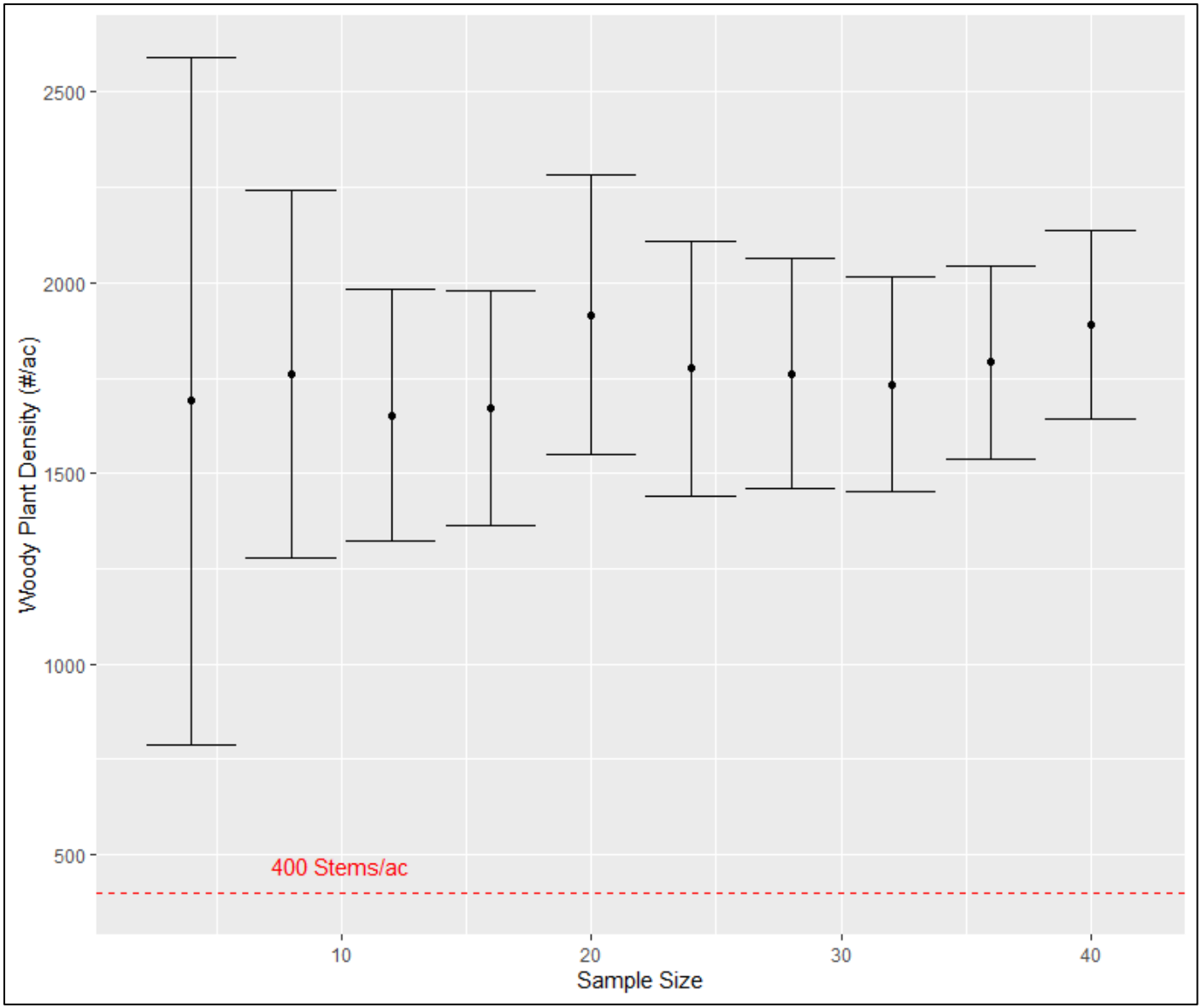


**Figure 7: Stabilization of Shrub Density Mean and Standard Deviation, O-VMU-2, 2024**



**APPENDIX A**

# Vegetation Data Summary

**Table A-1: O-VMU-2 Line Point Intercept Foliar Cover Data (first hits), 2024**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P* | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRTE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | 1 | -- | -- |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | 7 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | 3 | 1 | 1 | 1 | -- | 2 | 4 | 4 | -- | -- | -- | 1 | 1 | 3 | -- | -- | 1 | 1 | -- | 3 | -- | -- | -- | -- | -- | -- |
| AGCR | 1 | -- | 1 | -- | 9 | -- | -- | -- | -- | 8 | -- | 14 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- |
| ELLA3 | 3 | -- | 8 | 6 | -- | -- | 3 | 2 | -- | -- | 28 | -- | 1 | -- | 8 | -- | -- | -- | 4 | -- | -- | -- | 1 | 1 | -- | 4 | 2 | 3 | 4 | 8 | 2 | 7 | -- | 3 | 4 | -- | -- | -- | 16 | -- |
| HECO26 | 2 | -- | 1 | 4 | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | 12 | -- | 7 | -- | -- | -- | -- | -- | 3 | 1 | -- | -- | -- | 2 | 1 | 3 | 6 | 1 | 3 | 2 | -- | 1 | -- | -- | -- | -- |
| PASM | 2 | 6 | 4 | 2 | 9 | -- | 2 | 2 | -- | 1 | -- | -- | 8 | -- | 3 | 1 | 5 | 3 | 4 | 2 | 6 | 7 | 9 | 1 | 8 | 2 | 4 | 5 | 3 | 1 | 4 | 2 | 6 | 1 | 5 | 3 | 1 | 11 | 4 | -- |
| PSJU3 | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | 5 | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- |
| PSSP6 | -- | -- | 1 | -- | -- | -- | 1 | 5 | -- | -- | -- | -- | 17 | -- | -- | -- | -- | -- | 3 | -- | -- | -- | 2 | 1 | -- | 2 | -- | 11 | 1 | 5 | 8 | -- | 2 | -- | 1 | -- | -- | 1 | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 2 | -- | 15 | -- | -- | 4 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BODA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | -- |
| BOGR2 | 1 | 3 | 10 | -- | -- | -- | 1 | 1 | -- | 2 | 2 | -- | -- | 4 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 3 | 3 | -- | 3 | 1 | 2 | 1 | -- | -- | 1 | 3 | 1 | -- | -- | -- | 3 | -- |
| PLJA | 14 | 17 | 4 | 15 | 4 | 1 | 10 | 13 | -- | 14 | -- | 1 | 1 | 20 | 1 | -- | 2 | 3 | 5 | 1 | -- | -- | 10 | 21 | -- | 5 | 14 | 3 | 8 | 9 | 3 | 5 | 7 | 2 | 8 | 9 | 4 | 6 | 9 | 8 |
| SPAI | -- | -- | 1 | 5 | -- | -- | 3 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 2 | 2 | -- | -- | 3 | -- | -- | -- | -- | 3 | 1 | -- | 1 | -- | -- | 1 | -- | -- |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ALDE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HEAN3 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SATR12 | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 4 | -- | -- | -- | 15 | -- | 3 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TRDU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| MACA2 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEOF | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| CONVO | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MESA | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | 1 | -- | 1 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| ACRE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ASSU2 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| RACO3 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARFR4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- |
| ATCA2 | -- | 1 | -- | -- | -- | -- | 9 | 4 | -- | 5 | 1 | 4 | 1 | -- | -- | 1 | 5 | 5 | 2 | 9 | -- | 1 | 1 | -- | 5 | 3 | 4 | 2 | 5 | 1 | 3 | 2 | 4 | 5 | 2 | 1 | 8 | 8 | -- | 10 |
| ATCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| ELAN | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | 4 | -- | -- | 1 | -- | -- | 1 | -- | 2 | -- | -- | -- | 1 | 1 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- |
| GUSA2 | -- | 1 | -- | -- | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 3 | 1 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 2 | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | 6 | 2 | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- |
| PUME | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- |
| SAVE4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation | 32 | 29 | 34 | 36 | 26 | 23 | 32 | 31 | -- | 30 | 32 | 19 | 37 | 29 | 35 | 23 | 32 | 21 | 28 | 24 | 28 | 31 | 32 | 35 | 20 | 26 | 35 | 34 | 27 | 29 | 30 | 22 | 31 | 26 | 24 | 25 | 18 | 27 | 36 | 19 |
| Live Vegetation[1] | 32 | 29 | 34 | 36 | 26 | 23 | 32 | 31 | -- | 30 | 32 | 19 | 37 | 29 | 35 | 23 | 31 | 21 | 28 | 24 | 28 | 30 | 32 | 35 | 20 | 26 | 35 | 34 | 27 | 29 | 30 | 22 | 31 | 26 | 24 | 25 | 15 | 26 | 36 | 19 |
| Perennial Vegetation[2] | 32 | 29 | 34 | 36 | 23 | 21 | 32 | 31 | -- | 30 | 32 | 19 | 36 | 29 | 35 | 23 | 27 | 21 | 25 | 24 | 11 | 30 | 29 | 35 | 20 | 26 | 35 | 33 | 27 | 29 | 30 | 22 | 31 | 26 | 24 | 25 | 15 | 26 | 36 | 19 |
| Rock | 3 | 1 | 1 | 0 | 2 | 0 | 0 | 3 | -- | 8 | 1 | 2 | 3 | 5 | 9 | 15 | 2 | 8 | 5 | 2 | 5 | 8 | 2 | 3 | 0 | 3 | 0 | 1 | 4 | 4 | 5 | 14 | 0 | 4 | 0 | 0 | 3 | 8 | 1 | 8 |
| Litter | 4 | 4 | 3 | 7 | 6 | 16 | 8 | 6 | -- | 3 | 9 | 10 | 4 | 5 | 3 | 6 | 7 | 5 | 3 | 4 | 12 | 5 | 7 | 3 | 13 | 4 | 6 | 7 | 3 | 7 | 9 | 5 | 5 | 5 | 5 | 4 | 8 | 4 | 4 | 4 |
| Bare Soil | 11 | 16 | 12 | 7 | 16 | 11 | 10 | 10 | -- | 9 | 8 | 19 | 6 | 11 | 3 | 6 | 9 | 16 | 14 | 20 | 5 | 6 | 9 | 9 | 17 | 17 | 9 | 8 | 16 | 10 | 6 | 9 | 14 | 15 | 21 | 21 | 21 | 11 | 9 | 19 |

Notes:
Species codes defined in Table A-6
*Data lost due to file corruption
[1] Live vegetation is the total vegetation foliar hits for the transect, NOT including noxious weeds
[2] Perennial vegetation is the total vegetation foliar hits for the transect, NOT including annuals and noxious weeds

**Table A-2: O-VMU-2 Line Point Intercept Foliar Cover Data (all hits), 2023**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRTE | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | 1 | -- | -- |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | 7 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 4 | -- | 3 | 1 | 1 | 1 | -- | 2 | 4 | 4 | -- | -- | 1 | 1 | 1 | 3 | -- | -- | 1 | 1 | -- | 5 | -- | -- | -- | -- | -- | -- |
| AGCR | 1 | -- | 1 | -- | 9 | -- | -- | -- | 9 | -- | 16 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| ELLA3 | 3 | -- | 8 | 7 | -- | -- | 3 | 2 | -- | 28 | -- | 1 | -- | 10 | -- | -- | -- | 5 | -- | -- | -- | 2 | 1 | -- | 4 | 2 | 3 | 6 | 8 | 2 | 8 | -- | 3 | 4 | -- | -- | -- | 16 | -- |
| HECO26 | 2 | -- | 1 | 4 | -- | -- | 3 | -- | -- | -- | -- | -- | -- | 12 | -- | 7 | -- | -- | -- | -- | -- | 3 | 1 | -- | -- | -- | 2 | 1 | 3 | 7 | 1 | 3 | 2 | -- | 1 | -- | -- | -- | -- |
| PASM | 2 | 7 | 4 | 2 | 9 | -- | 2 | 4 | 1 | -- | -- | 8 | -- | 3 | 1 | 6 | 3 | 4 | 2 | 6 | 8 | 9 | 1 | 9 | 3 | 5 | 6 | 3 | 2 | 4 | 2 | 7 | 1 | 5 | 4 | 2 | 13 | 4 | -- |
| PSJU3 | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | 5 | -- | 1 | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- |
| PSSP6 | -- | -- | 1 | -- | -- | -- | 1 | 5 | -- | -- | -- | 18 | -- | -- | -- | -- | -- | 3 | -- | -- | -- | 2 | 3 | -- | 2 | -- | 11 | 2 | 5 | 10 | -- | 2 | -- | 1 | -- | -- | -- | 1 | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 3 | -- | 15 | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BODA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | 1 | -- | -- | -- | -- | -- | -- |
| BOGR2 | 1 | 3 | 10 | -- | -- | -- | 1 | 1 | 2 | 2 | -- | -- | 4 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 3 | 3 | -- | 3 | 1 | 2 | 1 | -- | -- | 1 | 3 | 1 | -- | -- | -- | 3 | -- |
| PLJA | 15 | 17 | 4 | 15 | 5 | 2 | 11 | 15 | 16 | -- | 1 | 1 | 21 | 1 | -- | 2 | 3 | 5 | 1 | -- | -- | 10 | 21 | -- | 6 | 14 | 3 | 10 | 9 | 4 | 5 | 8 | 2 | 9 | 9 | 4 | 6 | 10 | 8 |
| SPAI | -- | -- | 1 | 5 | -- | -- | 3 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 2 | 2 | -- | -- | 3 | -- | -- | -- | -- | 4 | 1 | -- | 1 | -- | -- | 1 | -- | -- |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ALDE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HEAN3 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SATR12 | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 4 | -- | -- | -- | 15 | -- | 3 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TRDU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| MACA2 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEOF | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CONVO | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MESA | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | 1 | -- | 1 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| ACRE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ASSU2 | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| RACO3 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARFR4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- |
| ATCA2 | -- | 1 | -- | -- | -- | -- | 9 | 4 | 5 | 1 | 4 | 1 | -- | -- | 1 | 5 | 5 | 2 | 11 | -- | 1 | 1 | -- | 5 | 3 | 4 | 2 | 5 | 1 | 3 | 2 | 4 | 5 | 2 | 1 | 8 | 8 | -- | 10 |
| ATCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- |
| ELAN | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | 4 | -- | -- | 1 | -- | -- | 1 | -- | 2 | -- | -- | -- | 1 | 1 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- |
| GUSA2 | -- | 1 | -- | -- | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | 3 | 1 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 2 | -- | 2 | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | 6 | 2 | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | 1 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- |
| OPPH | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| PUME | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- |
| SAVE4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

Notes:

Species codes defined in Table A-6

**Table A-3: O-VMU-2 Quadrat Canopy Cover Data (%), 2024**

| Transect | T01P | | | T02P | | | T03P | | | T04P | | | T05P | | | T06P | | | T07P | | | T08P | | | T09P | | | T10P | | | T11P | | | T12P | | | T13P | | | T14P | | | T15P | | | T16P | | | T16P | | | T17P | | | T19P | | | T20P | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quadrat | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRTE | -- | -- | -- | -- | -- | -- | 0.3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.0 | -- | -- | -- | -- | -- | -- | -- | -- | 15.0 | -- | -- | -- | -- | -- | -- | -- | -- |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | 7.0 | 19.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6.0 | -- | -- | -- | -- | -- | -- | 3.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9.0 | -- | 40.0 | -- | -- | -- | -- | 12.0 | -- | -- | -- | -- | 5.0 | 20.0 | -- | -- | -- | -- | -- | 11.0 | -- | -- |
| AGCR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 38.0 | 2.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 41.0 | -- | -- | -- | -- | 85.0 | 62.0 | 50.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 19.0 | -- | -- | -- | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3.0 | -- | -- | -- | -- | -- | -- | 2.0 | 3.0 |
| ELEL5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELLA3 | -- | -- | 9.0 | -- | -- | -- | -- | -- | 20.0 | 15.0 | 4.0 | -- | -- | -- | -- | 2.5 | -- | -- | -- | 5.0 | 15.0 | 16.0 | -- | 6.0 | 1.0 | -- | -- | -- | -- | -- | 20.0 | 30.0 | 40.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 40.0 | 20.0 | 25.0 | -- | -- | -- | 3.0 | -- | -- | -- | -- | 5.0 | 34.0 | -- | -- | -- |
| ELTR7 | -- | -- | -- | -- | -- | -- | -- | -- | 25.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HECO26 | -- | -- | -- | -- | -- | -- | 32.0 | -- | -- | -- | -- | 55.0 | -- | -- | -- | -- | -- | -- | -- | 5.0 | -- | 4.0 | -- | -- | -- | -- | 1.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.0 | -- | 4.0 | -- | -- | -- | -- | 25.0 | 24.0 | -- | -- | -- | -- | -- | -- | -- |
| PASM | -- | -- | -- | -- | 0.5 | 10.0 | -- | 18.0 | 5.0 | -- | -- | -- | 2.0 | 35.0 | 22.0 | -- | -- | 6.0 | -- | 2.0 | 2.0 | -- | -- | -- | -- | -- | -- | -- | 7.0 | -- | -- | -- | -- | 0.3 | -- | -- | -- | 12.0 | 10.0 | -- | 8.0 | 3.0 | -- | -- | -- | -- | -- | -- | -- | 15.0 | -- | -- | 20.0 | -- | 20.0 | 16.0 | -- | 18.0 |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 47.0 | -- | -- | -- | -- | -- | -- | 55.0 | -- | -- | -- | -- | -- |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 20.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 16.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 43.0 | 41.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 25.0 | -- | -- | -- | -- | -- | -- | 1.0 | 3.0 |
| Warm-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MUSQ3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.0 | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BODA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5.0 | -- | -- | -- | -- | 7.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | -- | -- | 1.0 | -- | -- | 10.0 | -- | -- | 2.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 15.0 | -- | -- | -- | -- | -- | 12.0 | -- | -- | 7.0 | -- | 25.0 | -- | -- | 3.0 | -- | -- | -- | -- | -- | -- | 2.0 | 6.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PLJA | -- | -- | 30.0 | 85.0 | 26.0 | -- | -- | -- | -- | 19.0 | -- | -- | -- | -- | -- | 1.0 | -- | -- | 30.0 | 21.0 | -- | -- | 28.0 | 40.0 | 30.0 | 48.0 | -- | 34.0 | -- | 35.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 30.0 | 25.0 | 35.0 | -- | -- | -- | -- | -- | -- | 37.0 | -- | 40.0 | 38.0 | -- | -- | -- |
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| Total Vegetation Cover | 7.0 | 21.5 | 48.0 | 93.0 | 26.5 | 20.0 | 42.0 | 20.0 | 52.0 | 54.0 | 18.0 | 55.0 | 32.0 | 75.0 | 25.0 | 52.0 | 26.0 | 25.0 | 51.0 | 85.0 | 22.0 | 36.0 | 28.0 | 48.0 | 43.0 | 30.0 | 1.1 | 73.0 | 7.8 | 60.0 | 20.0 | 36.0 | 50.0 | 85.0 | 62.0 | 60.0 | 59.0 | 41.0 | 65.0 | 44.0 | 44.0 | 45.0 | 45.0 | 37.0 | 26.5 | 7.8 | 47.0 | 70.0 | 35.0 | 22.0 | 50.0 | 25.0 | 56.0 | 55.0 | 67.0 | 71.0 | 25.0 | 37.0 | 91.0 | 48.5 |
| Rock | 6.0 | 7.0 | 0.5 | 0.0 | 1.0 | 1.5 | 2.5 | 1.0 | 1.0 | 5.0 | 2.0 | 0.5 | 0.5 | 0.0 | 1.0 | 0.0 | 1.3 | 12.0 | 0.5 | 0.0 | 0.1 | 0.5 | 14.0 | 1.0 | 1.0 | 0.3 | 5.0 | 0.5 | 6.0 | 30.0 | 0.2 | 1.0 | 0.5 | 0.3 | 1.5 | 0.0 | 0.5 | 2.0 | 4.0 | 0.1 | 4.0 | 5.0 | 10.0 | 28.0 | 6.0 | 86.0 | 6.0 | 1.0 | 0.0 | 1.0 | 1.0 | 20.0 | 1.0 | 5.0 | 0.0 | 0.3 | 3.0 | 4.0 | 0.0 | 0.0 |
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| Bare Soil | 36.0 | 62.5 | 50.5 | 5.0 | 69.5 | 73.5 | 42.5 | 62.0 | 41.0 | 29.0 | 73.0 | 34.5 | 63.5 | 17.0 | 69.0 | 30.0 | 54.8 | 43.0 | 38.5 | 6.5 | 72.9 | 63.5 | 49.0 | 41.0 | 54.0 | 6.8 | 91.0 | 19.5 | 82.3 | 6.0 | 78.8 | 55.0 | 29.5 | 5.8 | 13.5 | 37.0 | 33.5 | 49.0 | 26.0 | 43.9 | 49.0 | 47.0 | 35.0 | 29.0 | 64.5 | 5.0 | 39.0 | 14.0 | 60.0 | 69.0 | 39.0 | 52.0 | 39.0 | 25.0 | 8.0 | 14.8 | 62.0 | 9.0 | 0.0 | 0.0 |

**Table A-3: O-VMU-2 Quadrat Canopy Cover Data (%), 2024 (cont'd)**

| Transect | T21P | | | T22P | | | T23P | | | T24P | | | T25P | | | T26P | | | T27P | | | T28P | | | T29P | | | T30P | | | T33P | | | T32P | | | T33P | | | T34P | | | T35P | | | T36P | | | T36P | | | T37P | | | T39P | | | T40P | | |
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| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Rock | 7.0 | 11.0 | 1.0 | 1.0 | 9.0 | 0.5 | 2.0 | 1.0 | 3.0 | 0.0 | 0.0 | 8.0 | 2.0 | 3.0 | 2.0 | 7.0 | 0.0 | 2.0 | T | 0.5 | 0.1 | 1.5 | 0.0 | 1.0 | 10.0 | 2.0 | 1.0 | 4.0 | 1.3 | 2.0 | 8.0 | 3.0 | 0.0 | 10.0 | 11.0 | 0.5 | 0.0 | T | T | 9.0 | 8.0 | 4.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.5 | 0.0 | 15.0 | 5.0 | 0.0 | 0.0 | 3.0 | 5.0 | 0.1 | T | 0.5 | 11.0 | 0.0 | 0.0 |
| Litter | 56.0 | 42.0 | 15.0 | 4.0 | 11.0 | 40.0 | 3.0 | 15.0 | 3.0 | 2.0 | 15.0 | 7.0 | 35.0 | 14.0 | 5.0 | 10.0 | 10.0 | 15.0 | 0.0 | 10.0 | 2.0 | 5.0 | 14.0 | 7.0 | 4.0 | 22.0 | 5.0 | 3.0 | 7.0 | 4.0 | 8.0 | 23.0 | 92.0 | 5.0 | 8.0 | 2.0 | 60.0 | 2.0 | 1.0 | 4.0 | 5.0 | 4.0 | 18.0 | 5.0 | 20.0 | 10.0 | 45.0 | 3.0 | 19.0 | 8.0 | 5.0 | 5.0 | 9.0 | 4.0 | 8.0 | 50.0 | 7.0 | 8.0 | 11.5 | 12.0 |
| Bare Soil | 8.0 | 15.0 | 36.0 | 80.0 | 47.0 | 24.5 | 14.0 | 38.0 | 69.0 | 6.0 | 18.0 | 45.0 | 27.0 | 17.0 | 23.0 | 57.0 | 19.0 | 75.0 | 5.0 | 51.5 | 42.9 | 53.5 | 40.0 | 54.0 | 62.0 | 36.0 | 48.0 | 86.4 | 38.8 | 74.0 | 72.0 | 31.0 | 4.0 | 77.0 | 43.5 | 4.5 | 4.0 | 65.0 | 66.0 | 41.0 | 75.0 | 70.0 | 14.0 | 51.0 | 25.0 | 30.0 | 50.3 | 90.8 | 36.0 | 80.0 | 15.0 | 35.0 | 15.0 | 50.0 | 54.9 | 8.0 | 81.5 | 45.0 | 0.0 | 0.0 |

Notes:
Species codes defined in Table A-6
[1]Total vegetation canopy cover for the transect by the quadrat canopy cover estimate method

**Table A-4: O-VMU-2 Air-dry Aboveground Annual Forage Production Data (g/m2), 2024**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Perennial Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | 12 | -- | -- | -- | -- | -- | 10 | -- | 8 | -- | -- | -- | 28 | -- | 10 | -- | 16 | -- | -- | 24 | 5 | 7 | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | 36 | -- | -- | -- | -- | -- | -- |
| AGCR | -- | -- | -- | -- | 49 | -- | -- | -- | -- | 51 | -- | 169 | -- | -- | -- | -- | -- | 70 | -- | -- | -- | -- | -- | -- | -- | 18 | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | 47 | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | 9 | -- | -- |
| ELLA3 | 10 | -- | 20 | 8 | -- | 5 | 19 | 21 | 5 | -- | 103 | -- | -- | -- | 33 | -- | 6 | -- | 31 | -- | 13 | -- | -- | 36 | 1 | -- | 9 | 32 | 20 | 5 | 6 | 15 | 3 | 5 | 17 | -- | 5 | -- | 6 | -- |
| ELTR7 | -- | -- | 46 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| HECO26 | -- | -- | 17 | 60 | -- | -- | 13 | 7 | 5 | -- | -- | -- | -- | 6 | 5 | -- | 35 | -- | -- | -- | -- | -- | 26 | -- | -- | -- | -- | 20 | -- | 14 | 7 | -- | -- | 6 | 9 | -- | -- | 46 | 12 | -- |
| PASM | -- | 14 | 37 | -- | 58 | 8 | 21 | -- | -- | 13 | -- | 0 | 15 | 24 | 7 | -- | -- | 23 | 62 | 36 | 75 | 37 | 6 | 6 | 77 | 11 | 162 | 26 | 25 | -- | -- | 23 | -- | 13 | 57 | 5 | 12 | -- | 15 | -- |
| PSJU3 | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 48 | -- | 14 | -- | -- | 5 | -- | -- | -- | -- | 19 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PSSP6 | -- | -- | -- | 20 | -- | -- | -- | 14 | -- | -- | -- | -- | 66 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 28 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 26 | -- | -- | -- | 11 | -- | 49 | -- | -- | 8 | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BODA2 | -- | -- | -- | -- | -- | -- | 9 | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 14 | -- | -- | 5 | -- | -- | 18 | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- |
| BOGR2 | 5 | 9 | 5 | -- | -- | -- | 19 | -- | 12 | 17 | 6 | -- | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- | 71 | 5 | 11 | 24 | 6 | -- | 5 | 9 | -- | -- | -- | -- | 7 | 7 | -- | -- | 8 | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PLJA | 25 | 95 | -- | 22 | -- | 5 | 80 | 59 | 95 | 58 | -- | -- | -- | 103 | -- | -- | -- | 45 | 121 | -- | -- | -- | -- | 147 | -- | 67 | 38 | -- | 35 | 14 | -- | 75 | 43 | 10 | 6 | 56 | 64 | -- | 38 | 3 |
| SPAI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 15 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | 7 | -- | -- | 5 | -- | -- | 6 | -- | 7 | -- | -- | -- | -- | -- |
| SPCR | -- | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- |
| **Perennial/Biennial Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ASSU2 | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BADI | -- | -- | -- | -- | 6 | 4 | -- | 7 | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHER2 | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERFL | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | 51 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 31 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- |
| HEMU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LASE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MACA2 | -- | -- | -- | 10 | -- | 30 | -- | -- | -- | -- | 46 | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | 6 | -- | -- | -- | 7 | -- | -- | -- | 28 | -- | -- | -- | 11 | -- |
| MEOF | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- |
| MESA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 13 | -- | -- | -- | -- | -- |
| PEPA8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 17 | -- | -- | -- | -- | -- | -- |
| SIAL2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 24 | -- |
| SPCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | 5 | 4 | -- | 4 | 9 | -- | -- | -- | -- | -- | 5 | -- | -- |
| SPFE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- |
| TRDU | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| TRPR | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | 13 | 5 | -- | 5 | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | 5 | 5 | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 45 | -- | -- | -- |
| ATCA2 | 6 | -- | -- | -- | -- | -- | 129 | -- | -- | 5 | -- | 12 | 12 | -- | -- | -- | -- | 11 | -- | 195 | -- | 25 | -- | -- | 42 | -- | 8 | 5 | -- | -- | -- | -- | 0 | -- | 29 | -- | 6 | 109 | -- | 226 |
| ATCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 100 | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | -- | 23 | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- |
| ERLE10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | 19 | -- | -- | 28 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GUSA2 | -- | 5 | -- | -- | -- | 21 | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | 43 | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | 24 | -- | -- | -- |
| SAVE4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Total Air-dry Aboveground Annual Forage Production** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total (g) | 58 | 174 | 142 | 132 | 112 | 106 | 299 | 108 | 154 | 145 | 170 | 181 | 145 | 157 | 62 | 125 | 69 | 163 | 219 | 326 | 106 | 118 | 139 | 230 | 164 | 150 | 240 | 94 | 120 | 86 | 56 | 233 | 77 | 96 | 179 | 113 | 92 | 221 | 137 | 229 |
| Total (lbs/ac) | 343 | 1,034 | 843 | 787 | 665 | 632 | 1,781 | 644 | 919 | 861 | 1,011 | 1,075 | 865 | 933 | 368 | 741 | 408 | 971 | 1,305 | 1,942 | 632 | 701 | 828 | 1,366 | 975 | 892 | 1,428 | 559 | 715 | 511 | 335 | 1,384 | 461 | 572 | 1,064 | 671 | 545 | 1,315 | 817 | 1,361 |

Notes:
Species codes defined in Table A-6
Total (g) is the total of all three .5 $m^2$ quads (1.5$m^2$ total) per transect
lbs/ac=total grams÷1.5*(4046.86 $m^2$/ac ÷ 453.59 g/lbs)
Forage plants are perennial and/or biennial duration excluding noxious weeds

**Table A-5: O-VMU-2 Shrub Belt Transect Data (frequency), 2024**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Shrubs, Trees, and Cacti | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARCA13 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 31 | -- | -- | -- | -- | -- |
| ARDR4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARFR4 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- |
| ARLU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARNO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | 2 | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | 20 | -- | -- | -- | -- |
| ATCA2 | 38 | 15 | 25 | 8 | 35 | 4 | 59 | 22 | 15 | 30 | 13 | 23 | 17 | 10 | 10 | 5 | 29 | 40 | 14 | 70 | 11 | 39 | 7 | 17 | 51 | 25 | 14 | 20 | 16 | 4 | 20 | 21 | 38 | 18 | 17 | 19 | 44 | 86 | 11 | 78 |
| ATCO | 1 | -- | -- | -- | -- | -- | -- | -- | 3 | -- | 1 | -- | -- | -- | 1 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 1 | -- | 10 | -- | -- | -- | 2 | -- | -- | 1 | -- |
| ATCO4 | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 32 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 6 | -- | -- | -- | 2 | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- |
| CYSP8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELAN | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| EPVI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- |
| ERLE10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 33 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| ERNA10 | 1 | -- | -- | 2 | -- | -- | -- | 2 | 18 | -- | 1 | -- | 17 | -- | 2 | 21 | -- | 1 | 2 | 1 | 3 | 3 | -- | 8 | 4 | -- | 1 | 3 | 4 | 3 | 14 | -- | 6 | 9 | -- | -- | -- | -- | 2 | -- |
| GUSA2 | 1 | 50 | -- | -- | 7 | 42 | 5 | -- | 1 | -- | -- | -- | 21 | 1 | -- | -- | -- | 14 | -- | 16 | 3 | 5 | -- | 3 | 15 | -- | -- | -- | 2 | 3 | -- | -- | 6 | -- | 2 | -- | 7 | -- | -- | -- |
| KRLA2 | 8 | 6 | 2 | 2 | -- | -- | -- | -- | -- | -- | 27 | -- | -- | 5 | -- | -- | 22 | 17 | 3 | 9 | -- | 2 | 1 | -- | -- | 3 | 9 | 16 | 4 | 3 | -- | 37 | 2 | 2 | 2 | 12 | -- | -- | 32 | 2 |
| OPPH | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| PIED | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUME | 5 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | 1 | 1 | -- | 19 | -- | -- | -- | -- | -- | -- |
| PUTR2 | -- | -- | 1 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SAVE4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Total** | 54 | 73 | 28 | 12 | 43 | 46 | 65 | 27 | 40 | 30 | 42 | 30 | 56 | 28 | 16 | 71 | 85 | 84 | 21 | 96 | 19 | 50 | 8 | 29 | 74 | 28 | 25 | 39 | 28 | 14 | 35 | 75 | 59 | 57 | 52 | 55 | 63 | 86 | 46 | 80 |

Notes:
Species codes defined in Table A-6
The shrub belt transect area is 100m$^2$ (2mx50m); shrubs rooted in the belt transect were counted on an individual basi

**Table A-6: Species Observed 2019-2024, O-VMU-2**

| Common Name | Scientific Name | Code |
|---|---|---|
| **Cool-Season Grasses (20)** | | |
| **Annuals (3)** | | |
| Field brome | *Bromus arvensis* | BRAR5 |
| Cheatgrass | *Bromus tectorum* | BRTE |
| Common barley | *Hordeum vulgare* | HOVU |
| **Perennials (17)** | | |
| Indian ricegrass | *Achnatherum hymenoides* | ACHY |
| Crested wheatgrass | *Agropyron cristatum* | AGCR |
| Smooth brome | *Bromus inermis* | BRIN2 |
| Canada wildrye | *Elymus canadensis* | ELCA4 |
| Bottlebrush squirreltail | *Elymus elymoides* | ELEL5 |
| Thickspike wheatgrass | *Elymus lanceolatus* | ELLA3 |
| Slender wheatgrass | *Elymus trachycaulus* | ELTR7 |
| Arizona fescue | *Festuca arizonica* | FEAR2 |
| Needle and thread | *Hesperostipa comata* | HECO26 |
| Foxtail barley | *Hordeum jubatum* | HOJU |
| Colorado wildrye | *Leymus ambiguus* | LEAM |
| Basin wildrye | *Leymus cinereus* | LECI4 |
| Western wheatgrass | *Pascopyrum smithii* | PASM |
| Bluegrass | *Poa* sp. | POA |
| Russian wildrye | *Psathyrostachys juncea* | PSJU3 |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | PSSP6 |
| Intermediate wheatgrass | *Thinopyrum intermedium* | THIN6 |
| **Warm-Season Grasses (13)** | | |
| **Annuals (5)** | | |
| Sixweeks grama | *Bouteloua barbata* | BOBA2 |
| Matted grama | *Bouteloua simplex* | BOSI2 |
| Mat sandbur | *Cenchrus longispinus* | CELO3 |
| Stinkgrass | *Eragrostis cilianensis* | ERCI |
| False buffalograss | *Munroa squarrosa* | MUSQ3 |
| **Perennials (8)** | | |
| Purple threeawn | *Aristida purpurea* | ARPU9 |
| Sideoats grama | *Bouteloua curtipendula* | BOCU |
| Buffalograss | *Bouteloua dactyloides* | BODA2 |
| Blue grama | *Bouteloua gracilis* | BOGR2 |
| James' galleta | *Pleuraphis jamesii* | PLJA |
| Tumblegrass | *Schedonnardus paniculatus* | SCPA |
| Alkali sacaton | *Sporobolus airoides* | SPAI |
| Sand dropseed | *Sporobolus cryptandrus* | SPCR |
| **Forbs (85)** | | |
| **Annuals (28)** | | |
| Desert madwort | *Alyssum desertorum* | ALDE |
| Alyssum | *Alyssum simplex* | ALSI8 |
| Redroot amaranth | *Amaranthus retroflexus* | AMRE |
| Burningbush | *Bassia scoparia* | BASC5 |
| Lambsquarters | *Chenopodium album* | CHAL7 |
| Ribseed sandmat | *Chamaesyce glyptosperma* | CHGL13 |
| Mealy goosefoot | *Chenopodium incanum* | CHIN2 |
| Narrowleaf goosefoot | *Chenopodium leptophyllum* | CHLE4 |
| Spotted sandmat | *Chamaesyce maculata* | CHMA15 |
| Threadstem sandmat | *Chamaesyce revoluta* | CHRE4 |
| Thymeleaf sandmat | *Chamaesyce serpyllifolia* | CHSE6 |
| Rocky Mountain beeplant | *Cleome serrulata* | CLSE |
| Wright's bird's beak | *Cordylanthus wrightii* | COWR2 |
| Fetid marigold | *Dyssodia papposa* | DYPA |
| Nodding buckwheat | *Eriogonum cernuum* | ERCE2 |
| Divergent buckwheat | *Eriogonum divaricatum* | ERDI5 |
| Common sunflower | *Helianthus annuus* | HEAN3 |
| Longleaf false goldeneye | *Heliomeris longifolia* | HELO6 |
| Prairie sunflower | *Helianthus petiolaris* | HEPE |
| King's lupine | *Lupinus kingii* | LUKI |
| Fendler's desertdandelion | *Malacothrix fendleri* | MAFE |
| Erect knotweed | *Polygonum erectum* | POER2 |
| Little hogweed | *Portulaca oleracea* | POOL |
| Prickly Russian thistle | *Salsola tragus* | SATR12 |
| Manyflower false threadleaf | *Schkuhria multiflora* | SCMU6 |
| Unknown Annual Forb | Unknown Annual Forb | UNKAF |
| Golden crownbeard | *Verbesina encelioides* | VEEN |
| Rough cocklebur | *Xanthium strumarium* | XAST |

**Table A-6: Species Observed 2019-2024, O-VMU-2**

| Common Name | Scientific Name | Code |
|---|---|---|
| **Perennials/Biennials (57)** | | |
| Common yarrow | *Achillea millefolium* | ACMI2 |
| Russian knapweed | *Acroptilon repens* | ACRE3 |
| Nodding onion | *Allium cernuum* | ALCE2 |
| Ragweed sagebrush | *Artemisia franserioides* | ARFR3 |
| **Horsetail milkweed** | **Asclepias subverticillata** | **ASSU2** |
| Ragleaf bahia | *Bahia dissecta* | BADI |
| Wyoming Indian paintbrush | *Castilleja linariifolia* | CALI4 |
| Sego lily | *Calochortus nuttallii* | CANU3 |
| Musk thistle | *Carduus nutans* | CANU4 |
| Whitemargin sandmat | *Chamaesyce albomarginata* | CHAL11 |
| Chenopod | Chenopodiaceae | CHENOP |
| Rose heath | *Chaetopappa ericoides* | CHER2 |
| Greenleaf five eyes | *Chamaesaracha coronopus* | CHCO2 |
| Canadian horseweed | *Conyza canadensis* | COCA5 |
| White prairie clover | *Dalea candida* | DACA7 |
| Purple prairie clover | *Dalea purpurea* | DAPU5 |
| Mountain tansymustard | *Descurainia incana* | DEIN5 |
| Western tansymustard | *Descurainia pinnata* | DEPI |
| Flixweed | *Descurainia sophia* | DESO |
| Redstem stork's bill | *Erodium cicutarium* | ERCI6 |
| Spreading fleabane | *Erigeron divergens* | ERDI4 |
| Blanketflower | *Gaillardia aristata* | GAAR |
| Indian blanket | *Gaillardia pulchella* | GAPU |
| Hairy gumweed | *Grindelia hirsutula* | GRHI |
| Curlytop gumweed | *Grindelia nuda* var. *aphanactis* | GRNUA |
| Curlycup gumweed | *Grindelia squarrosa* | GRSQ |
| Showy goldeneye | *Heliomeris multiflora* | HEMU3 |
| Scarlet gilia | *Ipomopsis aggregata* | IPAG |
| Flaxflowered ipomopsis | *Ipomopsis longiflora* | IPLO2 |
| Manyflowered ipomopsis | *Ipomopsis multiflora* | IPMU3 |
| Flatspine stickseed | *Lappula occidentalis* | LAOC3 |
| Prickly lettuce | *Lactuca serriola* | LASE |
| Mesa pepperwort | *Lepidium alyssoides* | LEAL4 |
| Lewis flax | *Linum lewisii* | LILE3 |
| Hoary tansyaster | *Machaeranthera canescens* | MACA2 |
| Tanseyleaf tansyaster | *Machaeranthera tanacetifolia* | MATA2 |
| Horehound | *Marrubium vulgare* | MAVU |
| Sweetclover | *Melilotus officinalis* | MEOF |
| Alfalfa | *Medicago sativa* | MESA |
| Colorado four o'clock | *Mirabilis multiflora* | MIMU |
| Beardlip penstemon | *Penstemon barbatus* | PEBA2 |
| Palmer's penstemon | *Penstemon palmeri* | PEPA8 |
| Prostrate knotweed | *Polygonum aviculare* | POAV |
| Upright prairie coneflower | *Ratibida columnifera* | RACO3 |
| Curly dock | *Rumex crispus* | RUCR |
| Tall tumblemustard | *Sisymbrium altissimum* | SIAL2 |
| Nightshade | *Solanum* sp. | SOLAN |
| Scarlet globemallow | *Sphaeralcea coccinea* | SPCO |
| Fendler's globemallow | *Sphaeralcea fendleri* | SPFE |
| Gooseberryleaf globemallow | *Sphaeralcea grossulariifolia* | SPGR2 |
| Spear globemallow | *Sphaeralcea hastulata* | SPHA |
| Gray globemallow | *Sphaeralcea incana* | SPIN2 |
| Ives' fournerved daisy | *Tetraneuris ivesiana* | TEIV |
| Wright's thelypody | *Thelypodium wrightii* | THWR |
| Yellow salsify | *Tragopogon dubius* | TRDU |
| Salsify | *Tragopogon porrifolius* | TRPO |
| Jack-go-to-bed-at-noon | *Tragopogon pratensis* | TRPR |

**Table A-6: Species Observed 2019-2024, O-VMU-2**

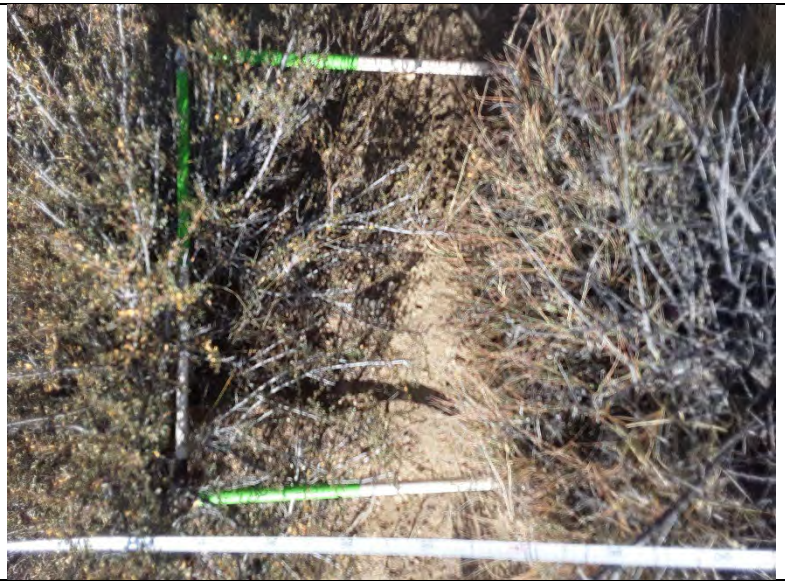
| Common Name | Scientific Name | Code |
|---|---|---|
| **Shrubs, Trees, and Cacti (42)** | | |
| Silver sagebrush | *Artemisia cana* | ARCA13 |
| Prairie sagewort | *Artemisia frigida* | ARFR4 |
| White sagebrush | *Artemisia ludoviciana* | ARLU |
| Black sagebrush | *Artemisia nova* | ARNO4 |
| Big sagebrush | *Artemisia tridentata* | ARTR2 |
| Mountain big sagebrush | *Artemisia tridentata* ssp. *vaseyana* | ARTRV |
| Tubercled saltbush | *Atriplex acanthocarpa* | ATAC |
| Fourwing saltbush | *Atriplex canescens* | ATCA2 |
| Shadscale saltbush | *Atriplex confertifolia* | ATCO |
| Mat saltbush | *Atriplex corrugata* | ATCO4 |
| Gardner's saltbush | *Atriplex gardneri* | ATGA |
| Mound saltbush | *Atriplex obovata* | ATOB |
| Longflower rabbitbrush | *Chrysothamnus depressus* | CHDE2 |
| Greene's rabbitbrush | *Chrysothamnus greenei* | CHGR6 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | CHVI8 |
| Russian olive | *Elaeagnus angustifolia* | ELAN |
| Mormon tea | *Ephedra viridis* | EPVI |
| Rubber rabbitbrush | *Ericameria nauseosa* | ERNA10 |
| Slenderleaf buckwheat | *Eriogonum leptophyllum* | ERLE10 |
| Broom snakeweed | *Gutierrezia sarothrae* | GUSA2 |
| Hairy false goldenaster | *Heterotheca villosa* | HEVI4 |
| Oneseed juniper | *Juniperus monosperma* | JUMO |
| Winterfat | *Krascheninnikovia lanata* | KRLA2 |
| Pale desert-thorn | *Lycium pallidum* | LYPA |
| Plains pricklypear | *Opuntia polyacantha* | OPPO |
| Twoneedle pinyon | *Pinus edulis* | PIED |
| Narrowleaf cottonwood | *Populus angustifolia* | POAN3 |
| Eastern cottonwood | *Populus deltoides* | PODE3 |
| Mexican cliffrose | *Purshia mexicana* | PUME |
| Antelope bitterbrush | *Purshia tridentata* | PUTR2 |
| Fragrant sumac | *Rhus aromatica* | RHAR4 |
| Skunkbush sumac | *Rhus trilobata* | RHTR |
| Woods' rose | *Rosa woodsii* | ROWO |
| White willow | *Salix alba* | SAAL2 |
| Narrowleaf willow | *Salix exigua* | SAEX |
| Greasewood | *Sarcobatus vermiculatus* | SAVE4 |
| Threadleaf ragwort | *Senecio flaccidus* | SEFL3 |
| Saltcedar | *Tamarix ramosissima* | TARA |
| Spineless horsebrush | *Tetradymia canescens* | TECA2 |
| Siberian elm | *Ulmus pumila* | ULPU |
| Banana yucca | *Yucca baccata* | YUBA |
| Soapweed yucca | *Yucca glauca* | YUGL |

Notes:

Bold species are newly observed on O-VMU-2 in 2024

**APPENDIX B**

# Quadrat Photographs

| O-VMU2-T01P | |
|---|---|
|  |  |
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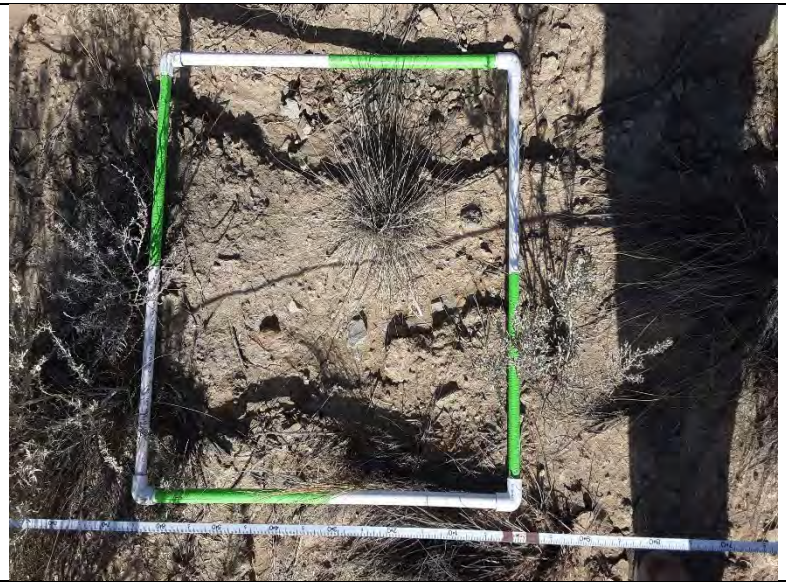
|  |  |
| Q2 | Q3 |

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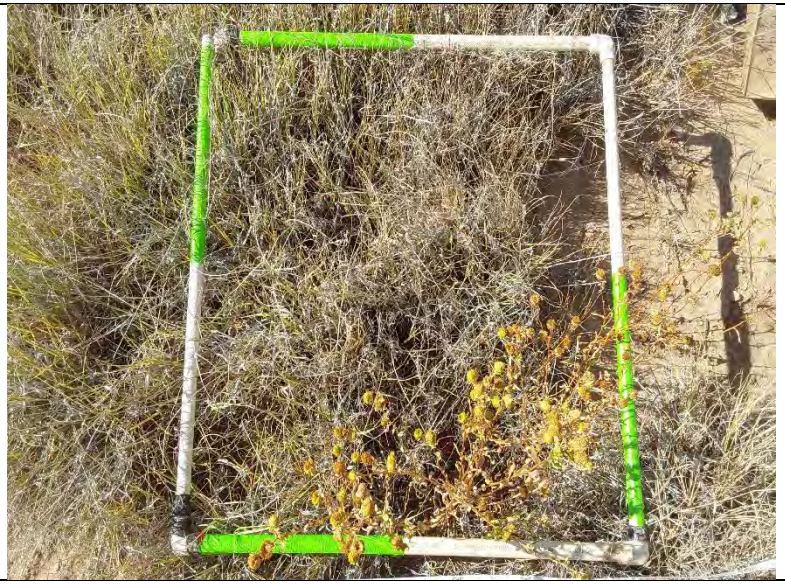
|  |  |
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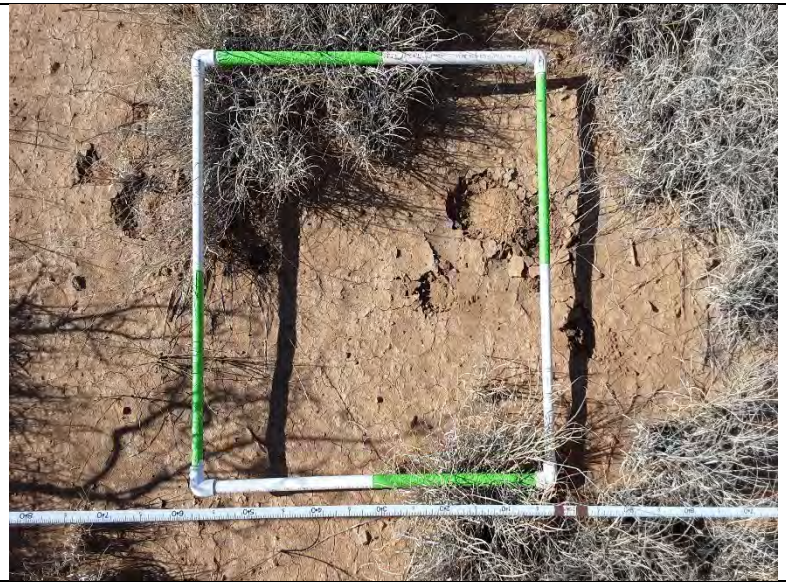
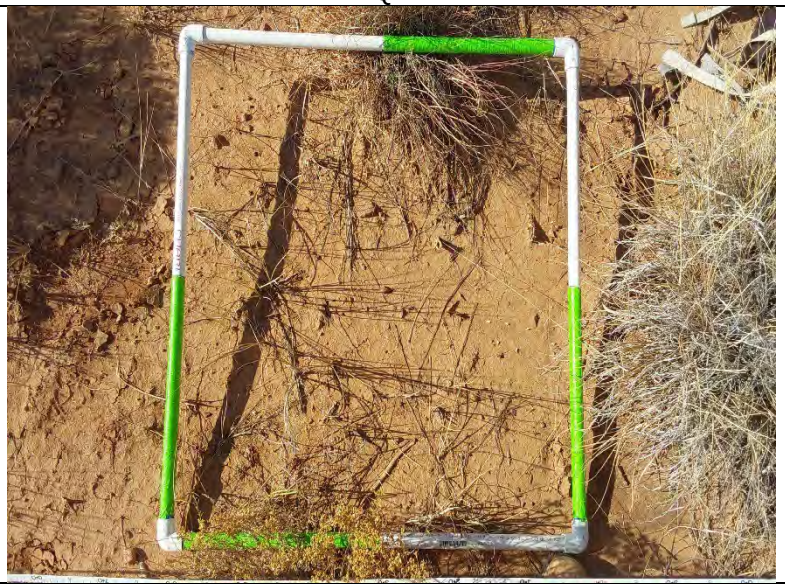
|  |  |
| Q2 | Q3 |

| O-VMU2-T03P | |
|---|---|
|  |  |
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| Q2 | Q3 |

| O-VMU2-T04P | |
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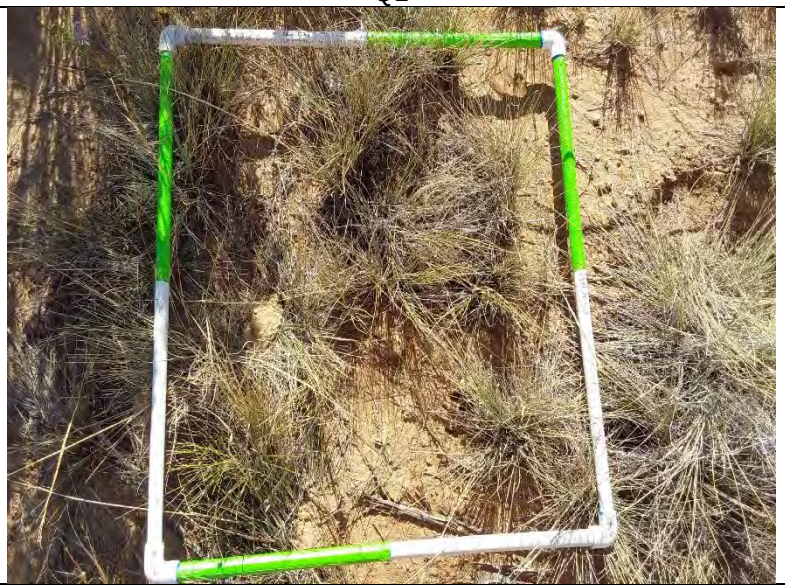
|  |  |
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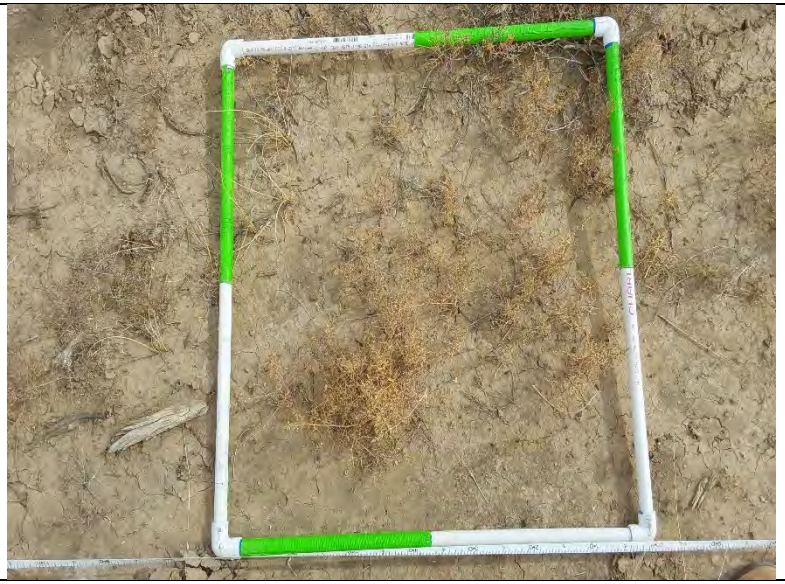
|  |  |
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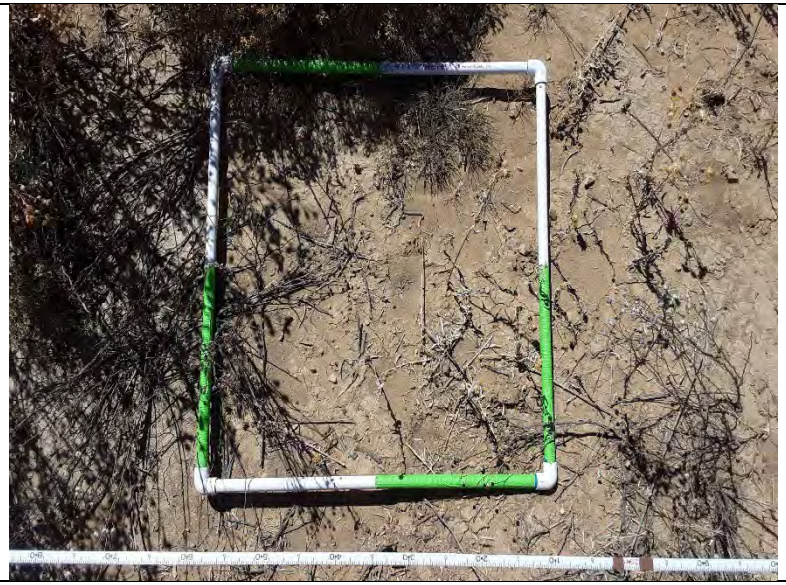
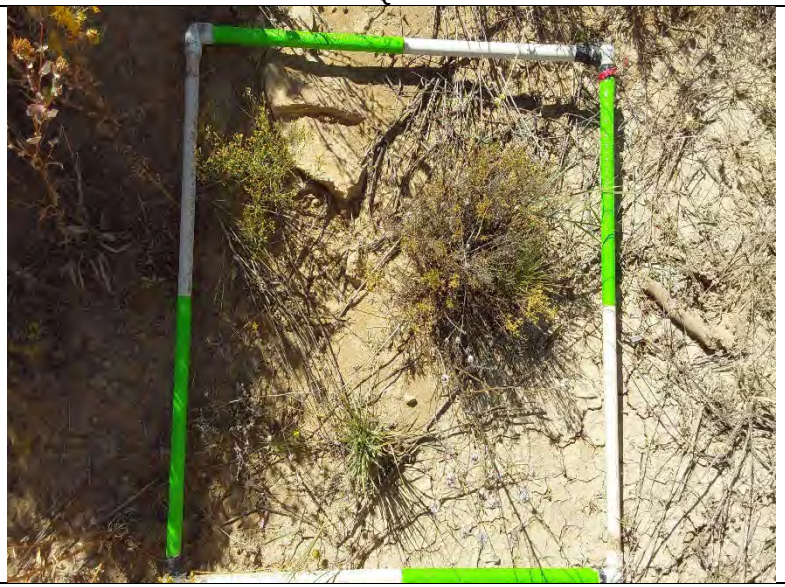
|  |  |
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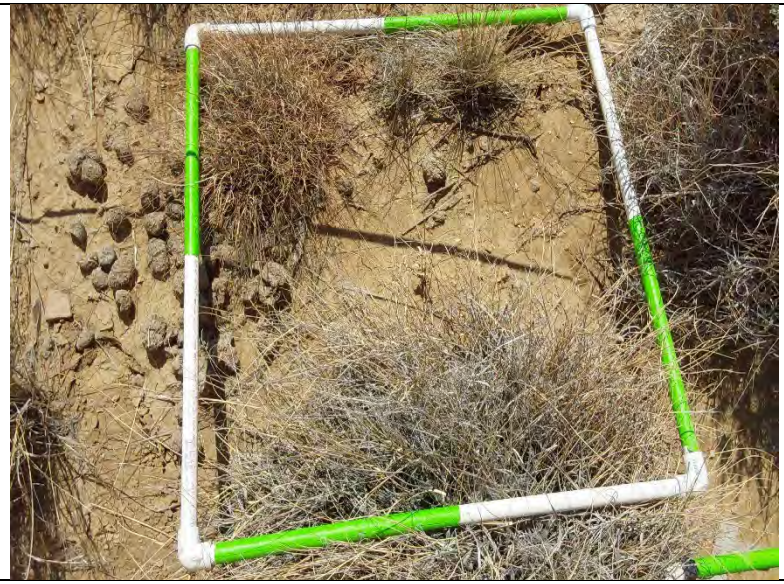
|  |  |
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| Q2 | Q3 |

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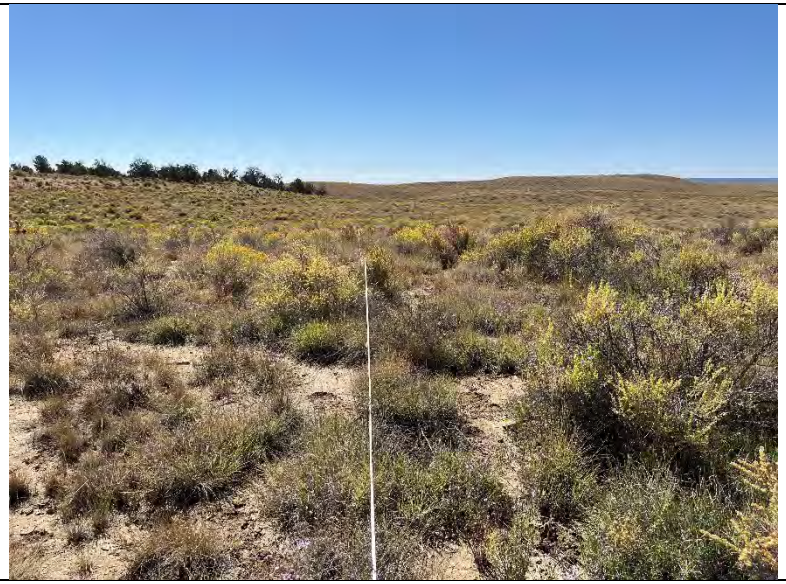
|  |  |
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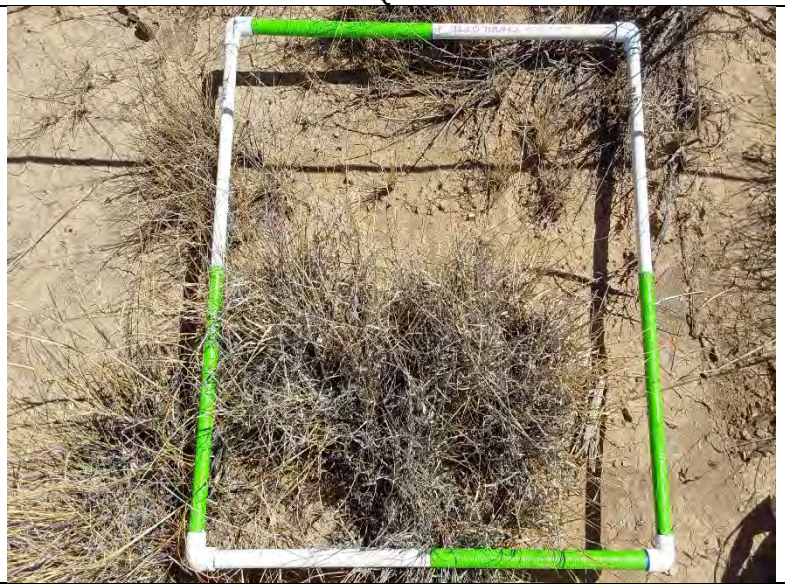
|  |  |
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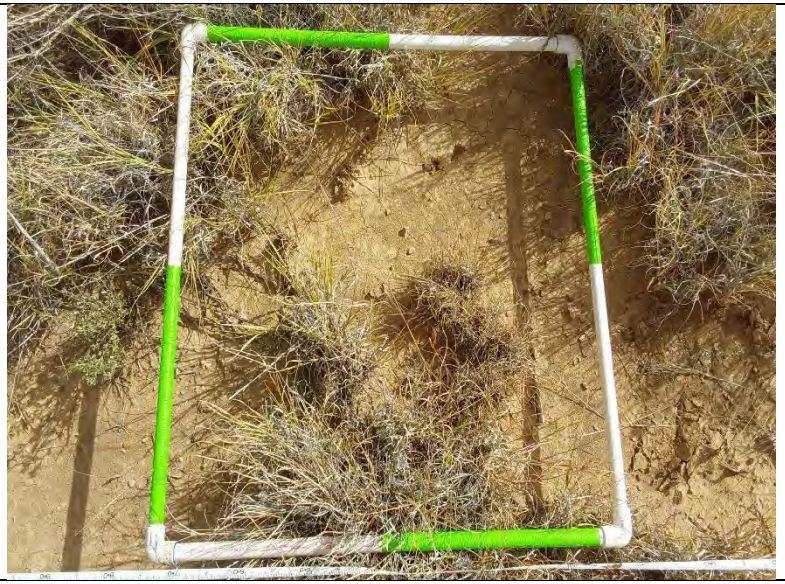
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

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|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T11P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T12P | |
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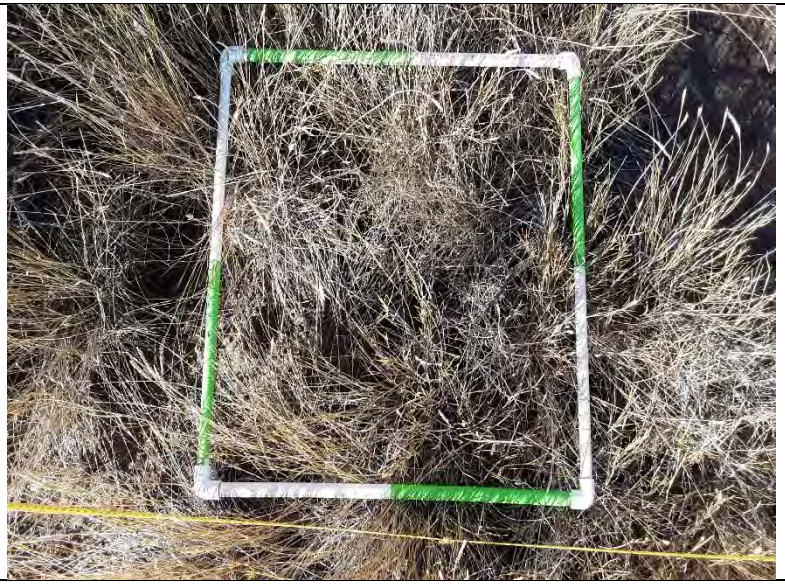
|  |  |
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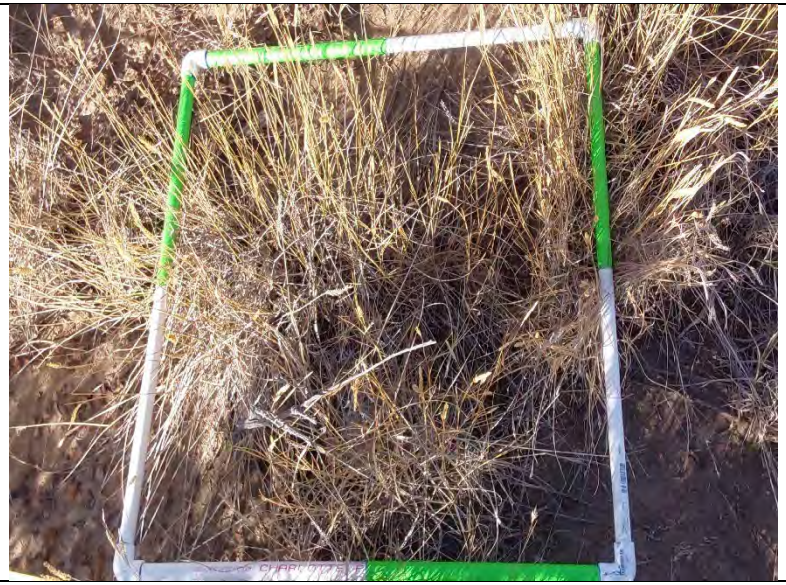
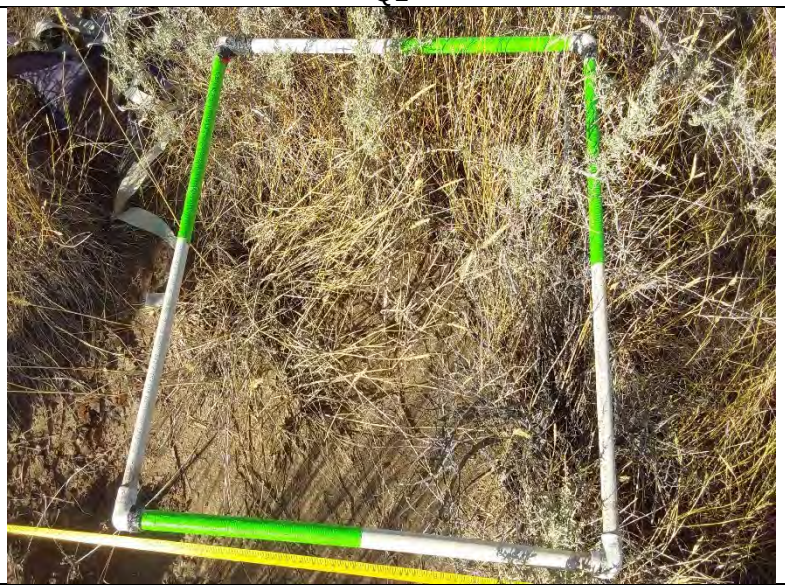
|  |  |
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|---|---|
|  |  |
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| Q2 | Q3 |

| O-VMU2-T14P | |
|---|---|
|  |  |
| Belt | Q1 |
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| Q2 | Q3 |

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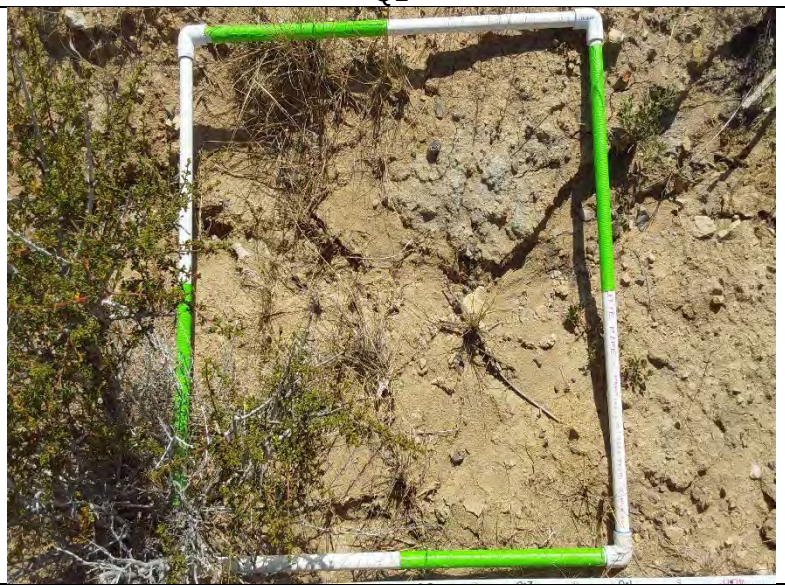
|  |  |
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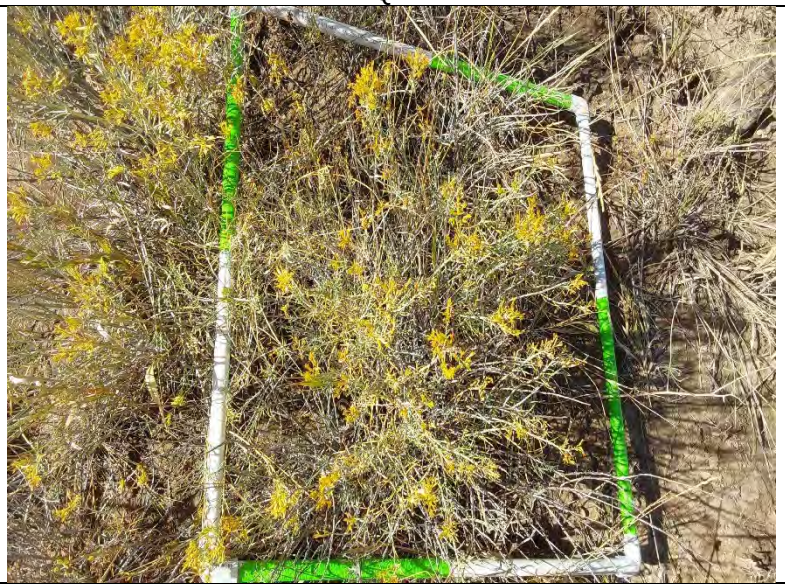
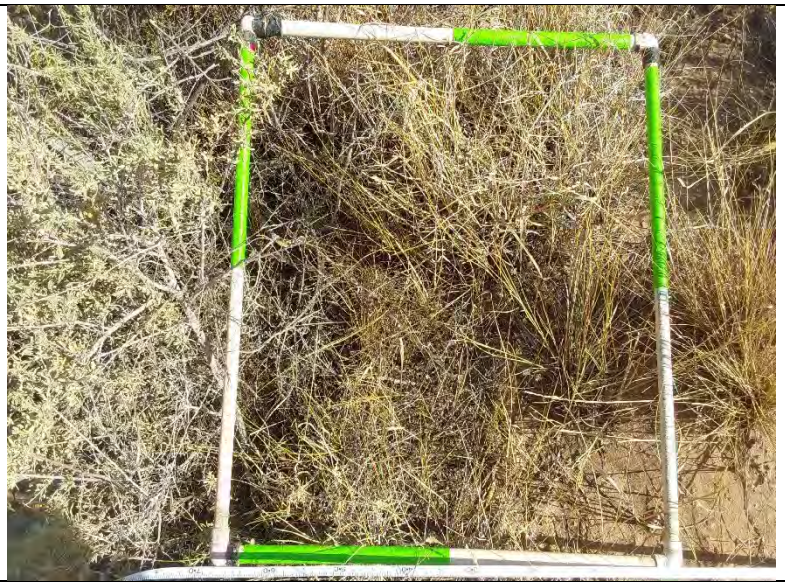
|  |  |
| Q2 | Q3 |

| O-VMU2-T17P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T18P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T19P | |
|---|---|
|  |  |
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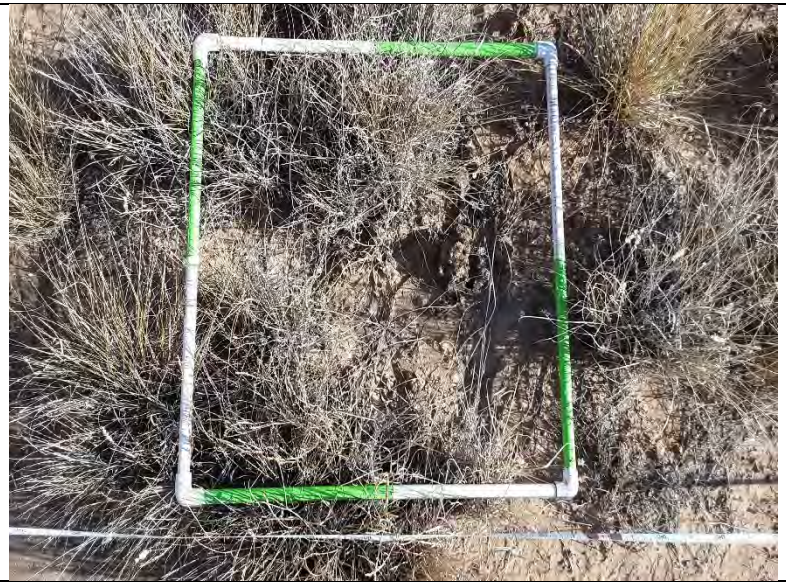
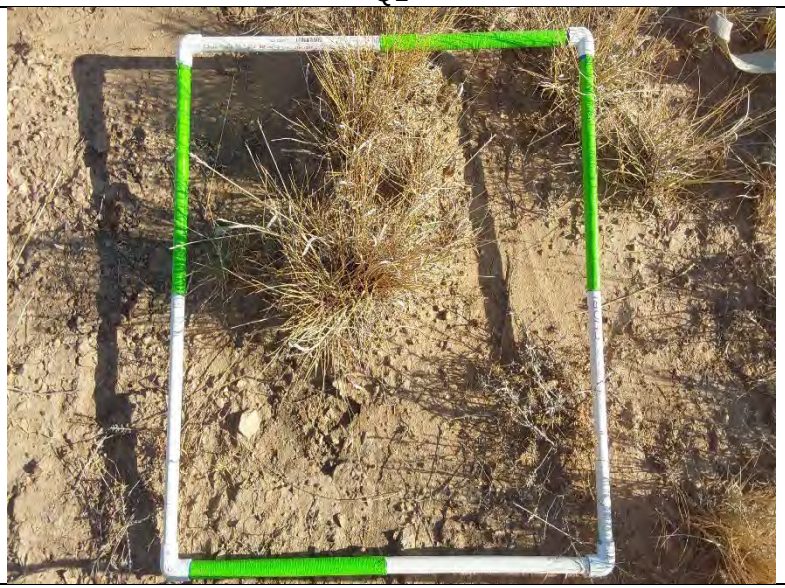
|  |  |
| Q2 | Q3 |

| O-VMU2-T20P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T21P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

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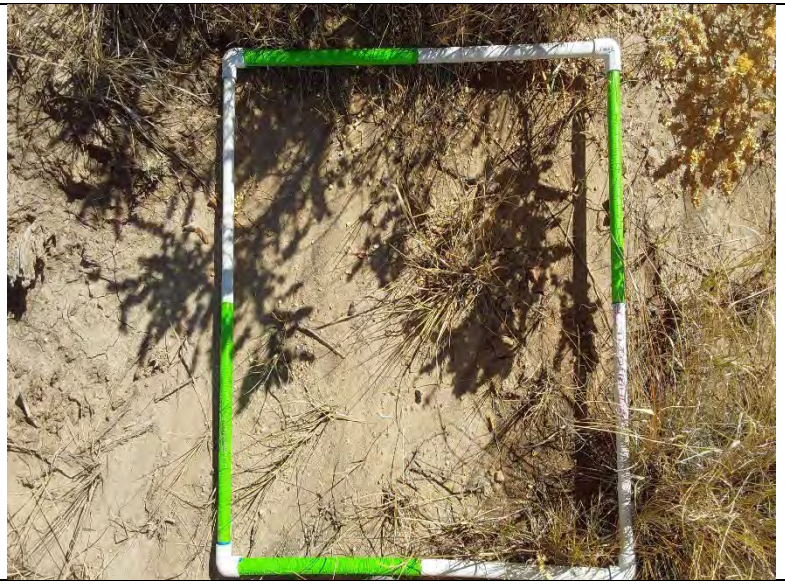
|  |  |
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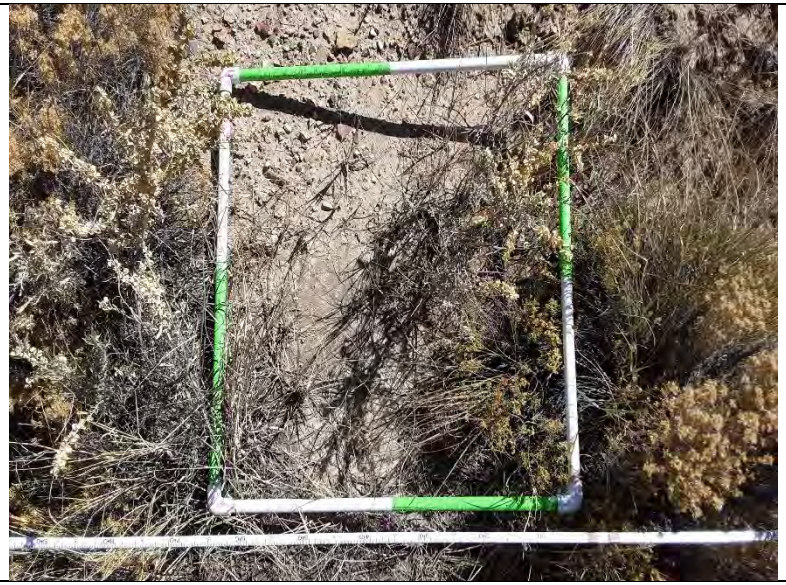
|  |  |
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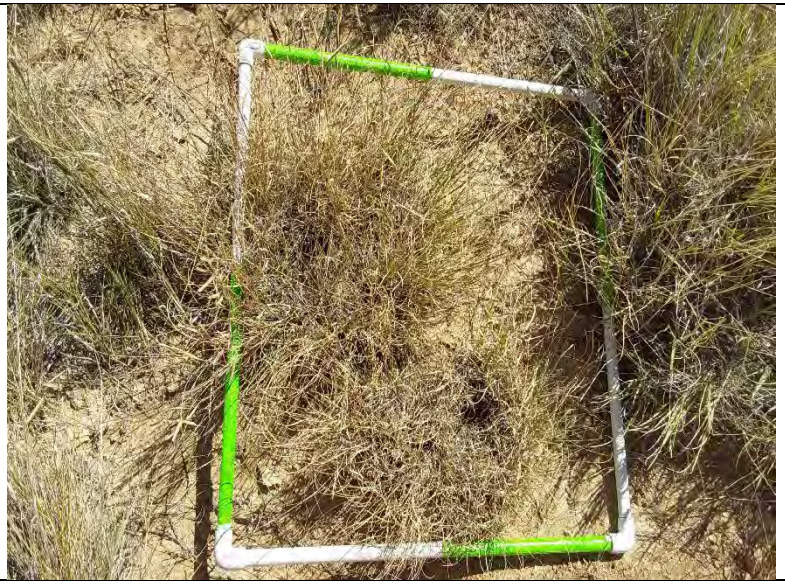
|  |  |
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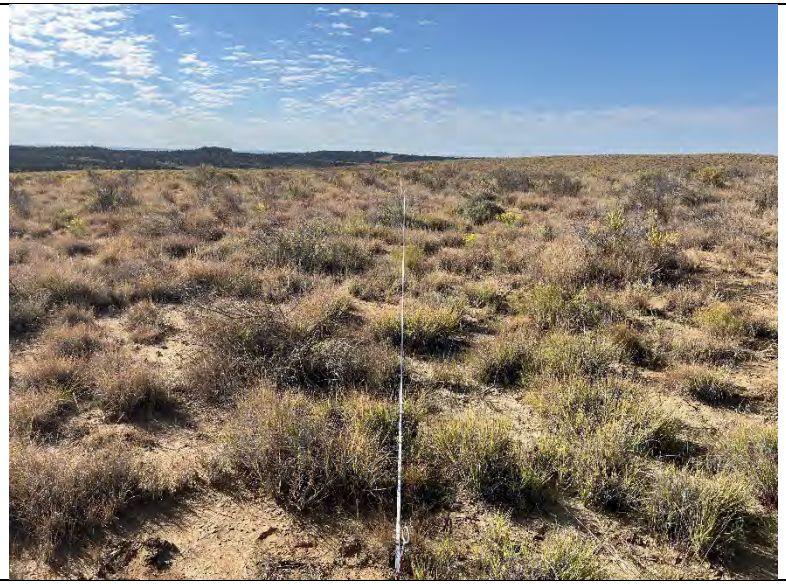
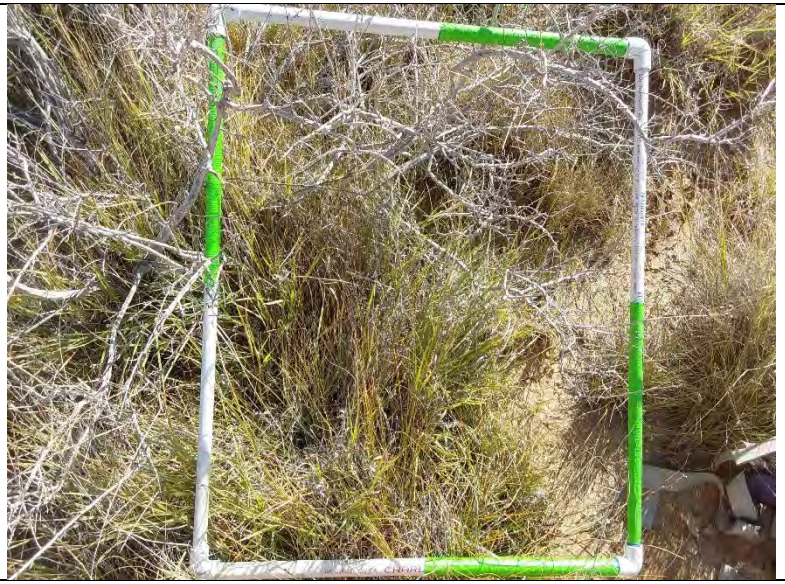
|  |  |
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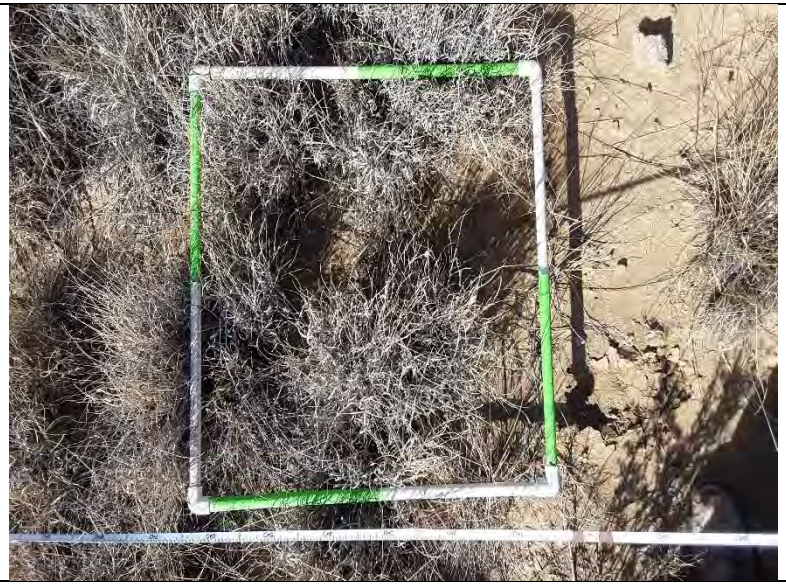
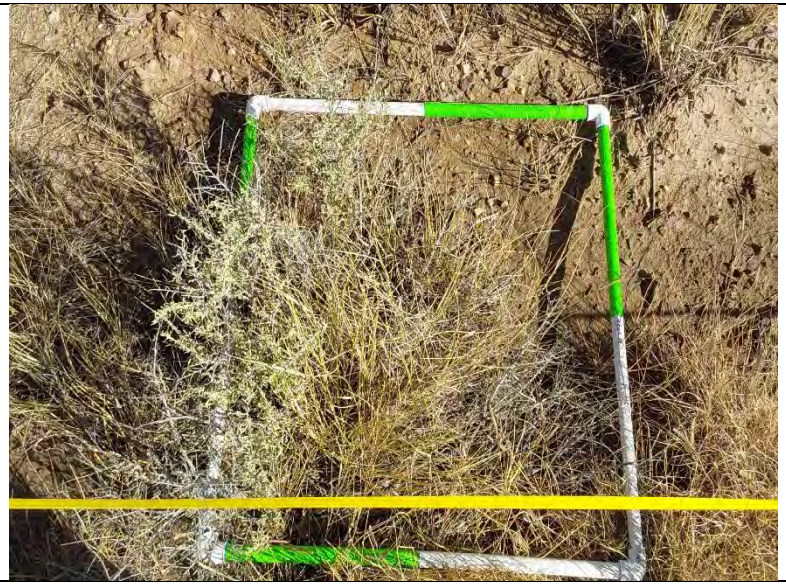
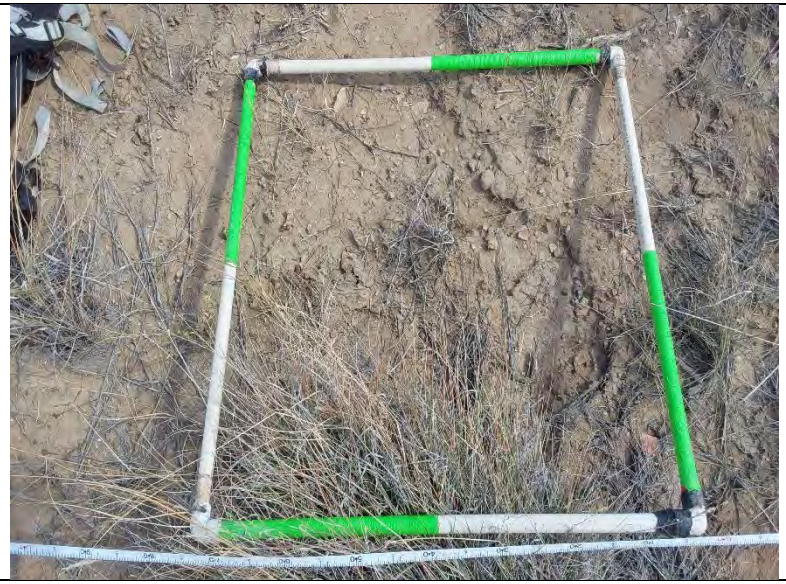
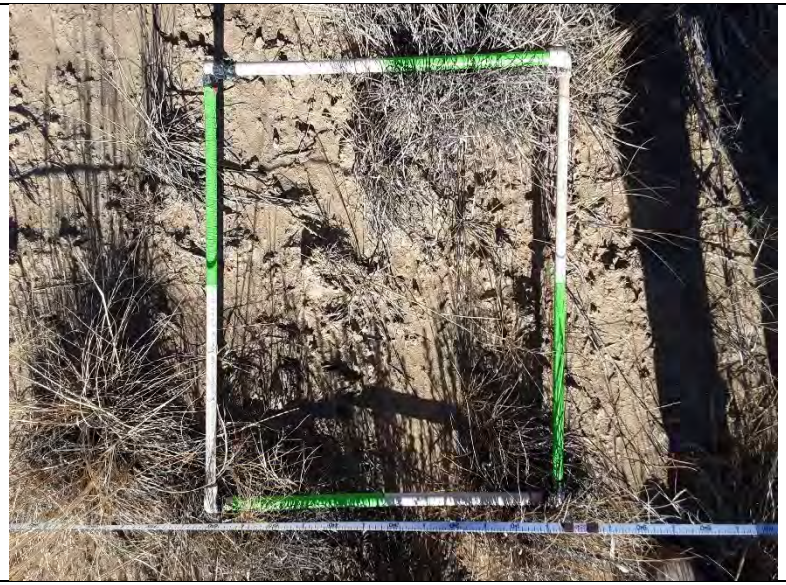
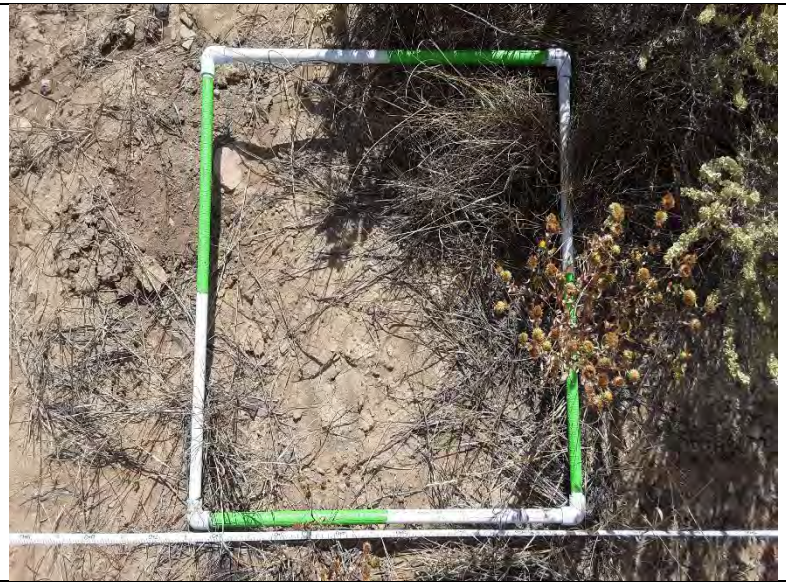
|  |  |
| Q2 | Q3 |

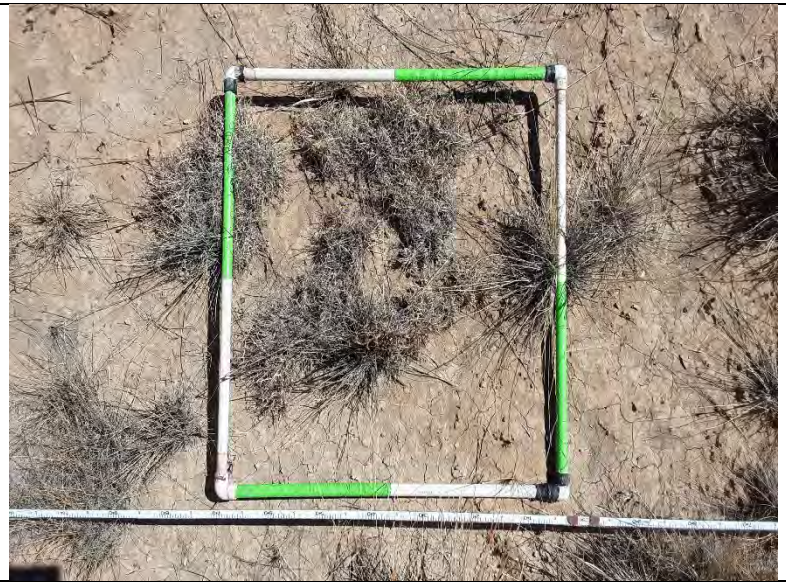
| O-VMU2-T25P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T26P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T27P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

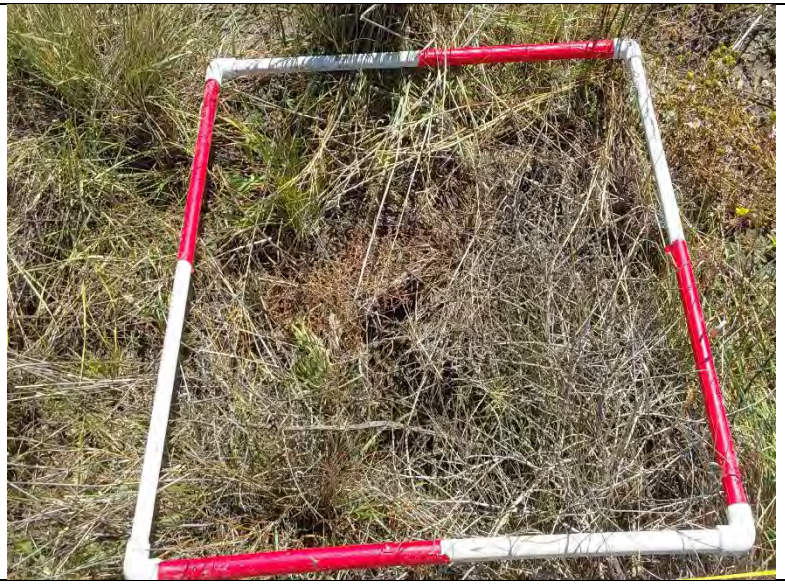
| O-VMU2-T28P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T29P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T30P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

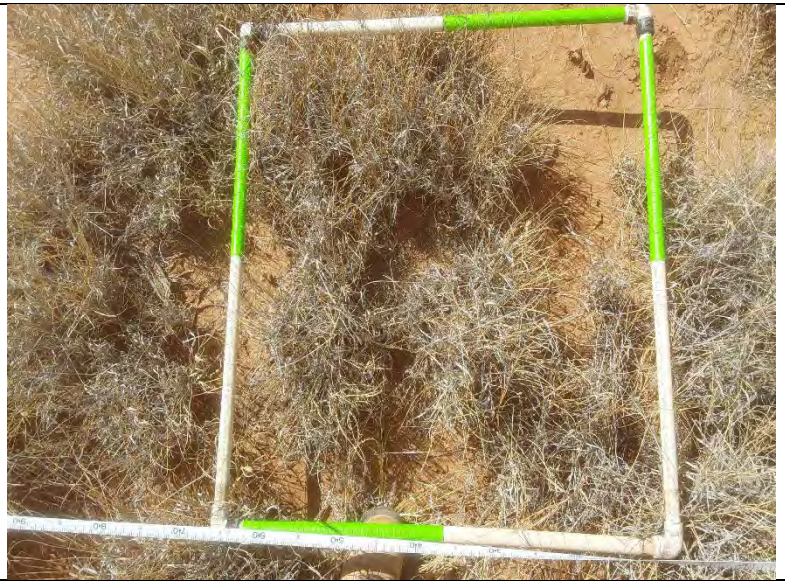
| O-VMU2-T31P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

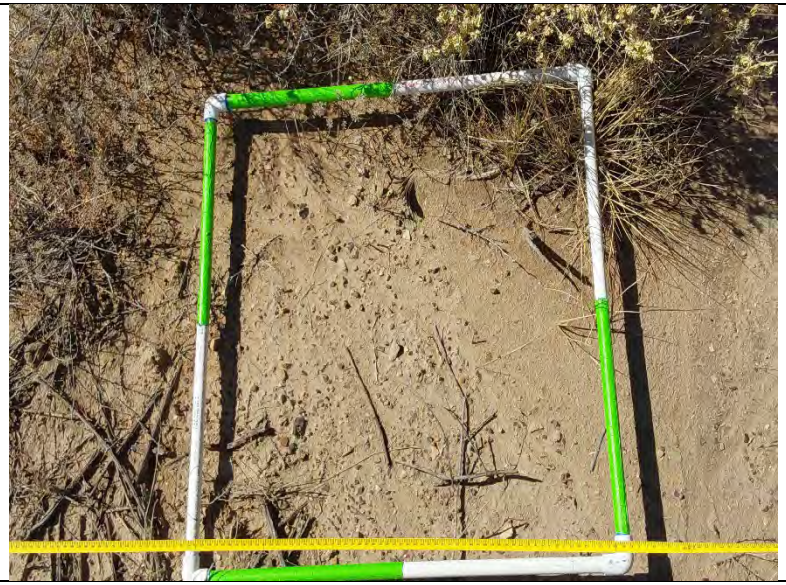
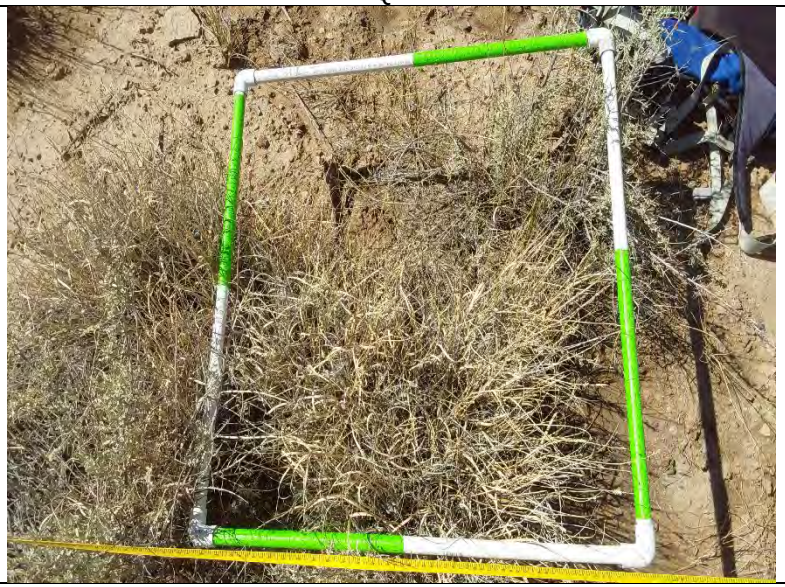
| O-VMU2-T32P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

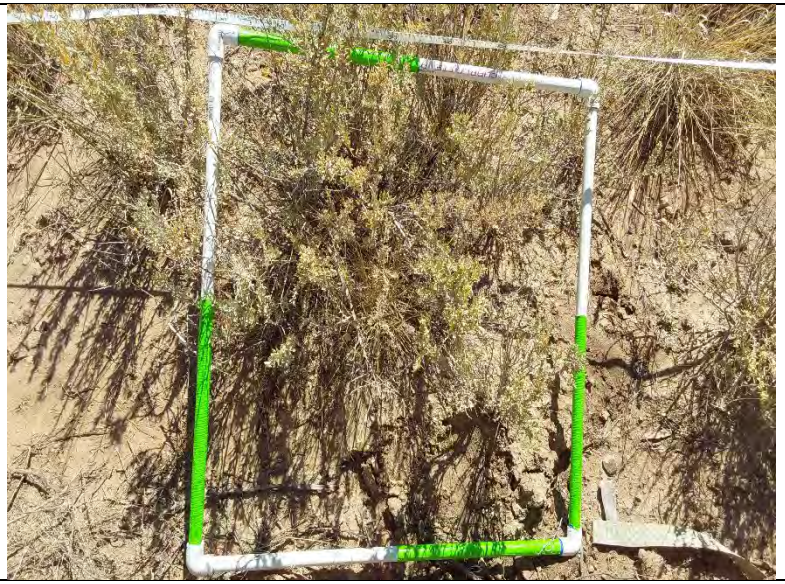
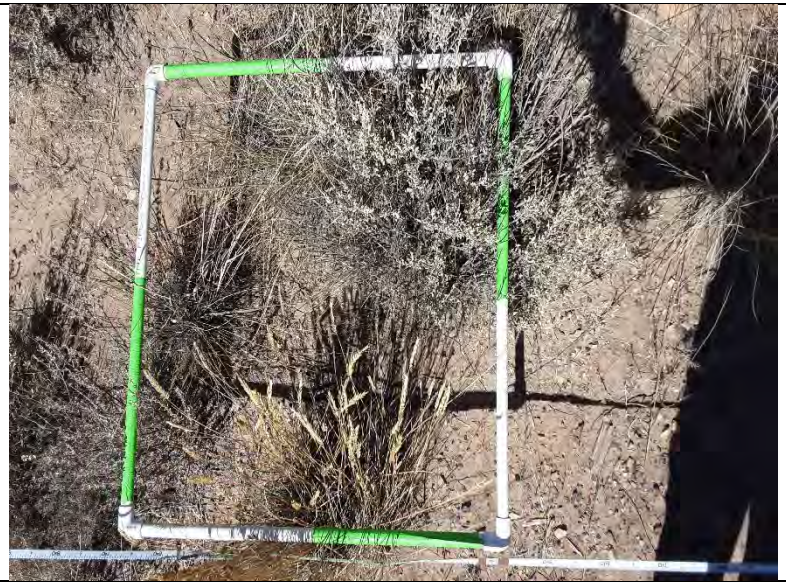
| O-VMU2-T33P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

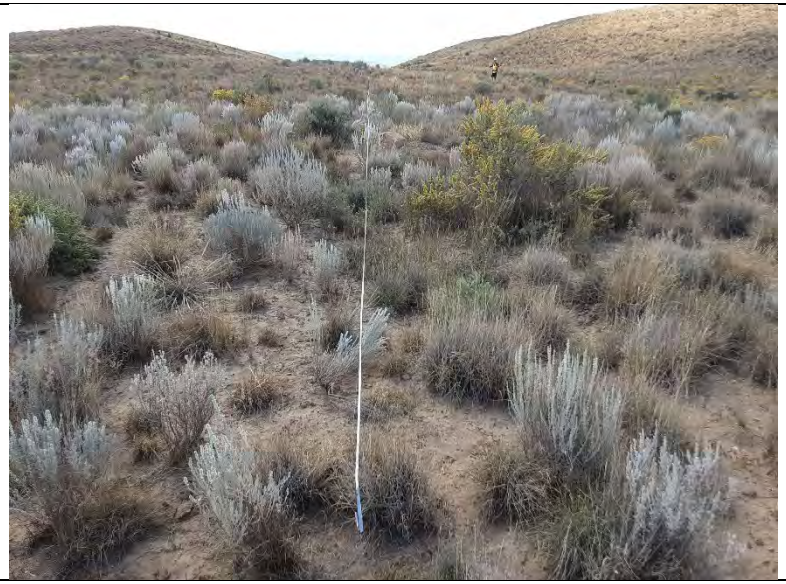
| O-VMU2-T34P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

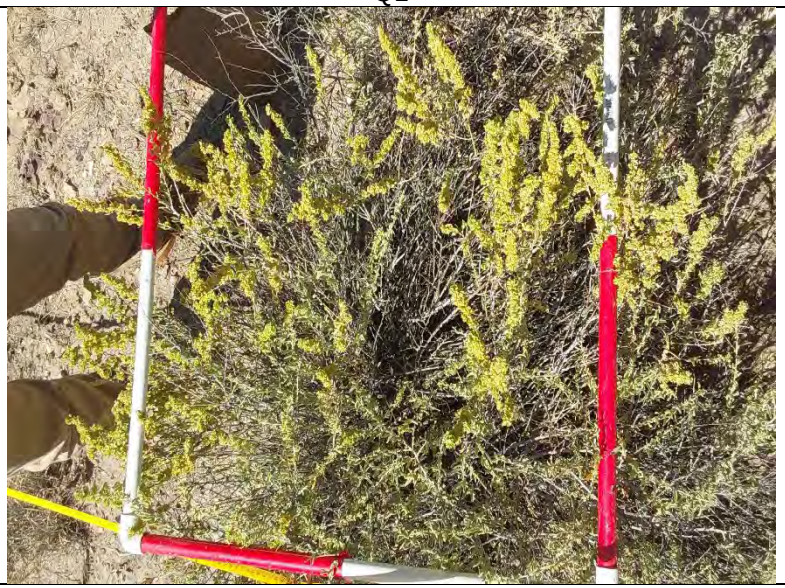
| O-VMU2-T35P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T36P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T37P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T38P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T39P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU2-T40P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

**APPENDIX C**

# Vegetation Statistical Analysis

**Table C1: Equations for Vegetation Data Analysis**

| Attribute | Equation | Where |
|---|---|---|
| Mean | $\bar{x} = \frac{\sum x}{n}$ | $\bar{x}$ = sample mean<br>$\sum$x = sum of values for variable<br>n = number of samples |
| Standard Deviation | $s = \sqrt{\frac{\sum(\bar{x} - x)^2}{n-1}}$ | s = standard deviation<br>$\sum$ = sum<br>$\bar{x}$ = sample mean<br>n = number of samples |
| Variance (sample) | $s^2 = \frac{\sum_{(x_i - \bar{x})^2}}{n-1}$ | $s^2$ = variance<br>$\sum$ = sum<br>$x_i$ = Value of variable for sample *i*<br>$\bar{x}$ = sample mean<br>n = number of samples |
| 90% Confidence Interval | $\bar{x} \pm z\frac{s}{\sqrt{n}}$ | $\bar{x}$ = sample mean<br>z = the critical value from the normal distribution with α/2 in each tail<br>s = standard deviation<br>n = number of samples |
| $N_{min}$ (Sample Adequacy - Normal Data) | $N_{min} = \frac{t^2 s^2}{(\bar{x}D)^2}$ | $N_{min}$ = number of samples required<br>t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom<br>s = standard deviation ($s^2$ = variance)<br>$\bar{x}$ = sample mean<br>D = the desired level of accuracy, which is 10 percent of the mean |
| Logarithmic Transformation | Y' = log(Y + k) | log = logarithmic function<br>Y = attribute value<br>k = constant, here we use 1 |
| one-sample, one-sided t test | $t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$ | t* = calculated t-statistic<br>$\bar{x} = sample\ mean$<br>s = standard deviation<br>n = sample size |
| one-sample, one-sided sign test | $z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$ | z = sign test statistic<br>k = test statistic resulting from the number of values falling below 90% of the technical standard<br>n = sample size |
| Relative Cover (Perennial/Biennial Species) | Rp/b-cvr = Cvrp/b-sp. / Cvrp/b-abs. | $R_{p/b\text{-}cvr}$ = Calculated Relative Cover for a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}sp.}$ = Mean Absolute Cover of a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}abs.}$ = Mean Absolute Perennial/Biennial Cover |
| Relative Cover (All Species) | Rcvr = Cvrsp. / CvrAbs. | $R_{cvr}$ = Calculated Relative Cover for a species<br>$Cvr_{sp.}$ = Mean Absolute Cover of ANY species<br>$Cvr_{abs.}$ = Mean Absolute Cover for All Species |

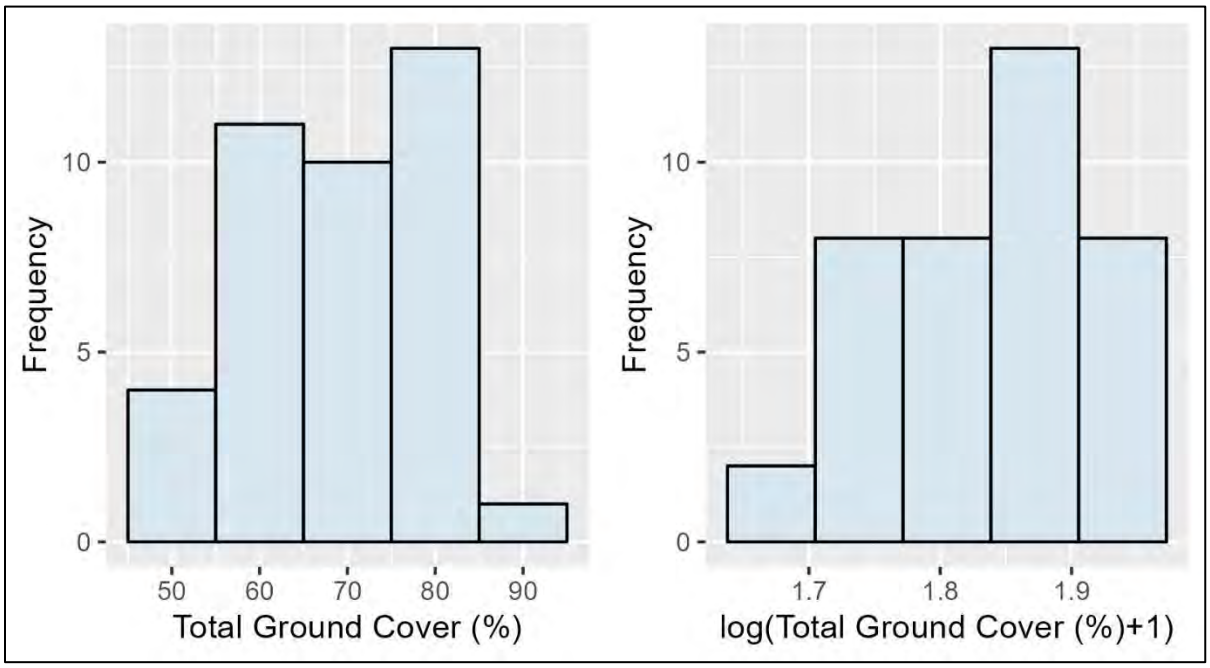
Notes:
All Appendix C analysis, tables, and figures computed using R software: (R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

**Table C-2: Data for Normal Distribution and Variance Analysis, O-VMU-2, 2024**

| Transect | Raw Data | | | | Transformed Data | |
|---|---|---|---|---|---|---|
| | Total Ground Cover (%) | Perennial Vegetation Cover (%) | Annual Forage Production (lbs/ac) | Woody Plant Density (#/ac) | Log - Total Ground Cover (%) | Log - Annual Forage Production |
| O-VMU2-T01P | 72 | 64 | 343 | 2,185 | 1.86 | 2.54 |
| O-VMU2-T02P | 66 | 58 | 1,034 | 2,954 | 1.83 | 3.01 |
| O-VMU2-T03P | 74 | 68 | 843 | 1,133 | 1.88 | 2.93 |
| O-VMU2-T04P | 86 | 72 | 787 | 486 | 1.94 | 2.90 |
| O-VMU2-T05P | 62 | 44 | 665 | 1,740 | 1.80 | 2.82 |
| O-VMU2-T06P | 78 | 42 | 632 | 1,862 | 1.90 | 2.80 |
| O-VMU2-T07P | 80 | 64 | 1,781 | 2,630 | 1.91 | 3.25 |
| O-VMU2-T08P | 72 | 60 | 644 | 1,093 | 1.86 | 2.81 |
| O-VMU2-T09P | -- | -- | 919 | 1,619 | -- | 2.96 |
| O-VMU2-T10P | 66 | 60 | 861 | 1,214 | 1.83 | 2.94 |
| O-VMU2-T11P | 82 | 64 | 1,011 | 1,700 | 1.92 | 3.01 |
| O-VMU2-T12P | 58 | 38 | 1,075 | 1,214 | 1.77 | 3.03 |
| O-VMU2-T13P | 82 | 72 | 865 | 2,266 | 1.92 | 2.94 |
| O-VMU2-T14P | 68 | 58 | 933 | 1,133 | 1.84 | 2.97 |
| O-VMU2-T15P | 76 | 70 | 368 | 647 | 1.89 | 2.57 |
| O-VMU2-T16P | 58 | 46 | 741 | 2,873 | 1.77 | 2.87 |
| O-VMU2-T17P | 76 | 54 | 408 | 3,440 | 1.89 | 2.61 |
| O-VMU2-T18P | 52 | 42 | 971 | 3,399 | 1.72 | 2.99 |
| O-VMU2-T19P | 58 | 46 | 1,305 | 850 | 1.77 | 3.12 |
| O-VMU2-T20P | 56 | 48 | 1,942 | 3,885 | 1.76 | 3.29 |
| O-VMU2-T21P | 80 | 22 | 632 | 769 | 1.91 | 2.80 |
| O-VMU2-T22P | 70 | 60 | 701 | 2,023 | 1.85 | 2.85 |
| O-VMU2-T23P | 78 | 58 | 828 | 324 | 1.90 | 2.92 |
| O-VMU2-T24P | 76 | 70 | 1,366 | 1,174 | 1.89 | 3.14 |
| O-VMU2-T25P | 66 | 40 | 975 | 2,995 | 1.83 | 2.99 |
| O-VMU2-T26P | 60 | 52 | 892 | 1,133 | 1.79 | 2.95 |
| O-VMU2-T27P | 82 | 70 | 1,428 | 1,012 | 1.92 | 3.15 |
| O-VMU2-T28P | 82 | 66 | 559 | 1,578 | 1.92 | 2.75 |
| O-VMU2-T29P | 60 | 54 | 715 | 1,133 | 1.79 | 2.85 |
| O-VMU2-T30P | 72 | 58 | 511 | 567 | 1.86 | 2.71 |
| O-VMU2-T31P | 78 | 60 | 335 | 1,416 | 1.90 | 2.53 |
| O-VMU2-T32P | 54 | 44 | 1,384 | 3,035 | 1.74 | 3.14 |
| O-VMU2-T33P | 72 | 62 | 461 | 2,388 | 1.86 | 2.66 |
| O-VMU2-T34P | 62 | 52 | 572 | 2,307 | 1.80 | 2.76 |
| O-VMU2-T35P | 58 | 48 | 1,064 | 2,104 | 1.77 | 3.03 |
| O-VMU2-T36P | 58 | 50 | 671 | 2,226 | 1.77 | 2.83 |
| O-VMU2-T37P | 46 | 30 | 545 | 2,550 | 1.67 | 2.74 |
| O-VMU2-T38P | 60 | 52 | 1,315 | 3,480 | 1.79 | 3.12 |
| O-VMU2-T39P | 80 | 72 | 817 | 1,862 | 1.91 | 2.91 |
| O-VMU2-T40P | 46 | 38 | 1,361 | 3,237 | 1.67 | 3.13 |
| Mean | 68.3 | 54.6 | 881.5 | 1890.9 | 1.83 | 2.91 |
| Standard Deviation | 10.8 | 12.2 | 376.3 | 948.5 | 0.1 | 0.2 |
| Count | 39 | 39 | 40 | 40 | 39 | 40 |
| Variance | 118 | 149 | 141602 | 899646 | 0.01 | 0.03 |
| 90% Confidence Interval | 2.9 | 3.2 | 97.9 | 246.7 | 0.02 | 0.05 |
| Technical Standard | 52% | 24% | 550 | 400 | 1.72 | 2.74 |
| **90% of Standard** | 46.8% | 21.6% | 495 | 360 | 1.68 | 2.70 |

Notes:
2024 Data are found in Appendix A
-- Data missing

## Appendix C: Statistics Exhibit 1: Total Ground Cover

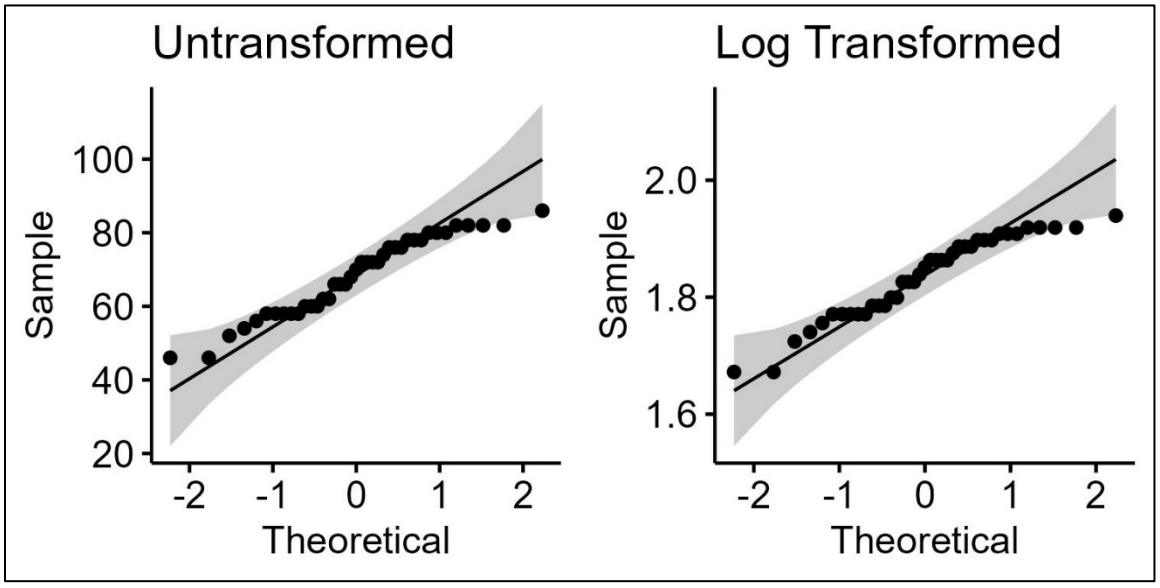



| Data | N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Data | 39 | 68.3 | 65.4 | 71.11 | 0.27 | 10.8 | -0.28 | 2.0 | 59 | 70 | 78 |
| log(X+1) | 39 | 1.83 | 1.82 | 1.85 | 0.002 | 0.07 | -0.53 | 2.4 | 1.78 | 1.85 | 1.90 |

Sample adequacy is 7 samples.

### Normality

Q-Q Plot



Normality (cont.)

Shapiro-Wilk Test

| Data | W statistic | P value |
|---|---|---|
| Data | 0.947 | 0.066 |
| Log | 0.934 | 0.025 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are not normally distributed with untransformed or with a logarithmic transformation, and sample adequacy has been met, therefore the statistical test was performed using a one sided, sign test under reverse null hypothesis:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

Therefore,

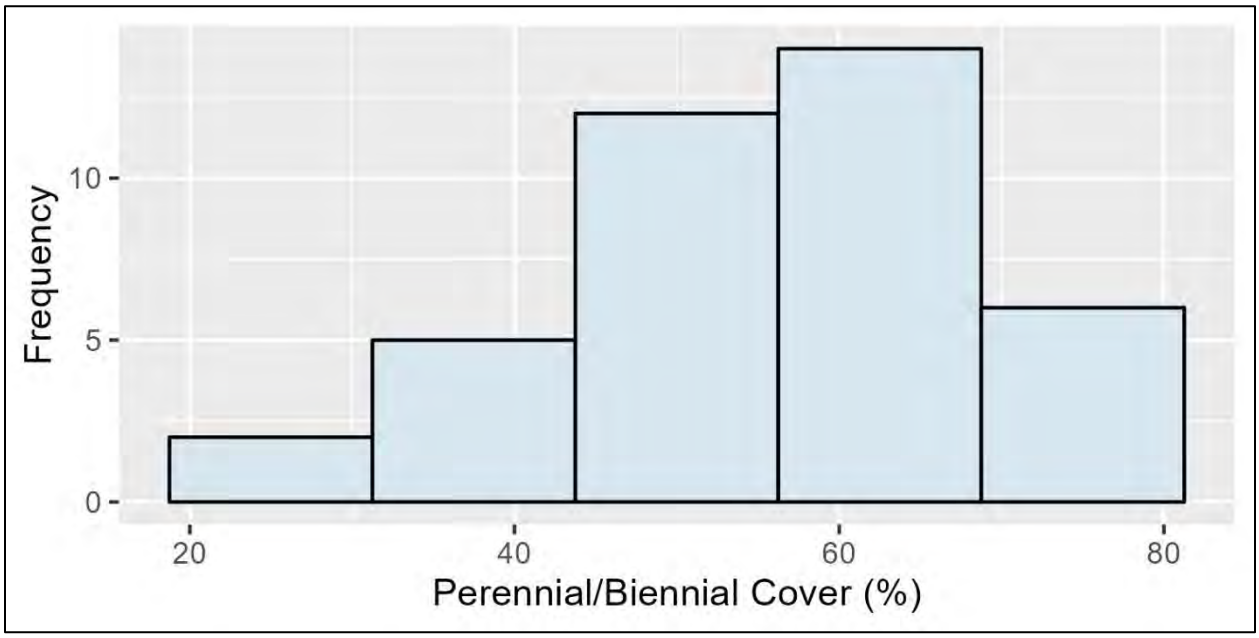
If P > 0.1), conclude failure to meet the performance standard.

If P ≤ 0.1, conclude that the performance standard was met.

| Production (lbs/ac) | |
|---|---|
| K (Number of values less than 90%*Standard [52%]) | 2 |
| N | 39 |
| Z | -5.44 |
| Standard one-tailed normal curve area (Table C-3; MMD, 1999) | ~0.4990 |
| p-value | p < 0.001 |

p < 0.1, the performance standard is met

Appendix C: Statistics Exhibit 2: Perennial Ground Cover

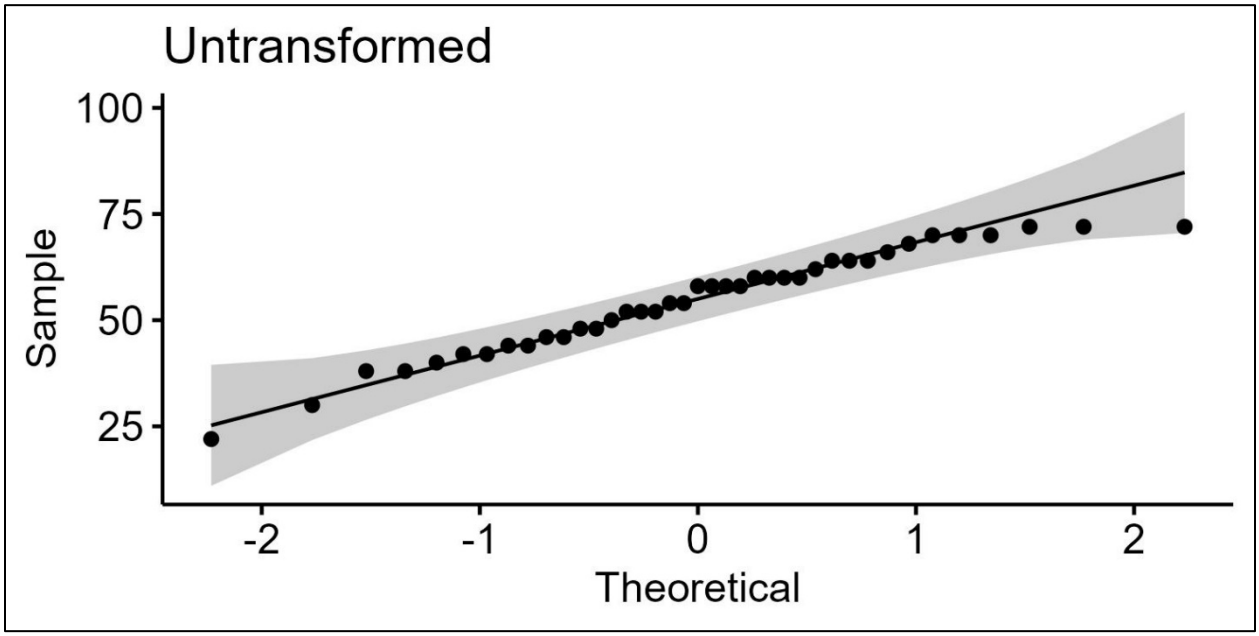



| N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|
| 39 | 54.6 | 51.3 | 57.8 | 0.31 | 12.2 | -0.52 | 2.80 | 46 | 58 | 64 |

Sample adequacy is 14 samples.

Normality

Q-Q Plot



Normality (cont.)

Shapiro-Wilk Test

| W statistic | P value |
|---|---|
| 0.960 | 0.180 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed, and sample adequacy has been met, therefore the statistical test was performed using a standard t-test under classic null hypothesis:

$H_0$: Reclaim ≥ 90% of the Performance Standard

$H_a$: Reclaim < 90% of the Performance Standard

Therefore,

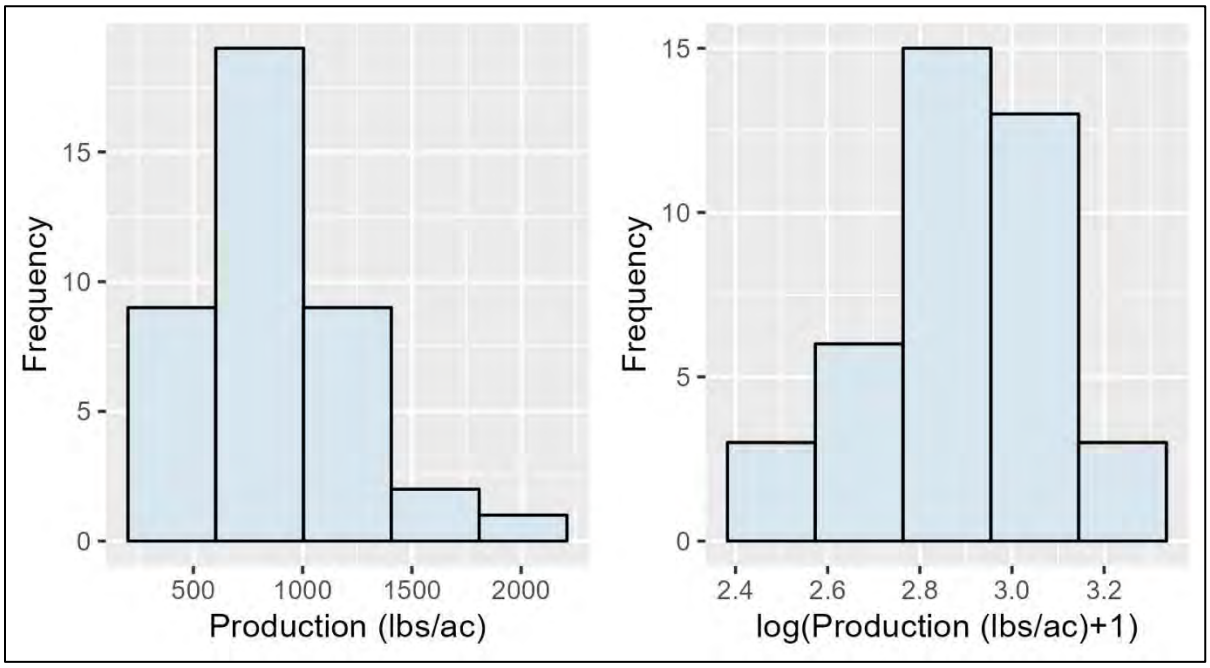
If $t^* \geq t_{(\alpha; n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha; n-1)}$, conclude failure to meet the performance standard.

| Perennial/Biennial Cover (%) | |
|---|---|
| Mean | 54.6 |
| Standard Deviation | 12.2 |
| Sample Size | 39 |
| Technical Standard | 24 |
| t* | 16.90 |
| 1-tail t (0.1, 39) | -1.304 |
| p-value | 1 |

t*(16.90) ≥ t(-1.304) and p>0.1, the performance standard is met

## Appendix C: Statistics Exhibit 3: Production

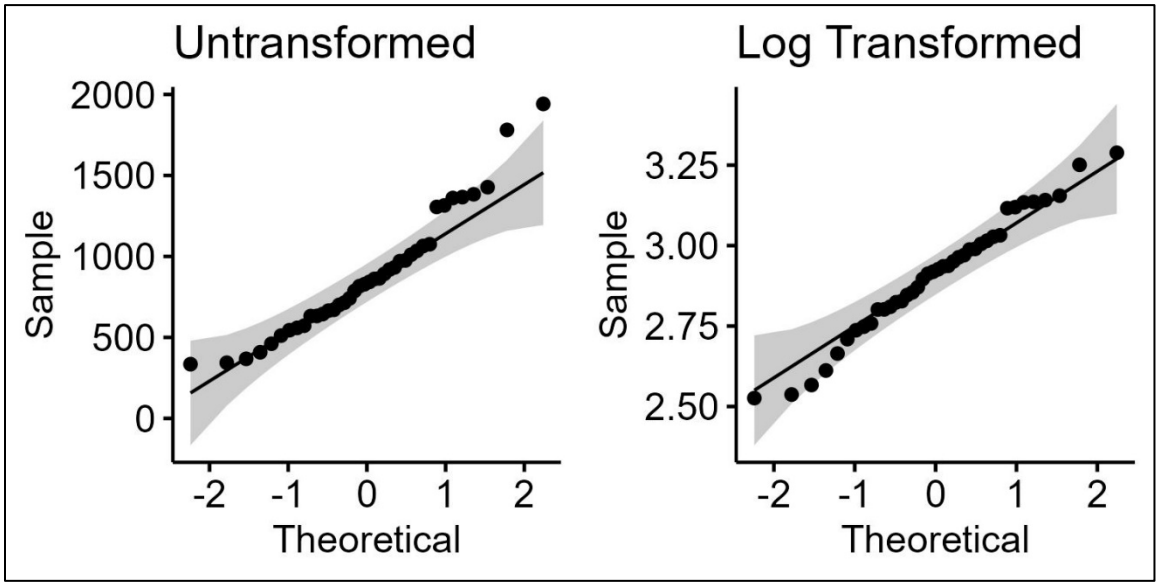



| Data | N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Data | 40 | 881.5 | 783.6 | 979.3 | 9.4 | 376.3 | 0.85 | 3.5 | 632.3 | 835.5 | 1041.6 |
| log(X+1) | 40 | 2.91 | 2.86 | 2.96 | 0.004 | 0.187 | -0.15 | 2.60 | 2.80 | 2.92 | 3.02 |

Sample adequacy is 52 samples.

## Normality

Q-Q Plot




## Normality (cont.)

Shapiro-Wilk Test

| Data | W statistic | P value |
|---|---|---|
| Data | 0.940 | 0.035 |
| Log | 0.983 | 0.784 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed with a logarithmic transformation, and sample adequacy has not been met, therefore the statistical test was performed using a standard t-test under reverse null hypothesis on the transformed data:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

Therefore,

If $t^* \geq t_{(1-\alpha;\, n-1)}$, conclude that the performance standard was met.

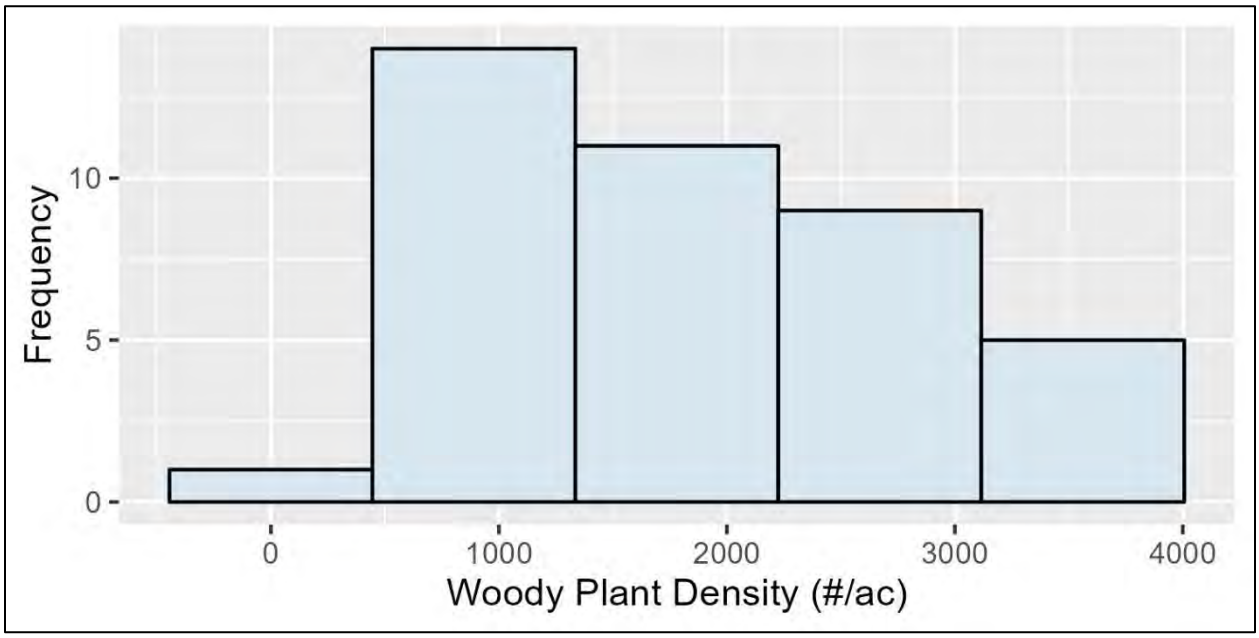
If $t^* < t_{(1-\alpha;\, n-1)}$, conclude failure to meet the performance standard.

| Production (lbs/ac) | |
|---|---|
| Mean | 2.91 |
| Standard Deviation | 0.187 |
| Sample Size | 40 |
| Technical Standard[1] | 2.70 |
| t* | 7.10 |
| 1-tail t (0.9, 39) | 1.304 |
| p-value | p < 0.001 |

t*(7.10) ≥ t(1.304) and p < 0.1, the performance standard is met

[1]Note the value reported is log(X)+log(0.9) not just the log(X), so log(550+1)+log(0.9)=2.70

Appendix C: Statistics Exhibit 4: Woody Plant Density

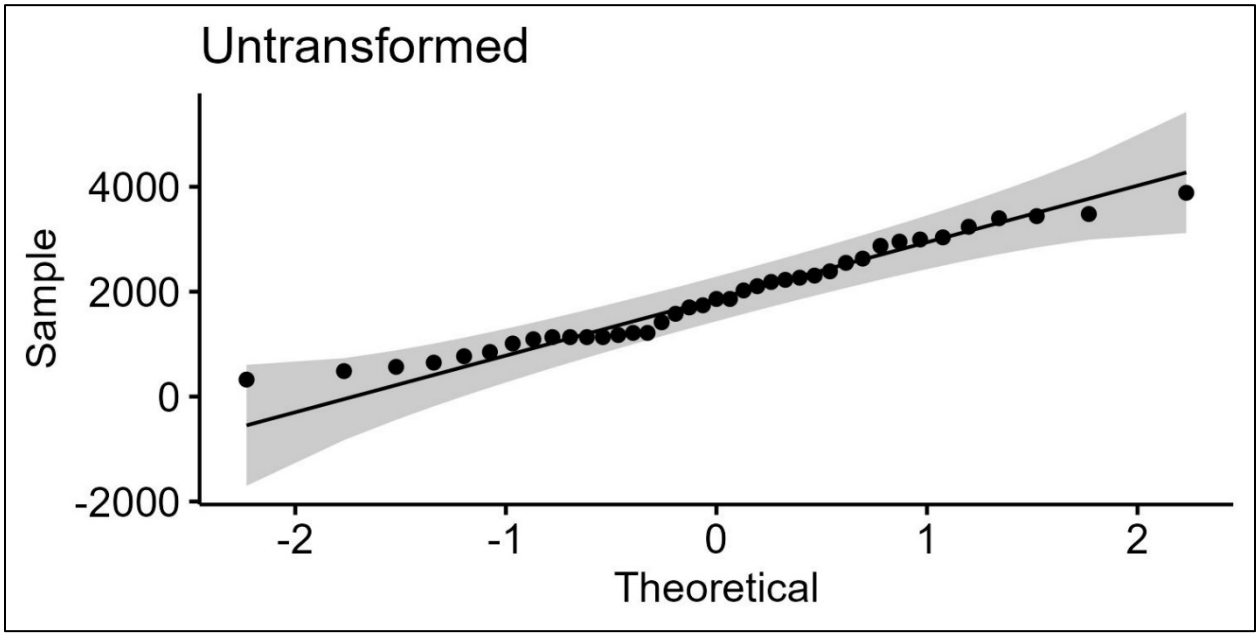



| N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 1891 | 1644 | 2137 | 23.7 | 948 | 0.31 | 2.10 | 1133 | 1801 | 2570 |

Sample adequacy is 73 samples.

Normality

Q-Q Plot



Normality (cont.)

Shapiro-Wilk Test

| W statistic | P value |
|---|---|
| 0.9591 | 0.167 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed, and sample adequacy has not been met, therefore the statistical test was performed using a standard t-test under reverse null hypothesis:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

Therefore,

If $t^* \geq t_{(\alpha; n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha; n-1)}$, conclude failure to meet the performance standard.

| Woody Plant Density (#/ac) | |
|---|---|
| Mean (#/ac) | 1891 |
| Standard Deviation (#/ac) | 948 |
| Sample Size | 40 |
| Technical Standard (#/ac) | 400 |
| t* | 10.21 |
| 1-tail t (0.1, 39) | 1.304 |
| p-value | p < 0.001 |

t*(10.21) ≥ t(1.304) and p<0.1, the performance standard is met



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**REPORT**

# Vegetation Management Unit 3
# Vegetation Success Monitoring, 2024

Submitted to:

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# 1.0 INTRODUCTION

Mining at the McKinley Mine ceased in 2009 and reclamation of remaining support facilities (e.g., impoundments, roads, etc.) is nearing completion. Reclamation practices have been applied at the McKinley Mine under various programs since at least the early 1970s. Chevron Mining Inc. (CMI) is assessing the vegetation in reclaimed areas in anticipation of future bond and liability release. CMI understands the importance of returning the mined lands to productive traditional uses in a timely manner. To qualify for release, the increment, or permit area as a whole, must meet the Permit No. NM-0001K (2016) (the Permit) permanent-program revegetation-success criteria as shown in Table 1 of this report. In general, the lands must be in a condition that is as good as or better than the pre-mine conditions, stable, and capable of supporting the designated postmining land uses of grazing and wildlife. WSP USA, Inc. (WSP) was retained to monitor and assess the vegetation relative to the established vegetation success standards.

This report documents the vegetation community attributes collected in 2024 in O-VMU-3 and compares them to the Permit's vegetation-success criteria. Section 1 includes the introduction and a general overview. Section 2 describes the vegetation monitoring methods that were used in 2024. Section 3 presents the results of the assessment with respect to total ground cover, perennial vegetation cover, forage production, woody plant density (shrub density), and composition and diversity. Section 4 is a summary of the results for O-VMU-3 with emphasis on vegetation success.

The 2024 sampling program was conducted and evaluated in accordance with the updated monitoring methods and revegetation success standards contained in Permit Modification Number 23-03. More details beyond what is already discussed throughout this report may be found in the Permit.

## 1.1 Vegetation Management Unit 3

This report presents results from 2024 quantitative vegetation monitoring conducted in Vegetation Management Unit 3 (O-VMU-3), which is in the western portion of Area 2 and minor portions of Areas 1 and 10 (Figure 1). The configuration of the vegetation monitoring units within the U.S. Department of the Interior – Office of Surface Mining Reclamation and Enforcement (OSMRE) Permit Area, were developed in consultation with OSMRE. Undisturbed lands included within the VMU were not part of the sampling program. O-VMU-3 encompasses about 959 acres, comprised of permanent program lands (PPL), prelaw, and initial program lands (IPL). All program lands, as one unit, must meet the PPL success criteria as discussed in the Permit in Section 6.5.1.2. The 10-year period of extended responsibility, however, only applies to PPL.

The elevation of O-VMU-3 ranges from about 6,950 to 7,100 feet above mean sea level. Reclamation started in 1975 with the vast majority seeded by 2003. Thus, the reclamation in the majority of O-VMU-3 ranges from 21 to almost 50 years old. This section provides a general description of the reclamation activities that were implemented. Additional details of the reclamation for specific areas can be obtained through review of the McKinley Mine annual reports.

## 1.2 Reclamation and Revegetation Procedures

Reclamation of permanent program lands included grading of the spoils to achieve a stable configuration, positive drainage, and approximate original contour. After grading, graded spoil monitoring was conducted to determine the suitability of the materials. A minimum of 6 inches of topdressing (topsoil or topsoil substitute) were then applied over suitable spoils.

After topdressing placement, the seedbed was scarified or ripped on the contour to a depth of about 8 to 12 inches. Seeding was done using various implements that drilled and/or broadcast the seed. After the seeding, certified weed-free, long-stem, hay mulch, or straw was applied at a rate of about 2 tons per acre. The mulch was anchored 3 to 4 inches into the cover with a tractor-drawn straight coulter disc. The seeding was generally performed in the fall, which tends to favor the establishment of cool-season grasses and shrubs. The approved seed mixes used at McKinley have varied over time but included both warm-season grasses, and introduced and native cool-season grasses, introduced and native forbs, and shrubs. The early seed mixes tended to emphasize the use the alfalfa and cool-season grasses. The majority of seed mixes planted on IPL consisted of native and introduced cool season grasses, limited warm-season grasses, some shrubs, but no forbs. Over time the seed mixes on PPL shifted to include more warm-season grasses, more shrub species, and a variety of forbs.

Initial program lands were typically graded so they were no steeper than 3:1 and topsoiled. Seeding practices were like those done on permanent program lands. Prelaw lands were generally graded to be no steeper than 3:1 but were not top-dressed before seeding.

## 1.3 Prevailing Climate Conditions

The amount and distribution of precipitation are important determinants for vegetation establishment and performance. Once vegetation is established, the precipitation dynamics affect the amount of vegetation cover and biomass on a year-to-year basis with grasses and forbs showing the most immediate response. Long term precipitation has been monitored at the McKinley North Mine throughout most of its life at the Bluff station (Figure 1). The mine added a system of 6 additional seasonal precipitation gauges to better capture more representative data from the various mining areas in 2011-2012 (gauges named by mining area). Data from the Rain 12 and Bluff gauges were used to evaluate precipitation in O-VMU-3 (Figure 1).

Table 2 contains a summary of precipitation recorded at all the rain gauges in the North Mine Area. Total annual precipitation measured at the Bluff gauge near the mine entrance was 11.97 inches, slightly above the regional average of 11.8 inches at Window Rock. Total annual precipitation for the season rain gauges is unavailable as they are taken offline due to freezing conditions from December through March.

Growing season precipitation provides context to evaluate vegetation performance in O-VMU-3. The departure of growing season precipitation (April through September) between Rain 12 and Bluff gauges and the Window Rock (1937-1999) long-term seasonal mean is illustrated in Figure 2. Growing season precipitation in O-VMU-3 has been below the long-term seasonal mean from 2016 to 2021 with a severe drought in 2020 when the site only received 20% of the normal growing season precipitation for the region. In 2022, O-VMU-3 growing season precipitation was about 49% above the long-term average. In 2023, the growing season was again dry with precipitation measured at the Rain 12 gauge was 60% of the long-term average. Over the past ten years, growing season precipitation measured at the Rain 12 gauge was on average 15% below regional norms.

Precipitation in 2024 was near normal for the growing season with a wetter than average June accounting for nearly 40% of the total growing season precipitation. The Rain 12 gauge recorded 6.82 inches of precipitation from April to September, slightly higher than the Bluff gauge that recorded approximately 6.57 inches of rain for the same period. Rainfall in April, May, July and September was below the monthly long-term average with a slightly wetter than normal August. Mine wide, the precipitation recorded in 2024 between April and November at the seven gauges indicate near normal regional rainfall, with average rainfall falling just 0.12 inches below the regional norm with variation both spatially and temporally (Table 2).

## 1.4 Livestock

CMI has aggressively managed trespass livestock (horses) the past several years, resulting in less evidence of overgrazing in the reclamation in O-VMU-3. The combination of past grazing pressure with exceptional drought, however, may in some years adversely affect the ability to demonstrate that the vegetation is meeting or can meet the revegetation success standards.

# 2.0 VEGETATION STANDARDS AND MONITORING METHODS

Vegetation attributes in O-VMU-3 were quantified using the methods described in Section 6.5 of the Permit as modified in Permit Modification 23-03. Vegetation monitoring in O-VMU-3 was conducted from September 24 through September 29, 2024.

## 2.1 Vegetation Success Standards

The vegetation success standards for the Permit Area consist of five vegetative parameters: total cover, perennial cover, forage production, woody plant density, and diversity (Table 1). The total ground cover requirement, or the combined means for live vegetation cover and litter cover on the reclamation, is 52%. The perennial vegetation cover requirement is 24%. Both total ground and perennial vegetation cover use absolute cover. The annual forage production requirement is 550 air-dry pounds per acre (lbs/ac). The shrub density success standard is 400 live woody stems per acre. In accordance with 30 CFR 816.116 (a)(2), success for total cover, perennial cover, forage production, and shrub density shall be ≥ 90% of the standard.

Cover is defined in three ways for accurate evaluation of diversity according to Table 1.

1) Absolute cover utilizes first-hit line point intercept (LPI) data and is used to assess the perennial grass diversity standard.
2) Relative perennial cover, the metric used to assess grass, forb, and shrub diversity, compares the cover of perennial species relative to the sum of perennial plants calculated from all-hit LPI data (excluding noxious weeds) within the VMU.
3) Relative total cover, the metric used to assess the any-single-species diversity standard, is calculated by dividing the percent cover of each perennial/biennial species by the total live vegetative cover from all-hit LPI data (excluding noxious weeds) within a VMU.

Biennial forbs are included in the vegetation cover analyses and biennial forb diversity standards because they are important to the long-term ecological success of the reclamation. As monocarpic, or single flowering species, these forbs produce a high number of seeds, and as a result, persist long-term in the reclamation plant community. Future mention of “perennial” in this report thus includes biennial forb species. Plant duration was derived from the USDA Plants Database.

Relative shrub density, the metric used to assess the single shrub species standard, is calculated using belt-transect data by dividing the density of each species by the total density within a sampling unit. Relative calculations are valuable to determine whether a species or functional group is excessively dominant. The number of species required for the various diversity standard components (e.g., ≥ 2 species of cool-season grasses) is calculated by adding the total number of unique species captured in the LPI surveys.

Diversity is evaluated against numerical guidelines for different vegetation types. In summary, the diversity guideline is met if perennial grasses contribute 7% or more absolute vegetation cover; at least two cool-season perennial grasses have individual relative perennial vegetation covers of 5% and 1.5% or more; at least two

warm-season perennial grasses species with the highest cover species 5% or more relative perennial vegetation cover and the remaining species combining to contribute 1.5% or more relative perennial vegetation cover, at least three non-annual non-noxious forbs combining to contribute 1% or more relative total vegetation cover; shrubs combining to 6% or more relative perennial vegetation cover and no single shrub species with greater than 70% relative shrub density, and no single species of any functional group with 40% or more relative total vegetation cover. Diversity is also demonstrated by evidence of colonization or recruitment of native (not-seeded) plants from adjacent undisturbed native areas.

## 2.2 Sampling Design

All lands (PPL, Prelaw and IPL) were included in the vegetation-sampling pool for unbiased random sampling. The transect locations were reviewed with OSMRE in advance of sampling. A 100-meter (m) by 100 m square grid was superimposed over the entire VMU to delineate vegetation sample plots. Random points were created in a geographic information system, and the locations, including the program land (IPL or PPL) designations, are shown in Figure 3. In the field, the randomly selected transect locations were assessed in numerical order with 40 primary transects accompanied by 10 alternate transects. If a transect location was determined to be unsuitable, the next alternative location was assessed for suitability. Transects that fell on or would intersect roads, drainage ways, wildlife rock piles, or prairie dog colonies were considered unsuitable.

Figure 4 shows the 100 m by 100 m vegetation plot with the cover transect orientation, and the location of the production quadrats and belt transect. The origin of the LPI transect is situated at the grid centroid and transect orientation (from 0° to 360°) is chosen randomly beginning from the transect origin, the point navigated to. LPI points are traversed on transect left with the laser pointed towards transect right, to limit disturbance from walking on the quad and belt survey areas located on transect right. Each LPI transect is 50 m long with three half square meter (½ $m^2$) production quadrats placed flush with the meter tape with the bottom left corner at the 10, 25, and 40 m mark to the right of the transect. The belt transect corridor is 2 m by 50 m along the transect's right side.

## 2.3 Foliar, Canopy and Ground Cover

The LPI method is used to collect cover measurements required by the Permit to evaluate total cover, perennial cover, and diversity. Prior to production clipping, a 50 m measuring tape is suspended between two metal pins to extend the tape fully. A tripod-mounted laser is then held along the edge of the tape, and readings are taken every meter for living plants, plant litter, rock fragments, and bare ground. When a live plant is encountered as a direct foliar hit, the species is recorded, and direct lower canopy live plant hits are also recorded that are observed down the profile. The LPI-derived data were evaluated against the permit vegetation success standards for vegetation cover and diversity provided in Table 1, with first hits used in absolute cover calculations and all hits (upper and lower canopy hits) used in relative cover calculations.

Additional cover measurements were estimated from each production quadrat, including relative cover for each species and total canopy cover, surface litter, rock fragments, and bare soil. Quadrat canopy cover data is not analyzed for success and is only briefly discussed in this report as additional support information (Table A-3). Canopy cover estimates include the foliage and foliage interspaces of all individual plant species rooted in the quadrat. Canopy cover is defined as the percentage of quadrat area included in the vertical projection of the canopy. The canopy cover estimates made on a species basis may exceed 100 percent in individual quadrats where the vegetation has multi-layered canopies. In contrast, the sum of the total canopy cover, surface litter, rock fragments, and bare soil does not exceed 100 percent. All cover estimates were made in 0.05 percent increments. Percent area cards were used to increase the accuracy and consistency of the cover estimates.

Not all plant species are expected to occur in the sampling transects and quadrats. Plants observed growing within the vegetation plots and across the reclaimed areas were inventoried while moving between transect locations and during formal sampling (Table A-6).

## 2.4 Annual Forage and Total Production

Forage production required by the Permit was determined by clipping and weighing all annual (current year's growth) above-ground forage biomass within the vertical confines of the three ½ $m^2$ quadrats placed systematically along the same 50 m transect used for LPI measurements. Biomass from all three quads from each transect are combined by species and the combined values for the transect (not the quads) are treated as a sampling unit. Production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. The Permit allows for excessively grazed production quadrats to be considered for exclusion from the sampling analysis in consultation with OSMRE, but no quadrats needed to be excluded in O-VMU-2 (the Permit, Section 6.5.2.2).

Grasses and forbs were clipped to within 5 centimeters (cm) of the soil surface, and the current year's growth was segregated from the previous year's growth (e.g., gray, weathered grass leaves, and dried culms). Production from shrubs was determined by clipping the current year's growth. Annuals and noxious weeds (e.g., Russian knapweed [*Acroptilon repens*]), when encountered, were not clipped. Photographs of the individual production quadrats are included in Appendix B.

The plant biomass samples of every species collected per transect were placed individually in labeled paper bags. The samples were air-dried (~ 90 days) until no weight changes were observed with repeated measurements on representative samples. The average tare weight of the empty paper bags was determined to correct the total sample weight to air-dry vegetation weights. The net weight of the air-dried vegetation was converted to lbs/ac.

## 2.5 Shrub Density

Shrub density (as required by the Permit), or the number of stems per square meter (stems/$m^2$), was determined using the belt transect method (Bonham 1989). The belt transect was located parallel to the 50 m transect used to determine cover. Shrubs rooted in the 2 m belt transect were counted on a species basis. A 2 m folding ruler was horizontally oriented perpendicular to the tape to ensure that observations were taken within the 2 m corridor. The number and species of woody plant stems within the belt transect were recorded.

## 2.6 Statistical Analysis

The procedures for liability release and the basis for statistical analysis applied in this report may be found in the Permit, and as referenced in the Permit: the Wyoming Department of Environmental Quality (WDEQ) handbook of sampling and statistical methods (WDEQ 2012), and the New Mexico Mining and Minerals Division (MMD) Coal Mine Reclamation Program guidelines (MMD 1999). Additional resources include *Evaluation and Comparison of Hypothesis Testing Techniques for Bond Release Applications* (McDonald et al. 2003), which was the basis of the WDEQ handbook, and other sources referenced herein. More specifically, Figure 6.5-1 and Appendix 6.5-B of the Permit guide the statistical approach in determining vegetation success for total ground cover, perennial vegetation cover, annual forage production, and shrub density. The statistical analyses applied to the O-VMU-2 vegetation data are presented in Appendix C, including equations for vegetation data analysis, vegetation attribute data with descriptive statistics, the statistical analyses comparing these attributes to the revegetation success standards, the statistical model, and descriptive statistics and normality for the vegetation attributes.

Descriptive statistics and statistical adequacy are presented for total ground cover, perennial vegetation cover, annual forage production, and shrub density in Tables 3 and C-2. Vegetation attribute data (Table C-2) was evaluated with the Shapiro-Wilk test to determine if data are normally distributed (Exhibits C-1 to C-4). For normally distributed data, statistical adequacy was assessed (Snedecor and Cochran 1967). Hypothesis testing for normal data that met sample adequacy was conducted using a one-sample, one-sided t-test under the classical null hypothesis. A one-sample, one-sided t-test using the reverse null hypothesis was applied for normally distributed data, which failed to meet statistical adequacy. A non-parametric one-sample, one-sided sign test using the reverse null hypothesis was applied to data that was not normally distributed and did not meet sample adequacy. While transformed data was not used in hypothesis testing for satisfying standards, as supplemental analyses, non-normal data were log-transformed. If the transformed data resulted in a normal distribution, a one-sample, one-sided t-test was used in accordance with the procedures described in Section 2.6.2. If a transformation is applied, the technical standard is also logarithmically transformed in congruence with the guidelines (MMD 1999, Appendix C, Section 6). This is done to be consistent with algebraic procedures where log(0.9x)=log(x)+log(0.9) and not 0.9*log(x). If transformed data were also non-normal, data were analyzed using the non-parametric one-sample, one-sided sign test using the reverse null hypothesis on the non-transformed data.

The following presents the statistical approach in more detail. Descriptive statistics and statistical tests were performed using both Microsoft® Excel and R-Studio (version 4.2.2).

### 2.6.1 Normality and Statistical Adequacy

The normality of each dataset was first assessed using the Shapiro-Wilk test to determine the appropriate hypothesis test method (i.e., parametric versus non-parametric). The Shapiro-Wilk null hypothesis is that the samples (of size n) come from a normal distribution. Data were considered normal when the test statistic had a p-value > 0.10 for alpha (α) = 0.10. If the data failed hypothesis testing and was not normal, a log transformation was performed, and if the transformation resulted in a normal distribution, the appropriate hypothesis test was chosen depending on sample adequacy ($N_{min}$) as outlined in Figure 6.5-1 of the Permit (2016).

The number of samples required to characterize a particular vegetation attribute depends on the uniformity of the vegetation and the desired degree of certainty required for the analysis. The number of samples necessary to meet $N_{min}$ was calculated assuming the data were normally distributed using the Snedecor and Cochran (1967) equation below.

$$N_{min} = \frac{t^2 s^2}{(\overline{x}D)^2}$$

Where $N_{min}$ equals the minimum number of samples required, $t$ is the two-tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom, $s$ is the standard deviation of the sample data, $\overline{x}$ is the mean, and $D$ is the desired level of accuracy, which is 10 percent of the mean in this case.

In addition to $N_{min}$, the standard deviation and the 90% confidence interval (CI) about the sample means are reported in Table 3.

It is often impractical to achieve sample adequacy in vegetation monitoring studies based on Snedecor and Cochran's equation listed above. In such cases, the Permit allows a maximum sample number approach to compare the data regardless of the distribution (WDEQ 2012, MMD 1999). Where sample adequacy cannot be met because of operational constraints or for other reasons, 40 samples are considered adequate as stated in the

Permit. The 40-sample maximum is based on an estimate of the number of samples needed for a t-test under a normal distribution (Sokal and Rohlf 1981). Schulz et al. (1961) demonstrated that 30 to 40 samples provide a robust estimate for most cover and density measures, with increased numbers of samples only slightly improving the precision of the estimate.

The maximum 40 samples were collected at the outset of sampling based on the guidance discussed above. Each transect is considered a unique sampling unit. Sample adequacy was calculated to determine the number of samples that would have been required for adequacy by the Snedecor and Cochran equation. Further analysis for sample adequacy of cover, production, and density attributes was also demonstrated using a graphical stabilization of the mean method (Clark 2001) when sample adequacy was not met.

### 2.6.2 Hypothesis Testing

The emphasis on statistical adequacy assumes that parametric tests of normally distributed data will be conducted to demonstrate compliance with the vegetation success standards. Thus, if statistical adequacy is met for normally distributed data, the data would be analyzed with a one-sample, one-sided t-test using the classical null hypothesis. Non-parametric hypothesis tests have sufficient power to analyze data that are not normally distributed. Thus, if data is not normal then it is permissible based on the Permit and technically appropriate to use the one-sample, one-sided sign test using the reverse null approach as encouraged by OSMRE.

Hypothesis testing used to demonstrate compliance with the vegetation success standards for total ground cover, perennial vegetation cover, annual forage production, and shrub density were structured as follows (in accordance with Appendix 6.5-B of the Permit):

Classical Null Hypothesis:

$H_0$: Reclaim ≥ 90% of the Performance Standard

$H_a$: Reclaim < 90% of the Performance Standard

Where $H_0$ is the null hypothesis, and $H_a$ is the alternative hypothesis.

The one-sample, one-sided t-test using the classical null hypothesis decision rules based on the test statistic are:

If $t^* \geq t_{(\alpha; n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha; n-1)}$, conclude failure to meet the performance standard.

Test Statistic:

$$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

Where t* is the calculated t-statistic, $\bar{x}$ is the sample mean, s is the standard deviation, n is the sample size, and α = 0.10. If this test is applied to the log transformed data, the log of the standard is added to the log of 0.9 rather than multiplying it.

Reverse Null Hypothesis:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

One-sample, one-sided sign test using the reverse null hypothesis decision rules are:

If P < 0.10 or z < $z_\alpha$ (for α = 0.10, $z_\alpha$ = -1.282), conclude that the performance standard was met (i.e., $H_o$ is rejected, the revegetation values tend to be statistically greater than 90% of the technical standard).

If P ≥ 0.10 or z ≥ $z_\alpha$ (α = 0.10, $z_\alpha$ = -1.282), conclude failure to meet the performance standard (i.e., $H_o$ is NOT rejected, the revegetation values tend to be statistically less than or equal to 90% of the technical standard).

The z critical values of the normal distribution can be found in WDEQ, Table 1 (2012)

Sign Test Statistic:

$$z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

Where z is the sign test statistic (Daniel 1990), k is the test statistic resulting from the number of measurements that were less than 90% of the technical standard, and n is the sample size.

All hypothesis tests were performed with a 90% level of confidence. Hypothesis testing was not conducted for parameters where the mean or median did not exceed the minimum permit requirements. P-values, when reported, were calculated using R's t distribution probability function with the appropriate t* and degrees of freedom. This function allows for calculating precise p-values given the relevant parameters of a distribution, without the need for a table (R Core Team 2023).

# 3.0 RESULTS

The vegetation in O-VMU-3 is well established and dominated by perennial plants and the vegetation community and statistically met all vegetation success standards in 2024 as it did in 2023. Table 3 summarizes the results for total ground cover, perennial vegetation cover, annual forage production, and woody plant density (shrub density) along with their corresponding technical standard.

Field data for LPI foliar cover, quadrat canopy cover, annual forage production, and shrub density by the belt transect are included in Appendix A (Tables A-1 through A-6). Photographs of the individual production quadrats are included in Appendix B and a representative photograph of the vegetation and topography is shown in Figure 5.

Table 4 summarizes the attributes for plants recorded in the LPI transects and production quadrats and Table A-6 summarizes all species observed within belt and quadrat surveys as well as those recorded opportunistically between transect locations during monitoring. Recruitment of additional native plant species is indicative of ecological succession and the capacity of the site to support a self-sustaining ecosystem.

Field data results and statistics for each vegetation parameter are discussed in the sections that follow.

## 3.1 Total Ground Cover

Total ground cover exceeded the revegetation success standard and met the required statistical demonstration. Total ground cover based on first hit LPI data in O VMU-3 in 2024 had a mean of 55.0 ± 4.2% and a median of

54% (Table 3), exceeding the revegetation success standard. Total ground cover data were normally distributed on its own (Exhibit C-1). Sample adequacy was 24 samples, which is less than the 40 samples taken indicating sample adequacy is met.

Given the attributes of the data, total ground cover was analyzed with a one-sample, one-sided t-test under the classical null hypothesis. The resulting t*-statistic for perennial vegetation cover was 3.20, with a sample mean of 54.95%, a standard deviation of 16.1%, measured against a one-tail t (0.1, 39) value of -1.304. So, under the classical null hypothesis ($t^* \geq t(\alpha; n-1)$) and a p-value of 1, we conclude that the performance standard of 24% total ground cover was met (Exhibit C-1).

## 3.2 Perennial Vegetation Cover

Perennial vegetation cover, based on first hit LPI data, was calculated by summing the perennial and biennial species vegetation cover of the sampling unit excluding annuals and noxious weeds. The average perennial cover was 41.4 ± 4.5% and the median cover was 38% (Table 3), exceeding the revegetation success standard.

Perennial vegetation cover data were normally distributed with log transformation and did not meet sample adequacy, data were statistically analyzed using a one-sample, one-sided t-test using the reverse null hypothesis on log transformed data. The resulting t*-statistic for perennial vegetation cover was 9.14, with a sample mean of 1.59, a standard deviation of 0.18, measured against a one-tail t (0.9, 39) value of 1.304. So, under the reverse null hypothesis ($t^* \geq t(\alpha; n-1)$) and a p-value less than 0.001, we conclude that the performance standard of 24% perennial vegetation cover was met (Exhibit C-2).

## 3.3 Production

Forage production exceeded the revegetation success standard and met the required statistical demonstration. Forage production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. Annual forage production in O-VMU-3 in 2024 was 845 ± 143 lbs/ac (median of 671 lbs/ac and standard deviation of 550) (Table 3). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for annual forage production was 120 samples (Table 3).

Annual forage production data for O-VMU-3 were not normally distributed, though the log-transformed values were (Exhibit C-3). Given that $N_{min}$ was larger than the number of samples taken, the use of the reverse null hypothesis is warranted as discussed in Section 2.6.2. Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean (Clark 2001). Figure 6 illustrates the stabilization of the mean and 90% CI for production that begins to stabilize at 28 samples. This analysis suggests that 40 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of annual forage production.

The one-sample, one-sided t-test with the reverse null hypothesis was used to test the mean against 90% of the technical standard of 550 lbs/ac. The resulting t*-statistic for production was 4.92, with a sample mean of 2.85, a standard deviation of 0.27, measured against a one-tail t (0.9, 39) value of 1.304. So, under the reverse null hypothesis ($t^* \geq t(\alpha; n-1)$) and a p-value less than 0.001, we conclude that the performance standard of 550 lbs/ac in production was met (Exhibit C-3).

## 3.4 Shrub Density

Shrub density exceeded the revegetation success standard and met the required statistical demonstration. In 2024 shrub density in O-VMU-3 substantially exceeded the vegetation success standard of 400 stems/ac from

belt transect data with an average of 1,741 ± 269 stems/ac and a median of 1,538 stems/ac with standard deviation of 1,033 (Table 3). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for shrub density was 100 samples (Table 3).

The shrub density data for O-VMU-3 were not normally distributed (Figure C-4) but the log transformed data were normal (Figure C-6). Given that $N_{min}$ was larger than the number of samples taken, the use of the reverse null hypothesis is warranted as discussed in Section 2.6.2. Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean (Clark 2001). Figure 7 illustrates the stabilization of the mean and 90% CI for shrub density that begins to stabilize at 20 samples. This analysis suggests that 40 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of shrub density.

The one-sample, one-sided t-test with the reverse null hypothesis was used to test the mean against 90% of the technical standard of 400 stems per acre. The resulting t*-statistic for woody plant density was 12.44, with a sample mean of 3.15, a standard deviation of 0.30, measured against a one-tail t (0.9, 39) value of 1.304. So, under the reverse null hypothesis ($t^* \geq t(\alpha; n-1)$) and a p-value less than 0.001, we conclude that the performance standard of 400 stems per acre in production was met (Exhibit C-4).

## 3.5 Composition and Diversity

In 2024, the standards were met for all the individual diversity standards in O-VMU-3 (Table 6). The revegetation diversity standards are based on a “lifeform statement” for grasses, forbs, and shrubs (Table 1) that consists of 12 individual parameters. The results for composition and diversity are discussed below by parameter. Relative cover values of perennial and biennial species are calculated from all LPI data (first hit and understory: Table A-2). Relative perennial vegetation cover of individual species is listed in Table 4.

Grasses dominated the perennial vegetation cover with James’ galleta (*Pleuraphis jamesii*) representing the highest cover of the warm-season grasses with blue grama (*Bouteloua gracilis*) and alkali sacaton (*Sporobolus airoides*) providing additional cover (Table 4). Cool-season grasses also dominated the vegetation reflecting the past seed mixes, season of seeding, and the site’s continued ability to support a diverse group of cool-season grasses. Western wheatgrass (*Pascopyrum smithii*) and Indian ricegrass (*Achnantherum hymenoides*) represented the highest cover of the cool-season grasses. Shrubs are important components of the reclamation due to their persistence and tolerance to harsh conditions. The woody plant component is dominated primarily by fourwing saltbush (*Atriplex canescens*), with rubber rabbitbrush (*Ericameria nauseosa*) and broom snakeweed (*Gutierrezia sarothrae*) subdominant. Perennial forb species occurred on the LPI transects, though they are minor contributors to vegetation cover, with curlycup gumweed (*Grindelia squarrosa*) contributing the highest cover.

The perennial grass diversity standard requires a total absolute vegetation cover of at least 7%, which was achieved in 2024 with 33.4%. The diversity standard for cool-season perennial grasses was achieved with 12 total species, and two species that represent at least 5 and 2.5% relative perennial vegetation cover (western wheatgrass [9.2%] and Indian ricegrass [6.3%]). The diversity standard for warm-season grasses is achieved with eight total species, one species representing at least 5% (James’ galleta [29.9%]) and all remaining species representing over 1.5% relative perennial vegetation cover at 6.9%.

The perennial forb diversity standard requires at least three perennial/biennial forbs (excluding noxious weeds) combining to at least 1% relative perennial vegetation cover. This standard was achieved in 2024 with 9 species totaling 3.5% relative perennial vegetation cover with the greatest contributions from curlycup gumweed (1.7%), showy goldeneye (0.7%, *Heliomeris multiflora*), and scarlet globemallow (0.4%, *Sphaeralcea coccinea*).

The diversity standard for shrubs requires the relative perennial vegetation cover for all shrub species to total at least 6% with no single shrub exceeding or equal to 70% relative shrub density. Both standards were achieved with 21.9% relative perennial vegetation cover of all shrubs and 58.7% relative shrub density of fourwing saltbush – the most dominant shrub (Table 5).

Lastly, the diversity standards require that no single species of any functional group represent greater than 40% relative total vegetative cover. Relative total vegetative here is defined as the percent foliar cover of any recorded species divided by the total foliar cover for all live vegetation of the sampling unit, including annuals and noxious weeds. James' galleta represented the highest relative total vegetation cover at 28.2%, thus the reclamation achieved the single species diversity standard.

From 2019 through 2024, 152 plant species have been observed within reclaimed areas in O-VMU-3 including 34 grasses, 77 forbs, and 41 shrubs, trees, and cacti (Table A-6). Of the 34 grasses,19 are cool-season perennials, three are cool-season annuals, 10 are warm-season perennials and two are warm-season annuals. Of the 77 forbs, 27 are annuals and the remaining 50 are perennials and/or biennials. Cacti (four species), succulents (two species), and trees (five species) were rare on the reclamation but provide diverse habitat or browse for wildlife. Shrubs and subshrubs were the most common of the 30 woody plants observed. The recruitment of native plants and establishment of seeded species within is indicative of ecological succession and the capacity of the site to support a diverse and self-sustaining ecosystem.

## 3.6 Noxious Weeds

During the 2024 monitoring program, Class C noxious weeds (NMDA 2020) were rarely encountered in O-VMU-3. Class C noxious weeds are generally widespread in the state and managed at the local level based on feasibility of control and level of infestation. Cheatgrass was encountered infrequently in LPI surveys and production quadrats. Noxious weeds are not used in the assessment of revegetation success but are included in the single species cover standard (Table 1). Noxious trees observed on O-VMU-3 in past years include saltcedar (*Tamarix ramosissima*) and Siberian elm (*Ulmus pumila*) but their presence in the reclaimed vegetation community is insignificant with densities much lower than native rangeland beyond the permit boundary. CMI continues to monitor for noxious weeds and actively controls them through husbandry practices that include annual services for weed management. Further, competition from desirable seeded and native species is expected to inhibit any substantial increase of noxious weeds in the reclamation.

# 4.0 SUMMARY

McKinley Mine's vegetation success standards for the post-mining land uses of grazing and wildlife are based on total ground cover, perennial vegetation cover, annual forage production, shrub density, and diversity. The technical standards (Table 1) were developed through negotiations with OSMRE based on the analysis of historical vegetation data, interpretation of the ecological site potential, and the anticipated post-mining land uses. The vegetation monitoring results for the past six years indicate that the vegetation community in O-VMU-3 has progressed and now meets the revegetation success standards despite persistent drought conditions over the past several years. This progression is evident as the shrub density standard in every year and the total ground cover and perennial vegetation cover standards in all but one year (Table 3). A summary of the findings from the past five years are:

1. Vegetation Cover: The total ground cover standard and perennial vegetation cover standard have been met every year except 2021, a year following two years of below normal growing season precipitation.

2. Forage Production: Average annual forage production met standards in both 2023 and 2024. Forage production was also above the numeric performance standards in 2022, though hypothesis testing did not demonstrate that the standard was met due to highly variable data.
3. Shrub Density: O-VMU-3 has exceeded the success parameters for shrub density in all six monitoring years.
4. Diversity: All plant diversity standards were met in 2019, 2022, 2023, and 2024 (Tables 6 and 7). In 2020 and 2021, years that received below average precipitation, grass standards were not met by small margins. In 2021 fourwing saltbush comprised more than 70% relative shrub cover (based on the LPI method). In 2023, relative shrub density derived from belt transect data were used to evaluate this standard instead of LPI relative shrub cover, a change which more accurately represents the shrub community and reduces bias towards larger canopied shrubs. With the revised diversity standards adopted to more accurately represent expected vegetation composition in semi-arid shrubland/grasslands, all diversity thresholds were met in 2023 and 2024.

The reclamation in O-VMU-3 has demonstrated the capability of meeting and sustaining the post-mining land use by fully meeting the vegetation performance standard over the past two years. Long-term vegetation performance in the reclamation is encouraging considering below-average precipitation in 5 of the past 6 years including the exceptional drought in 2020 and 2021. The performance of vegetation in O-VMU-3 under these conditions show that the reclaimed plant communities are resilient and capable of sustaining themselves under the adverse conditions that are characteristic of this region.

# 5.0 REFERENCES

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# Tables

**Table 1: Revegetation Success Standards in the McKinley Mine OSMRE Permit**

| Vegetative Parameter | Components | | Success Standards | |
|---|---|---|---|---|
| | | | 2019-2022 | 2023-2024 |
| Cover | Total Ground Cover | | ≥ 52% | ≥ 52% |
| | Perennial Vegetation Cover | | ≥ 24% | ≥ 24% |
| Diversity "Lifeform Statement" | Perennial Grasses | All Grasses | ≥ 7% absolute cover | ≥ 7% absolute cover |
| | | Cool-Season | ≥ 2 species, each ≥ 1.5% cover | ≥ 2 species, 1st species ≥ 5% relative perennial cover, 2nd species ≥ 2.5% relative perennial cove |
| | | Warm-Season | ≥ 2% contribution, ≥ 2 species, each ≥ 0.5% cover | ≥ 2 species, 1st species ≥ 5% relative perennial cover, all other species combined ≥ 1.5% relative perennial cove |
| | Perennial Forbs | | ≥ 3 species, combining for ≥ 1% relative | ≥ 3 species, combining for ≥ 1% relative perennial cove |
| | Shrubs | All Shrubs | ≥ 3% absolute cover | ≥ 6% relative total perennial cove |
| | | Any Single Species | ≤ 70% relative total shrub cover | ≤ 70% relative total shrub density |
| | Any Single Species (including weeds) | | ≤ 40% relative total vegetative cover | ≤ 40% relative total vegetative cover |
| Production | Pounds/acre (air dry) | | ≥ 550 lbs/ac | ≥ 550 lbs/ac |
| Woody Plant Density | Stems/acre | | ≥ 400/acre | ≥ 400/acre |

Notes:

Success for cover, production, and stocking shall be ≥ 90% of the standard in accordance with 30 CFR 816.116 (a)(2).

Total ground cover does not include noxious weeds.

Perennial vegetation cover is foliar cover from LPI, not including annuals and noxious weeds.

Relative cover is the percent cover of a species or functional group divided by the total vegetation cover including annuals and noxious weeds.

Relative perennial cover is the total cover of a perennial species or perennial functional group divided by the total perennial cover (see below).

Total perennial cover includes shrubs, cactus, trees, perennial grasses and perennial forbs not including noxious species.

Relative total shrub density is the density of each woody species divided by the total woody plant density not including noxious weeds.

Production includes above-ground biomass of forage species only.

**Table 2: North Mine Seasonal and Annual Precipitation, 2015-2024**

| Year | Station | Area | Precipitation (inches) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | January | February | March | April | May | June | July | August | September | October | November | December | Annual Total | Growing Season Total |
| 2015 | Rain Bluff | North Shop | 1.39 | 1.21 | 0.11 | 0.35 | 1.54 | 1.15 | 2.81 | 1.91 | 0.51 | 1.18 | 1.16 | 0.74 | 14.06 | 8.27 |
| | Rain 2 | 2 | NA | NA | NA | 0.52 | 1.51 | 1.98 | 3.17 | 1.39 | 0.50 | 1.08 | 0.92 | NA | NA | 9.07 |
| | Rain 3 | 3 | NA | NA | NA | 0.57 | 1.80 | 1.77 | 3.61 | 3.06 | 0.44 | 1.36 | 0.86 | NA | NA | 11.25 |
| | Rain 6 | 6 | NA | NA | NA | 0.54 | 0.71 | 2.12 | 2.66 | 2.12 | 0.00 | 0.92 | 0.70 | NA | NA | 8.15 |
| | Rain 10 | 10 | NA | NA | NA | 0.42 | 1.32 | 1.11 | 2.59 | 1.39 | 0.30 | 1.10 | 0.78 | NA | NA | 7.13 |
| | Rain 12 | 12 | NA | NA | NA | 0.49 | 1.59 | 1.39 | 2.88 | 2.14 | 0.47 | 1.17 | 1.29 | NA | NA | 8.96 |
| | Rain 15 | 15 | NA | NA | NA | 0.46 | 1.90 | 1.62 | 3.17 | 2.88 | 0.32 | 0.94 | 0.69 | NA | NA | 10.35 |
| 2016 | Rain Bluff | North Shop | 0.39 | 0.25 | 0.03 | 1.28 | 0.70 | 0.19 | 1.15 | 1.85 | 1.79 | 0.69 | 1.18 | 1.98 | 11.48 | 6.96 |
| | Rain 2 | 2 | NA | NA | NA | 0.17 | 0.58 | 0.14 | 2.22 | 0.71 | 0.87 | 0.21 | 0.02 | NA | NA | 4.69 |
| | Rain 3 | 3 | NA | NA | NA | 0.20 | 0.72 | 0.45 | 1.62 | 0.11 | 0.50 | 0.33 | 0.02 | NA | NA | 3.60 |
| | Rain 6 | 6 | NA | NA | NA | 0.20 | 0.75 | 0.29 | 2.00 | 0.40 | 1.19 | 0.19 | 0.02 | NA | NA | 4.83 |
| | Rain 10 | 10 | NA | NA | NA | 0.13 | 0.55 | 0.20 | 2.75 | 0.38 | 0.99 | 0.14 | 0.02 | NA | NA | 5.00 |
| | Rain 12 | 12 | NA | NA | NA | 0.30 | 0.78 | 0.36 | 1.34 | 0.49 | 1.16 | 0.18 | 0.05 | NA | NA | 4.43 |
| | Rain 15 | 15 | NA | NA | NA | 0.31 | 0.85 | 0.04 | 1.95 | 0.35 | 1.31 | 0.18 | 0.05 | NA | NA | 4.81 |
| 2017 | Rain Bluff | North Shop | 0.81 | 0.04 | 0.70 | 0.32 | 0.41 | 0.16 | 3.71 | 0.37 | 0.62 | 0.54 | 0.05 | 0.02 | 7.75 | 5.59 |
| | Rain 2 | 2 | NA | NA | NA | 1.28 | 0.66 | 0.22 | 0.78 | 2.08 | 1.46 | 0.63 | 0.44 | NA | NA | 6.48 |
| | Rain 3 | 3 | NA | NA | NA | 1.04 | 1.16 | 0.06 | 0.99 | 2.71 | 1.63 | 0.56 | 0.44 | NA | NA | 7.59 |
| | Rain 6 | 6 | NA | NA | NA | 0.86 | 1.50 | 0.02 | 0.96 | 2.04 | 1.52 | 0.38 | 0.51 | NA | NA | 6.90 |
| | Rain 10 | 10 | NA | NA | NA | 1.00 | 0.67 | 0.08 | 0.94 | 1.63 | 1.36 | 0.34 | 0.81 | NA | NA | 5.68 |
| | Rain 12 | 12 | NA | NA | NA | 1.17 | 0.91 | 0.05 | 0.88 | 1.89 | 1.77 | 0.47 | 0.46 | NA | NA | 6.67 |
| | Rain 15 | 15 | NA | NA | NA | 1.15 | 1.36 | 0.02 | 0.68 | 1.91 | 1.56 | 0.40 | 0.41 | NA | NA | 6.68 |
| 2018 | Rain Bluff | North Shop | 0.23 | 0.48 | 0.44 | 0.08 | 0.22 | 0.28 | 2.17 | 0.00 | 1.00 | 1.51 | 0.14 | 0.43 | 6.98 | 3.75 |
| | Rain 2 | 2 | NA | NA | NA | 0.06 | 0.26 | 0.30 | 1.10 | 0.90 | 1.40 | 1.48 | 0.00 | NA | NA | 4.02 |
| | Rain 3 | 3 | NA | NA | NA | 0.04 | 0.30 | 0.35 | 0.92 | 0.91 | 1.27 | 1.69 | 0.00 | NA | NA | 3.79 |
| | Rain 6 | 6 | NA | NA | NA | 0.03 | 0.21 | 0.46 | 0.97 | 0.56 | 1.02 | 1.45 | 0.00 | NA | NA | 3.25 |
| | Rain 10 | 10 | NA | NA | NA | 0.08 | 0.20 | 0.27 | 3.05 | 1.15 | 0.92 | 1.51 | 0.00 | NA | NA | 5.67 |
| | Rain 12 | 12 | NA | NA | NA | 0.06 | 0.37 | 0.26 | 1.08 | 1.36 | 1.09 | 1.54 | 0.00 | NA | NA | 4.22 |
| | Rain 15 | 15 | NA | NA | NA | 0.05 | 0.32 | 0.28 | 1.16 | 0.63 | 1.31 | 1.31 | 0.00 | NA | NA | 3.75 |
| 2019 | Rain Bluff | North Shop | 0.95 | 0.98 | 1.10 | 0.24 | 0.17 | 0.03 | 0.03 | 1.14 | 0.10 | 0.04 | 1.15 | 0.97 | 6.90 | 1.71 |
| | Rain 2 | 2 | NA | NA | NA | 0.22 | 1.41 | 0.15 | 0.35 | 0.73 | 1.35 | 0.04 | 0.05 | NA | NA | 4.21 |
| | Rain 3 | 3 | NA | NA | NA | 0.39 | 1.50 | 0.32 | 0.70 | 0.11 | 1.72 | 0.06 | 0.06 | NA | NA | 4.74 |
| | Rain 6 | 6 | NA | NA | NA | 0.36 | 1.20 | 0.00 | 0.01 | 0.34 | 1.82 | 0.04 | 0.03 | NA | NA | 3.73 |
| | Rain 10 | 10 | NA | NA | NA | 0.20 | 1.49 | 0.37 | 0.19 | 0.27 | 1.34 | 0.03 | 0.05 | NA | NA | 3.86 |
| | Rain 12 | 12 | NA | NA | NA | 0.20 | 1.59 | 0.28 | 0.35 | 0.14 | 1.38 | 0.07 | 0.04 | NA | NA | 3.94 |
| | Rain 15 | 15 | NA | NA | NA | 0.22 | 1.17 | 0.14 | 0.78 | 0.15 | 1.60 | 0.05 | 0.05 | NA | NA | 4.06 |
| 2020 | Rain Bluff | North Shop | 1.00 | 1.35 | 1.15 | 0.26 | 0.02 | 0.14 | 0.89 | 0.26 | 0.21 | 0.33 | 0.28 | 0.32 | 6.21 | 1.78 |
| | Rain 2 | 2 | NA | NA | NA | 0.26 | 0.09 | 0.05 | 1.65 | 0.20 | 0.17 | 0.31 | 0.16 | NA | NA | 2.42 |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.01 | 0.05 | 1.06 | 0.62 | 0.16 | 0.27 | 0.19 | NA | NA | 1.90 |
| | Rain 6 | 6 | NA | NA | NA | 0.05 | 0.02 | 0.02 | 0.82 | 0.55 | 0.14 | 0.08 | 0.16 | NA | NA | 1.60 |
| | Rain 10 | 10 | NA | NA | NA | 0.11 | 0.02 | 0.13 | 0.79 | 0.14 | 0.14 | 0.16 | 0.09 | NA | NA | 1.33 |
| | Rain 12 | 12 | NA | NA | NA | 0.25 | 0.08 | 0.06 | 0.97 | 0.47 | 0.35 | 0.29 | 0.28 | NA | NA | 2.18 |
| | Rain 15 | 15 | NA | NA | NA | 0.32 | 0.01 | 0.05 | 0.65 | 0.87 | 0.28 | 0.09 | 0.44 | NA | NA | 2.18 |
| 2021 | Rain Bluff | North Shop | 1.13 | 0.21 | 0.46 | 0.04 | 0.04 | 0.20 | 2.17 | 1.31 | 1.13 | 0.86 | 0.20 | 0.92 | 8.67 | 4.89 |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.03 | 0.16 | 0.99 | 1.09 | 1.04 | 0.93 | 0.00 | NA | NA | 3.31 |
| | Rain 3 | 3 | NA | NA | NA | 0.03 | 0.09 | 0.05 | 0.69 | 1.04 | 1.64 | 1.16 | 0.00 | NA | NA | 3.54 |
| | Rain 6 | 6 | NA | NA | NA | 0.02 | 0.06 | 0.03 | 0.83 | 0.19 | 0.47 | 1.05 | 0.00 | NA | NA | 1.60 |
| | Rain 10 | 10 | NA | NA | NA | 0.01 | 0.06 | 0.24 | 2.48 | 1.80 | 0.96 | 0.80 | 0.00 | NA | NA | 5.55 |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.08 | 0.22 | 1.58 | 2.08 | 1.24 | 1.01 | 0.00 | NA | NA | 5.20 |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.07 | 0.05 | 1.04 | 2.58 | 1.47 | 1.00 | 0.00 | NA | NA | 5.21 |
| 2022 | Rain Bluff | North Shop | -- | -- | 0.59 | 0.03 | 0.00 | 1.24 | 3.13 | 4.66 | 1.27 | 1.40 | 0.48 | 0.58 | 13.38 | 10.33 |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 3.00 | 3.77 | 1.22 | 1.14 | 0.39 | NA | NA | 9.02 |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 2.99 | 3.07 | 1.18 | 1.19 | 0.54 | NA | NA | 8.27 |
| | Rain 6 | 6 | NA | NA | NA | 0.01 | 0.00 | 0.66 | 2.55 | 3.05 | 0.69 | 0.28 | 0.47 | NA | NA | 6.96 |
| | Rain 10 | 10 | NA | NA | NA | 0.00 | 0.00 | 0.69 | 3.57 | 4.27 | 1.02 | 1.83 | 0.33 | NA | NA | 9.55 |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.00 | 0.91 | 3.76 | 4.07 | 1.08 | 1.57 | 0.52 | NA | NA | 9.82 |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.01 | 0.91 | 4.06 | 3.84 | 1.12 | 1.68 | 0.50 | NA | NA | 9.94 |
| 2023 | Rain Bluff | North Shop | 1.21 | 0.50 | 1.64 | 0.05 | 0.55 | 0.13 | 0.03 | 3.16 | 0.33 | 0.57 | 0.42 | NA | 8.59 | 4.25 |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.48 | 0.09 | 0.08 | 3.08 | 0.44 | 0.09 | 0.09 | NA | NA | 4.17 |
| | Rain 3 | 3 | NA | NA | NA | 0.01 | 0.84 | 0.22 | 0.26 | 2.93 | 0.54 | 0.08 | 0.08 | NA | NA | 4.80 |
| | Rain 6 | 6 | NA | NA | NA | 0.00 | 1.49 | 0.22 | 0.07 | 1.97 | 0.49 | 0.05 | 0.00 | NA | NA | 4.24 |
| | Rain 10 | 10 | NA | NA | NA | 0.03 | 0.53 | 0.13 | 0.06 | 2.61 | 0.51 | 0.03 | 0.00 | NA | NA | 3.87 |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.74 | 0.21 | 0.10 | 2.47 | 0.41 | 0.05 | 0.00 | NA | NA | 3.93 |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.79 | 0.21 | 0.43 | 2.67 | 0.56 | 0.05 | 0.00 | NA | NA | 4.66 |
| 2024 | Rain Bluff | North Shop | 1.06 | 0.58 | 2.22 | 0.45 | 0.03 | 2.27 | 1.17 | 2.33 | 0.32 | 1.18 | 0.36 | 0.00 | 11.97 | 6.57 |
| | Rain 2 | 2 | NA | NA | NA | 0.21 | 0.01 | 2.36 | 0.65 | 2.31 | 0.60 | 1.32 | 0.13 | NA | NA | 6.14 |
| | Rain 3 | 3 | NA | NA | NA | 0.28 | 0.01 | 2.23 | 0.87 | 2.64 | 0.48 | 1.55 | 0.15 | NA | NA | 6.51 |
| | Rain 6 | 6 | NA | NA | NA | 0.22 | 0.06 | 2.33 | 1.22 | 2.33 | 0.45 | 1.35 | 0.08 | NA | NA | 6.61 |
| | Rain 10 | 10 | NA | NA | NA | 0.16 | 0.05 | 2.65 | 0.38 | 1.92 | 0.37 | 0.98 | 0.12 | NA | NA | 5.53 |
| | Rain 12 | 12 | NA | NA | NA | 0.15 | 0.10 | 2.58 | 0.54 | 2.58 | 0.87 | 1.24 | 0.20 | NA | NA | 6.82 |
| | Rain 15 | 15 | NA | NA | NA | 0.18 | 0.05 | 3.36 | 0.48 | 2.41 | 0.72 | 1.21 | 0.29 | NA | NA | 7.20 |
| Window Rock, Long-term normals | | | 0.72 | 0.68 | 0.88 | 0.61 | 0.49 | 0.47 | 1.75 | 2.05 | 1.23 | 1.14 | 0.83 | 0.95 | 11.80 | 6.60 |

Notes:
Long-term averages are from Window Rock, Arizona Station (029410), 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season total precipitation is between April and September
NA=rain gauges taken offline due to freezing conditions, data unavailable.
-- Rain gauge malfunction
In 2017 Rain Bluff experienced power issues in the summer that may have resulted in inaccurate precipitation readings.
data incomplete

**Table 3: Summary Statistics, O-VMU-3, 2019-2024**

| | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | Technical Standard |
|---|---|---|---|---|---|---|---|
| **Total Ground Cover (%)[1]** | | | | | | | |
| Mean | 56.3 | 56.7 | 47.9 | 49.8 | 59.4 | 55.0 | ≥ 52% |
| Standard Deviatior | 10.8 | 10.3 | 13 | 11.9 | 11.4 | 16.1 | |
| 90% Confidence Interva | 2.7 | 2.7 | 3.4 | 3.1 | 3.0 | 4.2 | |
| Median | -- | 56 | 44 | 52 | 62 | 54 | |
| Nmin[2] | 10 | 9.3 | 19 | 17 | 11 | 24 | |
| **Live Vegetation Cover (%)[3]** | | | | | | | |
| Mean | 37.4 | 32.2 | 21.5 | 35.9 | 42.4 | 43.4 | None |
| Standard Deviatior | 11.8 | 9.8 | 13 | 11.7 | 10.4 | 16.9 | |
| 90% Confidence Interva | 3 | 3 | 3 | 3.0 | 2.7 | 4.0 | |
| Nmin[2] | 28 | 26 | 104 | 31 | 17 | 43 | |
| **Perennial Vegetation Cover (%)[4]** | | | | | | | |
| Mean | 33 | 31.9 | 19.5 | 27.7 | 37.1 | 41.4 | ≥ 24% |
| Standard Deviatior | 12.5 | 10.1 | 11.6 | 12.8 | 12.2 | 17.4 | |
| 90% Confidence Interva | 3.2 | 2.6 | 3 | 3.3 | 3.2 | 4.5 | |
| Median | -- | 31 | 18 | 26 | 38 | 38 | |
| Nmin[2] | 41 | 29 | 100 | 61 | 31 | 50 | |
| **Annual Forage Production (lbs/ac)[5]** | | | | | | | |
| Mean | 939 | 263 | 208 | 569 | 816 | 845 | ≥ 550 lbs/ac |
| Standard Deviatior | 1061 | 312 | 242 | 515 | 472 | 550 | |
| 90% Confidence Interva | 269 | 81 | 63 | 134 | 123 | 143 | |
| Median | -- | 156 | 132 | 509 | 708 | 671 | |
| Nmin[2] | 361 | 399 | 387 | 232 | 96 | 120 | |
| **Woody Plant Density (stems/acre) from Belt Transect** | | | | | | | |
| Mean | 2,756 | 2,194 | 1,874 | 1,807 | 1,911 | 1741 | ≥ 400/ac |
| Standard Deviatior | 1,825 | 1,347 | 1,404 | 866 | 1,049 | 1033 | |
| 90% Confidence Interva | 463 | 350 | 365 | 228 | 273 | 269 | |
| Median | -- | 2,064 | 1,639 | 1,659 | 1,639 | 1,538 | |
| Nmin[2] | 124 | 107 | 159 | 65 | 86 | 100 | |

Notes:

[1] Mean foliar cover of live vegetation and litter

[2] Minimum number of samples to obtain 90% probability that the sample mean is within 10% of the population mean

[3] Mean vegetation foliar cover not including noxious weeds

[4] Mean foliar cover not including annuals and noxious weeds

[5] Annual forage production in air dry pounds per acre (lbs/ac) not including annuals or noxious weeds

Hypothesis testing found the success standard was not met

**Table 4: Average and Relative Foliar Cover and Production by Species, O-VMU-3, 2024**

| Scientific Name | Common Name | Code | Mean Vegetation Cover (%) | | | | Mean Annual Production (lbs/ac) |
|---|---|---|---|---|---|---|---|
| | | | First Hit Foliar[1] | Under-story[2] | Relative Perennial | Relative Total | |
| **Cool-Season Grasses (13)** | | | | | | | |
| **Annuals (1)** | | | | | | | |
| *Bromus tectorum* | Cheatgrass | BRTE | 0.35 | 0.25 | NA | 1.3 | -- |
| **Perennials (12)** | | | | | | | |
| *Achnatherum hymenoides* | Indian ricegrass | ACHY | 2.70 | 0.10 | 6.3 | 5.9 | 44.1 |
| *Agropyron cristatum* | Crested wheatgrass | AGCR | 1.35 | 0.10 | 3.2 | 3.1 | 41.9 |
| *Bromus inermis* | Smooth brome | BRIN2 | 1.90 | 0.45 | 5.2 | 4.9 | 55.2 |
| *Elymus elymoides* | Bottlebrush squirreltail | ELEL5 | 0.40 | 0.10 | 1.1 | 1.1 | 33.7 |
| *Elymus lanceolatus* | Thickspike wheatgrass | ELLA3 | 1.40 | 0.25 | 3.7 | 3.5 | 37.6 |
| *Elymus trachycaulus* | Slender wheatgrass | ELTR7 | 0.60 | 0.05 | 1.5 | 1.4 | 10.2 |
| *Hesperostipa comata* | Needle and thread | HECO26 | 1.45 | -- | 3.2 | 3.1 | 30.2 |
| *Hordeum jubatum* | Foxtail barley | HOJU | -- | 0.05 | 0.1 | 0.1 | 2.3 |
| *Pascopyrum smithii* | Western wheatgrass | PASM | 3.30 | 0.85 | 9.3 | 8.7 | 80.0 |
| *Psathyrostachys juncea* | Russian wildrye | PSJU3 | 1.05 | 0.05 | 2.5 | 2.3 | 33.2 |
| *Pseudoroegneria spicata* | Bluebunch wheatgrass | PSSP6 | 0.60 | -- | 1.3 | 1.3 | 4.4 |
| *Thinopyrum intermedium* | Intermediate wheatgrass | THIN6 | 0.15 | -- | 0.3 | 0.3 | 1.0 |
| **Warm-Season Grasses (8)** | | | | | | | |
| **Perennials (8)** | | | | | | | |
| *Andropogon gerardii* | Big bluestem | ANGE | 0.35 | -- | 0.8 | 0.7 | 1.9 |
| *Bouteloua curtipendula* | Sideoats grama | BOCU | 0.05 | -- | 0.1 | 0.1 | -- |
| *Bouteloua gracilis* | Blue grama | BOGR2 | 0.80 | -- | 1.8 | 1.7 | 10.0 |
| *Muhlenbergia wrightii* | Spike muhly | MUWR | 0.35 | -- | 0.8 | 0.7 | -- |
| *Pleuraphis jamesii* | James' galleta | PLJA | 12.65 | 0.75 | 29.9 | 28.2 | 222.2 |
| *Schedonnardus paniculatus* | Tumblegrass | SCPA | 0.05 | -- | 0.1 | 0.1 | 0.8 |
| *Sporobolus airoides* | Alkali sacaton | SPAI | 1.10 | 0.10 | 2.7 | 2.5 | 10.5 |
| *Sporobolus cryptandrus* | Sand dropseed | SPCR | 0.35 | -- | 0.8 | 0.7 | 9.7 |
| **Forbs (18)** | | | | | | | |
| **Annuals (5)** | | | | | | | |
| *Atriplex powellii* | Powell's Saltweed | ATPO2 | 0.15 | -- | NA | 0.3 | -- |
| *Bassia scoparia* | Burningbush | BASC5 | 0.25 | 0.10 | NA | 0.7 | -- |
| *Salvia reflexa* | Lanceleaf sage | SARE3 | 0.10 | -- | NA | 0.2 | -- |
| *Salsola tragus* | Prickly Russian thistle | SATR12 | 1.45 | -- | NA | 3.1 | -- |
| *Schkuhria multiflora* | Manyflower false threadleaf | SCMU6 | 0.05 | -- | NA | 0.1 | -- |
| **Perennials/Biennials (13)** | | | | | | | |
| *Conyza canadensis* | Canadian horseweed | COCA5 | 0.05 | -- | 0.1 | 0.1 | 2.6 |
| *Asclepias subverticillata* | Horsetail milkweed | ASSU2 | 0.05 | -- | 0.1 | 0.1 | 0.7 |
| *Bahia dissecta* | Ragleaf bahia | BADI | 0.05 | -- | 0.1 | 0.1 | 2.2 |
| *Chaenactis douglasii* | Douglas' dustymaiden | CHDO | 0.05 | -- | 0.1 | 0.1 | -- |
| *Descurainia pinnata* | Western tansymustard | DEPI | -- | -- | NA | -- | 1.6 |
| *Erigeron flagellaris* | Trailing fleabane | ERFL | 0.05 | -- | 0.1 | 0.1 | -- |
| *Grindelia squarrosa* | Curlycup gumweed | GRSQ | 0.55 | 0.20 | 1.7 | 1.6 | 14.3 |
| *Heliomeris multiflora* | Showy goldeneye | HEMU3 | 0.30 | -- | 0.7 | 0.6 | 6.7 |
| *Machaeranthera canescens* | Hoary tansyaster | MACA2 | -- | -- | NA | -- | 4.7 |
| *Medicago sativa* | Alfalfa | MESA | 0.05 | -- | 0.1 | 0.1 | 0.8 |
| *Sphaeralcea coccinea* | Scarlet globemallow | SPCO | 0.20 | -- | 0.4 | 0.4 | 13.8 |
| *Tragopogon dubius* | Yellow salsify | TRDU | -- | -- | NA | -- | 3.9 |
| *Tragopogon pratensis* | Jack-go-to-bed-at-noon | TRPR | -- | -- | NA | -- | 0.7 |
| **Shrubs, Trees, and Cacti (10)** | | | | | | | |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.15 | -- | 0.3 | 0.3 | -- |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 6.70 | 0.15 | 15.3 | 14.4 | 123.9 |
| *Atriplex gardneri* | Gardner's saltbush | ATGA | 0.05 | -- | 0.1 | 0.1 | -- |
| *Chrysothamnus greenei* | Greene's rabbitbrush | CHGR6 | 0.20 | -- | 0.4 | 0.4 | 3.2 |
| *Eriogonum microthecum* | Slender buckwheat | ERMI4 | 0.05 | -- | 0.1 | 0.1 | -- |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 0.90 | -- | 2.0 | 1.9 | 8.6 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 0.80 | 0.20 | 2.2 | 2.1 | 9.3 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 0.20 | -- | 0.4 | 0.4 | 3.9 |
| *Purshia mexicana* | Mexican cliffrose | PUME | 0.05 | -- | 0.1 | 0.1 | 1.8 |
| *Sarcobatus vermiculatus* | Greasewood | SAVE4 | 0.35 | -- | 0.8 | 0.7 | 13.1 |
| **Cover Components** | | | | | | | |
| | | | 55.3 | | | | |
| | | | 43.8 | | | | |
| | | | 41.4 | | | | |
| | | | 4.7 | | | | |
| | | | 11.6 | | | | |
| | | | 40.0 | | | | |

Notes:

[1] First hit foliar is calculated from first hits only

[2] Understory cover is calculated from second and lower hits

"--" = species captured in either LPI or quadrats but not both

NA = annuals not included in relative perennial cover calculations

**Table 5: Relative Shrub, Tree, and Cacti Density, O-VMU-3, 2024**

| Scientific Name | Common Name | Code | Relative Density (%) |
|---|---|---|---|
| *Artemisia nova* | Black sagebrush | ARNO4 | 0.06 |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.76 |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 58.69 |
| *Atriplex corrugata* | Mat saltbush | ATCO4 | 0.29 |
| *Atriplex gardneri* | Gardner's saltbush | ATGA | 0.58 |
| *Chrysothamnus greenei* | Greene's rabbitbrush | CHGR6 | 4.71 |
| *Ephedra viridis* | Mormon tea | EPVI | 0.23 |
| *Eriogonum microthecum* | Slender buckwheat | ERMI4 | 0.29 |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 6.16 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 19.47 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 6.04 |
| *Opuntia phaeacantha* | Tulip pricklypear | OPPH | 0.12 |
| *Purshia mexicana* | Mexican cliffrose | PUME | 0.23 |
| *Purshia tridentata* | Antelope bitterbrush | PUTR2 | 0.17 |
| *Sarcobatus vermiculatus* | Greasewood | SAVE4 | 2.03 |
| *Senecio flaccidus* | Threadleaf ragwort | SEFL3 | 0.06 |
| *Yucca baccata* | Banana yucca | YUBA | 0.12 |

Notes:
Relative density derived from belt method

Relative Density = (avg density per species per VMU ÷ avg total shrub density per VMU) * 100
Bolded species are newly observed on O-VMU-1 in 2024

**Table 6: Results for Diversity, O-VMU-3, 2023-2024**

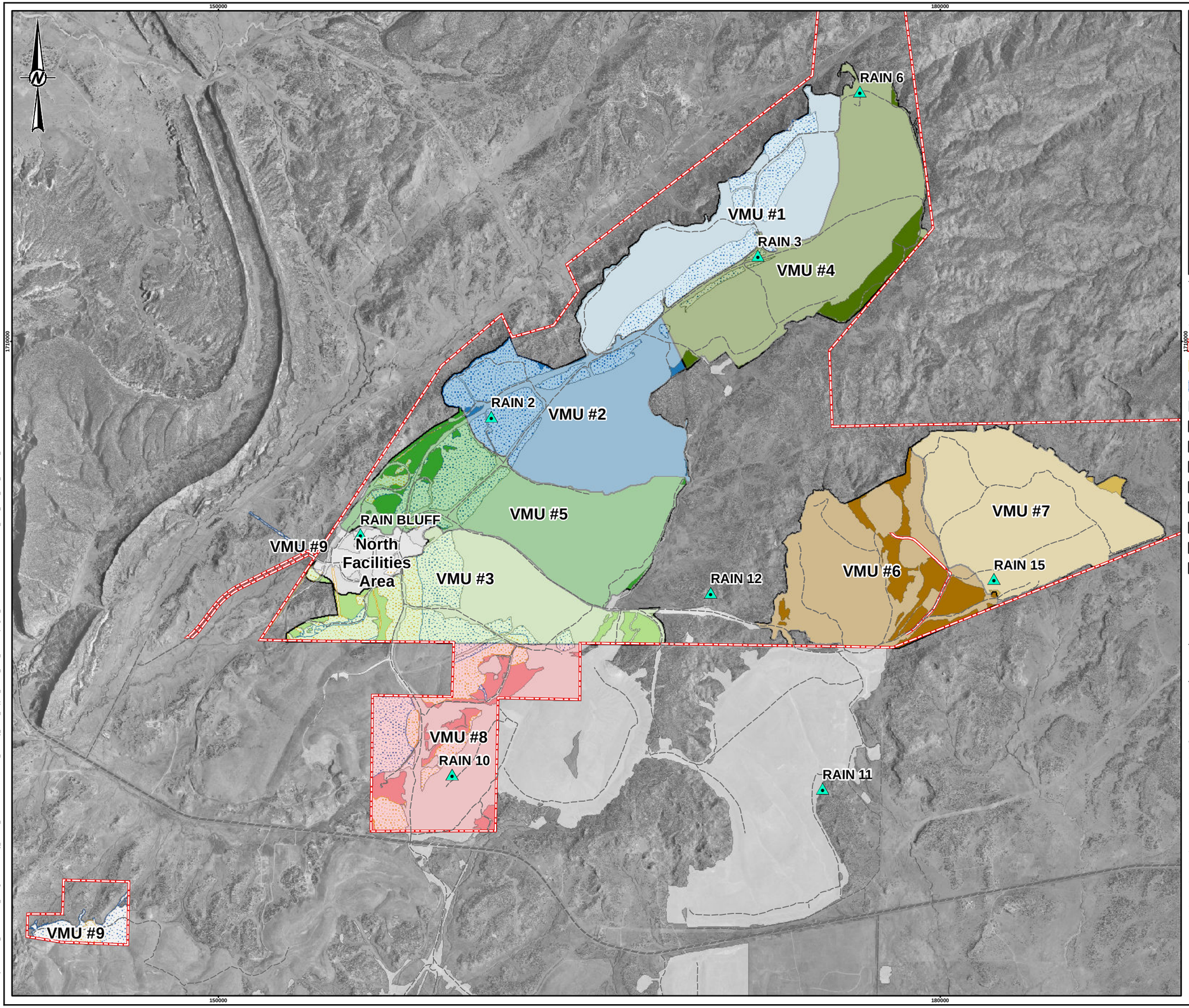
| Diversity Component | Metric | Standard | 2023 | | 2024 | |
|---|---|---|---|---|---|---|
| | | | Result | Species | Result | Species |
| **Perennial Grasses** | Absolute cover | ≥ 7% | 26.5% | -- | 33.4% | -- |
| Cool-season Grasses | # Species | ≥[2] | 11 | -- | 12 | -- |
| Grass 1 | Relative perennial cover | ≥ 5% | 17.8% | Western wheatgrass | 9.2% | Western wheatgrass |
| Grass 2 | Relative perennial cover | ≥ 2.5% | 6.4% | Crested wheatgrass | 6.3% | Indian ricegrass |
| Warm-season Grasses | # Species | ≥ 2 | 5 | -- | 8 | -- |
| Grass 1 | Relative perennial cover | ≥ 5% | 22.1% | James' galleta | 29.9% | James' galleta |
| All remaining species | Relative perennial cover | ≥ 1.5% | 4.9% | -- | 6.9% | -- |
| **Perennial Forbs** | # Species | ≥3 | 11 | -- | 9 | -- |
| | Relative perennial cover | ≥ 1% | 4.1% | -- | 3.5% | -- |
| **Shrubs or Subshrubs** | Relative perennial cover | ≥ 6% | 23.3% | -- | 21.9% | -- |
| Single Shrub Species | Relative shrub density | ≤ 70% | 69.7% | Fourwing saltbush | 58.7% | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 19.2% | James' galleta | 28.2% | James' galleta |

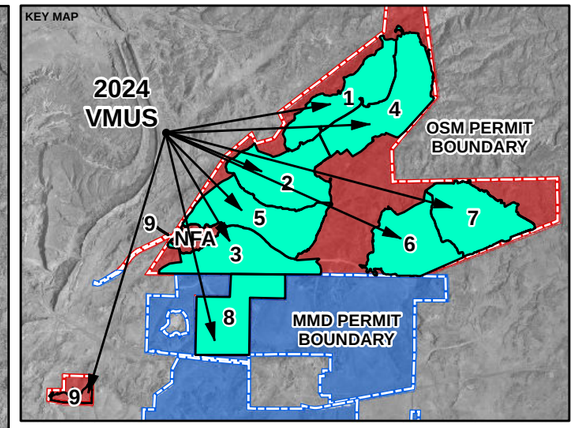
**Table 7: Results for Diversity, O-VMU-3, 2019-2022**

| Diversity Component | Metric | Standard | 2019 | | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Result | Species | Result | Species | Result | Species | Result | Species |
| **Perennial Grasses** | Total absolute cover | ≥ 7% | 20.7% | -- | 23.7% | -- | 11.4% | -- | 18.9% | -- |
| Cool-season Grasses | # Species | ≥[2] | 11 | -- | 14 | -- | 10 | -- | 9 | -- |
| Grass 1 | Absolute cover | ≥ 1.5% | 6.2% | Western wheatgrass | 6.8% | Western wheatgrass | 2.6% | Western wheatgrass | 1.5% | Western wheatgrass |
| Grass 2 | Absolute cover | ≥ 1.5% | 3.8% | Thickspike wheatgrass | 2.8% | Bluebunchwheatgrass | 1.0% | Russian wildrye | 1.5% | Russian wildrye |
| Warm-season Grasses | # Species | ≥ 2 | 4 | -- | 4 | -- | 4 | -- | 5 | -- |
| | Total absolute cover | ≥ 2.0% | 2.7% | -- | 4.5% | -- | 5.2% | -- | 10.5% | -- |
| Grass 1 | Absolute cover | ≥ 0.5% | 2.1% | James' galleta | 3.8% | James' galleta | 3.9% | James galleta | 8.2% | James' galleta |
| Grass 2 | Absolute cover | ≥ 0.5% | 0.5% | Alkali sacaton | 0.4% | Blue grama | 0.5% | Blue grama | 1.7% | Blue grama |
| **Perennial Forbs** | # Species | ≥ 3 | 8 | -- | 4 | -- | 8 | -- | 7 | -- |
| | Relative perennial cover | ≥ 1% | 5.0% | -- | 1.1% | -- | 13.4% | -- | 4.2% | -- |
| **Shrubs or Subshrubs** | Total absolute cover | ≥ 3% | 10.4% | -- | 8.1% | -- | 5.5% | -- | 7.7% | -- |
| Single Shrub Species | Relative shrub cover | ≤ 70% | 67.9% | Fourwing saltbush | 55.1% | Fourwing saltbush | 78.5% | Fourwing saltbush | 68.8% | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 18.6% | Fourwing saltbush | 20.2% | Western wheatgrass | 20.0% | Fourwing saltbush | 22.8% | James' galleta |

Notes:
Diversity calculated in accordance with Table 1 in either absolute or relative % cover
Success standard was not met

# Figures




LEGEND

- Rain Gauges
- Mine Site Roads
- OSM Permit Boundary
- Prelaw (~ 387 acres)
- Initial Program (~ 1,248 acres)
- Permanent Program (~ 11,327 acres)
- OSM VMU 1 (~ 934 acres)
- OSM VMU 2 (~ 1,085 acres)
- OSM VMU 3 (~ 959 acres)
- OSM VMU 4 (~ 1,242 acres)
- OSM VMU 5 (~ 1,129 acres)
- OSM VMU 6 (~ 1,024 acres)
- OSM VMU 7 (~ 1,045 acres)
- OSM VMU 8 (~ 953 acres)

0 4,000 8,000

1 inch = 4,000 feet FEET

**NOTE(S)**
1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN

**REFERENCE(S)**
1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT
CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT
MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2024 VEGETATION MONITORING

TITLE
**GENERAL OVERVIEW OF THE MCKINLEY OSMRE PERMIT AREA VEGETATION MANAGEMENT UNITS (VMU), 2024**

CONSULTANT

wsp

| | |
|---|---|
| YYYY-MM-DD | 2025-02-14 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MT |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| US-WSP-31406184.000 | D003 | 0 | 1 |

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1in

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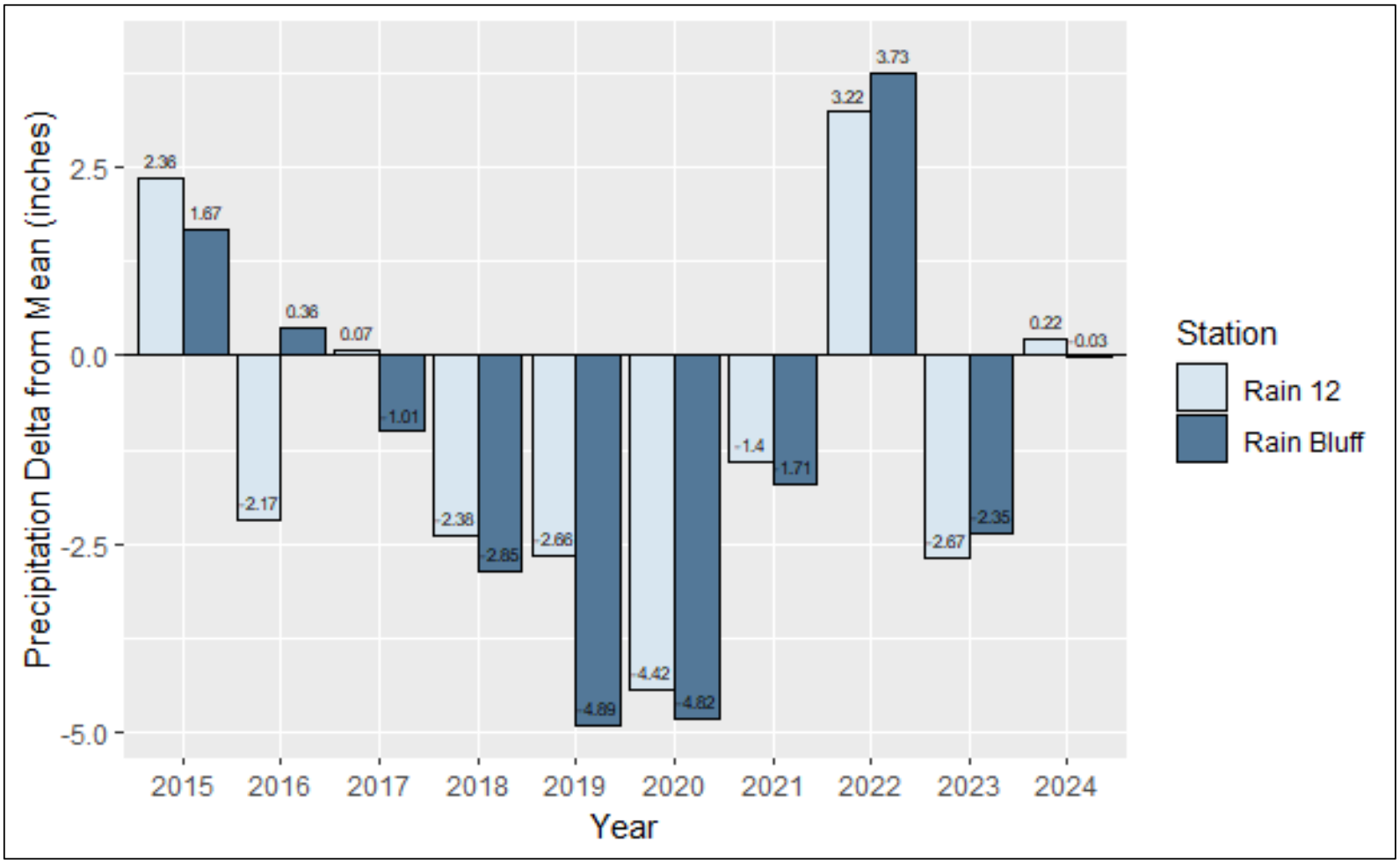
**Figure 2: Departure of Growing Season Precipitation from Long-Term Mean at Window Rock: Rain 12 and Bluff Gauges**

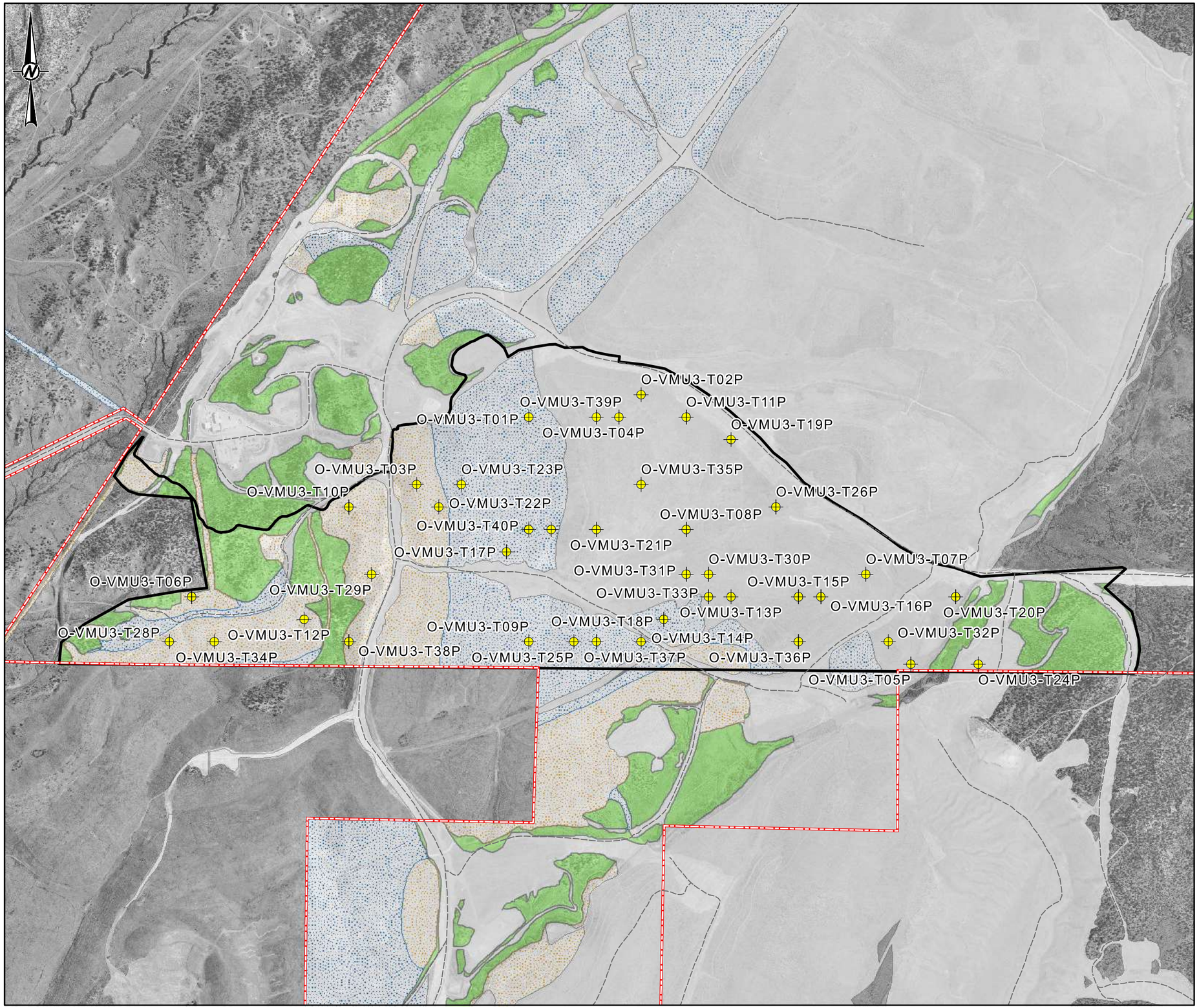



Notes:

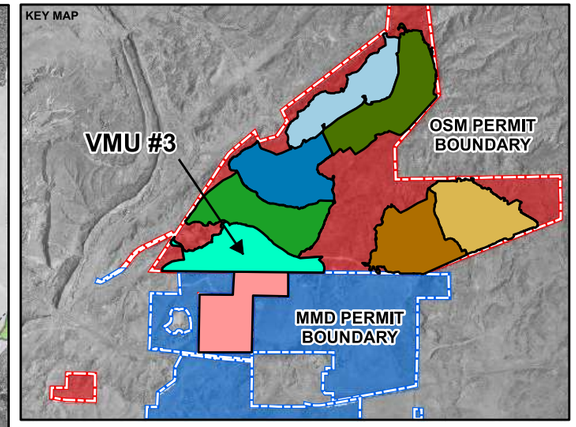
Long-term seasonal mean is from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2020).

Growing season precipitation is April through September

Source data is in Table 2




KEY MAP




LEGEND

- Primary Transect
- Alternate Transect
- Mine Site Roads
- OSM VMU 3 (~ 959 acres)
- Prelaw
- Initial Program
- Permanent Program
- Native Areas
- OSM Permit Boundary

TRANSECT LABEL EXPLANATION

O-VMU-1-T1P

- OSM Permit Area
- Vegetation Management Unit (VMU-#)
- Transect Number
- Primary (P) or Alternate (A)

0 1,400 2,800

1 inch = 1,430 feet FEET

**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN
2. KEY MAP SCALE IS DIFFERENT FROM OVERVIEW OF VMUS
3. TRANSECT LOCATIONS WERE CREATED IN ACCORDANCE WITH THE METHODS OUTLINED IN THE PERMIT

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT
CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT
MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2024 VEGETATION MONITORING

TITLE
**SURVEYED VEGETATION MONITORING TRANSECTS, 2024 VEGETATION MANAGEMENT UNIT 3**

CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2025-02-14 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MT |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| US-WSP-31406184.000 | D002 | 0 | 3 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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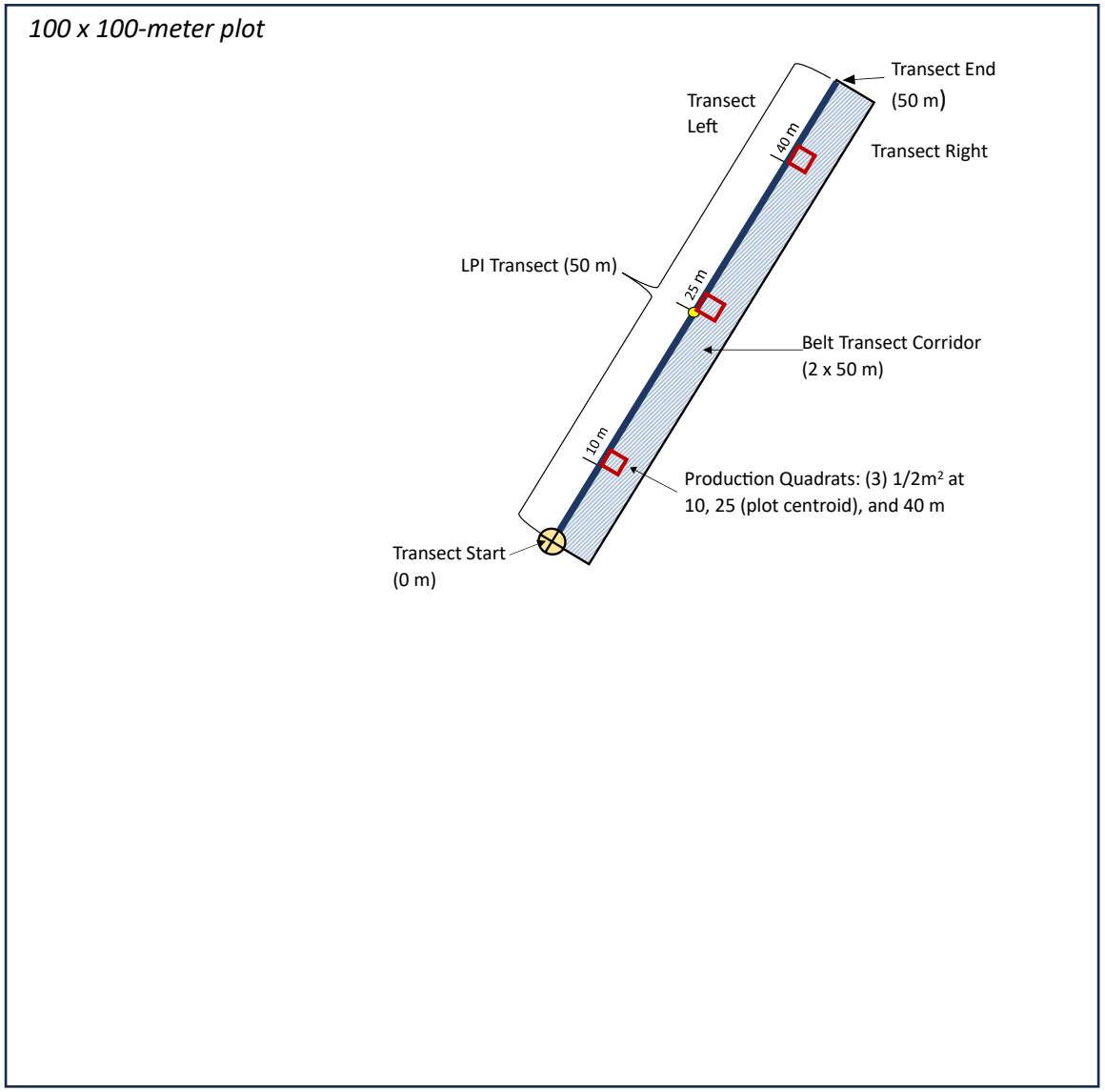
**Figure 4: Vegetation Plot and Transect Layout**




**Transect start placed on plot centroid and oriented randomly (0-360 degrees)* **Not to Scale**

**Figure 5: Typical Grass-Shrubland Vegetation in O-VMU-3, October 2024**



**Figure 6: Stabilization of the Annual Forage Production Mean and 90% Confidence Interval, O-VMU-3, 2024**

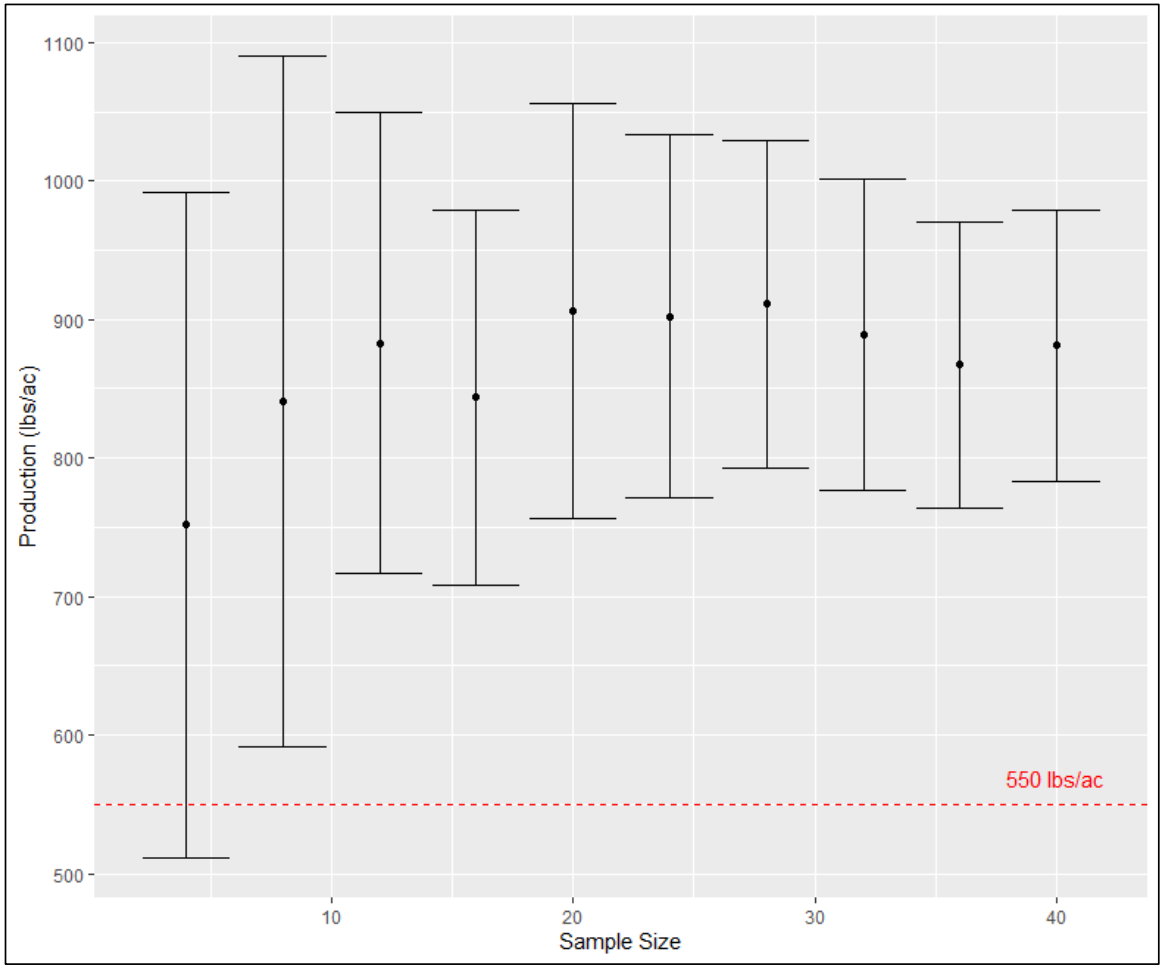
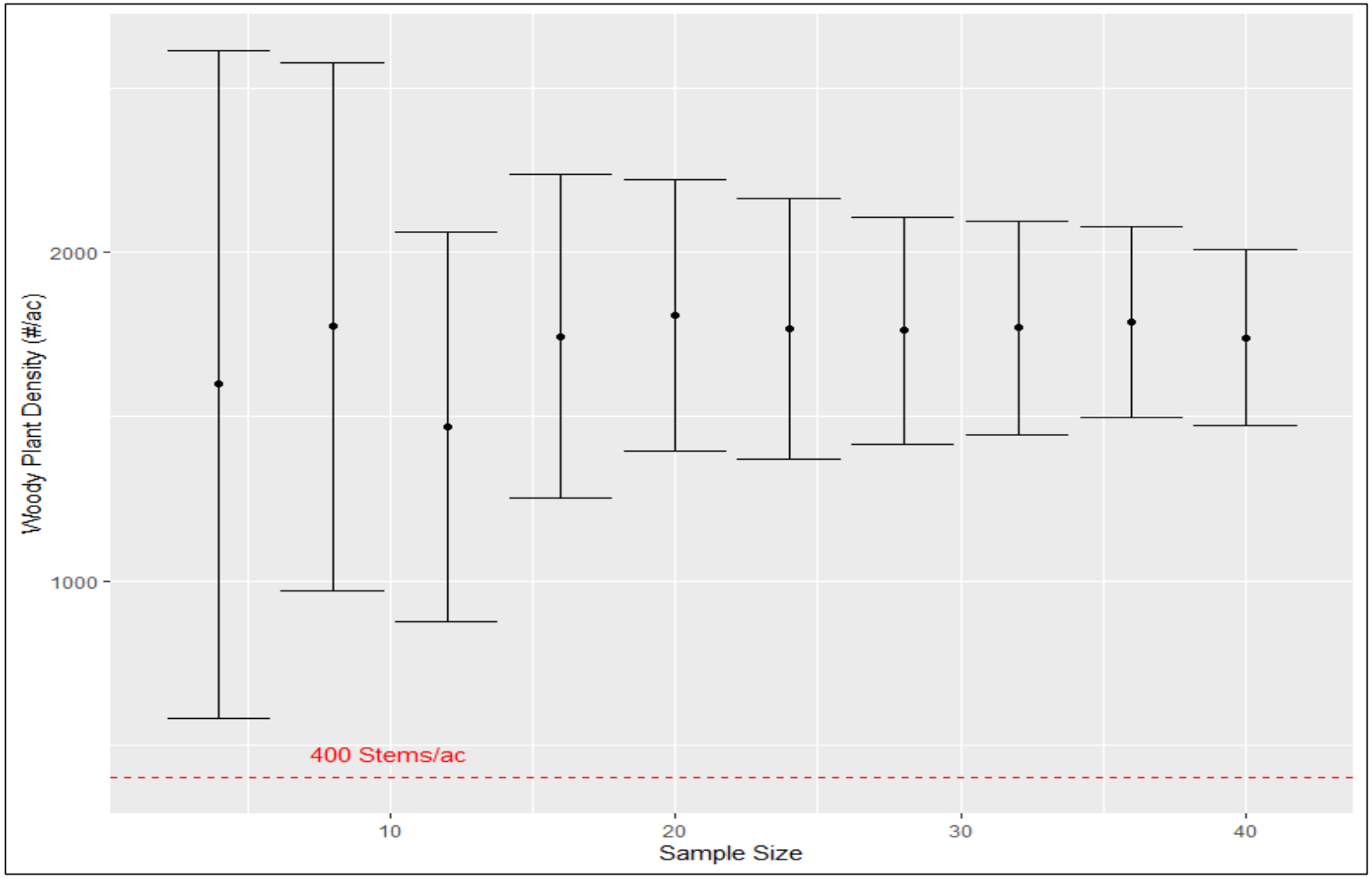


**Figure 7: Stabilization of the Shrub Density Mean and 90% Confidence Interval, O-VMU-3, 2024**



**APPENDIX A**

# Vegetation Data Summary

**Table A-1: O-VMU-3 Line Point Intercept Foliar Cover Data (first hits), 2024**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRTE | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 2 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | 3 | 9 | -- | -- | -- | 1 | -- | 3 | 4 | -- | -- | -- | 2 | 1 | 9 | 2 | -- | -- | -- | 4 | 1 | -- | 1 | -- | -- | 2 | -- | 1 | -- | 1 | -- | 3 | 4 | -- | 2 | -- | -- | -- | 1 | -- |
| AGCR | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 3 | 1 | -- | -- | -- | -- | -- | -- | 6 | -- | 2 | -- | -- | -- | 1 | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 25 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | 11 | -- | -- |
| ELEL5 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELLA3 | -- | -- | -- | 1 | -- | -- | 4 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 12 | -- | 1 | -- | -- | -- | -- | 2 | -- | -- | -- | 2 | -- | -- | 3 | -- |
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| PASM | 1 | -- | -- | 6 | 3 | -- | 1 | 1 | 1 | 2 | -- | -- | -- | -- | 1 | -- | -- | 4 | -- | 1 | 1 | -- | 1 | -- | 4 | -- | 3 | 4 | -- | 1 | 3 | -- | -- | 5 | -- | -- | 3 | 3 | -- | 17 |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | 5 | -- | -- | 5 | -- | -- | -- | 1 | -- | 6 | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | 1 | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ANGE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOCU | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 3 | -- | 2 | 3 | -- | -- | -- | -- | 1 | 2 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | 1 | -- | -- | -- | 1 | -- |
| MUWR | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PLJA | 7 | 2 | 5 | 7 | 5 | -- | 27 | 11 | 5 | -- | 12 | -- | 8 | 3 | 1 | 12 | 3 | 3 | 8 | -- | 8 | 19 | 2 | 5 | 6 | 6 | 20 | -- | -- | 12 | 6 | -- | 12 | 1 | -- | 16 | 4 | -- | 4 | 13 |
| SCPA | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPAI | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | 6 | -- | 2 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
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| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BASC5 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SARE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| SATR12 | 7 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | 2 | -- | -- | -- | 1 | 2 | -- | 1 | -- | 4 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- |
| SCMU6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ASSU2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATPO2 | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BADI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| CHDO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- |
| COCA5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERFL | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
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| MESA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | 1 | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARTR2 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCA2 | 7 | -- | -- | 4 | -- | 1 | 3 | 3 | 1 | 5 | 3 | -- | 4 | 3 | 8 | 2 | 4 | 1 | 7 | 1 | 5 | 4 | -- | -- | 3 | 2 | 2 | 7 | 9 | 2 | 3 | 2 | 4 | 9 | 1 | 10 | 2 | 6 | 3 | 3 |
| ATGA | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERMI4 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | 3 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| GUSA2 | -- | 3 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | -- | -- | -- | 1 | 1 | 1 | -- | -- | 1 | -- | 1 | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUME | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| SAVE4 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation | 26 | 24 | 9 | 24 | 20 | 12 | 40 | 18 | 14 | 8 | 24 | 47 | 19 | 18 | 28 | 33 | 16 | 18 | 20 | 26 | 18 | 36 | 11 | 25 | 14 | 19 | 32 | 18 | 21 | 23 | 22 | 18 | 25 | 17 | 12 | 26 | 13 | 21 | 19 | 41 |
| Live Vegetation[1] | 20 | 19 | 31 | 12 | 18 | 23 | 27 | 21 | 20 | 18 | 13 | 12 | 24 | 22 | 21 | 20 | 22 | 18 | 11 | 24 | 16 | 20 | 27 | 19 | 16 | 23 | 22 | 19 | 30 | 15 | 16 | 28 | 29 | 21 | 26 | 26 | 23 | 32 | 24 | 19 |
| Perennial Vegetation[2] | 20 | 12 | 20 | 10 | 12 | 18 | 27 | 21 | 12 | 17 | 13 | 8 | 22 | 10 | 21 | 10 | 22 | 18 | 9 | 24 | 9 | 20 | 16 | 16 | 16 | 19 | 22 | 18 | 30 | 15 | 16 | 28 | 27 | 21 | 20 | 25 | 23 | 32 | 24 | 19 |
| Rock | 2 | 1 | 0 | 2 | 2 | 14 | 1 | 2 | 1 | 15 | 0 | 0 | 0 | 3 | 0 | 0 | 4 | 0 | 4 | 1 | 1 | 0 | 5 | 1 | 4 | 1 | 0 | 2 | 19 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 1 | 1 | 3 | 0 |
| Litter | 4 | 3 | 5 | 3 | 6 | 2 | 1 | 6 | 5 | 10 | 2 | 2 | 4 | 6 | 6 | 4 | 3 | 8 | 7 | 4 | 3 | 4 | 2 | 3 | 5 | 12 | 5 | 9 | 6 | 4 | 12 | 12 | 8 | 7 | 11 | 5 | 7 | 17 | 4 | 4 |
| Bare Soil | 18 | 22 | 36 | 21 | 22 | 22 | 8 | 24 | 30 | 17 | 24 | 1 | 27 | 23 | 16 | 13 | 27 | 24 | 19 | 19 | 28 | 10 | 32 | 21 | 27 | 18 | 13 | 21 | 4 | 23 | 16 | 20 | 14 | 26 | 27 | 18 | 29 | 11 | 24 | 5 |

Notes:
Species codes defined in Table A-6
[1] Live vegetation is the total vegetation foliar hits for the transect, NOT including noxious weeds
[2] Perennial vegetation is the total vegetation foliar hits for the transect, NOT including annuals and noxious weeds

**Table A-2: O-VMU-3 Line Point Intercept Foliar Cover Data (all hits), 2023**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BRTE | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 3 | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 1 | 1 | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | 4 | 9 | -- | -- | -- | 1 | -- | 3 | 4 | -- | -- | -- | 2 | 1 | 9 | 2 | -- | -- | -- | 5 | 1 | -- | 1 | -- | -- | 2 | -- | 1 | -- | 1 | -- | 3 | 4 | -- | 2 | -- | -- | -- | 1 | -- |
| AGCR | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | 3 | 1 | -- | -- | -- | -- | -- | -- | 7 | -- | 2 | -- | -- | -- | 1 | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 32 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | 1 | -- | -- | -- | -- | -- | 11 | -- | -- |
| ELEL5 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 4 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
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| ELTR7 | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 2 | 2 | -- | -- | -- | -- | 1 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 1 | -- |
| HECO26 | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | 3 | -- | 2 | -- | -- | -- | 2 | 3 | -- | 3 | -- | 2 | -- | -- | -- | 2 | -- |
| HOJU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | 2 | -- | -- | 7 | 4 | -- | 1 | 1 | 1 | 3 | -- | 1 | -- | -- | 1 | -- | 2 | 4 | 1 | 1 | 1 | -- | 1 | -- | 4 | -- | 5 | 4 | -- | 1 | 4 | -- | -- | 8 | -- | -- | 3 | 3 | -- | 20 |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | 5 | -- | -- | 5 | -- | -- | -- | 1 | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 1 | -- |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | 1 | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ANGE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOCU | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 3 | -- | 2 | 3 | -- | -- | -- | -- | 1 | 2 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | 1 | -- | -- | -- | 1 | -- |
| MUWR | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PLJA | 7 | 2 | 5 | 7 | 5 | -- | 29 | 11 | 5 | -- | 13 | -- | 8 | 3 | 1 | 12 | 3 | 3 | 9 | -- | 8 | 21 | 2 | 5 | 7 | 6 | 20 | -- | -- | 12 | 6 | -- | 13 | 1 | 1 | 17 | 4 | -- | 7 | 15 |
| SCPA | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPAI | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | 7 | -- | 2 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
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| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ATPO2 | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BASC5 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SARE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
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| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COCA5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
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| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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**Table A-3: O-VMU-3 Quadrat Canopy Cover Data (%), 2024**

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| Total Vegetation Cover[1] | 31.0 | 22.0 | 42.0 | 78.0 | 35.0 | 15.0 | 1.5 | 6.0 | 17.0 | 28.5 | 21.0 | 35.0 | 36.0 | 50.0 | 50.0 | 22.0 | 72.5 | 0.0 | 77.0 | 78.0 | 62.0 | 32.5 | 11.3 | 10.0 | 28.0 | 34.0 | 19.0 | 0.0 | 14.3 | 40.0 | 31.0 | 18.0 | 23.0 | 85.0 | 75.0 | 88.5 | 18.0 | 58.0 | 17.0 | 53.0 | 12.0 | 3.0 | 96.0 | 40.0 | 10.0 | 47.0 | 67.5 | 17.5 | 45.0 | 39.4 | 29.0 | 24.0 | 54.0 | 1.5 | 57.0 | 93.1 | 15.0 | 38.0 | 30.0 | 4.3 |
| Rock | 4.0 | 5.0 | 4.0 | 0.0 | 7.0 | 29.0 | 5.0 | 4.0 | 2.0 | 5.0 | 6.0 | 1.0 | 0.1 | 1.5 | 5.0 | 43.0 | 6.0 | 1.5 | 1.5 | 2.0 | 1.0 | 4.0 | 1.0 | 3.0 | 6.0 | 5.0 | 0.5 | 48.0 | 10.0 | 0.0 | 2.0 | 2.0 | 5.0 | 0.0 | 0.0 | 0.0 | 5.0 | 0.1 | 0.5 | 0.0 | 2.0 | 0.5 | 0.0 | 0.5 | 0.1 | 1.0 | 0.0 | 0.8 | 1.0 | 5.0 | 5.0 | 7.0 | 4.0 | 2.0 | 2.5 | 0.0 | 4.0 | 4.0 | 0.3 | 0.3 |
| Litter | 14.0 | 4.0 | 12.0 | 9.0 | 6.0 | 5.0 | 0.0 | 2.0 | 12.0 | 16.0 | 5.0 | 4.0 | 6.0 | 3.0 | 3.0 | 27.0 | 7.0 | 15.0 | 3.0 | 11.0 | 7.0 | 9.0 | 3.0 | 2.0 | 7.0 | 4.0 | 6.0 | 9.0 | 38.0 | 40.0 | 10.0 | 7.0 | 6.0 | 14.0 | 20.0 | 5.0 | 4.0 | 15.0 | 13.0 | 3.0 | 25.0 | 50.0 | 1.0 | 0.1 | 4.0 | 0.5 | 0.5 | 3.0 | 7.0 | 7.0 | 13.0 | 6.0 | 25.0 | 2.0 | 5.0 | 6.9 | 18.0 | 20.0 | 4.0 | 2.5 |
| Bare Soil | 51.0 | 69.0 | 42.0 | 13.0 | 52.0 | 51.0 | 93.5 | 88.0 | 69.0 | 50.5 | 68.0 | 60.0 | 57.9 | 45.5 | 42.0 | 8.0 | 14.5 | 83.5 | 18.5 | 9.0 | 30.0 | 54.5 | 84.8 | 85.0 | 59.0 | 57.0 | 74.5 | 43.0 | 37.8 | 20.0 | 57.0 | 73.0 | 66.0 | 1.0 | 5.0 | 6.5 | 73.0 | 26.9 | 69.5 | 44.0 | 61.0 | 46.5 | 3.0 | 59.4 | 85.9 | 51.5 | 32.0 | 78.8 | 47.0 | 48.6 | 53.0 | 63.0 | 17.0 | 94.5 | 35.5 | 0.0 | 63.0 | 38.0 | 75.8 | 93.0 |

**Table A-3: O-VMU-3 Quadrat Canopy Cover Data (%), 2024 (cont'd)**

| Transect | T21P | | | T22P | | | T23P | | | T24P | | | T25P | | | T26P | | | T27P | | | T28P | | | T29P | | | T30P | | | T31P | | | T32P | | | T33P | | | T34P | | | T35P | | | T36P | | | T37P | | | T38P | | | T39P | | | T40P | | |
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| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| AGCR | -- | -- | -- | -- | -- | 6.0 | -- | -- | -- | -- | 90.0 | 35.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.5 | -- | -- | 53.0 | 28.0 | 25.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5.0 | -- | -- | 3.0 | -- | -- | -- | -- |
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| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| SAVE4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation Cover[1] | 20.0 | 16.0 | 28.0 | 64.0 | 46.0 | 37.5 | 4.0 | 34.0 | 12.0 | 35.0 | 90.0 | 35.0 | 48.0 | 29.0 | 5.0 | 9.0 | 47.0 | 0.0 | 52.0 | 17.0 | 80.0 | 32.0 | 82.0 | 27.0 | 91.0 | 40.0 | 57.0 | 16.0 | 89.0 | 18.5 | 14.0 | 37.0 | 42.0 | 55.0 | 28.0 | 76.0 | 48.0 | 0.0 | 37.0 | 78.0 | 27.0 | 16.0 | 26.0 | 38.0 | 33.0 | 33.0 | 53.0 | 17.0 | 13.0 | 28.0 | 8.5 | 10.0 | 50.0 | 65.0 | 35.0 | 17.0 | 11.0 | 94.0 | 84.0 | 27.0 |
| Rock | 7.0 | 5.0 | 4.0 | 0.0 | 0.0 | 0.0 | 12.0 | 16.0 | 10.0 | 0.5 | 0.0 | 0.0 | 1.0 | 5.0 | 6.0 | 0.5 | 0.2 | 8.0 | 0.0 | 0.1 | 0.0 | 13.0 | 0.0 | 3.0 | 0.0 | 15.0 | 10.0 | 1.0 | 0.0 | 2.0 | 0.3 | 1.0 | 0.5 | 2.0 | 4.0 | 0.0 | 3.0 | 7.0 | 3.0 | 0.1 | 0.0 | 5.0 | 2.0 | 1.0 | 3.0 | 0.3 | 4.0 | 4.0 | 0.1 | 0.1 | 0.2 | 9.0 | 3.0 | 0.0 | 5.0 | 17.0 | 11.0 | 0.0 | 0.0 | 0.0 |
| Litter | 13.0 | 18.0 | 7.0 | 18.0 | 18.0 | 4.0 | 11.0 | 5.0 | 8.0 | 6.0 | 8.5 | 25.0 | 2.0 | 1.0 | 5.0 | 7.0 | 6.0 | 0.1 | 8.0 | 10.0 | 12.0 | 24.0 | 18.0 | 25.0 | 9.0 | 15.0 | 12.0 | 3.0 | 5.0 | 5.0 | 18.0 | 13.0 | 8.0 | 16.0 | 10.0 | 7.0 | 10.0 | 18.0 | 8.0 | 12.0 | 42.0 | 4.0 | 14.0 | 7.0 | 5.0 | 6.0 | 5.0 | 17.0 | 4.0 | 1.0 | 0.5 | 14.0 | 30.0 | 20.0 | 14.0 | 11.0 | 18.0 | 6.0 | 5.0 | 18.0 |
| Bare Soil | 60.0 | 61.0 | 61.0 | 18.0 | 36.0 | 58.5 | 73.0 | 45.0 | 70.0 | 58.5 | 1.5 | 40.0 | 49.0 | 65.0 | 84.0 | 83.5 | 46.8 | 91.9 | 40.0 | 72.9 | 8.0 | 31.0 | 0.0 | 45.0 | 0.0 | 13.0 | 21.0 | 80.0 | 6.0 | 74.5 | 67.8 | 49.0 | 49.5 | 27.0 | 58.0 | 17.0 | 39.0 | 75.0 | 62.0 | 9.9 | 31.0 | 75.0 | 58.0 | 54.0 | 59.0 | 60.8 | 38.0 | 62.0 | 83.0 | 71.0 | 90.8 | 67.0 | 17.0 | 15.0 | 46.0 | 55.0 | 60.0 | 0.0 | 11.0 | 55.0 |

Notes:
Species codes defined in Table A-6
[1]Total vegetation canopy cover for the transect by the quadrat canopy cover estimate method

**Table A-4: O-VMU-3 Air-dry Aboveground Annual Forage Production Data (g/m2), 2024**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Perennial Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | 16 | 12 | -- | 13 | -- | -- | -- | 5 | -- | -- | 9 | -- | 25 | 5 | 20 | 13 | -- | 7 | -- | 41 | 26 | -- | 13 | -- | -- | -- | 6 | -- | -- | 8 | -- | -- | 42 | -- | 9 | -- | 20 | -- | 5 | -- |
| AGCR | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 35 | -- | -- | -- | -- | -- | -- | -- | 32 | -- | 77 | -- | -- | -- | -- | -- | -- | 5 | 112 | -- | -- | -- | -- | 8 | 8 | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 288 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | 75 | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | 10 | 10 | 4 | -- | 4 | -- | 143 | -- | -- | 7 | -- | -- | -- | -- | 13 | -- | -- | -- | -- | -- | -- | 18 | -- | 7 | 5 | -- | -- | -- |
| ELLA3 | -- | -- | -- | 8 | 16 | -- | 10 | 5 | -- | -- | 17 | -- | -- | 19 | 11 | -- | -- | -- | 5 | 5 | -- | -- | -- | 30 | -- | 7 | -- | -- | -- | 14 | 60 | -- | -- | -- | 12 | 13 | -- | -- | 22 | -- |
| ELTR7 | -- | -- | -- | 16 | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 27 | -- | -- | -- | 12 |
| HECO26 | 7 | 9 | -- | 36 | -- | -- | -- | 10 | -- | -- | 43 | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | 18 | -- | -- | -- | -- | -- | -- | -- | 68 | -- | -- | -- | 6 | -- |
| HOJU | -- | -- | -- | -- | 15 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | 33 | 14 | -- | 12 | 41 | -- | -- | -- | 18 | -- | -- | 10 | 11 | 9 | -- | 9 | -- | 17 | -- | -- | 7 | 62 | -- | -- | 14 | 13 | -- | 24 | -- | 5 | 11 | -- | -- | 60 | -- | 13 | 11 | -- | -- | 145 |
| PSJU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 44 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- | -- | 49 | -- | -- | -- | -- | -- | 113 | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- |
| PSSP6 | -- | 12 | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ANGE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | 5 | -- | -- | 6 | 6 | -- | -- | -- | -- | -- | -- | -- | 22 | -- | 11 | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PLJA | 16 | 109 | 15 | -- | 9 | -- | 200 | 39 | 31 | -- | 13 | -- | -- | 9 | -- | 19 | 5 | -- | 227 | -- | 46 | 59 | -- | 10 | 42 | -- | 117 | -- | -- | 145 | 17 | -- | 72 | -- | -- | 62 | -- | -- | 24 | 208 |
| SCPA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPAI | -- | -- | -- | -- | 49 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | 14 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCR | 11 | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | 5 | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | 12 | -- | -- | -- | 7 | -- | -- | 13 |
| **Perennial/Biennial Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ASSU2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BADI | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 63 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 17 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 16 |
| HEMU3 | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 30 |
| MACA2 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 22 | -- | -- | -- | -- | -- | -- |
| MESA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- |
| SPCO | 6 | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | 11 | 10 | -- | 5 | 5 | 5 | -- | -- | 5 | -- | -- | 6 | 7 | -- | -- | -- | -- | -- | 5 | 7 | 10 | -- | 5 | -- | -- | -- | -- |
| TRDU | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | 5 | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- |
| TRPR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ATCA2 | 6 | -- | -- | -- | -- | -- | -- | -- | 30 | 27 | -- | -- | 30 | 24 | 81 | -- | 23 | 122 | 5 | -- | 16 | 53 | -- | -- | -- | 31 | -- | 165 | 147 | -- | -- | 44 | -- | -- | -- | -- | 6 | 14 | 10 | -- |
| ERNA10 | -- | -- | -- | -- | 58 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GUSA2 | 6 | 24 | -- | 11 | -- | -- | -- | -- | -- | -- | -- | 6 | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12 | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- |
| PUME | -- | -- | -- | 12 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SAVE4 | -- | -- | -- | -- | -- | 74 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 14 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Total Air-dry Aboveground Annual Forage Production** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total (g) | 116 | 180 | 20 | 122 | 207 | 79 | 210 | 65 | 85 | 71 | 89 | 398 | 99 | 127 | 150 | 68 | 43 | 311 | 274 | 63 | 102 | 228 | 62 | 117 | 62 | 89 | 130 | 203 | 261 | 194 | 103 | 175 | 133 | 110 | 90 | 135 | 53 | 105 | 81 | 425 |
| Total (lbs/ac) | 690 | 1,069 | 119 | 726 | 1,230 | 468 | 1,250 | 386 | 508 | 420 | 529 | 2,366 | 587 | 758 | 889 | 406 | 253 | 1,849 | 1,632 | 377 | 607 | 1,354 | 369 | 694 | 366 | 532 | 772 | 1,207 | 1,551 | 1,153 | 611 | 1,041 | 793 | 652 | 535 | 805 | 313 | 624 | 480 | 2,525 |

Notes:
Species codes defined in Table A-6
Total (g) is the total of all three .5 $m^2$ quads (1.5$m^2$ total) per transect
lbs/ac=total grams÷1.5*(4046.86 m2/ac ÷ 453.59 g/lbs)
Forage plants are perennial and/or biennial duration excluding noxious weeds

**Table A-5: O-VMU-3 Shrub Belt Transect Data (frequency), 2024**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Shrubs, Trees, and Cacti | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARNO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | 1 | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- |
| ATCA2 | 13 | 17 | 12 | 23 | 6 | 6 | 23 | 8 | 12 | 40 | 1 | 3 | 41 | 41 | 45 | 15 | 31 | 20 | 54 | 11 | 85 | 22 | 10 | 9 | 33 | 22 | 20 | 46 | 23 | 17 | 17 | 28 | 34 | 51 | 13 | 49 | 19 | 55 | 17 | 18 |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- |
| ATGA | -- | -- | -- | 3 | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- |
| CHGR6 | -- | -- | -- | 1 | -- | 72 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- |
| EPVI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERMI4 | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | 7 | -- | 6 | 16 | -- | -- | -- | -- | 8 | 1 | 1 | -- | 6 | -- | -- | -- | -- | -- | 49 | -- | -- | -- | -- | -- | -- | 3 | 2 | -- | -- | 1 | -- | -- | 1 | 1 | -- | -- | -- | 4 | -- |
| GUSA2 | -- | 22 | -- | 43 | 2 | 3 | -- | -- | -- | -- | -- | 5 | 3 | 14 | 31 | 38 | 6 | 11 | -- | 10 | 9 | 5 | -- | 2 | -- | 14 | 7 | -- | -- | 55 | 2 | 13 | -- | -- | 35 | 1 | 3 | -- | 1 | -- |
| KRLA2 | 5 | -- | -- | -- | -- | -- | 28 | -- | -- | -- | 14 | -- | 7 | -- | 4 | 8 | -- | -- | -- | -- | 5 | -- | -- | 2 | 4 | -- | -- | -- | -- | 18 | -- | 4 | -- | -- | -- | 4 | 1 | -- | -- | -- |
| OPPH | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PUME | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- |
| PUTR2 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SAVE4 | -- | -- | -- | -- | -- | 19 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 16 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SEFL3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| YUBA | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- |
| **Total** | 18 | 50 | 12 | 78 | 29 | 105 | 51 | 8 | 12 | 48 | 16 | 9 | 51 | 62 | 80 | 61 | 38 | 31 | 59 | 76 | 99 | 27 | 11 | 18 | 38 | 37 | 30 | 66 | 23 | 92 | 20 | 45 | 36 | 52 | 50 | 54 | 24 | 56 | 31 | 18 |

Notes:
Species codes defined in Table A-6
The shrub belt transect area is 100m$^2$ (2mx50m); shrubs rooted in the belt transect were counted on an individual basi

**Table A-6 : Species Observed 2019-2024, O-VMU-3**

| Common Name | Scientific Name | Code |
|---|---|---|
| **Cool-Season Grasses (22)** | | |
| **Annuals (3)** | | |
| Field brome | *Bromus arvensis* | BRAR5 |
| Cheatgrass | *Bromus tectorum* | BRTE |
| Common barley | *Hordeum vulgare* | HOVU |
| **Perennials (19)** | | |
| Indian ricegrass | *Achnatherum hymenoides* | ACHY |
| Crested wheatgrass | *Agropyron cristatum* | AGCR |
| Smooth brome | *Bromus inermis* | BRIN2 |
| Bottlebrush squirreltail | *Elymus elymoides* | ELEL5 |
| Blue wildrye | *Elymus glaucus* | ELGL |
| Thickspike wheatgrass | *Elymus lanceolatus* | ELLA3 |
| Slender wheatgrass | *Elymus trachycaulus* | ELTR7 |
| Arizona fescue | *Festuca arizonica* | FEAR2 |
| Field fescue | *Festuca arvernensis* | FEAR4 |
| Needle and thread | *Hesperostipa comata* | HECO26 |
| Foxtail barley | *Hordeum jubatum* | HOJU |
| Prairie Junegrass | *Koeleria macrantha* | KOMA |
| Colorado wildrye | *Leymus ambiguus* | LEAM |
| Western wheatgrass | *Pascopyrum smithii* | PASM |
| Russian wildrye | *Psathyrostachys juncea* | PSJU3 |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | PSSP6 |
| Tall fescue | *Schedonorus arundinaceus* | SCAR7 |
| Intermediate wheatgrass | *Thinopyrum intermedium* | THIN6 |
| Tall wheatgrass | *Thinopyrum ponticum* | THPO7 |
| **Warm-Season Grasses (12)** | | |
| **Annuals (2)** | | |
| Matted grama | *Bouteloua simplex* | BOSI2 |
| False buffalograss | *Munroa squarrosa* | MUSQ3 |
| **Perennials (10)** | | |
| Purple threeawn | *Aristida purpurea* | ARPU9 |
| **Big bluestem** | ***Andropogon gerardii*** | **ANGE** |
| Sideoats grama | *Bouteloua curtipendula* | BOCU |
| Buffalograss | *Bouteloua dactyloides* | BODA2 |
| Blue grama | *Bouteloua gracilis* | BOGR2 |
| Saltgrass | *Distichlis spicata* | DISP |
| James' galleta | *Pleuraphis jamesii* | PLJA |
| Tumblegrass | *Schedonnardus paniculatus* | SCPA |
| Alkali sacaton | *Sporobolus airoides* | SPAI |
| Sand dropseed | *Sporobolus cryptandrus* | SPCR |
| **Forbs (77)** | | |
| **Annuals (27)** | | |
| Desert madwort | *Alyssum desertorum* | ALDE |
| Alyssum | *Alyssum simplex* | ALSI8 |
| Redroot amaranth | *Amaranthus retroflexus* | AMRE |
| Lambsquarters | *Chenopodium album* | CHAL7 |
| Ribseed sandmat | *Chamaesyce glyptosperma* | CHGL13 |
| Mealy goosefoot | *Chenopodium incanum* | CHIN2 |
| Narrowleaf goosefoot | *Chenopodium leptophyllum* | CHLE4 |
| Thymeleaf sandmat | *Chamaesyce serpyllifolia* | CHSE6 |
| Wright's bird's beak | *Cordylanthus wrightii* | COWR2 |
| Fetid marigold | *Dyssodia papposa* | DYPA |
| Nodding buckwheat | *Eriogonum cernuum* | ERCE2 |
| Divergent buckwheat | *Eriogonum divaricatum* | ERDI5 |
| Trailing fleabane | *Erigeron flagellaris* | ERFL |
| Common sunflower | *Helianthus annuus* | HEAN3 |
| Longleaf false goldeneye | *Heliomeris longifolia* | HELO6 |
| Burningbush | *Bassia scoparia* | BASC5 |
| Fendler's desertdandelion | *Malacothrix fendleri* | MAFE |
| Pony beebalm | *Monarda pectinata* | MOPE |
| Desert broomrape | *Orobanche cooperi* | ORCO4 |
| Lemonscent | *Pectis angustifolia* | PEAN |
| Erect knotweed | *Polygonum erectum* | POER2 |
| Little hogweed | *Portulaca oleracea* | POOL |
| Lanceleaf sage | *Salvia reflexa* | SARE3 |
| Prickly Russian thistle | *Salsola tragus* | SATR12 |
| Manyflower false threadleaf | *Schkuhria multiflora* | SCMU6 |
| Golden crownbeard | *Verbesina encelioides* | VEEN |
| Rough cocklebur | *Xanthium strumarium* | XAST |

## Table A-6 : Species Observed 2019-2024, O-VMU-3

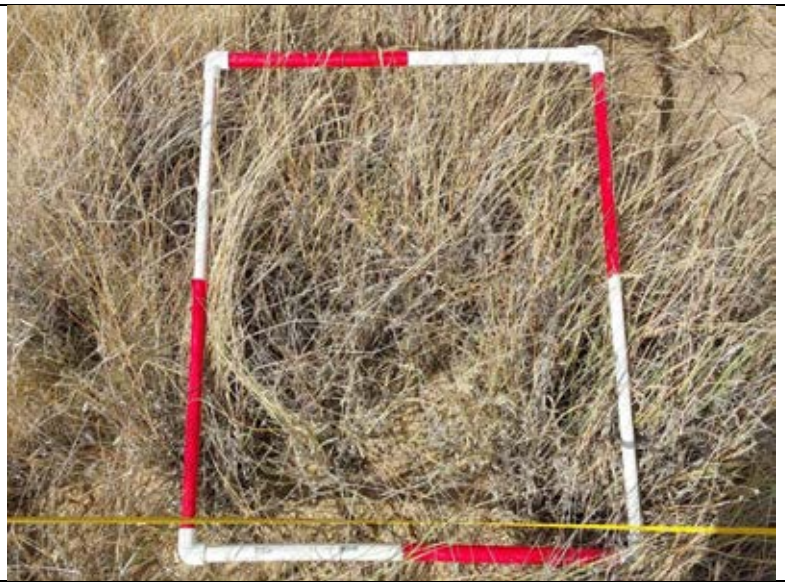
| Common Name | Scientific Name | Code |
|---|---|---|
| **Perennials/Biennials (50)** | | |
| Russian knapweed | *Acroptilon repens* | ACRE3 |
| Ragweed sagebrush | *Artemisia franserioides* | ARFR3 |
| **Horsetail milkweed** | ***Asclepias subverticillata*** | **ASSU2** |
| Silverscale saltbush | *Atriplex argentea* | ATAR2 |
| **Ragleaf bahia** | ***Bahia dissecta*** | BADI |
| Slimstalk spiderling | *Boerhavia gracillima* | **BOGR** |
| Wyoming Indian paintbrush | *Castilleja linariifolia* | CALI4 |
| Sego lily | *Calochortus nuttallii* | CANU3 |
| Musk thistle | *Carduus nutans* | CANU4 |
| Whitemargin sandmat | *Chamaesyce albomarginata* | CHAL11 |
| Sandmat | *Chamaesyce* sp. | CHAMA15 |
| Rose heath | *Chaetopappa ericoides* | CHER2 |
| Canadian horseweed | *Conyza canadensis* | COCA5 |
| White prairie clover | *Dalea candida* | DACA7 |
| Purple prairie clover | *Dalea purpurea* | DAPU5 |
| Flixweed | *Descurainia sophia* | DESO |
| Redstem stork's bill | *Erodium cicutarium* | ERCI6 |
| Spreading fleabane | *Erigeron divergens* | ERDI4 |
| James' buckwheat | *Eriogonum jamesii* | ERJA |
| Bastardsage | *Eriogonum wrightii* | ERWR |
| Indian blanket | *Gaillardia pulchella* | GAPU |
| Curlycup gumweed | *Grindelia squarrosa* | GRSQ |
| Showy goldeneye | *Heliomeris multiflora* | HEMU3 |
| Scarlet gilia | *Ipomopsis aggregata* | IPAG |
| Manyflowered ipomopsis | *Ipomopsis multiflora* | IPMU3 |
| Flatspine stickseed | *Lappula occidentalis* | LAOC3 |
| Prickly lettuce | *Lactuca serriola* | LASE |
| Mesa pepperwort | *Lepidium alyssoides* | LEAL4 |
| Lewis flax | *Linum lewisii* | LILE3 |
| Hoary tansyaster | *Machaeranthera canescens* | MACA2 |
| Tanseyleaf tansyaster | *Machaeranthera tanacetifolia* | MATA2 |
| Horehound | *Marrubium vulgare* | MAVU |
| Sweetclover | *Melilotus officinalis* | MEOF |
| Alfalfa | *Medicago sativa* | MESA |
| Colorado four o'clock | *Mirabilis multiflora* | MIMU |
| Palmer's penstemon | *Penstemon palmeri* | PEPA8 |
| Rocky Mountain penstemon | *Penstemon strictus* | PEST2 |
| Prostrate knotweed | *Polygonum aviculare* | POAV |
| Upright prairie coneflower | *Ratibida columnifera* | RACO3 |
| Curly dock | *Rumex crispus* | RUCR |
| Cutleaf vipergrass | *Scorzonera laciniata* | SCLA6 |
| Tall tumblemustard | *Sisymbrium altissimum* | SIAL2 |
| Scarlet globemallow | *Sphaeralcea coccinea* | SPCO |
| Emory's globemallow | *Sphaeralcea emoryi* | SPEM |
| Gooseberryleaf globemallow | *Sphaeralcea grossulariifolia* | SPGR2 |
| Spear globemallow | *Sphaeralcea hastulata* | SPHA |
| Wright's thelypody | *Thelypodium wrightii* | THWR |
| Yellow salsify | *Tragopogon dubius* | TRDU |
| Salsify | *Tragopogon porrifolius* | TRPO |
| Jack-go-to-bed-at-noon | *Tragopogon pratensis* | TRPR |
| **Shrubs, Trees, and Cacti (41)** | | |
| Prairie sagewort | *Artemisia frigida* | ARFR4 |
| Black sagebrush | *Artemisia nova* | ARNO4 |
| Big sagebrush | *Artemisia tridentata* | ARTR2 |
| Tubercled saltbush | *Atriplex acanthocarpa* | ATAC |
| Fourwing saltbush | *Atriplex canescens* | ATCA2 |
| Shadscale saltbush | *Atriplex confertifolia* | ATCO |
| Mat saltbush | *Atriplex corrugata* | ATCO4 |
| Gardner's saltbush | *Atriplex gardneri* | ATGA |
| Mound saltbush | *Atriplex obovata* | ATOB |
| Saltbush | *Atriplex* sp. | ATRIP |
| Longflower rabbitbrush | *Chrysothamnus depressus* | CHDE2 |
| Greene's rabbitbrush | *Chrysothamnus greenei* | CHGR6 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | CHVI8 |
| Beehive cactus | *Coryphantha* sp. | CORYP |
| Pinkflower hedgehog cactus | *Echinocereus fendleri* | ECFE |
| Kingcup cactus | *Echinocereus triglochidiatus* | ECTR |
| Russian olive | *Elaeagnus angustifolia* | ELAN |
| Longleaf jointfir | *Ephedra trifurca* | EPTR |
| Mormon tea | *Ephedra viridis* | EPVI |
| Slenderleaf buckwheat | *Eriogonum leptophyllum* | ERLE10 |
| **Slender buckwheat** | ***Eriogonum microthecum*** | **ERMI4** |
| Rubber rabbitbrush | *Ericameria nauseosa* | ERNA10 |
| Apache plume | *Fallugia paradoxa* | FAPA |
| Broom snakeweed | *Gutierrezia sarothrae* | GUSA2 |
| Hairy false goldenaster | *Heterotheca villosa* | HEVI4 |
| Oneseed juniper | *Juniperus monosperma* | JUMO |
| Winterfat | *Krascheninnikovia lanata* | KRLA2 |
| Pale desert-thorn | *Lycium pallidum* | LYPA |
| Torrey wolfberry | *Lycium torreyi* | LYTO |
| Plains pricklypear | *Opuntia polyacantha* | OPPO |
| Twoneedle pinyon | *Pinus edulis* | PIED |
| Eastern cottonwood | *Populus deltoides* | PODE3 |
| Mexican cliffrose | *Purshia mexicana* | PUME |
| Antelope bitterbrush | *Purshia tridentata* | PUTR2 |
| Skunkbush sumac | *Rhus trilobata* | RHTR |
| Greasewood | *Sarcobatus vermiculatus* | SAVE4 |
| Threadleaf ragwort | *Senecio flaccidus* | SEFL3 |
| Saltcedar | *Tamarix ramosissima* | TARA |
| Siberian elm | *Ulmus pumila* | ULPU |
| Banana yucca | *Yucca baccata* | YUBA |
| Soapweed yucca | *Yucca glauca* | YUGL |

Notes:
Bold species are newly observed on O-VMU-3 in 2024

**APPENDIX B**

# Quadrat Photographs

| O-VMU3-T01P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T02P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T03P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T04P | |
|---|---|
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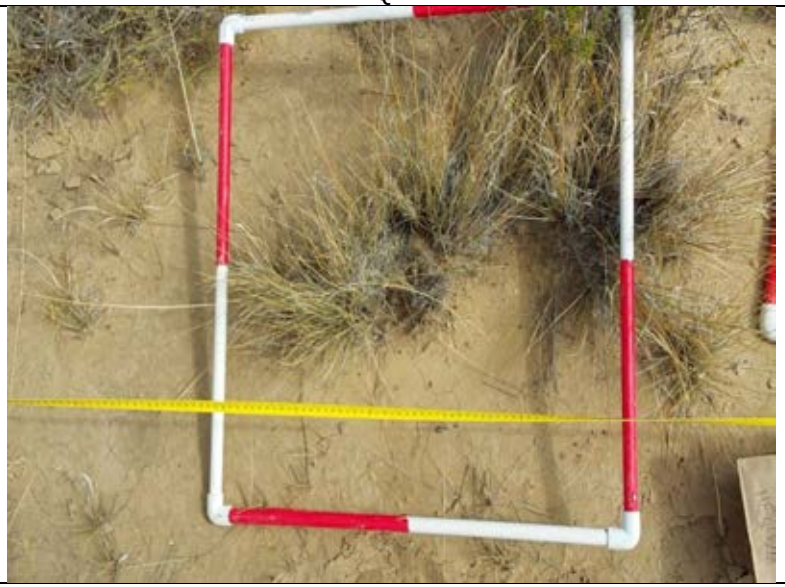
|  |  |
| Q2 | Q3 |

| O-VMU3-T05P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T06P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T07P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T08P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T09P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T10P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T11P | |
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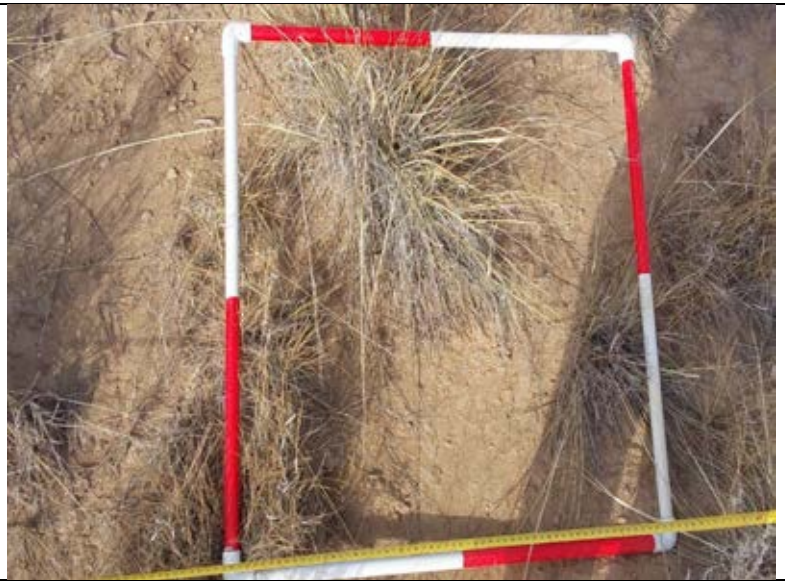
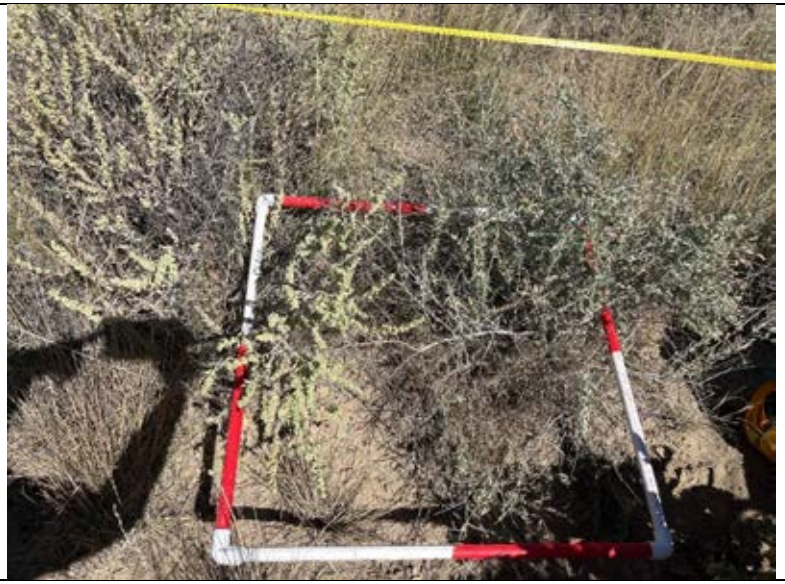
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T12P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T13P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T14P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T15P | |
|---|---|
|  |  |
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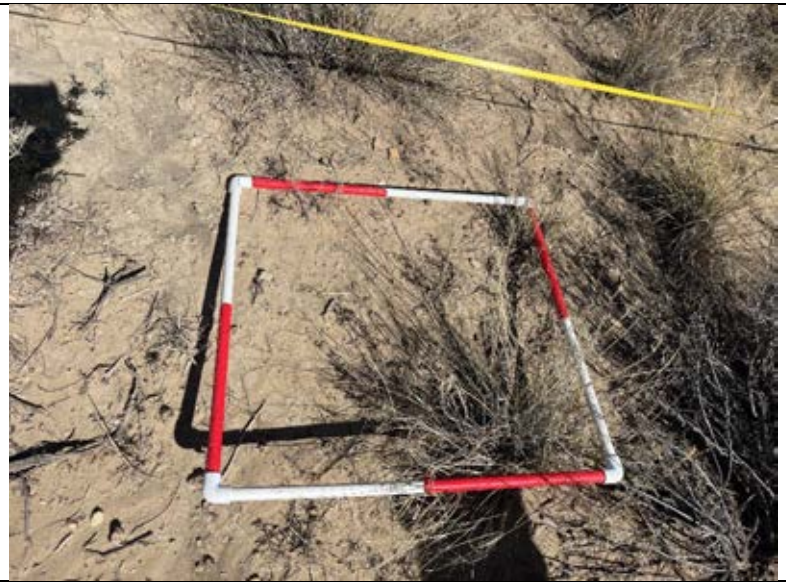
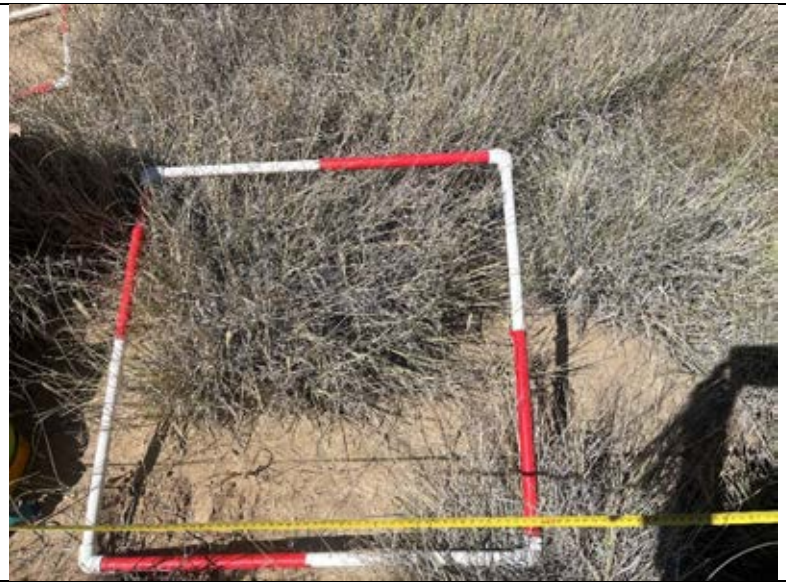
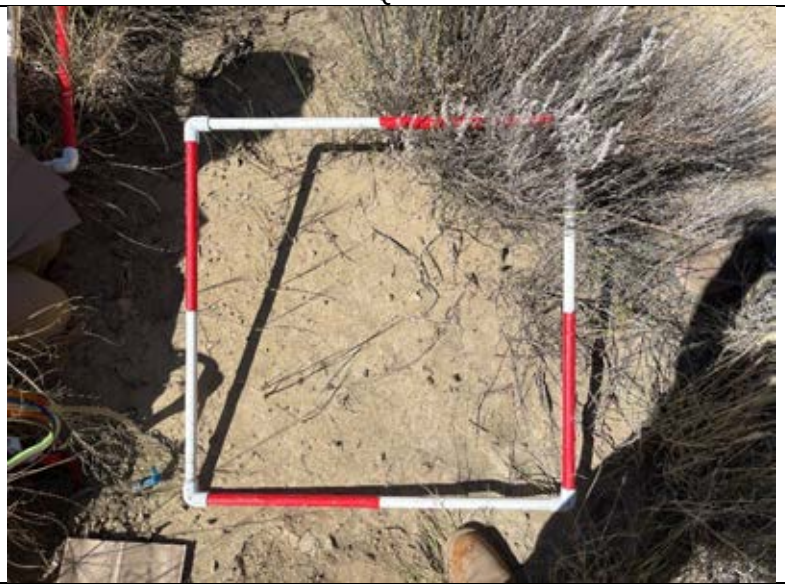
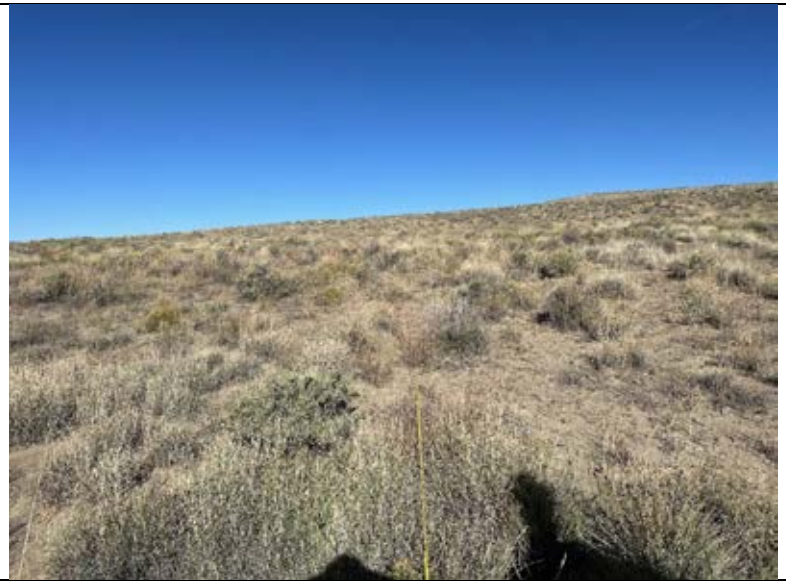
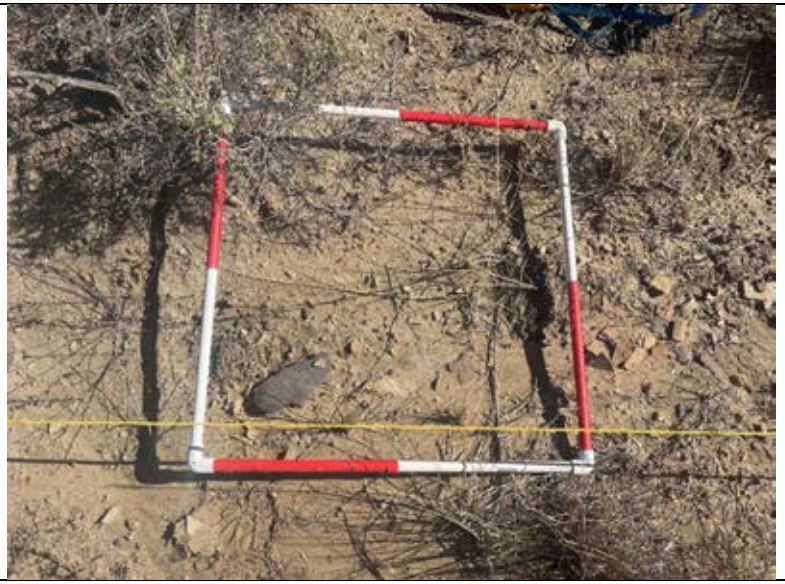
|  |  |
| Q2 | Q3 |

| O-VMU3-T16P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T17P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T18P | |
|---|---|
|  |  |
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|  |  |
| Q2 | Q3 |

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|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T20P | |
|---|---|
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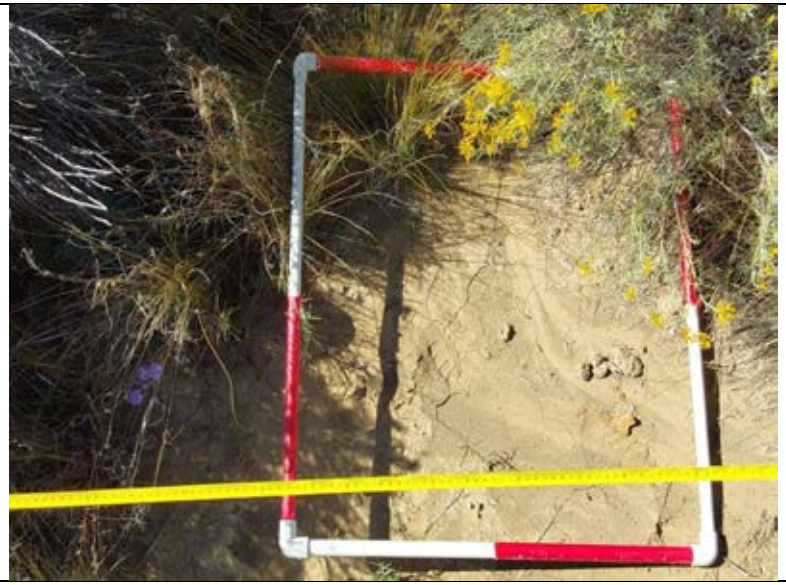
|  |  |
| Q2 | Q3 |

| O-VMU3-T21P | |
|---|---|
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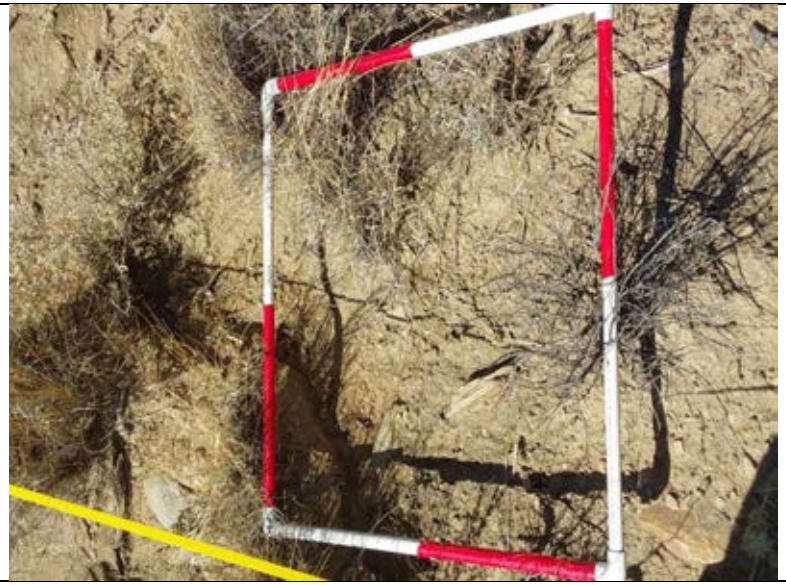
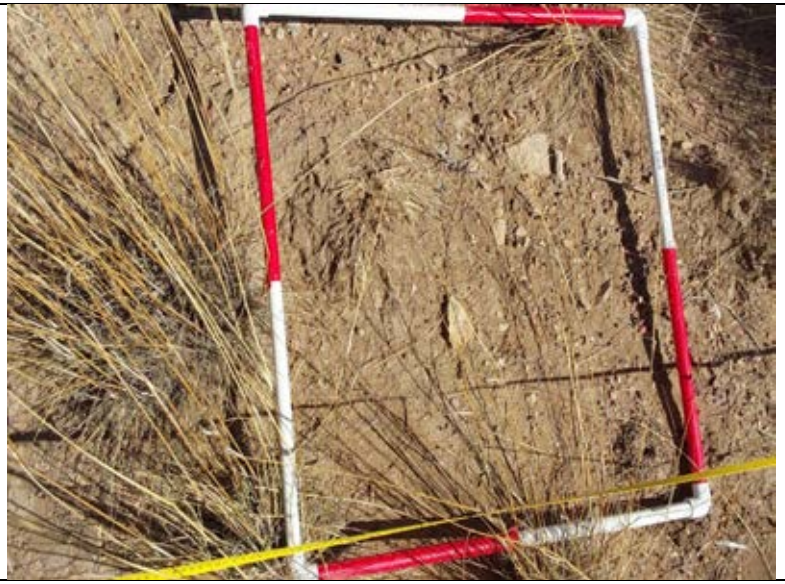
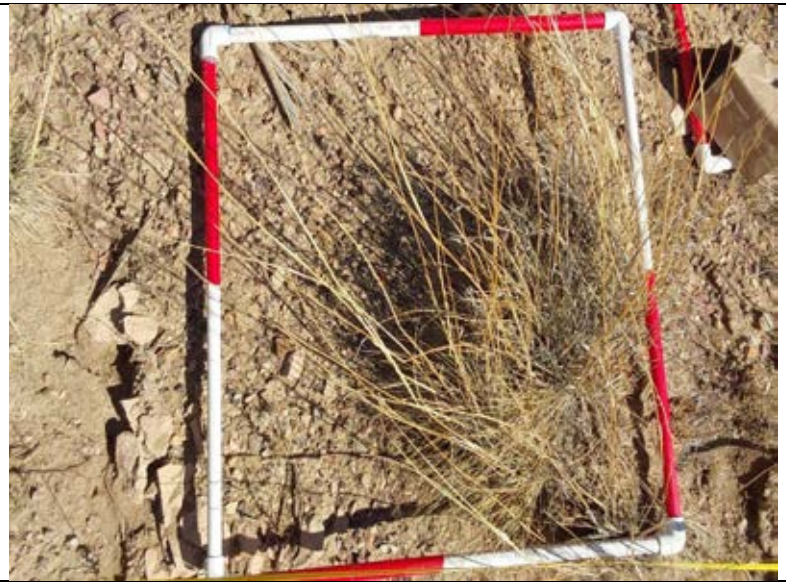
|  |  |
| Q2 | Q3 |

| O-VMU3-T22P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T23P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

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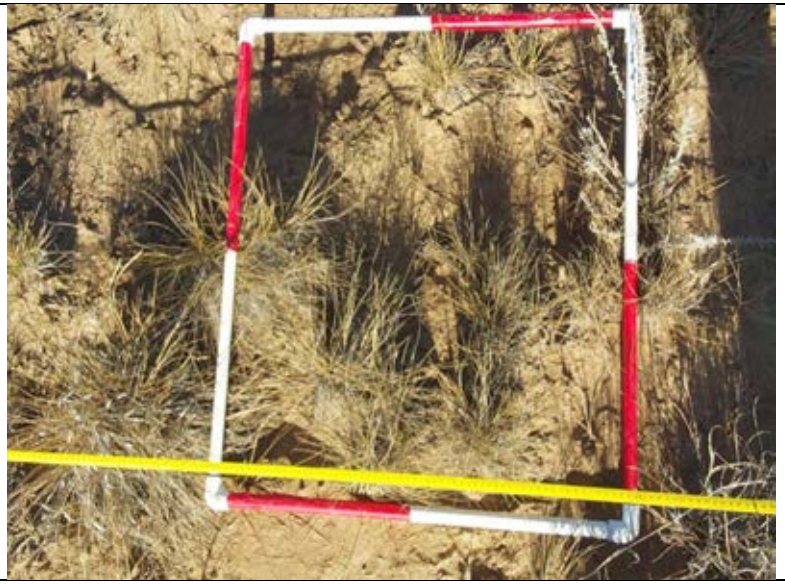
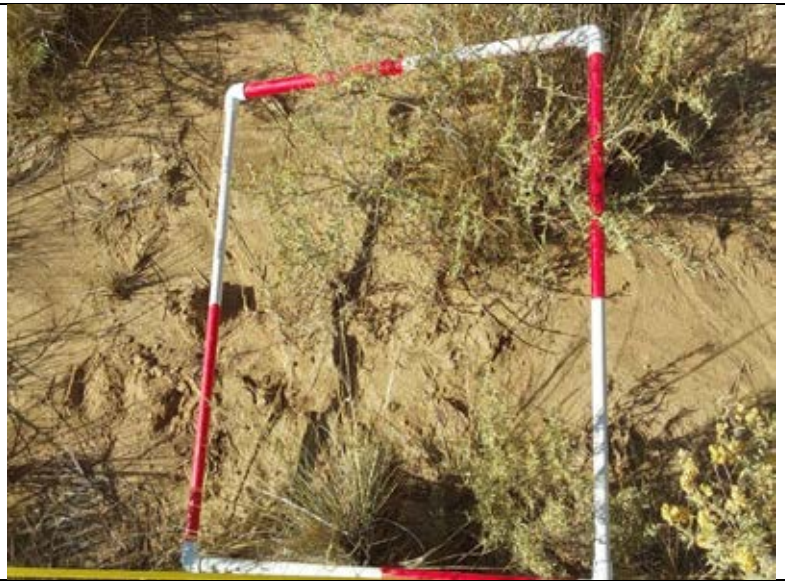
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T25P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T26P | |
|---|---|
|  |  |
| Belt | Q1 |
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| Q2 | Q3 |

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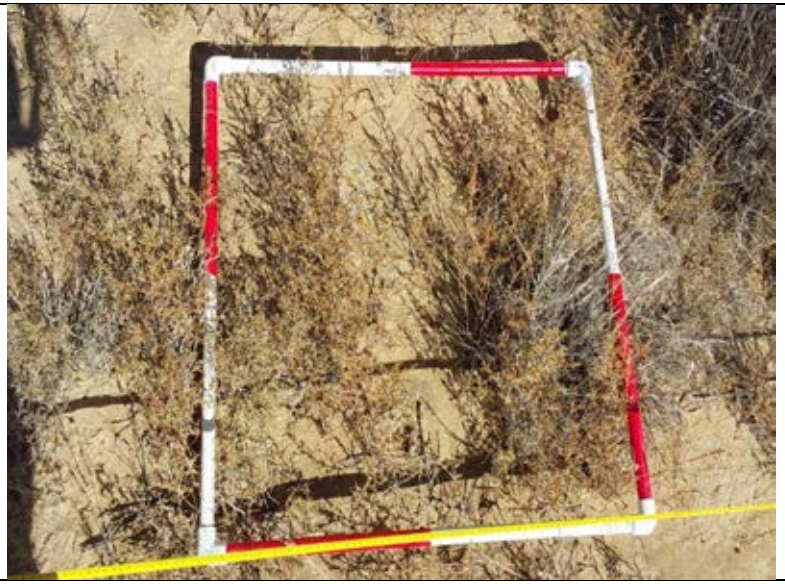
|---|---|
|  |  |
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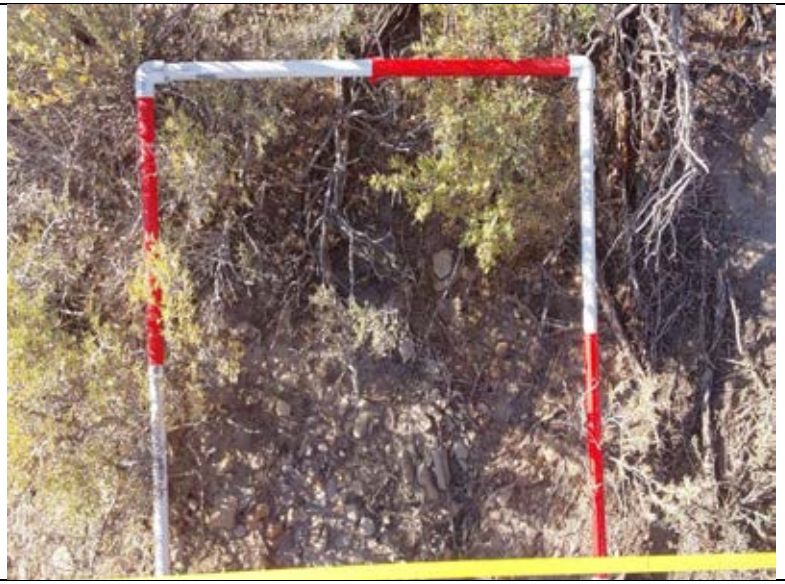
|  |  |
| Q2 | Q3 |

| O-VMU3-T28P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

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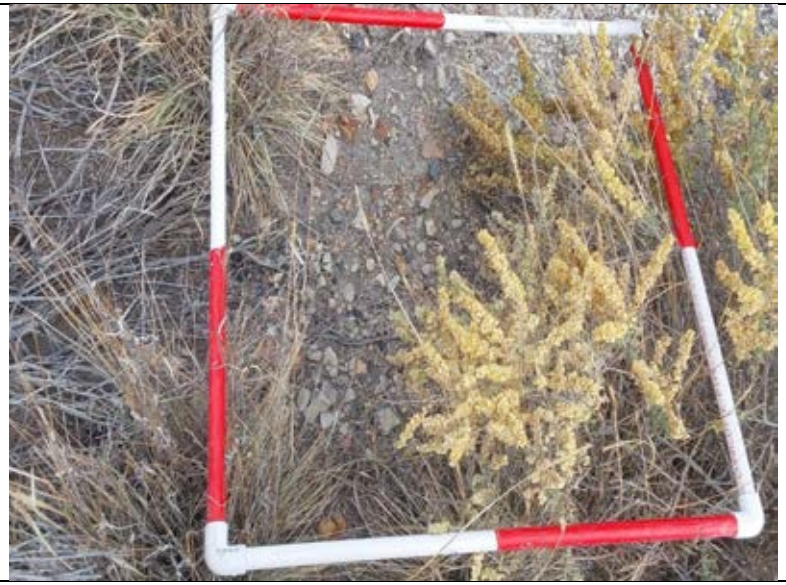
|  |  |
| Q2 | Q3 |

| O-VMU3-T30P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T31P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T32P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T33P | |
|---|---|
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| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T34P | |
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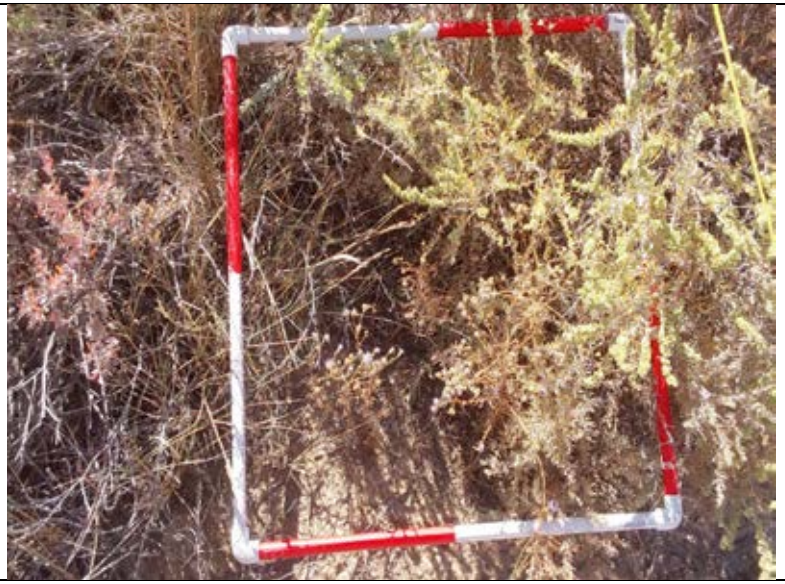
|  |  |
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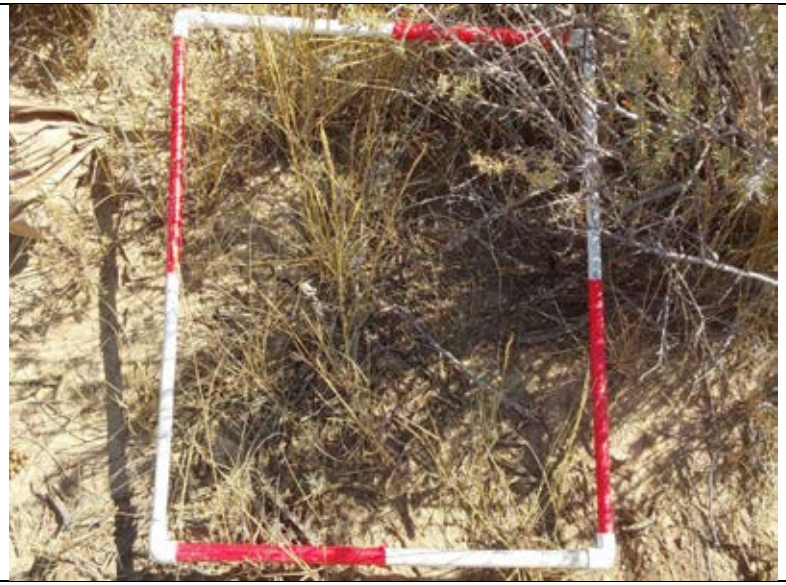
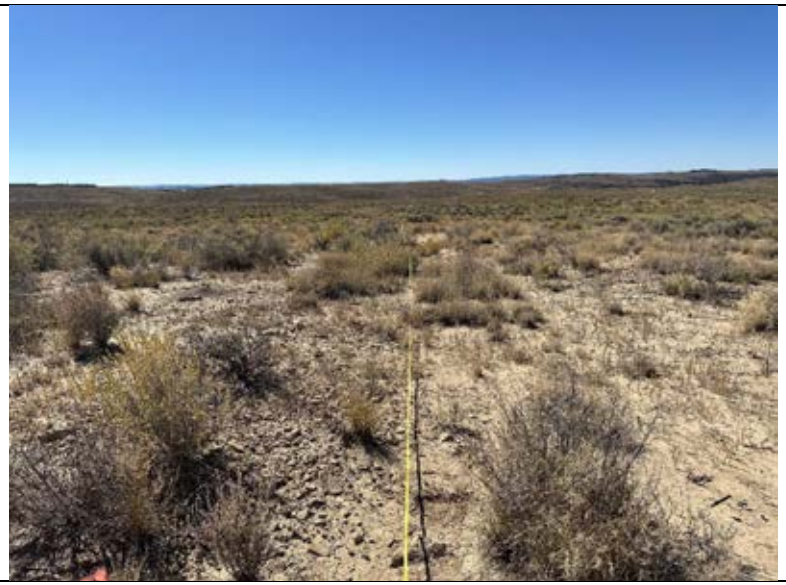
|  |  |
| Q2 | Q3 |

| O-VMU3-T35P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T36P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T37P | |
|---|---|
|  |  |
| Belt | Q1 |
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| Q2 | Q3 |

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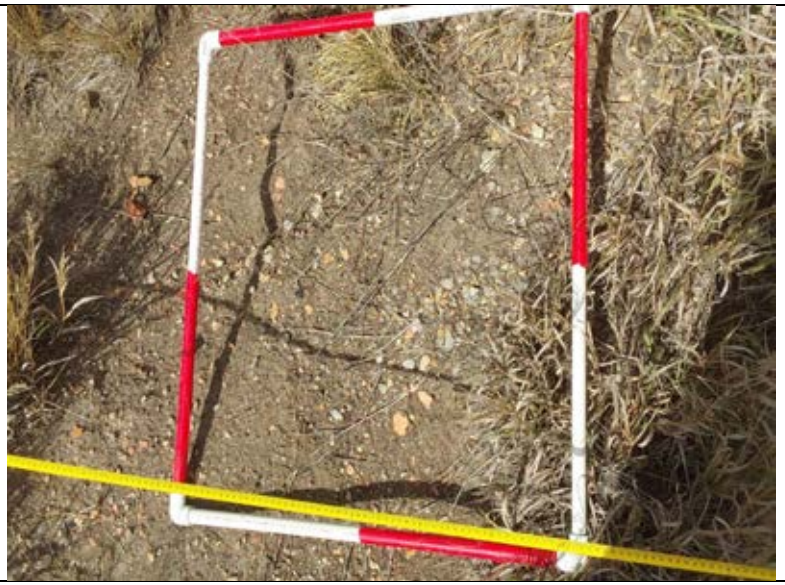
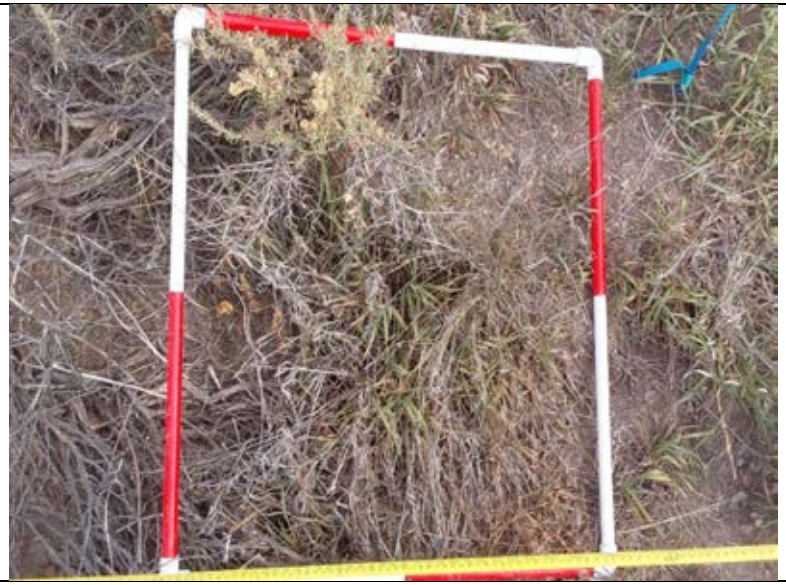
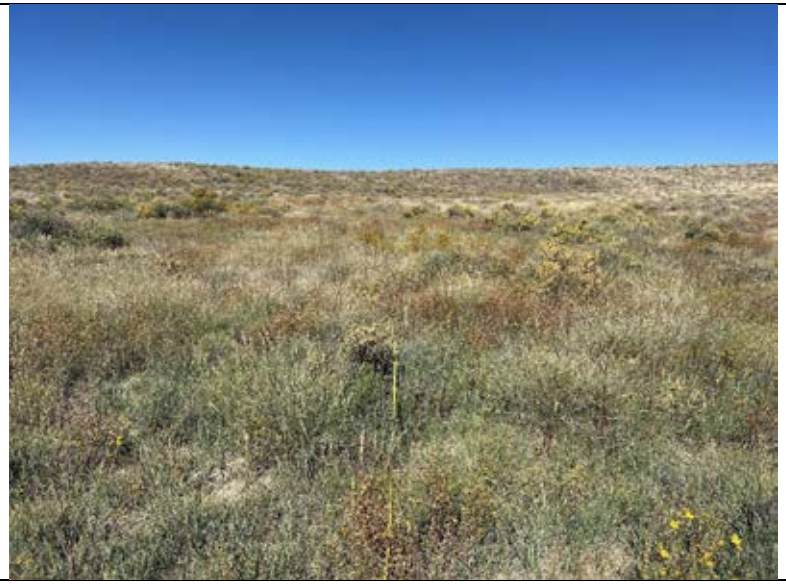
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T39P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU3-T40P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

**APPENDIX C**

# Vegetation Statistical Analysis

**Table C1: Equations for Vegetation Data Analysis**

| Attribute | Equation | Where |
|---|---|---|
| Mean | $\bar{x} = \frac{\sum x}{n}$ | $\bar{x}$ = sample mean<br>$\sum$x = sum of values for variable<br>n = number of samples |
| Standard Deviation | $s = \sqrt{\frac{\sum(\bar{x} - x)^2}{n-1}}$ | s = standard deviation<br>$\sum$ = sum<br>$\bar{x}$ = sample mean<br>n = number of samples |
| Variance (sample) | $s^2 = \frac{\sum_{(x_i - \bar{x})^2}}{n-1}$ | $s^2$ = variance<br>$\sum$ = sum<br>$x_i$ = Value of variable for sample *i*<br>$\bar{x}$ = sample mean<br>n = number of samples |
| 90% Confidence Interval | $\bar{x} \pm z\frac{s}{\sqrt{n}}$ | $\bar{x}$ = sample mean<br>z = the critical value from the normal distribution with α/2 in each tail<br>s = standard deviation<br>n = number of samples |
| $N_{min}$ (Sample Adequacy - Normal Data) | $N_{min} = \frac{t^2 s^2}{(\bar{x}D)^2}$ | $N_{min}$ = number of samples required<br>t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom<br>s = standard deviation ($s^2$ = variance)<br>$\bar{x}$ = sample mean<br>D = the desired level of accuracy, which is 10 percent of the mean |
| Logarithmic Transformation | Y' = log(Y + k) | log = logarithmic function<br>Y = attribute value<br>k = constant, here we use 1 |
| one-sample, one-sided t test | $t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$ | t* = calculated t-statistic<br>$\bar{x} = sample\ mean$<br>s = standard deviation<br>n = sample size |
| one-sample, one-sided sign test | $z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$ | z = sign test statistic<br>k = test statistic resulting from the number of values falling below 90% of the technical standard<br>n = sample size |
| Relative Cover (Perennial/Biennial Species) | Rp/b-cvr = Cvrp/b-sp. / Cvrp/b-abs. | $R_{p/b\text{-}cvr}$ = Calculated Relative Cover for a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}sp.}$ = Mean Absolute Cover of a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}abs.}$ = Mean Absolute Perennial/Biennial Cover |
| Relative Cover (All Species) | Rcvr = Cvrsp. / CvrAbs. | $R_{cvr}$ = Calculated Relative Cover for a species<br>$Cvr_{sp.}$ = Mean Absolute Cover of ANY species<br>$Cvr_{abs.}$ = Mean Absolute Cover for All Species |

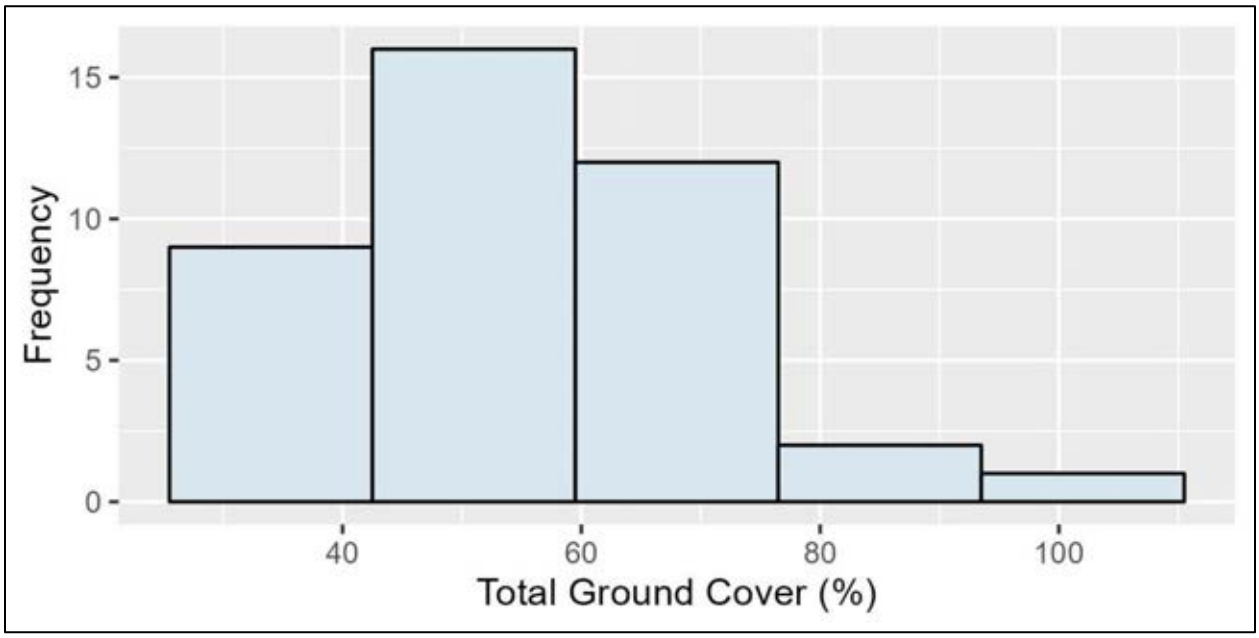
Notes:
All Appendix C analysis, tables, and figures computed using R software: (R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

**Table C-2: Data for Normal Distribution and Variance Analysis, O-VMU-3, 2024**

| Transect | Raw Data | | | | | Log-Transformed Data | |
|---|---|---|---|---|---|---|---|
| | Total Ground Cover (%) | Perennial Vegetation Cover (%) | Annual Forage Production (lbs/ac) | Woody Plant Density (#/ac) | Log - Perenial Vegetation Cover | Log - Annual Forage Production | Log - Woody Plant Density |
| O-VMU3-T01P | 60 | 36 | 690 | 728 | 1.57 | 2.84 | 2.86 |
| O-VMU3-T02P | 54 | 48 | 1,069 | 2,023 | 1.69 | 3.03 | 3.31 |
| O-VMU3-T03P | 28 | 14 | 119 | 486 | 1.18 | 2.08 | 2.69 |
| O-VMU3-T04P | 54 | 48 | 726 | 3,157 | 1.69 | 2.86 | 3.50 |
| O-VMU3-T05P | 52 | 40 | 1,230 | 1,174 | 1.61 | 3.09 | 3.07 |
| O-VMU3-T06P | 28 | 18 | 566 | 4,249 | 1.28 | 2.75 | 3.63 |
| O-VMU3-T07P | 82 | 80 | 1,250 | 2,064 | 1.91 | 3.10 | 3.31 |
| O-VMU3-T08P | 48 | 36 | 386 | 324 | 1.57 | 2.59 | 2.51 |
| O-VMU3-T09P | 36 | 26 | 508 | 486 | 1.43 | 2.71 | 2.69 |
| O-VMU3-T10P | 36 | 16 | 451 | 1,942 | 1.23 | 2.66 | 3.29 |
| O-VMU3-T11P | 52 | 48 | 529 | 647 | 1.69 | 2.72 | 2.81 |
| O-VMU3-T12P | 94 | 90 | 2,471 | 364 | 1.96 | 3.39 | 2.56 |
| O-VMU3-T13P | 44 | 36 | 587 | 2,064 | 1.57 | 2.77 | 3.31 |
| O-VMU3-T14P | 48 | 36 | 758 | 2,509 | 1.57 | 2.88 | 3.40 |
| O-VMU3-T15P | 68 | 56 | 889 | 3,237 | 1.76 | 2.95 | 3.51 |
| O-VMU3-T16P | 74 | 66 | 406 | 2,469 | 1.83 | 2.61 | 3.39 |
| O-VMU3-T17P | 38 | 16 | 282 | 1,538 | 1.23 | 2.45 | 3.19 |
| O-VMU3-T18P | 52 | 32 | 1,849 | 1,255 | 1.52 | 3.27 | 3.10 |
| O-VMU3-T19P | 54 | 40 | 1,632 | 2,388 | 1.61 | 3.21 | 3.38 |
| O-VMU3-T20P | 60 | 52 | 377 | 3,076 | 1.72 | 2.58 | 3.49 |
| O-VMU3-T21P | 42 | 36 | 607 | 4,006 | 1.57 | 2.78 | 3.60 |
| O-VMU3-T22P | 76 | 66 | 1,354 | 1,093 | 1.83 | 3.13 | 3.04 |
| O-VMU3-T23P | 26 | 18 | 369 | 445 | 1.28 | 2.57 | 2.65 |
| O-VMU3-T24P | 56 | 50 | 694 | 728 | 1.71 | 2.84 | 2.86 |
| O-VMU3-T25P | 38 | 26 | 366 | 1,538 | 1.43 | 2.56 | 3.19 |
| O-VMU3-T26P | 62 | 38 | 532 | 1,497 | 1.59 | 2.73 | 3.18 |
| O-VMU3-T27P | 72 | 52 | 772 | 1,214 | 1.72 | 2.89 | 3.08 |
| O-VMU3-T28P | 54 | 36 | 1,207 | 2,671 | 1.57 | 3.08 | 3.43 |
| O-VMU3-T29P | 54 | 34 | 1,551 | 931 | 1.54 | 3.19 | 2.97 |
| O-VMU3-T30P | 54 | 46 | 1,153 | 3,723 | 1.67 | 3.06 | 3.57 |
| O-VMU3-T31P | 68 | 44 | 611 | 809 | 1.65 | 2.79 | 2.91 |
| O-VMU3-T32P | 60 | 36 | 1,041 | 1,821 | 1.57 | 3.02 | 3.26 |
| O-VMU3-T33P | 66 | 48 | 793 | 1,457 | 1.69 | 2.90 | 3.16 |
| O-VMU3-T34P | 48 | 34 | 652 | 2,104 | 1.54 | 2.82 | 3.32 |
| O-VMU3-T35P | 46 | 24 | 535 | 2,023 | 1.40 | 2.73 | 3.31 |
| O-VMU3-T36P | 62 | 52 | 840 | 2,185 | 1.72 | 2.92 | 3.34 |
| O-VMU3-T37P | 40 | 24 | 313 | 971 | 1.40 | 2.50 | 2.99 |
| O-VMU3-T38P | 76 | 42 | 624 | 2,266 | 1.63 | 2.80 | 3.36 |
| O-VMU3-T39P | 46 | 38 | 480 | 1,255 | 1.59 | 2.68 | 3.10 |
| O-VMU3-T40P | 90 | 78 | 2,525 | 728 | 1.90 | 3.40 | 2.86 |
| Mean | 55.0 | 41.4 | 844.9 | 1741.2 | 1.59 | 2.85 | 3.15 |
| Standard Deviation | 16.1 | 17.4 | 550.1 | 1033.3 | 0.2 | 0.3 | 0.3 |
| Count | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Variance | 259 | 304 | 302565 | 1067658 | 0.03 | 0.07 | 0.09 |
| 90% Confidence Interval | 4.2 | 4.5 | 143.1 | 268.7 | 0.05 | 0.07 | 0.08 |
| Technical Standard | 52% | 24% | 550 | 400 | 1.38 | 2.74 | 2.60 |
| **90% of Standard** | 46.8% | 21.6% | 495 | 360 | 1.33 | 2.69 | 2.56 |

Notes:
2024 Data are found in Appendix A

Appendix C: Statistics Exhibit 1: Total Ground Cover

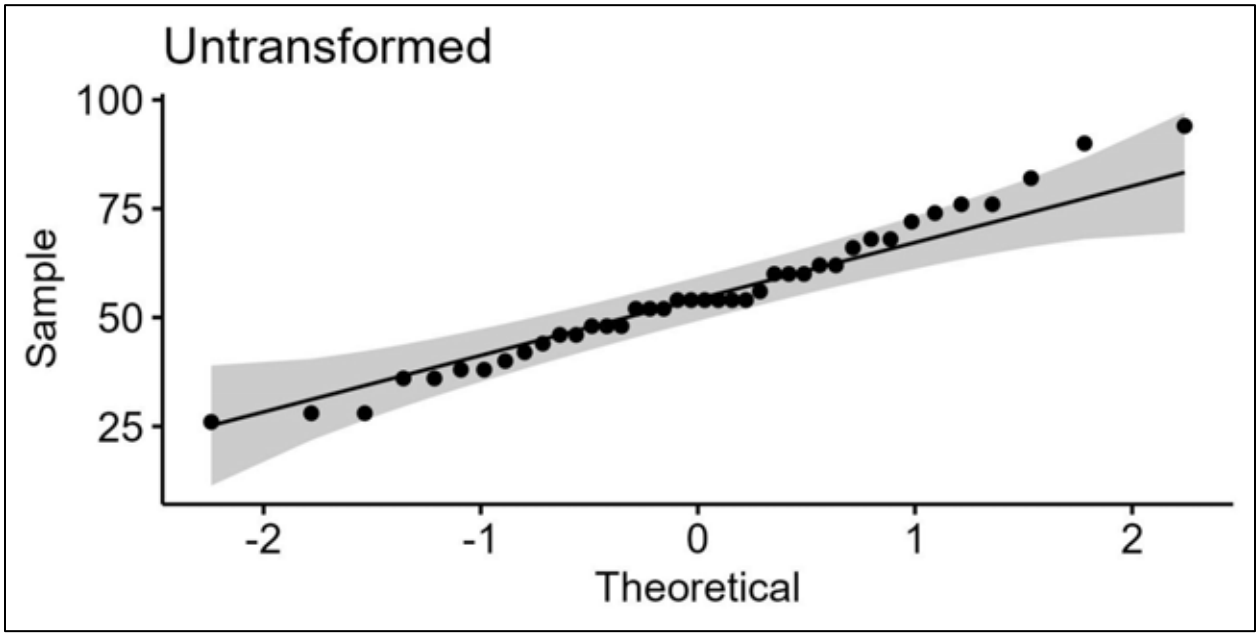



| N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 54.95 | 50.8 | 59.1 | 0.4 | 16.1 | 0.40 | 2.89 | 45.5 | 54 | 63 |

Sample adequacy is 24 samples.

Normality

Q-Q Plot



Normality (cont.)

Shapiro-Wilk Test

| W statistic | P value |
|---|---|
| 0.976 | 0.528 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed, and sample adequacy has been met, therefore the statistical test was performed using a standard t-test under classic null hypothesis:

$H_0$: Reclaim ≥ 90% of the Performance Standard

$H_a$: Reclaim < 90% of the Performance Standard

Therefore,

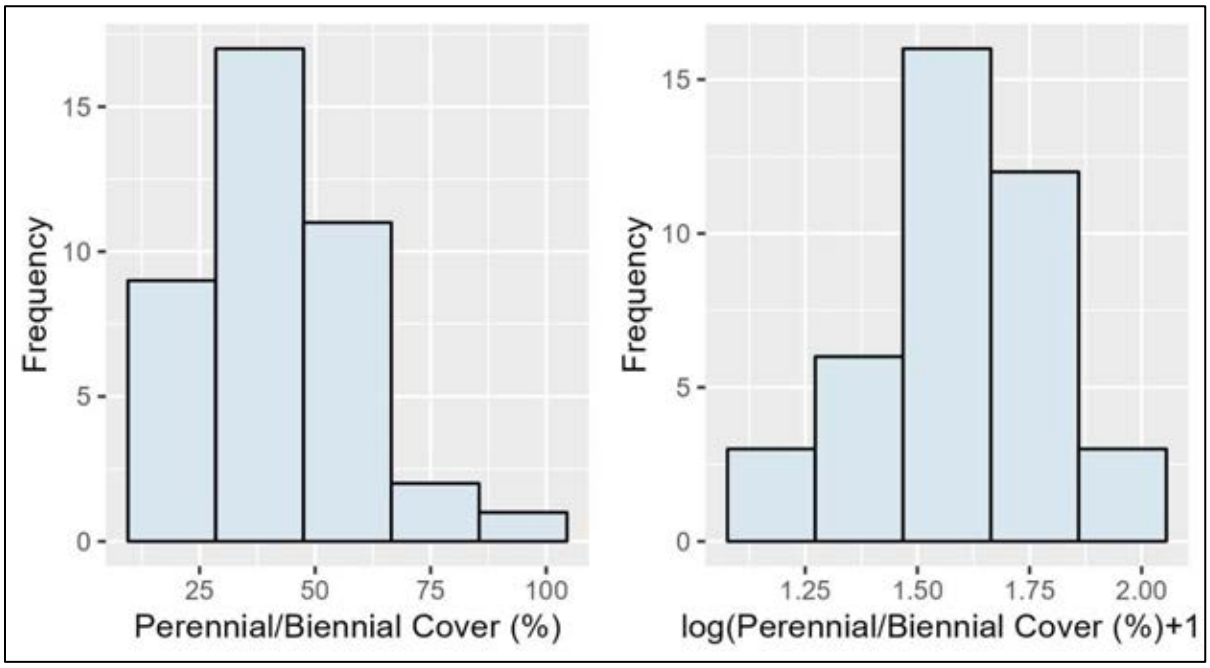
If $t^* \geq t_{(\alpha; n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha; n-1)}$, conclude failure to meet the performance standard.

| Total Ground Cover (%) | |
|---|---|
| Mean (%) | 54.95 |
| Standard Deviation (%) | 16.1 |
| Sample Size | 40 |
| Technical Standard (%) | 52 |
| t* | 3.20 |
| 1-tail t (0.1, 39) | -1.304 |
| p-value | 1 |

t*(3.20) ≥ t(-1.304) and p>0.1, the performance standard is met

## Appendix C: Statistics Exhibit 2: Perennial Ground Cover

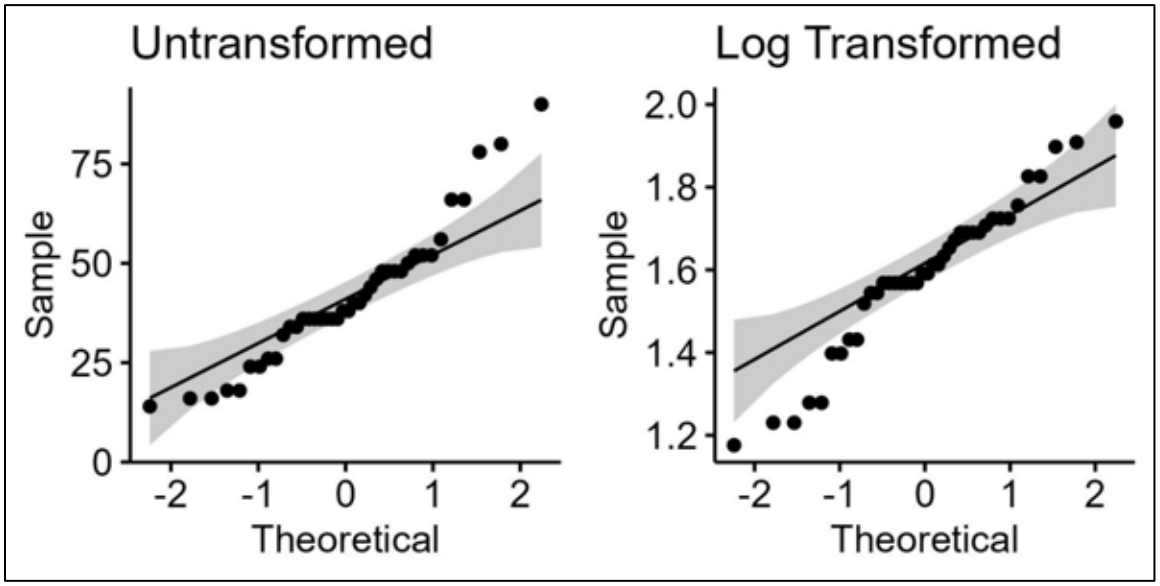



| Data | N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Data | 40 | 41.4 | 36.9 | 45.9 | 0.44 | 17.4 | 0.78 | 3.6 | 33.5 | 38 | 48.5 |
| log(X+1) | 40 | 1.59 | 1.54 | 1.64 | 0.004 | 0.18 | -0.37 | 2.9 | 1.54 | 1.59 | 1.69 |

Sample adequacy is 50 samples.

## Normality

Q-Q Plot




## Normality (cont.)

Shapiro-Wilk Test

| Data | W statistic | P value |
|---|---|---|
| Data | 0.939 | 0.032 |
| Log | 0.966 | 0.277 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed with a logarithmic transformation, and sample adequacy has not been met, therefore the statistical test was performed using a standard t-test under reverse null hypothesis on the transformed data:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

Therefore,

If $t^* \geq t_{(1-\alpha;\, n-1)}$, conclude that the performance standard was met.

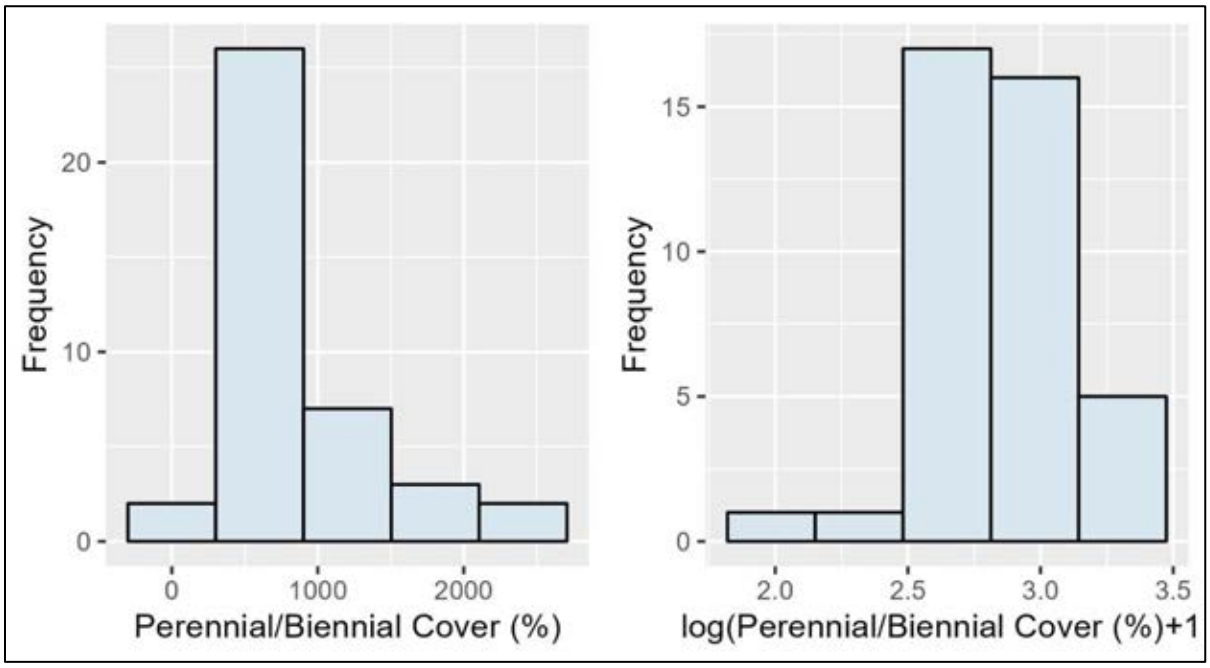
If $t^* < t_{(1-\alpha;\, n-1)}$, conclude failure to meet the performance standard.

| Perennial/Biennial Cover | |
|---|---|
| Mean | 1.59 |
| Standard Deviation | 0.18 |
| Sample Size | 40 |
| Technical Standard [1] | 1.33 |
| t* | 9.14 |
| 1-tail t (0.9, 39) | 1.304 |
| p-value | p < 0.001 |

t*(9.14) ≥ t(1.304) and p < 0.1, the performance standard is met

[1]Note the value reported is log(X)+log(0.9) not just the log(X)

## Appendix C: Statistics Exhibit 3: Production

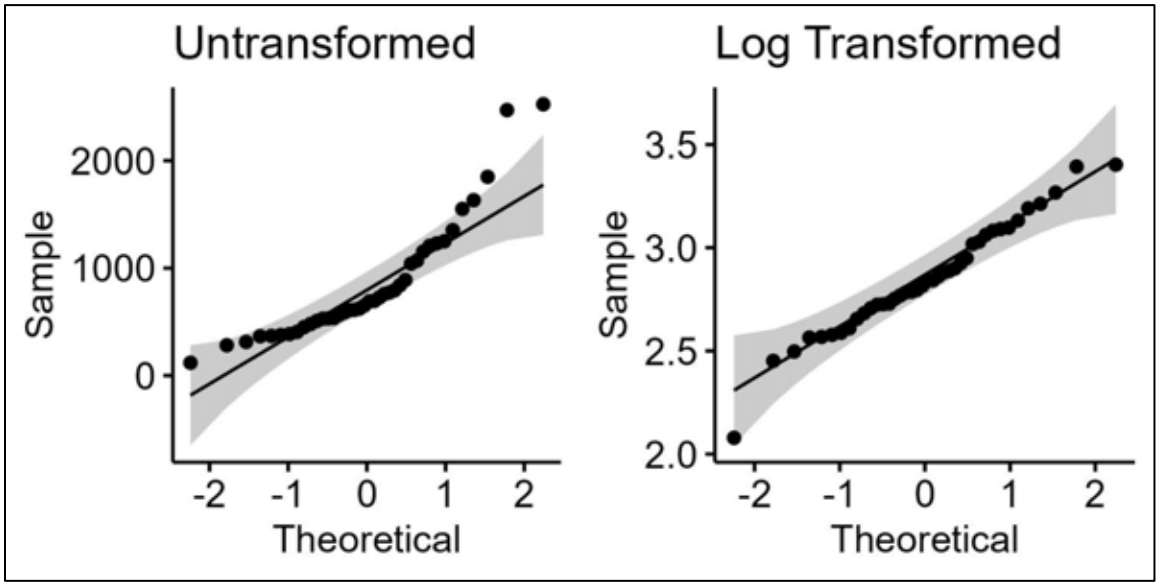



| Data | N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Data | 40 | 844.9 | 701.8 | 988.0 | 13.8 | 550.1 | 1.51 | 5.04 | 501.1 | 671.3 | 1090.3 |
| log(X+1) | 40 | 2.85 | 2.78 | 2.92 | 0.007 | 0.27 | -0.13 | 3.49 | 2.70 | 2.83 | 3.04 |

Sample adequacy is 120 samples.

## Normality

Q-Q Plot




## Normality (cont.)

Shapiro-Wilk Test

| Data | W statistic | P value |
|---|---|---|
| Data | 0.847 | $7.69 \times 10^{-5}$ |
| Log | 0.982 | 0.748 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed with a logarithmic transformation, and sample adequacy has not been met, therefore the statistical test was performed using a standard t-test under reverse null hypothesis on the transformed data:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

Therefore,

If $t^* \geq t_{(1-\alpha;\, n-1)}$, conclude that the performance standard was met.

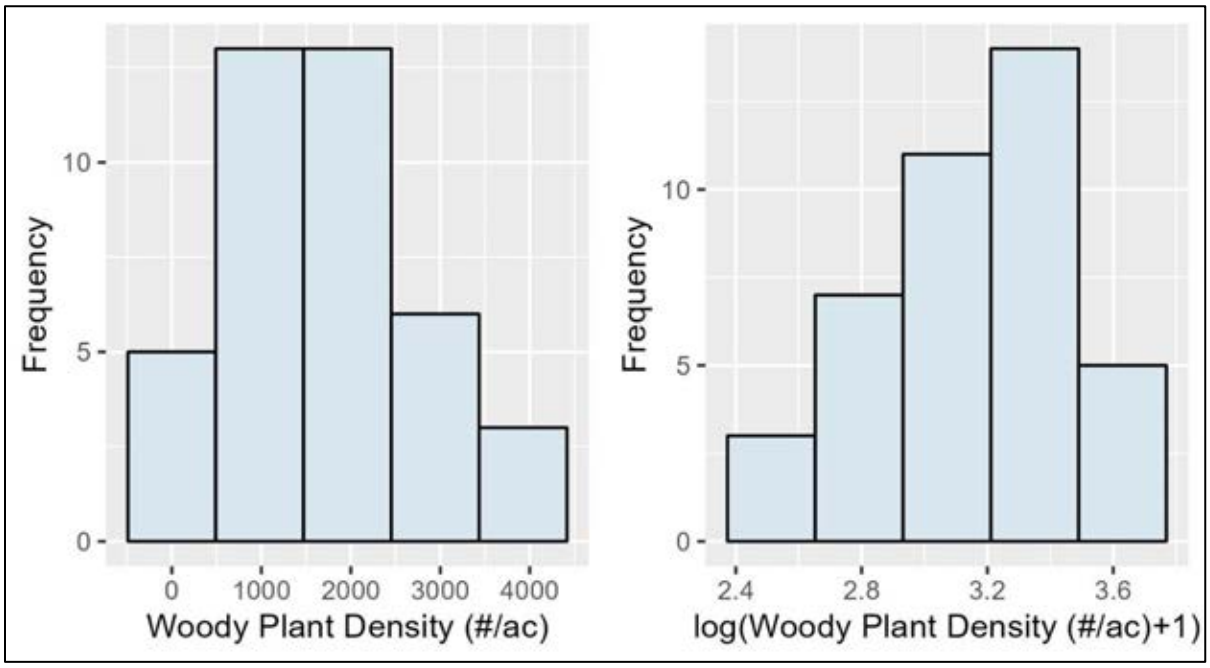
If $t^* < t_{(1-\alpha;\, n-1)}$, conclude failure to meet the performance standard.

| Production (lbs/ac) | |
|---|---|
| Mean | 2.85 |
| Standard Deviation | 0.27 |
| Sample Size | 40 |
| Technical Standard [1] | 2.64 |
| t* | 4.92 |
| 1-tail t (0.9, 39) | 1.304 |
| p-value | p < 0.001 |

**t*(4.92) ≥ t(1.304) and p < 0.1, the performance standard is met**

[1]Note the value reported is log(X)+log(0.9) not just the log(X)

## Appendix C: Statistics Exhibit 4: Woody Plant Density

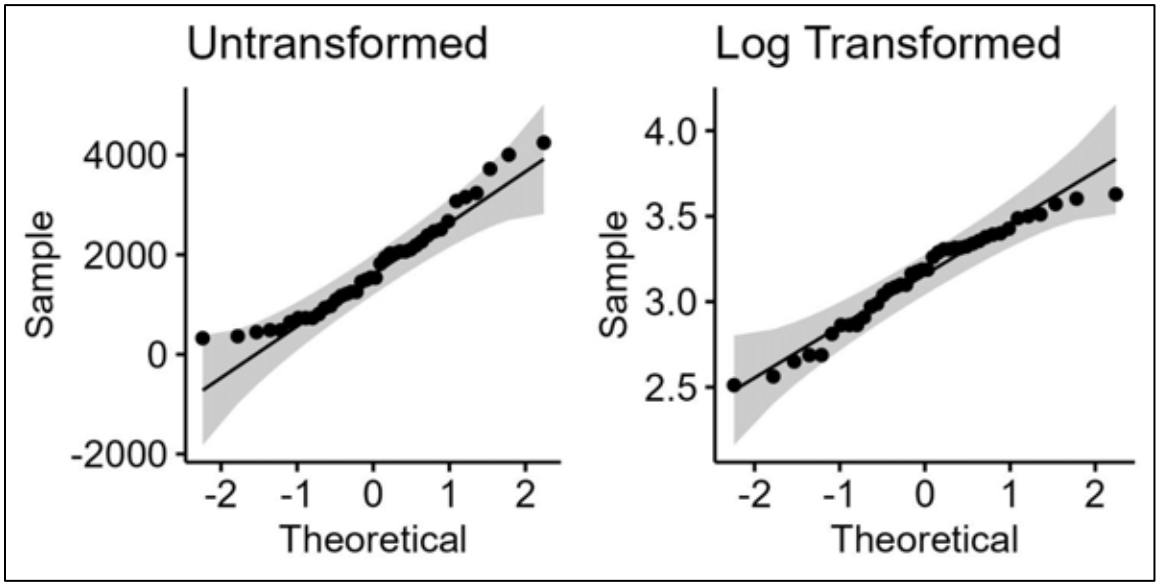



| Data | N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Data | 40 | 1741.2 | 1472.4 | 2009.9 | 25.83 | 1033.3 | 0.64 | 2.71 | 900.4 | 1537.8 | 2296.6 |
| log(X+1) | 40 | 3.15 | 3.07 | 3.23 | 0.01 | 0.30 | -0.46 | 2.34 | 2.95 | 3.19 | 3.36 |

Sample adequacy is 100 samples.

## Normality

Q-Q Plot




## Normality (cont.)

Shapiro-Wilk Test

| Data | W statistic | P value |
|---|---|---|
| Data | 0.944 | 0.046 |
| Log | 0.959 | 0.158 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed with a logarithmic transformation, and sample adequacy has not been met, therefore the statistical test was performed using a standard t-test under reverse null hypothesis on the transformed data:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

Therefore,

If $t^* \geq t_{(1-\alpha;\, n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(1-\alpha;\, n-1)}$, conclude failure to meet the performance standard.

| Woody Plant Density (#/ac) | |
|---|---|
| Mean | 3.15 |
| Standard Deviation | 0.30 |
| Sample Size | 40 |
| Technical Standard [1] | 2.56 |
| t* | 12.44 |
| 1-tail t (0.9, 39) | 1.304 |
| p-value | p < 0.001 |

t*(12.44) ≥ t(1.304) and p < 0.1, the performance standard is met

[1]Note the value reported is log(X)+log(0.9) not just the log(X)



wsp.com

**REPORT**

# Vegetation Management Unit 5
# Vegetation Success Monitoring, 2024

Submitted to:

**Chevron Mining Inc. - McKinley Mine**

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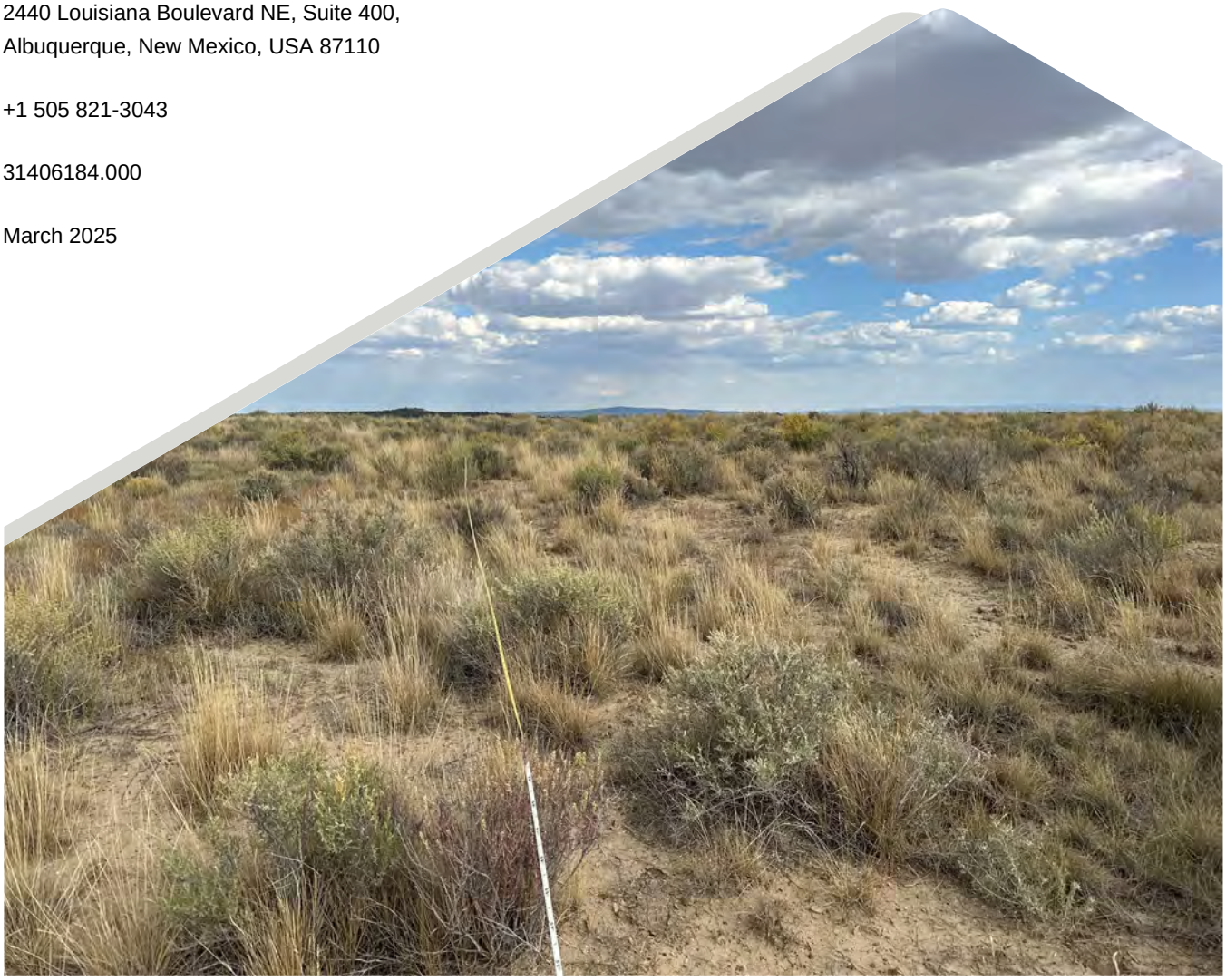
March 2025



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# 1.0 INTRODUCTION

Mining at the McKinley Mine ceased in 2009 and reclamation of remaining support facilities (e.g., impoundments, roads, etc.) is nearing completion. Reclamation practices have been applied at the McKinley Mine under various programs since at least the early 1970s. Chevron Mining Inc. (CMI) is assessing the vegetation in reclaimed areas in anticipation of future bond and liability release. CMI understands the importance of returning the mined lands to productive traditional uses in a timely manner. To qualify for release, the increment, or permit area as a whole, must meet the Permit No. NM-0001K (2016) (the Permit) permanent-program revegetation-success criteria as shown in Table 1 of this report. In general, the lands must be in a condition that is as good as or better than the pre-mine conditions, stable, and capable of supporting the designated postmining land uses of grazing and wildlife. WSP USA, Inc. (WSP) was retained to monitor and assess the vegetation relative to the established vegetation success standards.

This report documents the vegetation community attributes collected in 2024 in O-VMU-5 and compares them to the Permit's vegetation-success criteria. Section 1 includes the introduction and a general overview. Section 2 describes the vegetation monitoring methods that were used in 2024. Section 3 presents the results of the assessment with respect to total ground cover, perennial vegetation cover, forage production, woody plant density (shrub density), and composition and diversity. Section 4 is a summary of the results for O-VMU-5 with emphasis on vegetation success.

The 2024 sampling program was conducted and evaluated in accordance with the updated monitoring methods and revegetation success standards contained in Permit Modification Number 23-03. More details beyond what is already discussed throughout this report may be found in the Permit.

## 1.1 Vegetation Management Unit 5

This report presents results from 2024 quantitative vegetation monitoring conducted in Vegetation Management Unit 5 (O-VMU-5), which is in the western portion of Area 2 and minor portions of Areas 1 and 10 (Figure 1). The configuration of the vegetation monitoring units within the U.S. Department of the Interior – Office of Surface Mining Reclamation and Enforcement (OSMRE) Permit Area, were developed in consultation with OSMRE. Undisturbed lands included within the VMU were not part of the sampling program. O-VMU-5 encompasses about 1,129 acres, comprised of permanent program lands (PPL), prelaw, and initial program lands (IPL). Both PPL and IPL as one unit must meet the PPL revegetation success criteria as discussed in the Permit in Section 6.5.1.2. The 10-year period of extended responsibility, however, only applies to PPL.

The elevation of O-VMU-5 ranges from about 7,000 to 7,200 feet above mean sea level. Reclamation started in 1975 with the vast majority seeded by 2003. Thus, the reclamation in the majority of O-VMU-5 ranges from 21 to almost 50 years old. This section provides a general description of the reclamation activities that were implemented. Additional details of the reclamation for specific areas can be obtained through review of the McKinley Mine annual reports.

## 1.2 Reclamation and Revegetation Procedures

Reclamation of permanent program lands included grading of the spoils to achieve a stable configuration, positive drainage, and approximate original contour. After grading, graded spoil monitoring was conducted to determine the suitability of the materials. A minimum of 6 inches of topdressing (topsoil or topsoil substitute) was then applied over suitable spoils.

After topdressing placement, the seedbed was scarified or ripped on the contour to a depth of about 8 to 12 inches. Seeding was done using various implements that drilled and/or broadcast the seed. After the seeding, certified weed-free, long-stem, hay mulch, or straw was applied at a rate of about 2 tons per acre. The mulch was anchored 3 to 4 inches into the cover with a tractor-drawn straight coulter disc. The seeding was generally performed in the fall, which tends to favor the establishment of cool-season grasses and shrubs. The approved seed mixes used at McKinley have varied over time but included both warm-season grasses, and introduced and native cool-season grasses, introduced and native forbs, and shrubs. The early seed mixes tended to emphasize the use of alfalfa and cool-season grasses. The majority of seed mixes planted on IPL consisted of native and introduced cool-season grasses, limited warm-season grasses, some shrubs, but no forbs. Over time, the seed mixes on PPL shifted to include more warm-season grasses, more shrub species, and a variety of forbs.

Initial program lands were typically graded so they were no steeper than 3:1 and topsoiled. Seeding practices were like those done on permanent program lands.

## 1.3 Prevailing Climate Conditions

The amount and distribution of precipitation are important determinants for vegetation establishment and performance. Once vegetation is established, the precipitation dynamics affect the amount of vegetation cover and biomass on a year-to-year basis with grasses and forbs showing the most immediate response. Long term precipitation has been monitored at the McKinley North Mine at the Bluff station (Figure 1). The mine added a system of 6 additional seasonal precipitation gauges to better capture more representative data from the various mining areas in 2011-2012 (gauges named by mining area). Data from the Rain 2 and Bluff gauges were used to evaluate precipitation in O-VMU-5 (Figure 1).

Table 2 contains a summary of precipitation recorded at all the rain gauges in the North Mine Area. Total annual precipitation measured at the Bluff gauge near the mine entrance was 11.97 inches in 2024, slightly exceeding the regional average of 11.8 inches at Window Rock. Total annual precipitation for the season rain gauges is unavailable as they are taken offline due to freezing conditions from December through March.

Growing season precipitation provides additional context to evaluate vegetation performance in O-VMU-5. The departure of growing season precipitation (April through September) between the Rain 2 and Bluff gauges compared to the Window Rock (1937-1999) long-term seasonal mean is illustrated in Figure 2. Growing season precipitation in O-VMU-5 has been below the long-term seasonal mean from 2018 to 2024 with a severe drought in 2020 when the site only received 32% of the normal growing season precipitation for the region. In 2022, O-VMU-5 growing season was about 146% above the long-term-average. In 2023, growing season precipitation measured at the Rain 2 gauge was 64% of the long-term average. Over the past ten years, growing season precipitation measured at the Rain 2 gauge was on average 19% below regional norms.

Precipitation in 2024 was near normal for the growing season with a wetter than average June accounting for nearly 38% of the total growing season precipitation. The Rain 2 gauge recorded 6.14 inches of precipitation from April to September, slightly lower than the Bluff gauge that recorded approximately 6.57 inches of rain for the same period. Rainfall in April, May, July, and September was below the monthly long-term averages with a slightly wetter than normal August. Mine wide, the precipitation recorded in 2024 between April and November at the seven gauges indicate near normal regional rainfall, with average rainfall falling just 0.12 inches below the regional norm with variation both spatially and temporally (Table 2).

## 1.4 Livestock

CMI has aggressively managed trespass livestock (horses) the past several years, resulting in less evidence of overgrazing in the reclamation in 2024 in O-VMU-5. The combination of past grazing pressure with exceptional drought, however, may in some years adversely affected the ability to demonstrate that the vegetation is meeting or can meet the revegetation success standards.

# 2.0 VEGETATION STANDARDS AND MONITORING METHODS

Vegetation attributes in O-VMU-5 were quantified using the methods described in Section 6.5 of the Permit as modified in Permit Modification 23-03. Vegetation monitoring in O-VMU-5 was conducted from September 23 through October 1, 2024.

## 2.1 Vegetation Success Standards

The vegetation success standards for the Permit Area consist of five vegetative parameters: total cover, perennial cover, forage production, woody plant density, and diversity (Table 1). The total ground cover requirement, or the combined means for live vegetation cover and litter cover on the reclamation, is 52%. The perennial vegetation cover requirement is 24%. Both total ground and perennial vegetation cover use absolute cover. The annual forage production requirement is 550 air-dry pounds per acre (lbs/ac). The shrub density success standard is 400 live woody stems per acre. In accordance with 30 CFR 816.116 (a)(2), success for total cover, perennial cover, forage production, and shrub density shall be ≥ 90% of the standard.

Cover is defined in three ways for accurate evaluation of diversity according to Table 1.

1) Absolute cover utilizes first-hit line point intercept (LPI) data and is used to assess the perennial grass diversity standard.
2) Relative perennial cover, the metric used to assess grass, forb, and shrub diversity, compares the cover of perennial species relative to the sum of perennial plants calculated from all-hit LPI data (excluding noxious weeds) within the VMU.
3) Relative total cover, the metric used to assess the any-single-species diversity standard, is calculated by dividing the percent cover of each perennial/biennial species by the total live vegetative cover from all-hit LPI data (excluding noxious weeds) within a VMU.

Biennial forbs are included in the vegetation cover analyses and biennial forb diversity standards because they are important to the long-term ecological success of the reclamation. As monocarpic, or single flowering species, these forbs produce a high number of seeds, and as a result, persist long-term in the reclamation plant community. Future mention of “perennial” in this report thus includes biennial forb species. Plant duration was derived from the USDA Plants Database.

Relative shrub density, the metric used to assess the single shrub species standard, is calculated using belt-transect data by dividing the density of each species by the total density within a sampling unit. Relative calculations are valuable to determine whether a species or functional group is excessively dominant. The number of species required for the various diversity standard components (e.g., ≥ 2 species of cool-season grasses) is calculated by adding the total number of unique species captured in the LPI surveys.

Diversity is evaluated against numerical guidelines for different vegetation types. In summary, the diversity guideline is met if perennial grasses contribute 7% or more absolute vegetation cover; at least two cool-season perennial grasses have individual relative perennial vegetation covers of 5% and 1.5% or more; at least two

warm-season perennial grasses species with the highest cover species 5% or more relative perennial vegetation cover and the remaining species combining to contribute 1.5% or more relative perennial vegetation cover, at least three non-annual non-noxious forbs combining to contribute 1% or more relative total vegetation cover; shrubs combining to 6% or more relative perennial vegetation cover and no single shrub species with greater than 70% relative shrub density, and no single species of any functional group with 40% or more relative total vegetation cover. Diversity is also demonstrated by evidence of colonization or recruitment of native (not-seeded) plants from adjacent undisturbed native areas.

## 2.2 Sampling Design

The LPI method is used to collect cover measurements required by the Permit to evaluate total cover, perennial cover, and diversity. Prior to production clipping, a 50 m measuring tape is suspended between two metal pins to extend the tape fully. A tripod-mounted laser is then held along the edge of the tape, and readings are taken every meter for living plants, plant litter, rock fragments, and bare ground. When a live plant is encountered as a direct foliar hit, the species is recorded, and direct lower canopy live plant hits are also recorded that are observed down the profile. The LPI-derived data were evaluated against the permit vegetation success standards for vegetation cover and diversity provided in Table 1, with first hits used in absolute cover calculations and all hits (upper and lower canopy hits) used in relative cover calculations.

Additional cover measurements were estimated from each production quadrat, including relative cover for each species and total canopy cover, surface litter, rock fragments, and bare soil. Quadrat canopy cover data is not analyzed for success and is only briefly discussed in this report as additional support information (Table A-3). Canopy cover estimates include the foliage and foliage interspaces of all individual plant species rooted in the quadrat. Canopy cover is defined as the percentage of quadrat area included in the vertical projection of the canopy. The canopy cover estimates made on a species basis may exceed 100 percent in individual quadrats where the vegetation has multi-layered canopies. In contrast, the sum of the total canopy cover, surface litter, rock fragments, and bare soil does not exceed 100 percent. All cover estimates were made in 0.05 percent increments. Percent area cards were used to increase the accuracy and consistency of the cover estimates.

Not all plant species are expected to occur in the sampling transects and quadrats. Plants observed growing within the vegetation plots and across the reclaimed areas were inventoried while moving between transect locations and during formal sampling (Table A-6).

## 2.3 Foliar, Canopy and Ground Cover

The LPI method is used to collect cover measurements required by the Permit to evaluate total cover, perennial cover, and diversity. Prior to production clipping, a 50 m measuring tape is suspended between two metal pins to extend the tape fully. A tripod mounted laser is then held along the edge of the tape, and readings are taken every meter for living plants, plant litter, rock fragments, and bare ground. When a live plant is encountered as a direct foliar hit, the species is recorded, and direct lower canopy live plant hits are also recorded that are observed down the profile. The LPI-derived data were evaluated against the permit area vegetation success standards for vegetation cover and diversity provided in Table 1, with first hits used in absolute cover calculations and all hits (upper and lower canopy hits) used in relative cover calculations.

Additional cover measurements were estimated from each production quadrat including relative cover for each species and total canopy cover, surface litter, rock fragments, and bare soil. Quadrat canopy cover data is not analyzed for success and is only briefly discussed in this report as additional support information (Table A-3). Canopy cover estimates include the foliage and foliage interspaces of all individual plant species rooted in the

quadrat. Canopy cover is defined as the percentage of quadrat area included in the vertical projection of the canopy. The canopy cover estimates made on a species basis may exceed 100 percent in individual quadrats where the vegetation has multi-layered canopies. In contrast, the sum of the total canopy cover, surface litter, rock fragments, and bare soil does not exceed 100 percent. All cover estimates were made in 0.05 percent increments. Percent area cards were used to increase the accuracy and consistency of the cover estimates.

Not all plant species are expected to occur in the sampling transects and quadrats. Plants observed growing within the vegetation plots and across the reclaimed facility were inventoried while moving between sample locations and during formal sampling (Table A-6).

## 2.4 Annual Forage and Total Production

Forage production required by the Permit was determined by clipping and weighing all annual (current year's growth) above-ground forage biomass within the vertical confines of the three ½ $m^2$ quadrats placed systematically along the same 50 m transect used for LPI measurements. Biomass from all three quads from each transect are combined by species and the combined values for the transect (not the quads) are treated as a sampling unit. Production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. The Permit allows for excessively grazed production quadrats to be considered for exclusion from the sampling analysis in consultation with OSMRE, but no quadrats needed to be excluded in O-VMU-5 (the Permit, Section 6.5.2.2).

Grasses and forbs were clipped to within 5 centimeters (cm) of the soil surface, and the current year's growth was segregated from the previous year's growth (e.g., gray, weathered grass leaves, and dried culms). Production from shrubs was determined by clipping the current year's growth. Annuals and noxious weeds (e.g., Russian knapweed [*Acroptilon repens*]), when encountered, were not clipped. Photographs of the individual production quadrats are included in Appendix B.

The plant biomass samples of every species collected per transect were placed individually in labeled paper bags. The samples were air-dried (~ 90 days) until no weight changes were observed with repeated measurements on representative samples. The average tare weight of the empty paper bags was determined to correct the total sample weight to air-dry vegetation weights. The net weight of the air-dried vegetation was converted to lbs/ac.

## 2.5 Shrub Density

Shrub density (as required by the Permit), or the number of stems per square meter (stems/$m^2$), was determined using the belt transect method (Bonham 1989). The belt transect was located parallel to the 50 m transect used to determine cover. Shrubs rooted in the 2 m belt transect were counted on a species basis. A 2 m folding ruler was horizontally oriented perpendicular to the tape to ensure that observations were taken within the 2 m corridor. The number and species of woody plant stems within the belt transect were recorded.

## 2.6 Statistical Analysis

The procedures for liability release and the basis for statistical analysis applied in this report may be found in the Permit, and as referenced in the Permit: the Wyoming Department of Environmental Quality (WDEQ) handbook of sampling and statistical methods (WDEQ 2012), and the New Mexico Mining and Minerals Division (MMD) Coal Mine Reclamation Program guidelines (MMD 1999). Additional resources include *Evaluation and Comparison of Hypothesis Testing Techniques for Bond Release Applications* (McDonald et al. 2003), which was the basis of the WDEQ handbook, and other sources referenced herein. More specifically, Figure 6.5-1 and Appendix 6.5-B of the Permit guide the statistical approach in determining vegetation success for total ground cover, perennial

vegetation cover, annual forage production, and shrub density. The statistical analyses applied to the O-VMU-2 vegetation data are presented in Appendix C, including equations for vegetation data analysis, vegetation attribute data with descriptive statistics, the statistical analyses comparing these attributes to the revegetation success standards, the statistical model, and descriptive statistics and normality for the vegetation attributes.

Descriptive statistics and statistical adequacy are presented for total ground cover, perennial vegetation cover, annual forage production, and shrub density in Tables 3 and C-2. Vegetation attribute data (Table C-2) was evaluated with the Shapiro-Wilk test to determine if data are normally distributed (Exhibits C-1 to C-4). For normally distributed data, statistical adequacy was assessed (Snedecor and Cochran 1967). Hypothesis testing for normal data that met sample adequacy was conducted using a one-sample, one-sided t-test under the classical null hypothesis. A one-sample, one-sided t-test using the reverse null hypothesis was applied for normally distributed data, which failed to meet statistical adequacy. A non-parametric one-sample, one-sided sign test using the reverse null hypothesis was applied to data that was not normally distributed and did not meet sample adequacy. While transformed data was not used in hypothesis testing for satisfying standards, as supplemental analyses, non-normal data were log-transformed. If the transformed data resulted in a normal distribution, a one-sample, one-sided t-test was used in accordance with the procedures described in Section 2.6.2. If a transformation is applied, the technical standard is also logarithmically transformed in congruence with the guidelines (MMD 1999, Appendix C, Section 6). This is done to be consistent with algebraic procedures where log(0.9x)=log(x)+log(0.9) and not 0.9*log(x). If transformed data were also non-normal, data were analyzed using the non-parametric one-sample, one-sided sign test using the reverse null hypothesis on the non-transformed data.

The following presents the statistical approach in more detail. Descriptive statistics and statistical tests were performed using both Microsoft® Excel and R-Studio (version 4.2.2).

### 2.6.1 Normality and Statistical Adequacy

The normality of each dataset was first assessed using the Shapiro-Wilk test to determine the appropriate hypothesis test method (i.e., parametric versus non-parametric). The Shapiro-Wilk null hypothesis is that the samples (of size n) come from a normal distribution. Data were considered normal when the test statistic had a p-value > 0.10 for alpha (α) = 0.10. If the data failed hypothesis testing and was not normal, a log transformation was performed, and if the transformation resulted in a normal distribution, the appropriate hypothesis test was chosen depending on sample adequacy ($N_{min}$) as outlined in Figure 6.5-1 of the Permit (2016).

The number of samples required to characterize a particular vegetation attribute depends on the uniformity of the vegetation and the desired degree of certainty required for the analysis. The number of samples necessary to meet $N_{min}$ was calculated assuming the data were normally distributed using the Snedecor and Cochran (1967) equation below.

$$N_{min} = \frac{t^2 s^2}{(\overline{x}D)^2}$$

Where $N_{min}$ equals the minimum number of samples required, $t$ is the two-tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom, $s$ is the standard deviation of the sample data, $\overline{x}$ is the mean, and $D$ is the desired level of accuracy, which is 10 percent of the mean in this case.

In addition to $N_{min}$, the standard deviation and the 90% confidence interval (CI) about the sample means are reported in Table 3.

It is often impractical to achieve sample adequacy in vegetation monitoring studies based on Snedecor and Cochran's equation listed above. In such cases, the Permit allows a maximum sample number approach to compare the data regardless of the distribution (WDEQ 2012, MMD 1999). Where sample adequacy cannot be met because of operational constraints or for other reasons, 40 samples are considered adequate as stated in the Permit. The 40-sample maximum is based on an estimate of the number of samples needed for a t-test under a normal distribution (Sokal and Rohlf 1981). Schulz et al. (1961) demonstrated that 30 to 40 samples provide a robust estimate for most cover and density measures, with increased numbers of samples only slightly improving the precision of the estimate.

The maximum 40 samples were collected at the outset of sampling based on the guidance discussed above. Each transect is considered a unique sampling unit. Sample adequacy was calculated to determine the number of samples that would have been required for adequacy by the Snedecor and Cochran equation. Further analysis for sample adequacy of cover, production, and density attributes was also demonstrated using a graphical stabilization of the mean method (Clark 2001) when sample adequacy was not met.

### 2.6.2 Hypothesis Testing

The emphasis on statistical adequacy assumes that parametric tests of normally distributed data will be conducted to demonstrate compliance with the vegetation success standards. Thus, if statistical adequacy is met for normally distributed data, the data would be analyzed with a one-sample, one-sided t-test using the classical null hypothesis. Non-parametric hypothesis tests have sufficient power to analyze data that are not normally distributed. Thus, if data is not normal then it is permissible based on the Permit and technically appropriate to use the one-sample, one-sided sign test using the reverse null approach as encouraged by OSMRE.

Hypothesis testing used to demonstrate compliance with the vegetation success standards for total ground cover, perennial vegetation cover, annual forage production, and shrub density were structured as follows (in accordance with Appendix 6.5-B of the Permit):

Classical Null Hypothesis:

$H_0$: Reclaim ≥ 90% of the Performance Standard

$H_a$: Reclaim < 90% of the Performance Standard

Where $H_0$ is the null hypothesis, and $H_a$ is the alternative hypothesis.

The one-sample, one-sided t-test using the classical null hypothesis decision rules based on the test statistic are:

If $t^* \geq t_{(\alpha;\, n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha;\, n-1)}$, conclude failure to meet the performance standard.

Test Statistic:

$$t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$$

Where t* is the calculated t-statistic, $\bar{x}$ is the sample mean, s is the standard deviation, n is the sample size, and α = 0.10. If this test is applied to the log transformed data, the log of the standard is added to the log of 0.9 rather than multiplying it.

Reverse Null Hypothesis:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

One-sample, one-sided sign test using the reverse null hypothesis decision rules are:

If P < 0.10 or z < $z_\alpha$ (for α = 0.10, $z_\alpha$ = -1.282), conclude that the performance standard was met (i.e., $H_o$ is rejected, the revegetation values tend to be statistically greater than 90% of the technical standard).

If P ≥ 0.10 or z ≥ $z_\alpha$ (α = 0.10, $z_\alpha$ = -1.282), conclude failure to meet the performance standard (i.e., $H_o$ is NOT rejected, the revegetation values tend to be statistically less than or equal to 90% of the technical standard).

The z critical values of the normal distribution can be found in WDEQ, Table 1 (2012)

Sign Test Statistic:

$$\mathrm{Z} = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$$

Where z is the sign test statistic (Daniel 1990), k is the test statistic resulting from the number of measurements that were less than 90% of the technical standard, and n is the sample size.

All hypothesis tests were performed with a 90% level of confidence. Hypothesis testing was not conducted for parameters where the mean or median did not exceed the minimum permit requirements. P-values, when reported, were calculated using R's t distribution probability function with the appropriate t* and degrees of freedom. This function allows for calculating precise p-values given the relevant parameters of a distribution, without the need for a table (R Core Team 2023).

# 3.0 RESULTS

The vegetation in O-VMU-5 is well established and dominated by perennial plants and the vegetation community achieved full compliance with the vegetation success standards in 2024. Table 3 summarizes the results for total ground cover, perennial vegetation cover, annual forage production and woody plant density (shrub density) along with their corresponding technical standard.

Field data for LPI foliar cover, quadrat canopy cover, annual forage production, and shrub density by the belt transect are included in Appendix A (Tables A-1 through A-6). Photographs of the individual production quadrats are included in Appendix B and a representative photograph of the vegetation and topography is shown in Figure 5.

Table 4 summarizes the attributes for plants recorded in the LPI transects and production quadrats and Table A-6 summarizes all species observed within belt and quadrat surveys as well as those recorded opportunistically

between transect locations during monitoring. Recruitment of additional native plant species is indicative of ecological succession and the capacity of the site to support a self-sustaining ecosystem.

Field data results and statistics for each vegetation parameter are discussed in the sections that follow.

## 3.1 Total Ground Cover

Total ground cover exceeded the revegetation success standard and met the required statistical demonstration. Total ground cover based on first hit LPI data in O VMU-5 in 2024 had a mean of 62.1 ± 3.4% (90% confidence interval [CI]) and a median of 60% (Table 3), exceeding the revegetation success standard. Total ground cover was normally distributed (Exhibit C-1). Sample adequacy was 13 samples, which is less than the 40 samples taken indicating sample adequacy is met.

Given the attributes of the data, total ground cover was analyzed with a one-sided t- test under the classical null hypothesis. The resulting t*-statistic for total ground cover was 7.33, with a sample mean of 62.1%, a standard deviation of 13.2%, measured against a one-tail t (0.1, 39) value of -1.304. So, under the classical null hypothesis ($t^* \geq t(\alpha; n-1)$) and a p-value of 1, we conclude that the performance standard of 24% perennial vegetation cover was met (Exhibit C-1).

## 3.2 Perennial Vegetation Cover

Perennial vegetation cover, based on first hit LPI data, was calculated by summing the perennial and biennial species vegetation cover of the sampling unit excluding annuals and noxious weeds. The average perennial cover was 42.4 ± 3.9% and the median cover was 40% (Table 3), exceeding the revegetation success standard. Sample adequacy was met with 36 samples.

Perennial vegetation cover data were normally distributed with a logarithmic transformation and met sample adequacy (Exhibit C-2); data were statistically analyzed using a one-sample, one-sided t-test using the classical null hypothesis. The resulting t*-statistic for perennial vegetation cover was 11.75, with a sample mean of 1.61, a standard deviation of 0.14, measured against a one-tail t (0.1, 39) value of -1.304. So, under the classical null hypothesis ($t^* \geq t(\alpha; n-1)$) and a p-value of 1, we conclude that the performance standard of 24% perennial vegetation cover was met (Exhibit C-2).

## 3.3 Production

Forage production exceeded the revegetation success standard and met the required statistical demonstration. Forage production for vegetation success is assessed for above-ground annual forage production, excluding annuals and noxious weeds in air-dry lbs/ac. Annual forage production in O-VMU-5 in 2024 was 855 ± 105 lbs/ac (median of 839 lbs/ac) (Table 3). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for annual forage production was 63 samples (Table 3).

Annual forage production data for O-VMU-5 were normally distributed (Exhibit C-3). Given that $N_{min}$ was larger than the number of samples taken, the use of the reverse null hypothesis is warranted as discussed in Section 2.6.2. Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean (Clark 2001). Figure 6 illustrates the stabilization of the mean and 90% CI for production that begins to stabilize at 28 samples. This analysis suggests that 40 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of annual forage production.

Forage production data were normally distributed (Exhibit C-3) and did not meet sample adequacy, so data were statistically analyzed using a one-sample, one-sided t-test using the reverse null hypothesis. The resulting t*-statistic for production was 5.64, with a sample mean of 854.5, a standard deviation of 403, measured against a one-tail t (0.9, 39) value of 1.304. So, under the reverse null hypothesis ($t^* \geq t_{(1-\alpha;\, n-1)}$), we conclude that the performance standard of 550 lbs/ac was met (Exhibit C-3).

## 3.4 Shrub Density

Shrub density exceeded the revegetation success standard and met the required statistical demonstration. In 2024 shrub density in O-VMU-5 substantially exceeded the vegetation success standard of 400 stems/ac from belt transect data with an average of 1,897 ± 356 stems/ac and a median of 1,518 stems/ac (Table 3). The calculated minimum sample size needed to meet $N_{min}$ at the 90% confidence level for shrub density was 148 samples (Table 3).

The shrub density data for O-VMU-5 were not normally distributed but the log transformed data were normal (Exhibit C-4). Given that $N_{min}$ was larger than the number of samples taken, the use of the reverse null hypothesis is warranted as discussed in Section 2.6.2. Because $N_{min}$ was not met and called for an unreasonable number of samples, the data were evaluated using the graphical stabilization of the mean (Clark 2001). Figure 7 illustrates the stabilization of the mean and 90% CI for shrub density that begins to stabilize at 28 samples. This analysis suggests that 40 samples were more than adequate, and that the collection of additional data would not improve the precision of the estimate of shrub density.

The shrub density log transformed data were normally distributed (Exhibit C-4) but did not meet sample adequacy, so data were statistically analyzed using a one-sample, one-sided t-test using the reverse null hypothesis. The resulting t*-statistic for production was 14.23, with a sample mean of 3.19, a standard deviation of 0.28, measured against a one-tail t (0.9, 39) value of 1.304. So, under the reverse null hypothesis ($t^* \geq t_{(1-\alpha;\, n-1)}$), we conclude that the performance standard of 550 lbs/ac was met (Table C-2).

## 3.5 Composition and Diversity

In 2024, the standards were met for all the individual diversity standards in O-VMU-5 (Table 6). The revegetation diversity standards are based on a “lifeform statement” for grasses, forbs, and shrubs (Table 1) that consists of 12 individual parameters. The results for composition and diversity are discussed below by parameter. Relative cover values of perennial and biennial species are calculated from all LPI data (first hit and understory: Table A-2). Relative perennial vegetation cover of individual species is listed in Table 4.

Grasses dominated the perennial vegetation cover with James’ galleta (*Pleuraphis jamesii*) representing the highest cover of the warm-season grasses, with alkali sacaton (*Sporobolus airoides*) and blue grama (*Bouteloua gracilis*) providing additional cover. (Table 4). Cool-season grasses are well represented reflecting the past seed mixes, season of seeding, and the site’s continued ability to support a diverse group of cool-season grasses. Thickspike wheatgrass (*Elymus lanceolatus*) and western wheatgrass (*Pascopyrum smithii*) represented the highest cover of the cool-season grasses. Shrubs are important components of the reclamation due to their persistence and tolerance to harsh conditions. The woody plant component is dominated primarily by fourwing saltbush (*Atriplex canescens*), with rubber rabbitbrush (*Ericameria nauseosa*) and winterfat (*Krascheninnikovia lanata*) frequently present. Perennial forb species occurred infrequently on the LPI transects with scarlet globemallow (*Sphaeralcea coccinea*) contributing the highest cover.

The perennial grass diversity standard requires a total absolute vegetation cover of at least 7%, which was achieved in 2024 with 36.4%. The diversity standard for cool-season perennial grasses was achieved with 10 total species, and two species that represent at least 5 and 2.5% relative perennial vegetation cover (thickspike wheatgrass [21.0%] and western wheatgrass [10.6%]). The diversity standard for warm-season grasses is achieved with five total species, one species representing at least 5% (James' galleta [25.6%]) and all remaining species representing over 1.5% relative perennial vegetation cover at 9.6%.

The perennial forb diversity standard requires at least three perennial/biennial forbs (not including noxious weeds) combining to at least 1% relative perennial vegetation cover (calculated based on the percent foliar cover of perennial species excluding annuals and noxious weeds). This standard was achieved in 2024 with 7 species totaling 1.6% relative perennial vegetation cover with the greatest contributions from scarlet globemallow (0.5 %) and sweetclover (0.5%, *Melilotus officianalis*).

The diversity standard for shrubs requires the relative perennial vegetation cover for all shrub species to total at least 6% with no single shrub exceeding or equal to 70% relative shrub density. Both of these standards were achieved with 20.3% relative perennial vegetation cover of all shrubs (Table 6) and 57.3% relative shrub density of fourwing saltbush – the most dominant shrub (Table 5).

Lastly, the diversity standards require that no single species of any functional group represent greater than 40% relative total vegetative cover. Relative total vegetative here is defined as the percent foliar cover of any recorded species divided by the total foliar cover for all live vegetation of the sampling unit, including annuals and noxious weeds. James' galleta represented the highest relative total vegetation cover at 24.9%, thus the reclamation achieved the single species diversity standard.

From 2019 through 2024, 166 plant species have been observed within reclaimed areas in O-VMU-5 including 36 grasses, 87 forbs, and 43 shrubs, trees, and cacti (Table A-6). Of the 36 grasses,18 are cool-season perennials, five are cool-season annuals, 10 are warm-season perennials and three are warm-season annuals. Of the 87 forbs, 36 are annuals, and the remaining 51 are perennials and/or biennials. Cacti (four species), succulents (two species), and trees (four species) were rare on the reclamation but provide diverse habitat or browse for wildlife. Shrubs and subshrubs were the most common woody plants observed of the 33 species observed. The recruitment of native plants and establishment of seeded species within is indicative of ecological succession and the capacity of the site to support a diverse and self-sustaining ecosystem.

## 3.6 Noxious Weeds

During the 2024 monitoring program, Class C noxious weeds (NMDA 2020) were rarely encountered in O-VMU-5. Class C noxious weeds are generally widespread in the state and managed at the local level based on feasibility of control and level of infestation. Noxious weeds are not used in the assessment of revegetation success but are included in the single species cover standard (Table 1). Noxious trees and shrubs observed on O-VMU-5 in past years include Siberian elm (*Ulmus pumila*), saltcedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*) but their presence in the reclaimed vegetation community is insignificant with densities much lower than native rangeland beyond the permit boundary. CMI continues to monitor for noxious weeds and actively controls them through husbandry practices that include annual services for weed management. Further, competition from desirable seeded and native species is expected to inhibit any substantial increase of noxious weeds in the reclamation.

# 4.0 SUMMARY

McKinley Mine's vegetation success standards for the post-mining land uses of grazing and wildlife are based on total ground cover, perennial vegetation cover, annual forage production, shrub density, and diversity. The technical standards (Table 1) were developed through negotiations with OSMRE based on the analysis of historical vegetation data, interpretation of the ecological site potential, and the anticipated post-mining land uses. The vegetation monitoring results for the past six years indicate that the vegetation community in O-VMU-5 has progressed and now meets the revegetation success standards despite persistent drought conditions over the past several years. This progression is evident as the shrub density and total ground cover standards have been met every year and the perennial vegetation cover standard in all but one year (Table 3). Moreover, annual forage production passed hypothesis testing in 2023 and 2024. A summary of the findings from the past five years are:

1. Vegetation Cover: The total ground cover standard and perennial vegetation cover standard have been met every year since monitoring began in 2019 apart from perennial vegetation cover in 2021.
2. Forage Production: Average annual forage production met standards in both 2023 and 2024. Forage production was also above the numeric performance standards in 2019 though hypothesis testing did not demonstrate that the standard was met due to highly variable data.
3. Shrub Density: O-VMU-5 has exceeded the success parameters for shrub density in all six monitoring years.
4. Diversity: All plant diversity standards were met in 2020, 2023, and 2024 (Tables 6 and 7). Between 2019 and 2022 all but one diversity standard was met; fourwing saltbush comprised more than 70% relative shrub cover in three out f the four years (based on the LPI method). In 2023 and 2024, relative shrub density derived from belt transect data were used to evaluate this standard instead of LPI relative shrub cover, a change which more accurately represents the shrub community and reduces bias towards larger canopied shrubs. With the revised diversity standards adopted to accurately represent expected vegetation composition in semi-arid shrubland/grasslands, all diversity thresholds were met in 2023 and 2024.

The reclamation in O-VMU-5 has demonstrated the capability of meeting and sustaining the post-mining land use by fully meeting the vegetation performance standard over the past two years. Long-term vegetation performance in the reclamation is encouraging considering below-average precipitation in 4 of the past 6 years including the exceptional drought in 2020 and 2021. The performance of vegetation in O-VMU-5 under these conditions show that the reclaimed plant communities are resilient and capable of sustaining themselves under the adverse conditions that are characteristic of this region.

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# Tables

**Table 1: Revegetation Success Standards in the McKinley Mine OSMRE Permit**

| Vegetative Parameter | Components | | Success Standards | |
|---|---|---|---|---|
| | | | 2019-2022 | 2023-2024 |
| Cover | Total Ground Cover | | ≥ 52% | ≥ 52% |
| | Perennial Vegetation Cover | | ≥ 24% | ≥ 24% |
| Diversity "Lifeform Statement" | Perennial Grasses | All Grasses | ≥ 7% absolute cover | ≥ 7% absolute cover |
| | | Cool-Season | ≥ 2 species, each ≥ 1.5% cover | ≥ 2 species, 1st species ≥ 5% relative perennial cover, 2nd species ≥ 2.5% relative perennial cove |
| | | Warm-Season | ≥ 2% contribution, ≥ 2 species, each ≥ 0.5% cover | ≥ 2 species, 1st species ≥ 5% relative perennial cover, all other species combined ≥ 1.5% relative perennial cove |
| | Perennial Forbs | | ≥ 3 species, combining for ≥ 1% relative perennial cover | ≥ 3 species, combining for ≥ 1% relative perennial cover |
| | Shrubs | All Shrubs | ≥ 3% absolute cover | ≥ 6% relative total perennial cove |
| | | Any Single Species | ≤ 70% relative total shrub cover | ≤ 70% relative total shrub density |
| | Any Single Species (including weeds) | | ≤ 40% relative total vegetative cover | ≤ 40% relative total vegetative cover |
| Production | Pounds/acre (air dry) | | ≥ 550 lbs/ac | ≥ 550 lbs/ac |
| Woody Plant Density | Stems/acre | | ≥ 400/acre | ≥ 400/acre |

Notes:
Success for cover, production, and stocking shall be ≥ 90% of the standard in accordance with 30 CFR 816.116 (a)(2).
Total ground cover does not include noxious weeds.
Perennial vegetation cover is foliar cover from LPI, not including annuals and noxious weeds.
Relative cover is the percent cover of a species or functional group divided by the total vegetation cover including annuals and noxious weeds.
Relative perennial cover is the total cover of a perennial species or perennial functional group divided by the total perennial cover (see below).
Total perennial cover includes shrubs, cactus, trees, perennial grasses and perennial forbs not including noxious species.
Relative total shrub density is the density of each woody species divided by the total woody plant density not including noxious weeds.
Production includes above-ground biomass of forage species only.
Bolded standards are those that changed in 2023

**Table 2: North Mine Seasonal and Annual Precipitation, 2015-2024**

| Year | Station | Area | Precipitation (inches) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | January | February | March | April | May | June | July | August | September | October | November | December | Annual Total | Growing Season Total |
| 2015 | Rain Bluff | North Shop | 1.39 | 1.21 | 0.11 | 0.35 | 1.54 | 1.15 | 2.81 | 1.91 | 0.51 | 1.18 | 1.16 | 0.74 | 14.06 | 8.27 |
| | Rain 2 | 2 | NA | NA | NA | 0.52 | 1.51 | 1.98 | 3.17 | 1.39 | 0.50 | 1.08 | 0.92 | NA | NA | 9.07 |
| | Rain 3 | 3 | NA | NA | NA | 0.57 | 1.80 | 1.77 | 3.61 | 3.06 | 0.44 | 1.36 | 0.86 | NA | NA | 11.25 |
| | Rain 6 | 6 | NA | NA | NA | 0.54 | 0.71 | 2.12 | 2.66 | 2.12 | 0.00 | 0.92 | 0.70 | NA | NA | 8.15 |
| | Rain 10 | 10 | NA | NA | NA | 0.42 | 1.32 | 1.11 | 2.59 | 1.39 | 0.30 | 1.10 | 0.78 | NA | NA | 7.13 |
| | Rain 12 | 12 | NA | NA | NA | 0.49 | 1.59 | 1.39 | 2.88 | 2.14 | 0.47 | 1.17 | 1.29 | NA | NA | 8.96 |
| | Rain 15 | 15 | NA | NA | NA | 0.46 | 1.90 | 1.62 | 3.17 | 2.88 | 0.32 | 0.94 | 0.69 | NA | NA | 10.35 |
| 2016 | Rain Bluff | North Shop | 0.39 | 0.25 | 0.03 | 1.28 | 0.70 | 0.19 | 1.15 | 1.85 | 1.79 | 0.69 | 1.18 | 1.98 | 11.48 | 6.96 |
| | Rain 2 | 2 | NA | NA | NA | 0.17 | 0.58 | 0.14 | 2.22 | 0.71 | 0.87 | 0.21 | 0.02 | NA | NA | 4.69 |
| | Rain 3 | 3 | NA | NA | NA | 0.20 | 0.72 | 0.45 | 1.62 | 0.11 | 0.50 | 0.33 | 0.02 | NA | NA | 3.60 |
| | Rain 6 | 6 | NA | NA | NA | 0.20 | 0.75 | 0.29 | 2.00 | 0.40 | 1.19 | 0.19 | 0.02 | NA | NA | 4.83 |
| | Rain 10 | 10 | NA | NA | NA | 0.13 | 0.55 | 0.20 | 2.75 | 0.38 | 0.99 | 0.14 | 0.02 | NA | NA | 5.00 |
| | Rain 12 | 12 | NA | NA | NA | 0.30 | 0.78 | 0.36 | 1.34 | 0.49 | 1.16 | 0.18 | 0.05 | NA | NA | 4.43 |
| | Rain 15 | 15 | NA | NA | NA | 0.31 | 0.85 | 0.04 | 1.95 | 0.35 | 1.31 | 0.18 | 0.05 | NA | NA | 4.81 |
| 2017 | Rain Bluff | North Shop | 0.81 | 0.04 | 0.70 | 0.32 | 0.41 | 0.16 | 3.71 | 0.37 | 0.62 | 0.54 | 0.05 | 0.02 | 7.75 | 5.59 |
| | Rain 2 | 2 | NA | NA | NA | 1.28 | 0.66 | 0.22 | 0.78 | 2.08 | 1.46 | 0.63 | 0.44 | NA | NA | 6.48 |
| | Rain 3 | 3 | NA | NA | NA | 1.04 | 1.16 | 0.06 | 0.99 | 2.71 | 1.63 | 0.56 | 0.44 | NA | NA | 7.59 |
| | Rain 6 | 6 | NA | NA | NA | 0.86 | 1.50 | 0.02 | 0.96 | 2.04 | 1.52 | 0.38 | 0.51 | NA | NA | 6.90 |
| | Rain 10 | 10 | NA | NA | NA | 1.00 | 0.67 | 0.08 | 0.94 | 1.63 | 1.36 | 0.34 | 0.81 | NA | NA | 5.68 |
| | Rain 12 | 12 | NA | NA | NA | 1.17 | 0.91 | 0.05 | 0.88 | 1.89 | 1.77 | 0.47 | 0.46 | NA | NA | 6.67 |
| | Rain 15 | 15 | NA | NA | NA | 1.15 | 1.36 | 0.02 | 0.68 | 1.91 | 1.56 | 0.40 | 0.41 | NA | NA | 6.68 |
| 2018 | Rain Bluff | North Shop | 0.23 | 0.48 | 0.44 | 0.08 | 0.22 | 0.28 | 2.17 | 0.00 | 1.00 | 1.51 | 0.14 | 0.43 | 6.98 | 3.75 |
| | Rain 2 | 2 | NA | NA | NA | 0.06 | 0.26 | 0.30 | 1.10 | 0.90 | 1.40 | 1.48 | 0.00 | NA | NA | 4.02 |
| | Rain 3 | 3 | NA | NA | NA | 0.04 | 0.30 | 0.35 | 0.92 | 0.91 | 1.27 | 1.69 | 0.00 | NA | NA | 3.79 |
| | Rain 6 | 6 | NA | NA | NA | 0.03 | 0.21 | 0.46 | 0.97 | 0.56 | 1.02 | 1.45 | 0.00 | NA | NA | 3.25 |
| | Rain 10 | 10 | NA | NA | NA | 0.08 | 0.20 | 0.27 | 3.05 | 1.15 | 0.92 | 1.51 | 0.00 | NA | NA | 5.67 |
| | Rain 12 | 12 | NA | NA | NA | 0.06 | 0.37 | 0.26 | 1.08 | 1.36 | 1.09 | 1.54 | 0.00 | NA | NA | 4.22 |
| | Rain 15 | 15 | NA | NA | NA | 0.05 | 0.32 | 0.28 | 1.16 | 0.63 | 1.31 | 1.31 | 0.00 | NA | NA | 3.75 |
| 2019 | Rain Bluff | North Shop | 0.95 | 0.98 | 1.10 | 0.24 | 0.17 | 0.03 | 0.03 | 1.14 | 0.10 | 0.04 | 1.15 | 0.97 | 6.90 | 1.71 |
| | Rain 2 | 2 | NA | NA | NA | 0.22 | 1.41 | 0.15 | 0.35 | 0.73 | 1.35 | 0.04 | 0.05 | NA | NA | 4.21 |
| | Rain 3 | 3 | NA | NA | NA | 0.39 | 1.50 | 0.32 | 0.70 | 0.11 | 1.72 | 0.06 | 0.06 | NA | NA | 4.74 |
| | Rain 6 | 6 | NA | NA | NA | 0.36 | 1.20 | 0.00 | 0.01 | 0.34 | 1.82 | 0.04 | 0.03 | NA | NA | 3.73 |
| | Rain 10 | 10 | NA | NA | NA | 0.20 | 1.49 | 0.37 | 0.19 | 0.27 | 1.34 | 0.03 | 0.05 | NA | NA | 3.86 |
| | Rain 12 | 12 | NA | NA | NA | 0.20 | 1.59 | 0.28 | 0.35 | 0.14 | 1.38 | 0.07 | 0.04 | NA | NA | 3.94 |
| | Rain 15 | 15 | NA | NA | NA | 0.22 | 1.17 | 0.14 | 0.78 | 0.15 | 1.60 | 0.05 | 0.05 | NA | NA | 4.06 |
| 2020 | Rain Bluff | North Shop | 1.00 | 1.35 | 1.15 | 0.26 | 0.02 | 0.14 | 0.89 | 0.26 | 0.21 | 0.33 | 0.28 | 0.32 | 6.21 | 1.78 |
| | Rain 2 | 2 | NA | NA | NA | 0.26 | 0.09 | 0.05 | 1.65 | 0.20 | 0.17 | 0.31 | 0.16 | NA | NA | 2.42 |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.01 | 0.05 | 1.06 | 0.62 | 0.16 | 0.27 | 0.19 | NA | NA | 1.90 |
| | Rain 6 | 6 | NA | NA | NA | 0.05 | 0.02 | 0.02 | 0.82 | 0.55 | 0.14 | 0.08 | 0.16 | NA | NA | 1.60 |
| | Rain 10 | 10 | NA | NA | NA | 0.11 | 0.02 | 0.13 | 0.79 | 0.14 | 0.14 | 0.16 | 0.09 | NA | NA | 1.33 |
| | Rain 12 | 12 | NA | NA | NA | 0.25 | 0.08 | 0.06 | 0.97 | 0.47 | 0.35 | 0.29 | 0.28 | NA | NA | 2.18 |
| | Rain 15 | 15 | NA | NA | NA | 0.32 | 0.01 | 0.05 | 0.65 | 0.87 | 0.28 | 0.09 | 0.44 | NA | NA | 2.18 |
| 2021 | Rain Bluff | North Shop | 1.13 | 0.21 | 0.46 | 0.04 | 0.04 | 0.20 | 2.17 | 1.31 | 1.13 | 0.86 | 0.20 | 0.92 | 8.67 | 4.89 |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.03 | 0.16 | 0.99 | 1.09 | 1.04 | 0.93 | 0.00 | NA | NA | 3.31 |
| | Rain 3 | 3 | NA | NA | NA | 0.03 | 0.09 | 0.05 | 0.69 | 1.04 | 1.64 | 1.16 | 0.00 | NA | NA | 3.54 |
| | Rain 6 | 6 | NA | NA | NA | 0.02 | 0.06 | 0.03 | 0.83 | 0.19 | 0.47 | 1.05 | 0.00 | NA | NA | 1.60 |
| | Rain 10 | 10 | NA | NA | NA | 0.01 | 0.06 | 0.24 | 2.48 | 1.80 | 0.96 | 0.80 | 0.00 | NA | NA | 5.55 |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.08 | 0.22 | 1.58 | 2.08 | 1.24 | 1.01 | 0.00 | NA | NA | 5.20 |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.07 | 0.05 | 1.04 | 2.58 | 1.47 | 1.00 | 0.00 | NA | NA | 5.21 |
| 2022 | Rain Bluff | North Shop | -- | -- | 0.59 | 0.03 | 0.00 | 1.24 | 3.13 | 4.66 | 1.27 | 1.40 | 0.48 | 0.58 | 13.38 | 10.33 |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 3.00 | 3.77 | 1.22 | 1.14 | 0.39 | NA | NA | 9.02 |
| | Rain 3 | 3 | NA | NA | NA | 0.00 | 0.00 | 1.03 | 2.99 | 3.07 | 1.18 | 1.19 | 0.54 | NA | NA | 8.27 |
| | Rain 6 | 6 | NA | NA | NA | 0.01 | 0.00 | 0.66 | 2.55 | 3.05 | 0.69 | 0.28 | 0.47 | NA | NA | 6.96 |
| | Rain 10 | 10 | NA | NA | NA | 0.00 | 0.00 | 0.69 | 3.57 | 4.27 | 1.02 | 1.83 | 0.33 | NA | NA | 9.55 |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.00 | 0.91 | 3.76 | 4.07 | 1.08 | 1.57 | 0.52 | NA | NA | 9.82 |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.01 | 0.91 | 4.06 | 3.84 | 1.12 | 1.68 | 0.50 | NA | NA | 9.94 |
| 2023 | Rain Bluff | North Shop | 1.21 | 0.50 | 1.64 | 0.05 | 0.55 | 0.13 | 0.03 | 3.16 | 0.33 | 0.57 | 0.42 | -- | 8.59 | 4.25 |
| | Rain 2 | 2 | NA | NA | NA | 0.00 | 0.48 | 0.09 | 0.08 | 3.08 | 0.44 | 0.09 | 0.09 | NA | NA | 4.17 |
| | Rain 3 | 3 | NA | NA | NA | 0.01 | 0.84 | 0.22 | 0.26 | 2.93 | 0.54 | 0.08 | 0.08 | NA | NA | 4.80 |
| | Rain 6 | 6 | NA | NA | NA | 0.00 | 1.49 | 0.22 | 0.07 | 1.97 | 0.49 | 0.05 | 0.00 | NA | NA | 4.24 |
| | Rain 10 | 10 | NA | NA | NA | 0.03 | 0.53 | 0.13 | 0.06 | 2.61 | 0.51 | 0.03 | 0.00 | NA | NA | 3.87 |
| | Rain 12 | 12 | NA | NA | NA | 0.00 | 0.74 | 0.21 | 0.10 | 2.47 | 0.41 | 0.05 | 0.00 | NA | NA | 3.93 |
| | Rain 15 | 15 | NA | NA | NA | 0.00 | 0.79 | 0.21 | 0.43 | 2.67 | 0.56 | 0.05 | 0.00 | NA | NA | 4.66 |
| 2024 | Rain Bluff | North Shop | 1.06 | 0.58 | 2.22 | 0.45 | 0.03 | 2.27 | 1.17 | 2.33 | 0.32 | 1.18 | 0.36 | 0.00 | 11.97 | 6.57 |
| | Rain 2 | 2 | NA | NA | NA | 0.21 | 0.01 | 2.36 | 0.65 | 2.31 | 0.60 | 1.32 | 0.13 | NA | NA | 6.14 |
| | Rain 3 | 3 | NA | NA | NA | 0.28 | 0.01 | 2.23 | 0.87 | 2.64 | 0.48 | 1.55 | 0.15 | NA | NA | 6.51 |
| | Rain 6 | 6 | NA | NA | NA | 0.22 | 0.06 | 2.33 | 1.22 | 2.33 | 0.45 | 1.35 | 0.08 | NA | NA | 6.61 |
| | Rain 10 | 10 | NA | NA | NA | 0.16 | 0.05 | 2.65 | 0.38 | 1.92 | 0.37 | 0.98 | 0.12 | NA | NA | 5.53 |
| | Rain 12 | 12 | NA | NA | NA | 0.15 | 0.10 | 2.58 | 0.54 | 2.58 | 0.87 | 1.24 | 0.20 | NA | NA | 6.82 |
| | Rain 15 | 15 | NA | NA | NA | 0.18 | 0.05 | 3.36 | 0.48 | 2.41 | 0.72 | 1.21 | 0.29 | NA | NA | 7.20 |
| Window Rock, Long Term normals | | | 0.72 | 0.68 | 0.88 | 0.61 | 0.49 | 0.47 | 1.75 | 2.05 | 1.23 | 1.14 | 0.83 | 0.95 | 11.80 | 6.60 |

Notes:
Long-term averages are from Window Rock, Arizona Station (029410), 1937 to 1999 (Western Regional Climate Center, 2020).
Growing season total precipitation is between April and September
NA=rain gauges taken offline due to freezing conditions, data unavailable.
-- Rain gauge malfunction
In 2017 Rain Bluff experienced power issues in the summer that may have resulted in inaccurate precipitation readings.
data incomplete

**Table 3: Summary Statistics, O-VMU-5, 2019-2024**

| | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | Technical Standard |
|---|---|---|---|---|---|---|---|
| **Total Ground Cover (%)[1]** | | | | | | | |
| Mean | 59.7 | 59 | 53.3 | 53.0 | 60.5 | 62.1 | ≥ 52% |
| Standard Deviatior | 12.8 | 13.8 | 15 | 12.2 | 11.8 | 13.2 | |
| 90% Confidence Interva | 3.3 | 3.6 | 4 | 3.2 | 3.1 | 3.4 | |
| Median | -- | 58 | 52 | 54 | 60 | 60 | |
| Nmin[2] | 13 | 15 | 23 | 16 | 11 | 13 | |
| **Live Vegetation Cover (%)[3]** | | | | | | | |
| Mean | 42.9 | 31.1 | 21.3 | 36.7 | 43.5 | 43.8 | None |
| Standard Deviatior | 10.8 | 9.5 | 10.8 | 11.1 | 11.3 | 14.6 | |
| 90% Confidence Interva | 2.8 | 2.5 | 2.8 | 2.9 | 3.0 | 3.8 | |
| Nmin[2] | 18 | 26 | 73 | 26 | 19 | 32 | |
| **Perennial Vegetation Cover (%)[4]** | | | | | | | |
| Mean | 37.1 | 30.3 | 20.3 | 29.8 | 39.5 | 42.4 | ≥ 24% |
| Standard Deviatior | 10.9 | 10.5 | 10.5 | 11.9 | 11.6 | 15.0 | |
| 90% Confidence Interva | 2.8 | 2.7 | 2.8 | 3.1 | 3.0 | 3.9 | |
| Median | -- | 30 | 20 | 31 | 36 | 40 | |
| Nmin[2] | 24 | 34 | 76 | 46 | 25 | 36 | |
| **Annual Forage Production (lbs/ac)[5]** | | | | | | | |
| Mean | 975 | 358 | 422 | 473 | 848 | 855 | ≥ 550 lbs/ac |
| Standard Deviatior | 899 | 400 | 1004 | 411 | 571 | 403 | |
| 90% Confidence Interva | 234 | 104 | 261 | 107 | 149 | 105 | |
| Median | -- | 216 | 169 | 370 | 701 | 839 | |
| Nmin[2] | 242 | 354 | 1609 | 214 | 130 | 63 | |
| **Woody Plant Density (stems/acre) from Belt Transect** | | | | | | | |
| Mean | 2,874 | 2,015 | 2,258 | 2,257 | 2,180 | 1,897 | ≥ 400/ac |
| Standard Deviatior | 2,342 | 1,487 | 1,580 | 2,910 | 1,750 | 1367 | |
| 90% Confidence Interva | 609 | 387 | 411 | 757 | 455 | 356 | |
| Median | -- | 1,781 | 1,720 | 1,538 | 1,599 | 1518 | |
| Nmin[2] | 188 | 155 | 139 | 472 | 183 | 148 | |

Notes:

[1] Mean foliar cover of live vegetation and litter

[2] Minimum number of samples to obtain 90% probability that the sample mean is within 10% of the population mean

[3] Mean vegetation foliar cover not including noxious weeds

[4] Mean foliar cover not including annuals and noxious weeds

[5] Annual forage production in air dry pounds per acre (lbs/ac) not including annuals or noxious weeds

Hypothesis testing found the success standard was not met

**Table 4: Average and Relative Foliar Cover and Production by Species, O-VMU-5, 2024**

| Scientific Name | Common Name | Code | Mean Vegetation Cover (%) | | | | Mean Annual Production (lbs/ac) |
|---|---|---|---|---|---|---|---|
| | | | First Hit Foliar[1] | Under-story[2] | Relative Perennial | Relative Total | |
| **Cool-Season Grasses (11)** | | | | | | | |
| **Perennials (11)** | | | | | | | |
| *Achnatherum hymenoides* | Indian ricegrass | ACHY | 2.00 | 0.05 | 4.4 | 4.3 | 26.0 |
| *Agropyron cristatum* | Crested wheatgrass | AGCR | 1.50 | 0.10 | 3.4 | 3.3 | 57.1 |
| *Bromus inermis* | Smooth brome | BRIN2 | 0.10 | 0.05 | 0.3 | 0.3 | -- |
| *Elymus elymoides* | Bottlebrush squirreltail | ELEL5 | 0.05 | -- | 0.1 | 0.1 | -- |
| *Elymus lanceolatus* | Thickspike wheatgrass | ELLA3 | 8.25 | 1.50 | 20.9 | 20.3 | 107.4 |
| *Hesperostipa comata* | Needle and thread | HECO26 | 0.90 | -- | 1.9 | 1.9 | 19.6 |
| *Hordeum jubatum* | Foxtail barley | HOJU | -- | -- | -- | -- | 4.0 |
| *Pascopyrum smithii* | Western wheatgrass | PASM | 4.30 | 0.65 | 10.6 | 10.3 | 98.7 |
| *Psathyrostachys juncea* | Russian wildrye | PSJU3 | 0.35 | -- | 0.8 | 0.7 | -- |
| *Pseudoroegneria spicata* | Bluebunch wheatgrass | PSSP6 | 0.05 | -- | 0.1 | 0.1 | 5.2 |
| *Thinopyrum intermedium* | Intermediate wheatgrass | THIN6 | 0.10 | -- | 0.2 | 0.2 | -- |
| **Warm-Season Grasses (8)** | | | | | | | |
| **Annauls (1)** | | | | | | | |
| *Bouteloua simplex* | Matted grama | BOSI2 | 0.05 | -- | NA | 0.1 | -- |
| **Perennials (7)** | | | | | | | |
| *Aristida purpurea* | Purple threeawn | ARPU9 | -- | -- | -- | -- | 0.9 |
| *Bouteloua curtipendula* | Sideoats grama | BOCU | -- | -- | -- | -- | 3.9 |
| *Bouteloua dactyloides* | Buffalograss | BODA2 | 0.20 | -- | 0.4 | 0.4 | 1.2 |
| *Bouteloua gracilis* | Blue grama | BOGR2 | 1.25 | 0.10 | 2.9 | 2.8 | 48.5 |
| *Pleuraphis jamesii* | James' galleta | PLJA | 10.95 | 1.00 | 25.6 | 24.9 | 207.1 |
| *Sporobolus airoides* | Alkali sacaton | SPAI | 2.40 | 0.35 | 5.9 | 5.7 | 73.3 |
| *Sporobolus contractus* | Spike dropseed | SPCO4 | 0.20 | -- | 0.4 | 0.4 | 2.5 |
| **Forbs (13)** | | | | | | | |
| **Annuals (1)** | | | | | | | |
| *Salsola tragus* | Prickly Russian thistle | SATR12 | 1.30 | -- | NA | 2.7 | -- |
| **Perennials/Biennials (13)** | | | | | | | |
| *Conyza canadensis* | Canadian horseweed | COCA5 | 0.05 | -- | 0.1 | 0.1 | -- |
| *Bahia dissecta* | Ragleaf bahia | BADI | -- | -- | -- | -- | 2.4 |
| *Chaetopappa ericoides* | Rose heath | CHER2 | -- | -- | -- | -- | 0.7 |
| *Grindelia squarrosa* | Curlycup gumweed | GRSQ | 0.05 | -- | 0.1 | 0.1 | 7.1 |
| *Heliomeris multiflora* | Showy goldeneye | HEMU3 | -- | -- | -- | -- | 1.0 |
| *Linum lewisii* | Lewis flax | LILE3 | 0.05 | -- | 0.1 | 0.1 | 2.0 |
| *Machaeranthera canescens* | Hoary tansyaster | MACA2 | -- | -- | -- | -- | 1.0 |
| *Medicago sativa* | Alfalfa | MESA | -- | -- | -- | -- | 1.4 |
| *Melilotus officinalis* | Sweetclover | MEOF | 0.15 | 0.10 | 0.5 | 0.5 | 14.7 |
| *Penstemon palmeri* | Palmer's penstemon | PEPA8 | 0.05 | -- | 0.1 | 0.1 | -- |
| *Ratibida columnifera* | Upright prairie coneflower | RACO3 | -- | 0.05 | 0.1 | 0.1 | -- |
| *Sphaeralcea coccinea* | Scarlet globemallow | SPCO | 0.25 | -- | 0.5 | 0.5 | 10.8 |
| *Sphaeralcea incana* | Gray globemallow | SPIN2 | -- | -- | -- | -- | 3.7 |
| **Shrubs, Trees, and Cacti (10)** | | | | | | | |
| *Artemisia nova* | Black sagebrush | ARNO4 | 0.05 | -- | 0.1 | 0.1 | '-- |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.10 | -- | 0.2 | 0.2 | -- |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 6.85 | 0.20 | 15.1 | 14.7 | 107.2 |
| *Atriplex corrugata* | Mat saltbush | ATCO4 | 0.10 | -- | 0.2 | 0.2 | 4.0 |
| *Chrysothamnus greenei* | Greene's rabbitbrush | CHGR6 | 0.05 | -- | 0.1 | 0.1 | -- |
| *Ephedra viridis* | Mormon tea | EPVI | 0.05 | -- | 0.1 | 0.1 | -- |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 0.45 | -- | 1.0 | 0.9 | 0.7 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 0.35 | 0.05 | 0.9 | 0.8 | 10.7 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 1.05 | 0.05 | 2.4 | 2.3 | 28.2 |
| *Purshia tridentata* | Antelope bitterbrush | PUTR2 | 0.10 | -- | 0.2 | 0.2 | 3.6 |
| **Unknown Plants (1)** | | | | | | | |
| Unknown Plant | Unknown Plant | UNK | 0.05 | -- | -- | 0.1 | -- |
| **Cover Components** | | | | | | | |
| | | | 62.1 | | | | |
| | | | 43.8 | | | | |
| | | | 42.4 | | | | |
| | | | 2.2 | | | | |
| | | | 18.4 | | | | |
| | | | 35.7 | | | | |

Notes:

[1] First hit foliar is calculated from first hits only

[2] Understory cover is calculated from second and lower hits

"--" = species captured in either LPI or quadrats but not both

NA = annuals not included in relative perennial cover calculations

**Table 5: Relative Shrub, Tree, and Cacti Density, O-VMU-5, 2024**

| Scientific Name | Common Name | Code | Relative Density (%) |
|---|---|---|---|
| *Artemisia frigida* | Prairie sagewort | ARFR4 | 0.05 |
| *Artemisia ludoviciana* | White sagebrush | ARLU | 0.05 |
| *Artemisia nova* | Black sagebrush | ARNO4 | 0.91 |
| *Artemisia tridentata* | Big sagebrush | ARTR2 | 0.21 |
| *Atriplex canescens* | Fourwing saltbush | ATCA2 | 57.33 |
| *Atriplex confertifolia* | Shadscale saltbush | ATCO | 0.64 |
| *Atriplex corrugata* | Mat saltbush | ATCO4 | 1.28 |
| *Chrysothamnus greenei* | Greene's rabbitbrush | CHGR6 | 0.48 |
| *Ephedra trifurca* | Longleaf jointfir | EPTR | 0.16 |
| *Ephedra viridis* | Mormon tea | EPVI | 1.65 |
| *Ericameria nauseosa* | Rubber rabbitbrush | ERNA10 | 2.72 |
| *Gutierrezia sarothrae* | Broom snakeweed | GUSA2 | 5.87 |
| *Krascheninnikovia lanata* | Winterfat | KRLA2 | 26.88 |
| *Opuntia macrorhiza* | Twistspine pricklypear | OPMA2 | 0.05 |
| *Opuntia polycantha* | Plains pricklypear | OPPO | 0.05 |
| *Pinus edulis* | Twoneedle pinyon | PIED | 0.16 |
| *Purshia tridentata* | Antelope bitterbrush | PUTR2 | 0.85 |
| *Sarcobatus vermiculatus* | Greasewood | SAVE4 | 0.27 |
| *Senecio flaccidus* | Threadleaf ragwort | SEFL3 | 0.37 |

Notes:
Relative density derived from belt method
Relative Density = (avg density per species per VMU ÷ avg total shrub density per VMU) * 100
Bolded species are newly observed on O-VMU-5 in 2024

**Table 6: Results for Diversity, O-VMU-5, 2023-2024**

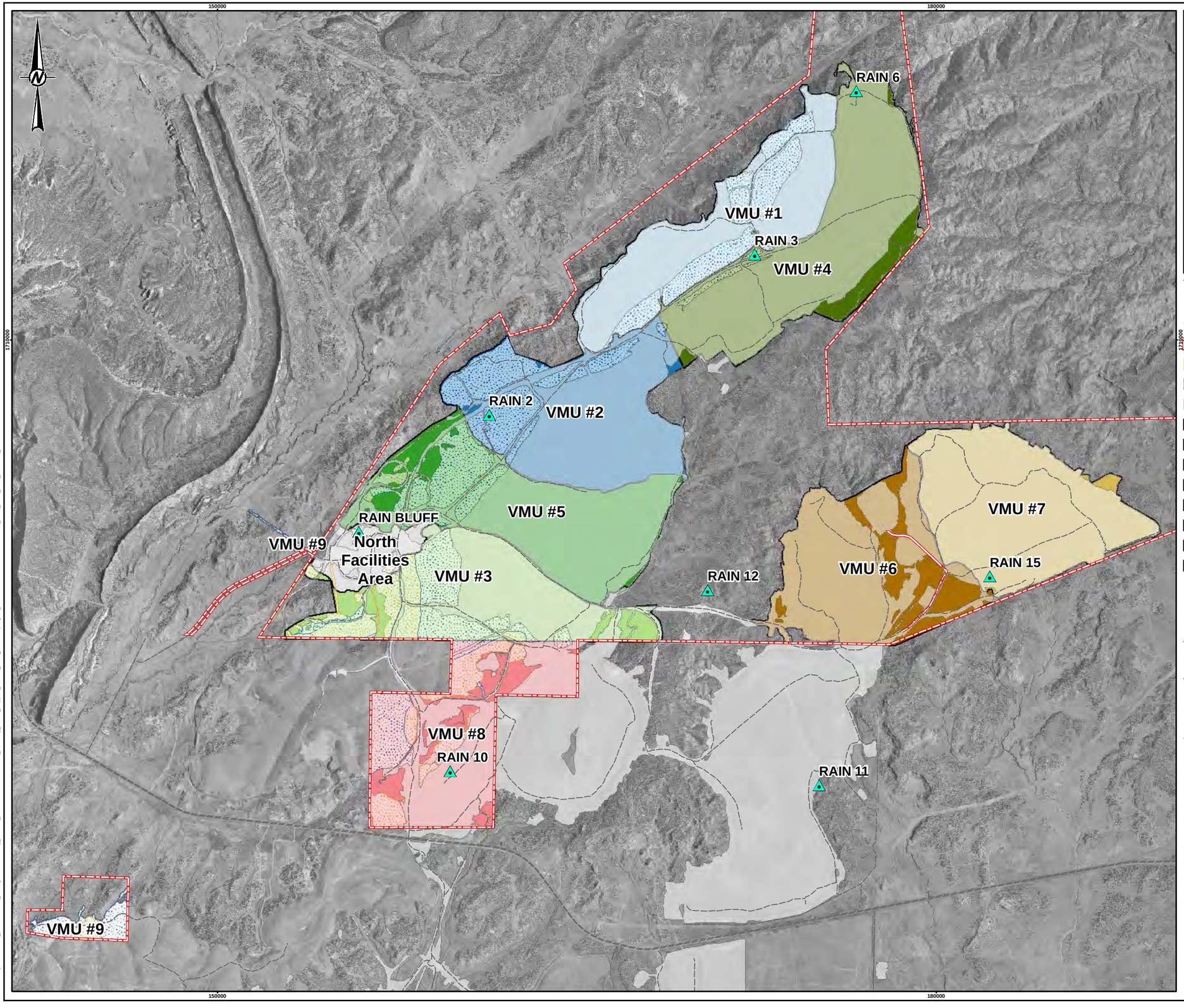
| Diversity Component | Metric | Standard | 2023 | | 2024 | |
|---|---|---|---|---|---|---|
| | | | Result | Species | Result | Species |
| **Perennial Grasses** | Absolute cover | ≥ 7% | 28.6% | -- | 36.4% | -- |
| Cool-season Grasses | # Species | ≥2 | 17 | -- | 10 | -- |
| Grass 1 | Relative perennial cover | ≥ 5% | 8.0% | Western wheatgrass | 21.0% | Thickspike wheatgrass |
| Grass 2 | Relative perennial cover | ≥ 2.5% | 7.4% | Needle and thread | 10.6% | Western wheatgrass |
| Warm-season Grasses | # Species | ≥ 2 | 7 | -- | 5 | -- |
| Grass 1 | Relative perennial cover | ≥ 5% | 23.1% | James' galleta | 25.6% | James' galleta |
| All remaining species | Relative perennial cover | ≥ 1.5% | 9.1% | -- | 9.6% | -- |
| **Perennial Forbs** | # Species | ≥3 | 11 | -- | 7 | -- |
| | Relative perennial cover | ≥ 1% | 3.3% | -- | 1.6% | -- |
| **Shrubs or Subshrubs** | Relative perennial cover | ≥ 6% | 22.8% | -- | 20.3% | -- |
| Single Shrub Species | Relative shrub density | ≤ 70% | 63.2% | Fourwing saltbush | 57.3% | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 20.8% | James' galleta | 24.9% | James' galleta |

**Table 7: Results for Diversity, O-VMU-5, 2019-2022**

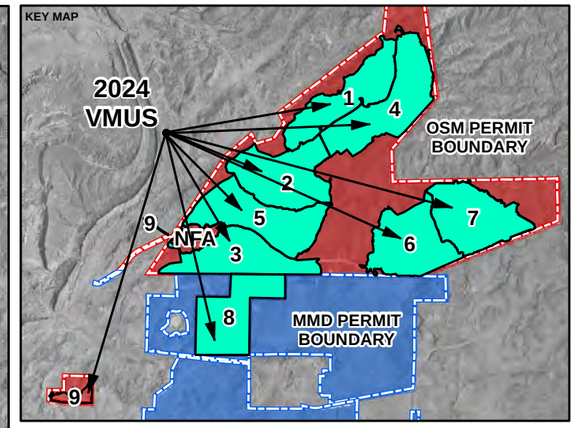
| Diversity Component | Metric | Standard | 2019 | | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Result | Species | Result | Species | Result | Species | Result | Species |
| **Perennial Grasses** | Total absolute cover | ≥ 7% | 21.0% | -- | 21.3% | -- | 10.5% | -- | 21.7% | -- |
| Cool-season Grasses | # Species | ≥2 | 11 | -- | 11 | -- | 14 | -- | 12 | -- |
| Grass 1 | Absolute cover | ≥ 1.5% | 7.1% | Western wheatgrass | 8.0% | Western wheatgrass | 2.3% | Western wheatgrass | 3.5% | Western wheatgrass |
| Grass 2 | Absolute cover | ≥ 1.5% | 2.3% | Thickspike wheatgrass | 3.7% | Slender wheatgrass | 1.6% | Crested wheatgrass | 1.8% | Indian ricegrass |
| Warm-season Grasses | # Species | ≥ 2 | 6 | -- | 4 | -- | 4 | -- | 6 | -- |
| | Total absolute cover | ≥ 2.0% | 5.7% | -- | 3.9% | -- | 3.0% | -- | 11.7% | -- |
| Grass 1 | Absolute cover | ≥ 0.5% | 4.3% | James' galleta | 2.8% | James' galleta | 2.4% | James' galleta | 7.4% | James' galleta |
| Grass 2 | Absolute cover | ≥ 0.5% | 0.6% | Alkali sacaton | 0.6% | Alkali sacaton | 0.5% | Alkali sacaton | 2.6% | Alkali sacaton |
| **Perennial Forbs** | # Species | ≥ 3 | 13 | -- | 4 | -- | 4 | -- | 10 | -- |
| | Relative perennial cover | ≥ 1% | 10.5% | -- | 1.3% | -- | 1.5% | -- | 2.6% | -- |
| **Shrubs or Subshrubs** | Total absolute cover | ≥ 3% | 12.2% | -- | 8.6% | -- | 9.4% | -- | 7.4% | -- |
| Single Shrub Species | Relative shrub cover | ≤ 70% | 70.9% | Fourwing saltbush | 58.7% | Fourwing saltbush | 75.0% | Fourwing saltbush | 73.0% | Fourwing saltbush |
| **Any Single Species** | Relative total cover | ≤ 40% | 19.3% | Fourwing saltbush | 25.6% | Western wheatgrass | 33.3% | Fourwing saltbush | 20.20% | James' galleta |

Notes:
Diversity calculated in accordance with Table 1 in either absolute or relative % cover
Success standard was not met

# Figures




KEY MAP




LEGEND

- Rain Gauges
- Mine Site Roads
- OSM Permit Boundary
- Prelaw (~ 387 acres)
- Initial Program (~ 1,248 acres)
- Permanent Program (~ 11,327 acres)
- OSM VMU 1 (~ 934 acres)
- OSM VMU 2 (~ 1,085 acres)
- OSM VMU 3 (~ 959 acres)
- OSM VMU 4 (~ 1,242 acres)
- OSM VMU 5 (~ 1,129 acres)
- OSM VMU 6 (~ 1,024 acres)
- OSM VMU 7 (~ 1,045 acres)
- OSM VMU 8 (~ 953 acres)

0 4,000 8,000

1 inch = 4,000 feet FEET

**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT

CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT

MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2024 VEGETATION MONITORING

TITLE

**GENERAL OVERVIEW OF THE MCKINLEY OSMRE PERMIT AREA VEGETATION MANAGEMENT UNITS (VMU), 2024**

CONSULTANT

wsp

| | |
|---|---|
| YYYY-MM-DD | 2025-02-14 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MT |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| US-WSP-31406184.000 | D003 | 0 | 1 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

1in

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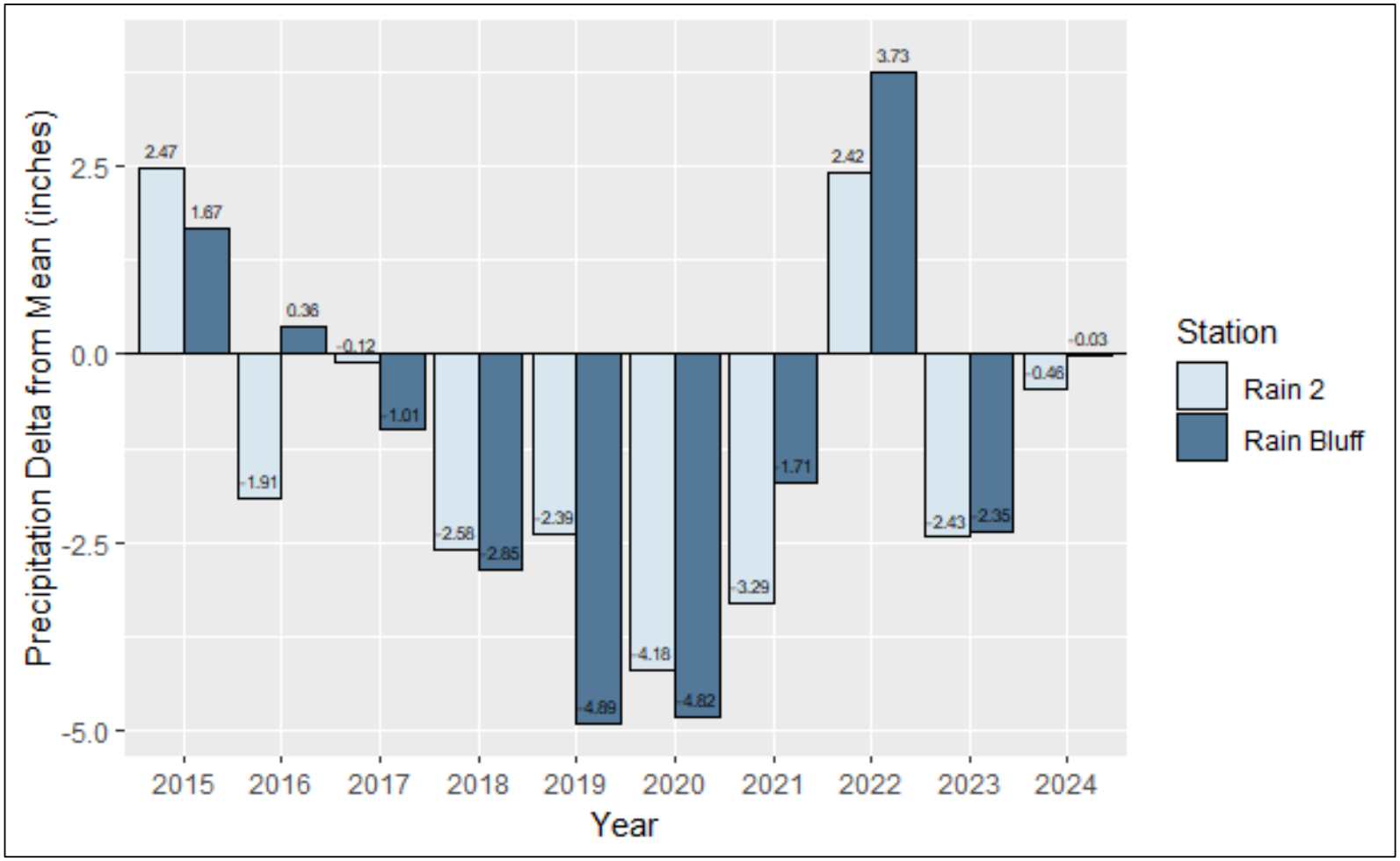
**Figure 2: Departure of Growing Season Precipitation from Long-Term Mean at Window Rock: Rain Bluff and Rain 2 Gauges**

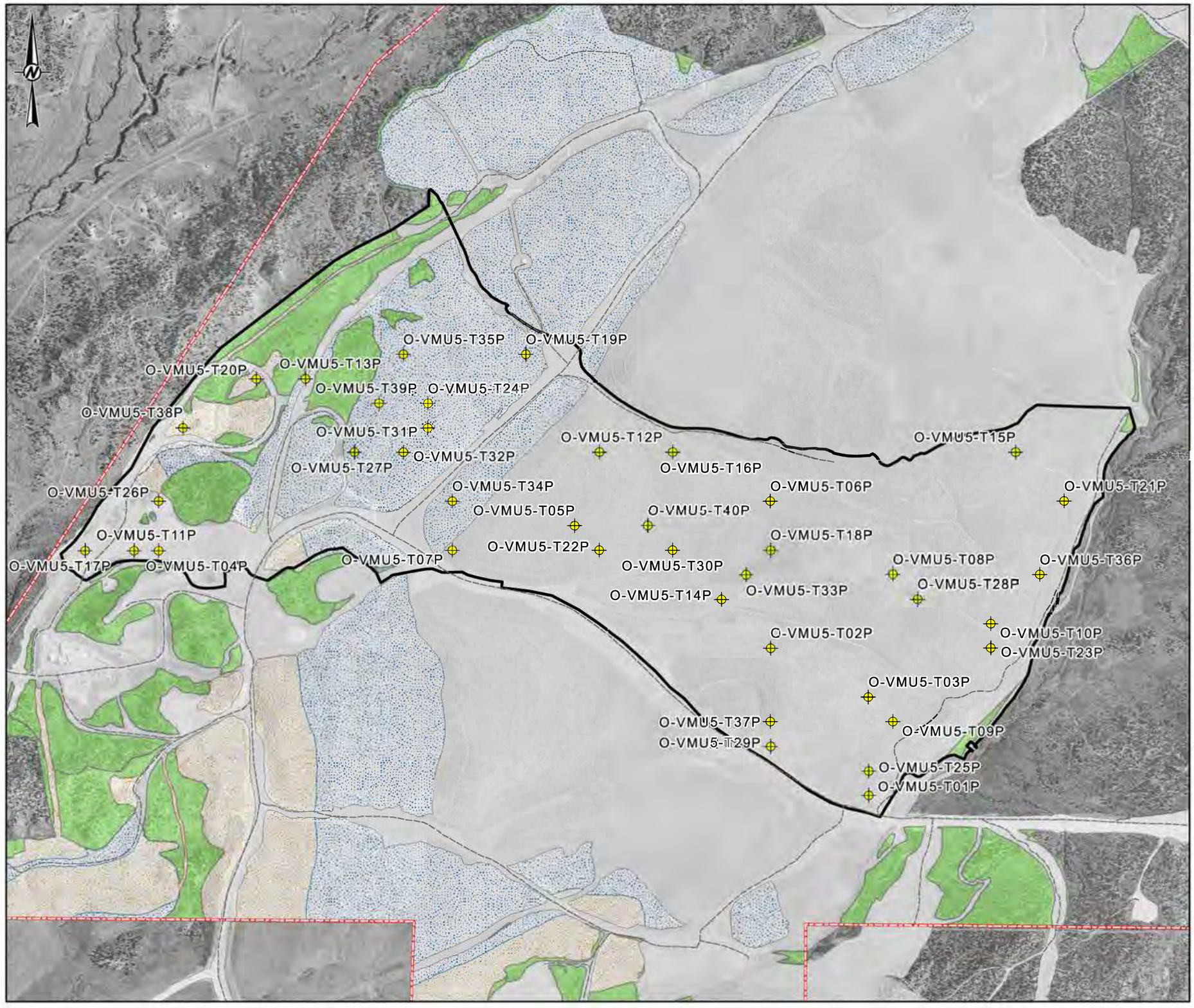



Notes:

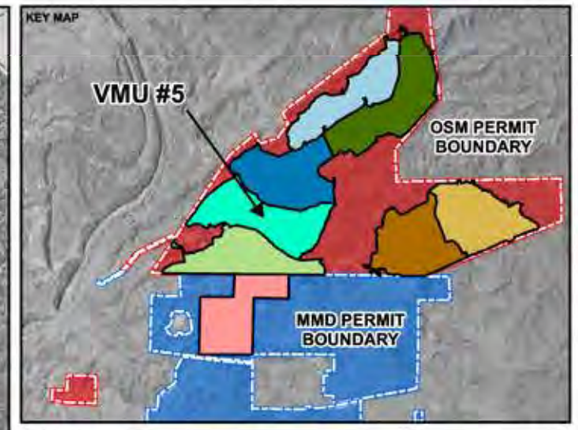
Long-term seasonal mean is from Window Rock, Arizona Station (029410) for 1937 to 1999 (Western Regional Climate Center, 2020).

Growing season precipitation is April through September

Source data is in Table 2




KEY MAP




LEGEND

- Primary Transect
- Alternate Transect
- Mine Site Roads
- OSM VMU 5 (~ 1,129 acres)
- Prelaw
- Initial Program
- Permanent Program
- Native Areas
- OSM Permit Boundary

TRANSECT LABEL EXPLANATION

O-VMU-1-T1P

| OSM Permit Area | Vegetation Management Unit (VMU-#) | Transect Number | Primary (P) or Alternate (A) |
|---|---|---|---|

0 1,300 2,600

1 inch = 1,305 feet FEET

**NOTE(S)**

1. VMU = VEGETATION MANAGEMENT UNIT FOR VEGETATION SAMPLING PLAN
2. KEY MAP SCALE IS DIFFERENT FROM OVERVIEW OF VMUS
3. TRANSECT LOCATIONS WERE CREATED IN ACCORDANCE WITH THE METHODS OUTLINED IN THE PERMIT

**REFERENCE(S)**

1. ORTHOIMAGE: CHEVRON, 2013

COORDINATE SYSTEM: NAD 1927 STATEPLANE NEW MEXICO WEST FIPS 3003
PROJECTION: TRANSVERSE MERCATOR
DATUM: NORTH AMERICAN 1927

CLIENT
CHEVRON ENVIRONMENTAL MANAGEMENT

PROJECT
MCKINLEY MINE - OSM PERMIT PHASE III BOND RELEASE, 2024 VEGETATION MONITORING

TITLE
**SURVEYED VEGETATION MONITORING TRANSECTS, 2024 VEGETATION MANAGEMENT UNIT 5**

CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2025-02-14 |
| DESIGNED | GFD |
| PREPARED | GFD |
| REVIEWED | MT |
| APPROVED | DR |

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| US-WSP-31406184.000 | D002 | 0 | 3 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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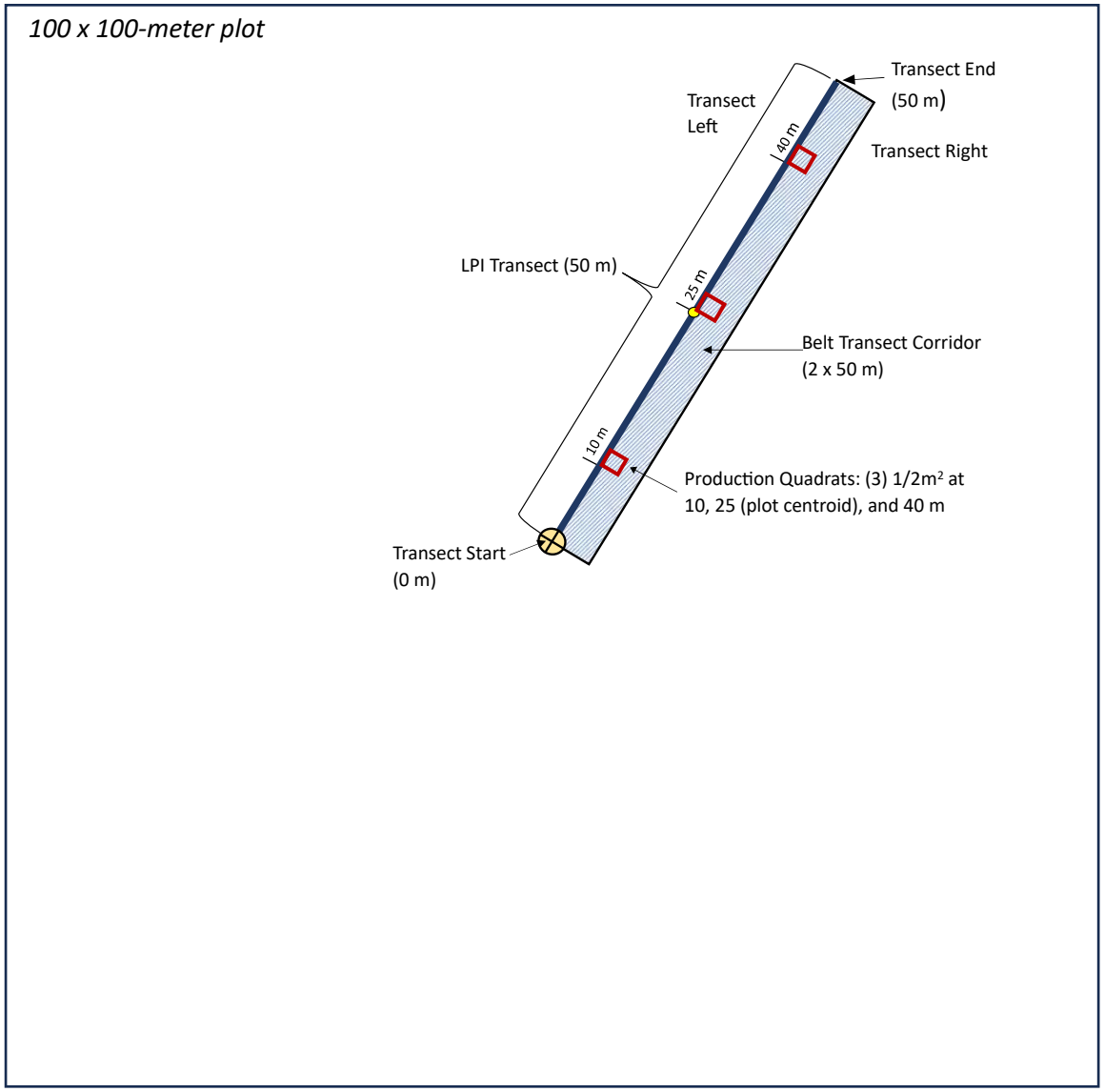
**Figure 4: Vegetation Plot and Transect Layout**




**Transect start placed on plot centroid and oriented randomly (0-360 degrees)* **Not to Scale**

**Figure 5: Typical Grass-Shrubland Vegetation in O-VMU-5, September 2024**



**Figure 7: Stabilization of the Annual Forage Production Mean and 90% Confidence Interval, O-VMU-5, 2024**

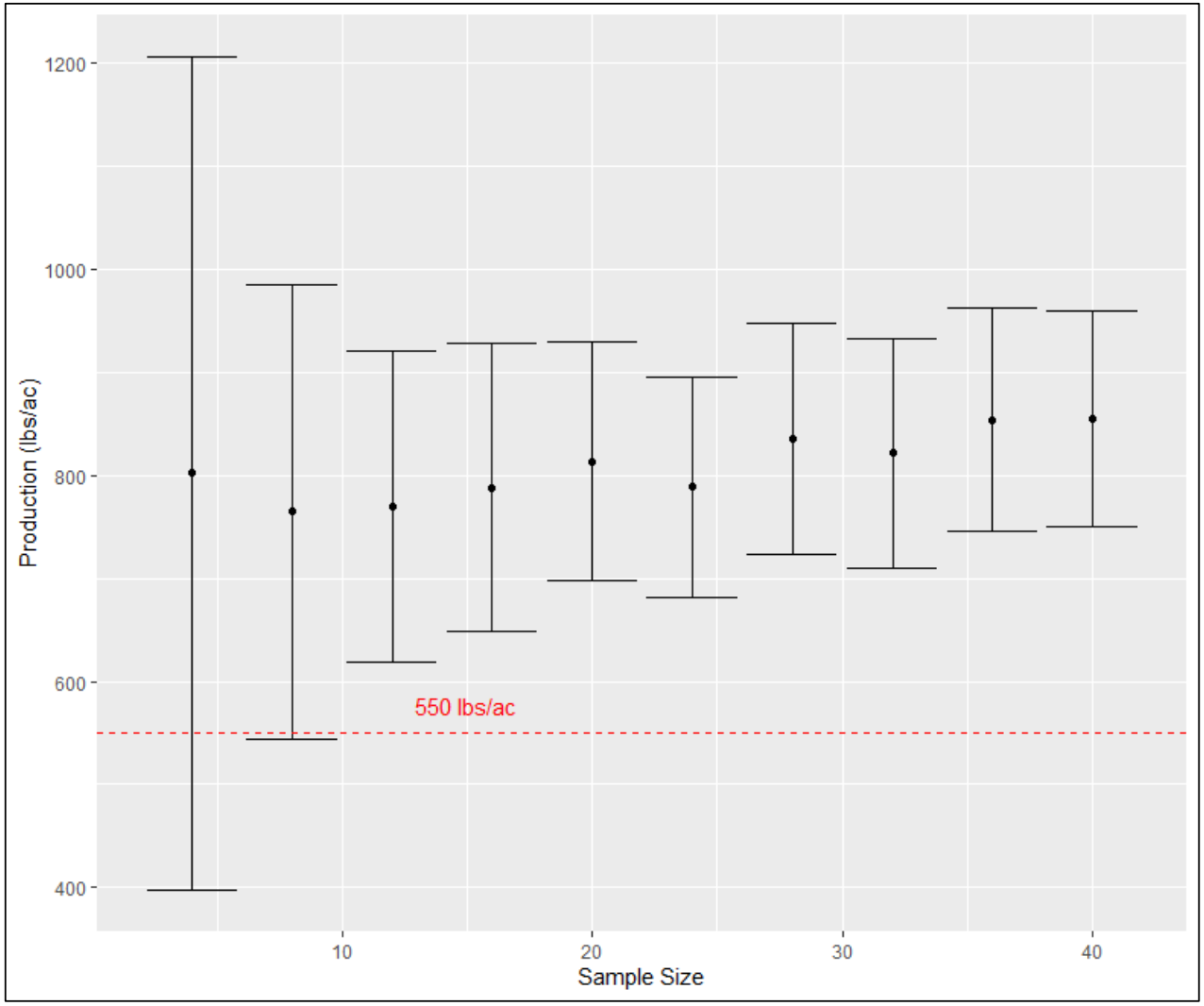
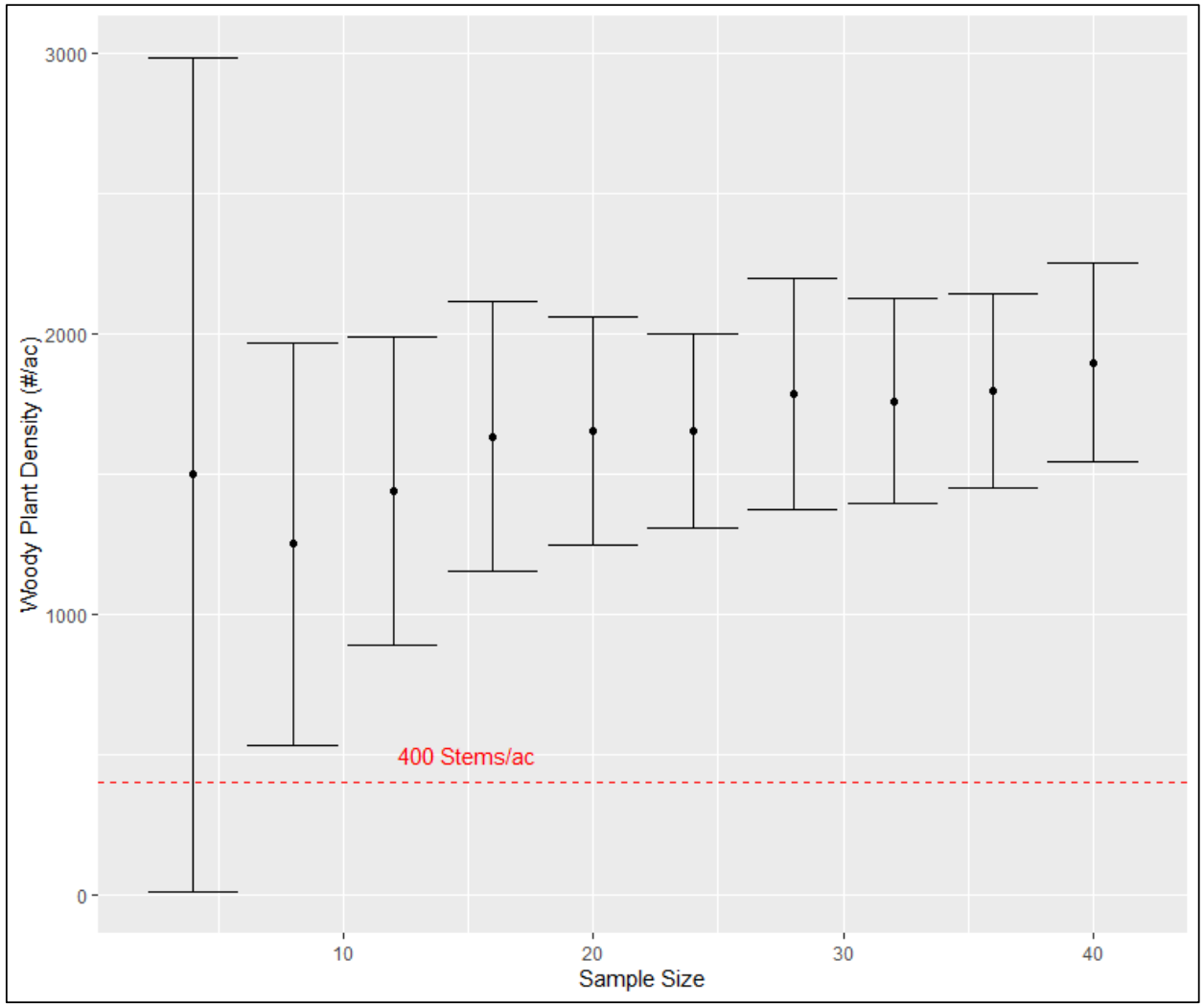


**Figure 8: Stabilization of the Shrub Density Mean and 90% Confidence Interval, O-VMU-5, 2024**



**APPENDIX A**

# Vegetation Data Summary

**Table A-1: O-VMU-5 Line Point Intercept Foliar Cover Data (first hits), 2024**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | -- | 3 | -- | -- | -- | 3 | 16 | -- | -- | -- | -- | -- | -- | 1 | -- | 2 | -- | 5 | -- | 1 | 3 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- |
| AGCR | -- | -- | -- | -- | -- | 2 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 17 | 1 | -- | -- | -- | -- | 1 | -- | 2 | -- | -- | -- | -- | -- | 1 | -- | 4 | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELLA3 | 3 | 9 | 4 | 5 | 15 | 4 | -- | 2 | 2 | 4 | 5 | 9 | 3 | 1 | 1 | 14 | 9 | -- | -- | -- | 1 | 2 | 15 | 2 | 9 | 5 | -- | 5 | 5 | 1 | 1 | -- | 4 | 6 | 6 | 1 | 7 | 1 | -- | 4 |
| HECO26 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | 2 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 2 | -- | 6 | -- | -- | -- | -- | 1 | -- | -- | -- | 4 |
| PASM | 2 | 4 | 1 | -- | 3 | 4 | 1 | -- | -- | 3 | 2 | 4 | -- | -- | 6 | 2 | -- | -- | 3 | -- | 1 | -- | -- | 5 | -- | 4 | 5 | 2 | -- | -- | 6 | 3 | -- | 1 | 10 | 6 | -- | -- | 1 | 7 |
| PSJU3 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 2 | 1 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOSI2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BODA2 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | -- | 2 | 2 | 1 | -- | -- | -- | -- | 1 | -- | 2 | -- | 1 | -- | 1 | -- | -- | 1 | -- | -- | 2 | -- | 1 | -- | 2 | 2 | -- | -- | -- | 4 | -- | -- | 1 | -- | -- | 1 | -- | -- | -- | 1 |
| PLJA | 12 | 5 | 2 | 11 | -- | -- | 2 | -- | 4 | 7 | 1 | 1 | 4 | 16 | 2 | 2 | 5 | 34 | 1 | 1 | 14 | 4 | 4 | 1 | 5 | -- | -- | 1 | 5 | 17 | 1 | 3 | 22 | -- | -- | 10 | 3 | 5 | -- | 14 |
| SPAI | 1 | 1 | -- | -- | -- | -- | -- | -- | 2 | -- | 11 | 1 | -- | -- | -- | -- | 13 | -- | -- | -- | 2 | -- | -- | -- | -- | 3 | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | 12 | -- | -- |
| SPCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SATR12 | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | 3 | -- | -- | 1 | -- | -- | -- | 1 | 5 | -- | 1 | 9 | -- | -- | -- | -- | -- |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COCA5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEOF | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| SPCO | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LILE3 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PEPA8 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARNO4 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- |
| ATCA2 | 1 | 2 | 1 | 2 | -- | 2 | 2 | -- | 1 | -- | 10 | 4 | 1 | 2 | 6 | -- | 12 | 1 | 4 | 6 | 1 | 3 | 5 | 4 | 1 | 6 | 5 | 1 | 7 | 4 | 5 | 7 | 2 | 3 | 4 | -- | 4 | 10 | 5 | 3 |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| EPVI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- |
| GUSA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | 2 | -- | -- | -- | 2 | 1 | -- | -- | -- | 6 | -- |
| PUTR2 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Unknown Plant** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UNK | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation | 20 | 23 | 16 | 20 | 19 | 13 | 20 | 20 | 11 | 16 | 32 | 19 | 12 | 23 | 20 | 20 | 41 | 36 | 18 | 24 | 25 | 19 | 26 | 16 | 17 | 29 | 14 | 18 | 20 | 36 | 14 | 20 | 32 | 16 | 30 | 25 | 21 | 28 | 12 | 34 |
| Live Vegetation[1] | 20 | 23 | 16 | 20 | 19 | 13 | 19 | 20 | 11 | 16 | 32 | 19 | 12 | 23 | 20 | 20 | 41 | 36 | 18 | 24 | 25 | 19 | 26 | 16 | 17 | 29 | 14 | 18 | 20 | 36 | 14 | 20 | 32 | 16 | 30 | 25 | 21 | 28 | 12 | 34 |
| Perennial Vegetation[2] | 20 | 23 | 16 | 20 | 18 | 13 | 15 | 20 | 11 | 16 | 32 | 19 | 12 | 23 | 20 | 20 | 41 | 36 | 18 | 24 | 25 | 17 | 26 | 13 | 17 | 29 | 13 | 18 | 20 | 36 | 13 | 15 | 32 | 15 | 21 | 25 | 21 | 28 | 12 | 34 |
| Rock | 0 | 1 | 1 | 2 | 0 | 4 | 2 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 3 | 0 | 2 | 0 | 0 | 3 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 6 | 1 | 1 | 5 | 0 |
| Litter | 7 | 10 | 6 | 8 | 14 | 12 | 20 | 7 | 6 | 7 | 4 | 11 | 15 | 3 | 6 | 13 | 1 | 4 | 12 | 12 | 13 | 11 | 5 | 10 | 3 | 12 | 12 | 8 | 10 | 7 | 15 | 12 | 9 | 22 | 8 | 4 | 8 | 7 | 9 | 4 |
| Bare Soil | 23 | 16 | 27 | 20 | 17 | 21 | 8 | 23 | 33 | 27 | 13 | 19 | 21 | 24 | 24 | 16 | 7 | 10 | 20 | 14 | 11 | 17 | 19 | 22 | 30 | 9 | 21 | 23 | 17 | 7 | 20 | 18 | 9 | 12 | 11 | 15 | 20 | 14 | 24 | 12 |

Notes:
Species codes defined in Table A-6
[1] Live vegetation is the total vegetation foliar hits for the transect, NOT including noxious weeds
[2] Perennial vegetation is the total vegetation foliar hits for the transect, NOT including annuals and noxious weeds

**Table A-2: O-VMU-5 Line Point Intercept Foliar Cover Data (all hits), 2023**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | -- | 3 | -- | -- | -- | 3 | 16 | -- | -- | -- | -- | -- | -- | 1 | -- | 2 | -- | 5 | -- | 1 | 3 | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- |
| AGCR | -- | -- | -- | -- | -- | 2 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 19 | 1 | -- | -- | -- | -- | 1 | -- | 2 | -- | -- | -- | -- | -- | 1 | -- | 4 | -- | -- | -- |
| BRIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- |
| ELEL5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELLA3 | 3 | 9 | 5 | 7 | 15 | 5 | -- | 2 | 2 | 4 | 7 | 12 | 3 | 1 | 1 | 14 | 13 | -- | -- | -- | 2 | 3 | 18 | 2 | 11 | 5 | -- | 5 | 10 | 1 | 1 | -- | 4 | 8 | 9 | 1 | 7 | 1 | -- | 4 |
| HECO26 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | 2 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 2 | -- | 6 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 4 |
| PASM | 2 | 4 | 1 | -- | 3 | 5 | 1 | -- | -- | 3 | 3 | 4 | -- | -- | 6 | 2 | -- | -- | 4 | -- | 1 | -- | -- | 6 | -- | 6 | 6 | 2 | 1 | -- | 8 | 4 | -- | 1 | 10 | 6 | -- | 2 | 1 | 7 |
| PSJU3 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 2 | 1 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| THIN6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOSI2 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BODA2 | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | -- | 2 | 2 | 1 | -- | -- | -- | -- | 1 | -- | 2 | -- | 1 | -- | 1 | -- | -- | 1 | -- | -- | 4 | -- | 1 | -- | 2 | 2 | -- | -- | -- | 4 | -- | -- | 1 | -- | -- | 1 | -- | -- | -- | 1 |
| PLJA | 12 | 6 | 2 | 11 | -- | -- | 2 | -- | 5 | 7 | 1 | 1 | 4 | 16 | 3 | 2 | 10 | 34 | 2 | 1 | 16 | 4 | 4 | 1 | 6 | -- | -- | 2 | 6 | 17 | 1 | 3 | 23 | -- | -- | 10 | 4 | 9 | -- | 14 |
| SPAI | 1 | 2 | -- | -- | -- | -- | -- | -- | 2 | -- | 12 | 1 | -- | -- | -- | -- | 16 | -- | -- | -- | 2 | -- | -- | -- | -- | 5 | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | 12 | -- | -- |
| SPCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SATR12 | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | 3 | -- | -- | 1 | -- | -- | -- | 1 | 5 | -- | 1 | 9 | -- | -- | -- | -- | -- |
| Perennials/Biennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COCA5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEOF | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| SPCO | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LILE3 | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PEPA8 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| RACO3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARNO4 | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCA2 | 1 | 2 | 1 | 2 | -- | 2 | 2 | -- | 1 | -- | 10 | 4 | 1 | 2 | 6 | -- | 12 | 1 | 5 | 6 | 1 | 3 | 5 | 4 | 1 | 6 | 5 | 1 | 7 | 4 | 5 | 7 | 2 | 3 | 4 | -- | 4 | 13 | 5 | 3 |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- |
| CHGR6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| EPVI | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | -- | -- | 1 | -- | -- | -- | -- | -- |
| GUSA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 2 | -- | -- | -- | -- | 1 | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | 2 | -- | -- | -- | -- | 2 | 1 | -- | -- | -- | 6 | -- |
| PUTR2 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Unknown Plant** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UNK | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

Notes:

Species codes defined in Table A-5

**Table A-3: O-VMU-5 Quadrat Canopy Cover Data (%), 2024**

| Transect | T01P | | | T02P | | | T03P | | | T04P | | | T05P | | | T06P | | | T7P | | | T08P | | | T09P | | | T10P | | | T11P | | | T12P | | | T13P | | | T14P | | | T15P | | | T16P | | | T17P | | | T18P | | | T19P | | | T20P | | |
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| Quadrat | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | -- | -- | -- | -- | -- | -- | 6.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10.0 | 45.0 | 33.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 35.0 | -- | -- | -- | -- | -- | 7.0 | 2.0 | -- | -- | -- | -- |
| AGCR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 40.0 | 57.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 28.0 | -- | 32.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 26.0 | 88.0 | 31.0 |
| ELLA3 | 4.0 | -- | 25.0 | 1.0 | 6.0 | 16.0 | 15.0 | 4.0 | -- | 9.5 | 18.0 | 3.0 | 37.0 | 27.0 | 48.0 | -- | -- | 12.0 | -- | -- | -- | -- | -- | 18.0 | -- | 12.0 | T | -- | -- | -- | 1.0 | -- | -- | 34.0 | 48.0 | 55.0 | 3.5 | 2.5 | 19.0 | 16.0 | -- | -- | 53.0 | -- | -- | -- | 70.0 | 72.0 | 8.0 | -- | 8.0 | -- | 2.0 | -- | -- | -- | -- | -- |
| HECO26 | 12.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.0 | -- | -- | -- | -- | -- | -- | -- | -- | 28.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HOJU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | -- | 2.0 | -- | -- | -- | 6.0 | 2.0 | -- | 22.0 | -- | -- | -- | 8.0 | 6.0 | 6.0 | -- | -- | -- | 3.0 | -- | -- | 4.0 | -- | -- | -- | -- | -- | -- | -- | 22.0 | -- | -- | -- | -- | -- | -- | 4.0 | -- | 8.0 | -- | 8.0 | 12.5 | 25.0 | 12.0 | 18.0 | -- | -- | -- | 3.0 | 10.0 | -- | -- | -- | -- | 42.0 | -- | -- | -- | -- |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 27.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOSI2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 16.0 | 6.0 | 3.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season Perennials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARPU9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOCU | -- | -- | -- | -- | -- | -- | -- | -- | 5.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BODA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | 28.0 | -- | -- | -- | 28.0 | -- | -- | 9.0 | 12.0 | -- | 1.0 | 5.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 20.0 | -- | -- | -- | -- | -- | -- | 8.0 | -- | -- | -- | -- | -- | -- | 2.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8.0 | -- | -- | -- | -- | -- | -- | -- |
| PLJA | -- | -- | -- | -- | 11.0 | -- | -- | -- | -- | -- | -- | 27.0 | -- | -- | -- | -- | -- | -- | -- | -- | 70.0 | -- | 8.0 | -- | -- | -- | 24.0 | -- | -- | -- | 21.0 | -- | -- | -- | -- | -- | -- | 15.0 | 23.0 | -- | 37.0 | 77.0 | -- | -- | 20.0 | -- | -- | -- | 8.0 | 28.0 | 4.0 | 88.0 | 18.0 | 50.0 | -- | -- | 62.0 | -- | -- |
| SPAI | -- | -- | -- | -- | -- | -- | -- | 46.0 | -- | -- | -- | 14.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 63.0 | 36.0 | -- | -- | 42.0 | -- | 12.0 | 43.0 | 0.8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 35.0 | -- | 60.0 | -- | -- | -- | -- | -- | -- | -- |
| SPCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annuals | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ALDE | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ALSI8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 12.0 | 10.0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHGL13 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHLE4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHST | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
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| Total Vegetation Cover[1] | 44.0 | 76.0 | 25.0 | 1.0 | 45.0 | 22.0 | 24.0 | 50.0 | 40.0 | 13.0 | 18.0 | 71.0 | 64.0 | 35.0 | 48.0 | 40.0 | 55.0 | 12.0 | 25.0 | 40.0 | 76.0 | 14.0 | 65.0 | 50.0 | 75.0 | 45.0 | 24.0 | 28.0 | 41.0 | 45.0 | 37.0 | 51.0 | 28.0 | 34.0 | 48.0 | 55.0 | 5.5 | 18.0 | 41.0 | 25.0 | 50.0 | 80.0 | 95.0 | 25.0 | 40.0 | 40.0 | 30.0 | 72.0 | 50.0 | 62.0 | 21.0 | 90.0 | 26.0 | 50.0 | 12.0 | 44.0 | 63.0 | 26.0 | 88.0 | 42.3 |
| Rock | 0.0 | 0.0 | 3.0 | 1.0 | 0.0 | 2.0 | 10.0 | 0.0 | 1.0 | 0.5 | 1.0 | 0.1 | 0.0 | 0.0 | 0.0 | 2.0 | 1.0 | 0.0 | 8.0 | 14.0 | 0.0 | 13.0 | 0.0 | 1.0 | 0.0 | 0.0 | 1.0 | 2.0 | 1.0 | 1.0 | 1.5 | 0.0 | 2.0 | 0.0 | 1.0 | 0.0 | 6.0 | 1.0 | 0.1 | 4.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.5 | 4.0 | 5.0 | 1.0 | 3.0 | 1.5 | 0.5 | 0.0 | T | 0.0 | 8.0 | 1.0 | 0.0 | 1.0 | 0.0 | 0.0 |
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| Bare Soil | 52.0 | 24.0 | 65.0 | 92.0 | 46.0 | 74.0 | 58.0 | 44.0 | 56.0 | 81.5 | 72.0 | 16.9 | 32.0 | 59.0 | 40.0 | 20.0 | 24.0 | 80.0 | 27.0 | 26.0 | 16.0 | 53.0 | 25.0 | 25.0 | 22.0 | 47.0 | 73.0 | 65.0 | 46.0 | 53.0 | 60.8 | 37.0 | 64.0 | 54.0 | 51.0 | 39.0 | 86.5 | 77.0 | 56.0 | 67.0 | 37.0 | 20.0 | 2.8 | 61.5 | 56.5 | 47.0 | 0.0 | 21.0 | 41.0 | 33.3 | 72.5 | 7.0 | 68.0 | 30.0 | 76.0 | 49.0 | 29.0 | 68.5 | 0.0 | 28.0 |

**Table A-3: O-VMU-5 Quadrat Canopy Cover Data (%), 2024 (cont'd)**

| Transect | T21P | | | T22P | | | T23P | | | T24P | | | T25P | | | T26P | | | T27P | | | T28P | | | T29P | | | T30P | | | T31P | | | T32P | | | T33P | | | T34P | | | T35P | | | T36P | | | T36P | | | T37P | | | T39P | | | T40P | | |
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| BOGR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHER2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.05 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HEMU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1.5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LILE3 | -- | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPIN2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GUSA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCA2 | -- | -- | -- | -- | -- | -- | 20 | -- | -- | -- | -- | -- | 37 | 88 | -- | -- | -- | -- | -- | -- | -- | 13 | -- | -- | -- | -- | -- | 62 | -- | -- | -- | -- | -- | -- | 18 | -- | -- | 14 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 44 | -- |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 16 | -- | -- | -- | -- | -- | -- | -- | -- |
| CYIM2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | T | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.5 | 2 | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8.5 | 38 | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 39 | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | 39 | -- | -- | -- |
| PUTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Cover Components** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Vegetation Cover[1] | 29 | 50 | 24.3 | 33 | 15 | 35 | 88 | 28 | 13 | 17.5 | 90 | 50 | 88 | 29 | 45 | 35 | 53 | 85 | 16 | 30 | 19 | 30 | 35 | 40 | 50 | 58 | 68 | 72 | 76 | 72 | 0.05 | 17 | 18.5 | 9.5 | 48 | 40 | 60 | 66 | 63 | 70 | 40 | 45 | 55 | 67 | 28 | 80 | 40 | 45 | 35 | 7 | 23 | 35 | 51 | 33 | 20 | 24 | 50 | 92 | 66 | 57 |
| Rock | 0.05 | 0 | 0 | 5 | 3 | 6 | 0 | 8 | 1 | 1 | 0.05 | 1 | 0 | 1 | 1 | 0 | 0 | 0.05 | 12 | 16 | 28 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0.5 | 0 | 0.05 | 0.05 | 0 | 0.25 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 4 | 0 | T | 0 | 42 | 25 | 39 | 0 | 0 | 0 |
| Litter | 25 | 3 | 20 | 8 | 6 | 4 | 10 | 2 | 8 | 2 | 7 | 12 | 12 | 8 | 12 | 19 | 6 | 5 | 24 | 22 | 6 | 50 | 17 | 3 | 34 | 6 | 8 | 16 | 24 | 12 | T | 27 | 6 | 3 | 32 | 6 | 12 | 1 | 4 | 8 | 20 | 30 | 18 | 8 | 4 | 5 | 1 | 3 | 10 | 8 | 12 | 1 | 10 | 6 | 6 | 18 | 5 | 0 | 22 | 37 |
| Bare Soil | 46 | 47 | 55.8 | 54 | 76 | 55 | 2 | 62 | 78 | 79.5 | 2.95 | 37 | 0 | 62 | 42 | 46 | 41 | 9.95 | 48 | 32 | 47 | 20 | 48 | 56 | 25 | 35 | 24 | 12 | 0 | 16 | 99.5 | 56 | 75.5 | 87.5 | 20 | 53.8 | 28 | 33 | 33 | 22 | 32 | 25 | 27 | 25 | 67 | 14 | 57 | 52 | 55 | 85 | 61 | 64 | 39 | 61 | 32 | 33 | 6 | 8 | 12 | 6 |

Notes:
Species codes defined in Table A-6
[1]Total vegetation canopy cover for the transect by the quadrat canopy cover estimate method

**Table A-4: O-VMU-5 Air-dry Aboveground Annual Forage Production Data, 2024**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Perennial Grasses** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cool-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACHY | -- | -- | 7 | -- | -- | -- | -- | 70 | -- | -- | -- | -- | -- | -- | -- | -- | 30 | -- | 18 | -- | -- | 7 | -- | -- | -- | -- | 5 | 5 | -- | -- | -- | 7 | -- | -- | -- | -- | 4 | -- | -- | 19 |
| AGCR | -- | -- | -- | -- | -- | 35 | -- | -- | -- | 72 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 156 | -- | -- | -- | -- | -- | -- | -- | 37 | -- | 84 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ELLA3 | 14 | 9 | 17 | 36 | 88 | 7 | -- | 21 | 10 | -- | -- | 89 | 17 | 15 | 59 | 45 | 15 | 5 | -- | -- | -- | 14 | 30 | -- | 28 | 34 | -- | 14 | 34 | 12 | 17 | -- | -- | 16 | -- | 13 | 43 | 20 | -- | -- |
| HECO26 | 8 | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- | 6 | -- | -- | 9 | -- | -- | -- | -- | -- | 17 | -- | -- | -- | 36 | -- | -- | 47 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| HOJU | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 27 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| PASM | 8 | 8 | 12 | -- | 17 | -- | 5 | 5 | -- | 26 | -- | -- | 11 | 10 | 55 | 16 | 19 | -- | 30 | -- | 36 | -- | 29 | 61 | -- | 16 | 28 | 73 | -- | -- | 10 | 7 | -- | 71 | 82 | -- | -- | -- | 23 | 5 |
| PSSP6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 35 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Warm-Season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARPU9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- |
| BOCU | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 15 | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BODA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 8 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| BOGR2 | 25 | 19 | 19 | 7 | -- | -- | -- | -- | 14 | -- | 10 | -- | -- | 5 | -- | -- | -- | 7 | -- | -- | 81 | -- | -- | -- | 5 | 23 | -- | 8 | -- | 45 | -- | -- | 14 | 6 | -- | 26 | -- | 13 | -- | -- |
| PLJA | -- | 9 | -- | 30 | -- | -- | 83 | 33 | 36 | -- | 27 | -- | 50 | 94 | 39 | -- | 43 | 91 | 100 | -- | 20 | 9 | -- | -- | 36 | -- | -- | -- | 29 | 40 | -- | 13 | 147 | -- | -- | 184 | -- | 72 | -- | 209 |
| SPAI | -- | -- | 33 | 13 | -- | -- | -- | -- | 106 | 36 | 59 | -- | -- | -- | -- | -- | 35 | 15 | -- | -- | -- | -- | -- | -- | 38 | 102 | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | 50 | -- | -- |
| SPCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 17 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Perennial/Biennial Forbs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BADI | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CHER2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- |
| GRSQ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 32 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | 11 | -- | -- | -- | -- | -- | -- |
| HEMU3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| LILE3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MACA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| MEOF | -- | -- | 10 | -- | -- | 4 | 15 | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | 29 | -- | 24 | -- | 7 | -- | -- |
| MESA | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SPCO | -- | -- | -- | -- | -- | -- | 19 | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | 4 | 6 | -- | -- | -- | -- | 6 | -- | -- | 6 | 8 | 8 | -- | -- | 5 | -- | -- | 5 | -- |
| SPIN2 | -- | -- | -- | -- | -- | -- | -- | 25 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ATCA2 | 184 | -- | -- | 51 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 83 | 22 | 4 | -- | -- | 38 | -- | -- | 38 | 26 | 124 | -- | 32 | -- | -- | 46 | -- | 28 | 11 | -- | -- | -- | -- | -- | -- | 34 |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 27 | -- | -- | -- | -- |
| ERNA10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- |
| GUSA2 | -- | -- | -- | -- | 44 | -- | -- | -- | -- | -- | -- | -- | -- | 19 | -- | -- | -- | -- | 9 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| KRLA2 | -- | -- | -- | -- | -- | -- | 10 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 59 | -- | 6 | -- | -- | -- | -- | 74 | 6 | -- | -- | -- | 36 | -- |
| PUTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 25 | -- | -- | -- | -- | -- |
| **Total Air-dry Aboveground Annual Forage Production** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total (g) | 240 | 44 | 103 | 152 | 149 | 47 | 140 | 153 | 166 | 134 | 136 | 89 | 84 | 142 | 248 | 93 | 148 | 118 | 157 | 194 | 196 | 53 | 97 | 100 | 231 | 279 | 79 | 164 | 138 | 233 | 34 | 64 | 177 | 208 | 94 | 271 | 85 | 161 | 64 | 268 |
| Total (lbs/ac) | 1,428 | 265 | 615 | 901 | 886 | 279 | 831 | 912 | 986 | 800 | 806 | 529 | 498 | 846 | 1,476 | 552 | 879 | 700 | 932 | 1,152 | 1,167 | 316 | 577 | 596 | 1,374 | 1,657 | 469 | 976 | 819 | 1,385 | 204 | 378 | 1,051 | 1,236 | 557 | 1,613 | 507 | 959 | 378 | 1,592 |

Notes:
Species codes defined in Table A-6
Total (g) is the total of all three .5 $m^2$ quads (1.5$m^2$ total) per transect
lbs/ac=total grams÷1.5*(4046.86 $m^2$/ac ÷ 453.59 g/lbs)
Forage plants are perennial and/or biennial duration excluding noxious weeds

**Table A-5: O-VMU-5 Shrub Belt Transect Data (frequency), 2024**

| Transect | T01P | T02P | T03P | T04P | T05P | T06P | T07P | T08P | T09P | T10P | T11P | T12P | T13P | T14P | T15P | T16P | T17P | T18P | T19P | T20P | T21P | T22P | T23P | T24P | T25P | T26P | T27P | T28P | T29P | T30P | T31P | T32P | T33P | T34P | T35P | T36P | T37P | T38P | T39P | T40P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Shrubs, Trees, and Cacti** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ARFR4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARLU | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARNO4 | -- | -- | -- | 13 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ARTR2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -- | -- | -- | -- |
| ATCA2 | 16 | 9 | 8 | 72 | 15 | 19 | 8 | 15 | 21 | 33 | 76 | 41 | 23 | 9 | 45 | 29 | 62 | 23 | 12 | 16 | 14 | 25 | 46 | 41 | 13 | 7 | 35 | 17 | 37 | 23 | 19 | 30 | 28 | 35 | 37 | 8 | 8 | 55 | 28 | 17 |
| ATCO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 4 | 4 | -- | -- | -- | -- | 1 | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- |
| ATCO4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 10 | -- | -- | 10 | -- | -- | -- | -- | -- | -- | 1 | 1 | -- | -- | -- |
| CHGR6 | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 6 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| EPTR | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| EPVI | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | 27 | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ERNA10 | -- | 5 | 1 | -- | 4 | -- | -- | 3 | -- | -- | -- | -- | 1 | 9 | -- | -- | -- | -- | 5 | -- | -- | -- | -- | 2 | -- | 2 | -- | 1 | -- | -- | 3 | 3 | -- | -- | -- | 9 | 2 | -- | 1 | -- |
| GUSA2 | -- | 1 | -- | -- | 4 | 1 | -- | 2 | -- | -- | -- | -- | 2 | 8 | -- | -- | -- | -- | 34 | -- | 1 | 1 | -- | 3 | 1 | 2 | -- | 4 | -- | 1 | 4 | 7 | 2 | 1 | -- | -- | 27 | -- | 4 | -- |
| KRLA2 | -- | -- | -- | 18 | -- | -- | 28 | -- | -- | 2 | 5 | -- | 24 | -- | 32 | 2 | 2 | 4 | -- | -- | -- | 22 | -- | -- | -- | 137 | -- | 9 | 17 | 1 | -- | -- | 1 | 65 | 10 | -- | -- | 13 | 110 | 2 |
| OPMA2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| OPPO | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| PIED | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 |
| PUTR2 | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | -- | -- | 1 | -- | -- | -- | -- | -- | 5 | -- | -- | -- | -- | -- | -- | -- | 3 | 3 | -- | -- | -- |
| SAVE4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SEFL3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 3 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- | -- | -- | -- | 2 | -- | -- | -- | -- |
| **Total** | 16 | 15 | 13 | 104 | 23 | 20 | 36 | 20 | 21 | 36 | 82 | 41 | 81 | 30 | 77 | 31 | 70 | 30 | 52 | 19 | 16 | 53 | 50 | 46 | 14 | 158 | 41 | 39 | 66 | 26 | 26 | 40 | 35 | 101 | 47 | 22 | 43 | 68 | 143 | 24 |

Notes:
Species codes defined in Table A-6
The shrub belt transect area is 100m$^2$ (2mx50m); shrubs rooted in the belt transect were counted on an individual basis

**Table A-6: Species Observed 2019-2024, O-VMU-5**

| Common Name | Scientific Name | Code |
|---|---|---|
| **Cool-Season Grasses (23)** | | |
| **Annuals (5)** | | |
| Field brome | *Bromus arvensis* | BRAR5 |
| Cheatgrass | *Bromus tectorum* | BRTE |
| Common barley | *Hordeum vulgare* | HOVU |
| Cereal rye | *Secale cereale* | SECE |
| Common Wheat | *Triticum aestivum* | TRAE |
| **Perennials (18)** | | |
| Indian ricegrass | *Achnatherum hymenoides* | ACHY |
| Crested wheatgrass | *Agropyron cristatum* | AGCR |
| Smooth brome | *Bromus inermis* | BRIN2 |
| Bottlebrush squirreltail | *Elymus elymoides* | ELEL5 |
| Blue wildrye | *Elymus glaucus* | ELGL |
| Thickspike wheatgrass | *Elymus lanceolatus* | ELLA3 |
| Slender wheatgrass | *Elymus trachycaulus* | ELTR7 |
| Arizona fescue | *Festuca arizonica* | FEAR2 |
| Needle and thread | *Hesperostipa comata* | HECO26 |
| Foxtail barley | *Hordeum jubatum* | HOJU |
| Colorado wildrye | *Leymus ambiguus* | LEAM |
| Basin wildrye | *Leymus cinereus* | LECI4 |
| Green needlegrass | *Nassella viridula* | NAVI4 |
| Western wheatgrass | *Pascopyrum smithii* | PASM |
| Russian wildrye | *Psathyrostachys juncea* | PSJU3 |
| Bluebunch wheatgrass | *Pseudoroegneria spicata* | PSSP6 |
| Intermediate wheatgrass | *Thinopyrum intermedium* | THIN6 |
| Tall wheatgrass | *Thinopyrum ponticum* | THPO7 |
| **Warm-Season Grasses (13)** | | |
| **Annuals (3)** | | |
| Sixweeks grama | *Bouteloua barbata* | BOBA2 |
| Matted grama | *Bouteloua simplex* | BOSI2 |
| False buffalograss | *Munroa squarrosa* | MUSQ3 |
| **Perennials (10)** | | |
| Purple threeawn | *Aristida purpurea* | ARPU9 |
| Sideoats grama | *Bouteloua curtipendula* | BOCU |
| Buffalograss | *Bouteloua dactyloides* | BODA2 |
| Blue grama | *Bouteloua gracilis* | BOGR2 |
| James' galleta | *Pleuraphis jamesii* | PLJA |
| Tumblegrass | *Schedonnardus paniculatus* | SCPA |
| Indiangrass | *Sorghastrum nutans* | SONU2 |
| Alkali sacaton | *Sporobolus airoides* | SPAI |
| Sand dropseed | *Sporobolus cryptandrus* | SPCR |
| **Spike dropseed** | ***Sporobolus contractus*** | **SPCO4** |
| **Forbs (87)** | | |
| **Annuals (36)** | | |
| Desert madwort | *Alyssum desertorum* | ALDE |
| Alyssum | *Alyssum simplex* | ALSI8 |
| Redroot amaranth | *Amaranthus retroflexus* | AMRE |
| Annual ragweed | *Ambrosia artemisiifolia* | AMAR2 |
| Burningbush | *Bassia scoparia* | BASC5 |
| Ribseed sandmat | *Chamaesyce glyptosperma* | CHGL13 |
| Spotted sandmat | *Chamaesyce maculata* | CHMA15 |
| Prairie sandmat | *Chamaesyce missurica* | CHMI8 |
| Threadstem sandmat | *Chamaesyce revoluta* | CHRE4 |
| Thymeleaf sandmat | *Chamaesyce serpyllifolia* | CHSE6 |
| **Esteve's pincushion** | ***Chaenactis stevioides*** | **CHST** |
| Mealy goosefoot | *Chenopodium incanum* | CHIN2 |
| Narrowleaf goosefoot | *Chenopodium leptophyllum* | CHLE4 |
| Lambsquarters | *Chenopodium album* | CHAL7 |
| Rocky Mountain beeplant | *Cleome serrulata* | CLSE |
| Wright's bird's beak | *Cordylanthus wrightii* | COWR2 |
| Fetid goosefoot | *Dysphania graveolens* | DYGR |
| Fetid marigold | *Dyssodia papposa* | DYPA |
| Nodding buckwheat | *Eriogonum cernuum* | ERCE2 |
| Divergent buckwheat | *Eriogonum divaricatum* | ERDI5 |
| Saltlover | *Halogeton glomeratus* | HAGL |
| Common sunflower | *Helianthus annuus* | HEAN3 |
| Prairie sunflower | *Helianthus petiolaris* | HEPE |
| Longleaf false goldeneye | *Heliomeris longifolia* | HELO6 |
| Coulter's horseweed | *Laennecia coulteri* | LACO13 |
| King's lupine | *Lupinus kingii* | LUKI |
| Fendler's desertdandelion | *Malacothrix fendleri* | MAFE |
| Pony beebalm | *Monarda pectinata* | MOPE |
| Erect knotweed | *Polygonum erectum* | POER2 |
| Little hogweed | *Portulaca oleracea* | POOL |
| Prickly Russian thistle | *Salsola tragus* | SATR12 |
| Manyflower false threadleaf | *Schkuhria multiflora* | SCMU6 |
| Cutleaf nightshade | *Solanum triflorum* | SOTR |
| Common sowthistle | *Sonchus oleraceus* | SOOL |
| Golden crownbeard | *Verbesina encelioides* | VEEN |
| Rough cocklebur | *Xanthium strumarium* | XAST |

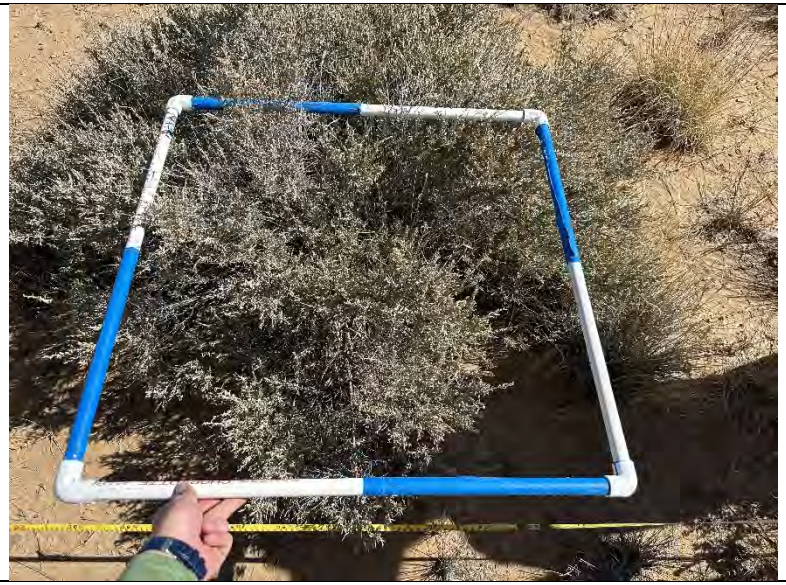
## Table A-6: Species Observed 2019-2024, O-VMU-5

| Common Name | Scientific Name | Code |
|---|---|---|
| **Perennials/Biennials (51)** | | |
| Common yarrow | *Achillea millefolium* | ACMI2 |
| Horsetail milkweed | *Asclepias subverticillata* | ASSU2 |
| Fort Wingate milkvetch | *Astragalus mingatanus* | ASWI2 |
| Ragleaf bahia | *Bahia dissecta* | BADI |
| **Slimstalk spiderling** | ***Boerhavia gracillima*** | **BOGR** |
| Sego lily | *Calochortus nuttallii* | CANU3 |
| Musk thistle | *Carduus nutans* | CANU4 |
| Wyoming Indian paintbrush | *Castilleja linariifolia* | CALI4 |
| Rose heath | *Chaetopappa ericoides* | CHER2 |
| Whitemargin sandmat | *Chamaesyce albomarginata* | CHAL11 |
| Canadian horseweed | *Conyza canadensis* | COCA5 |
| Purple prairie clover | *Dalea purpurea* | DAPU5 |
| Mountain tansymustard | *Descurainia incana* | DEIN5 |
| Western tansymustard | *Descurainia pinnata* | DEPI |
| Flixweed | *Descurainia sophia* | DESO |
| Spreading fleabane | *Erigeron divergens* | ERDI4 |
| Bastardsage | *Eriogonum wrightii* | ERWR |
| Redstem stork's bill | *Erodium cicutarium* | ERCI6 |
| Blanketflower | *Gaillardia aristata* | GAAR |
| Curlycup gumweed | *Grindelia squarrosa* | GRSQ |
| Showy goldeneye | *Heliomeris multiflora* | HEMU3 |
| Scarlet gilia | *Ipomopsis aggregata* | IPAG |
| Flaxflowered ipomopsis | *Ipomopsis longiflora* | IPLO2 |
| Manyflowered ipomopsis | *Ipomopsis multiflora* | IPMU3 |
| Prickly lettuce | *Lactuca serriola* | LASE |
| Flatspine stickseed | *Lappula occidentalis* | LAOC3 |
| Lewis flax | *Linum lewisii* | LILE3 |
| Hoary tansyaster | *Machaeranthera canescens* | MACA2 |
| Tanseyleaf tansyaster | *Machaeranthera tanacetifolia* | MATA2 |
| Horehound | *Marrubium vulgare* | MAVU |
| Alfalfa | *Medicago sativa* | MESA |
| Sweetclover | *Melilotus officinalis* | MEOF |
| Narrowleaf four-o'clock | *Mirabilis linearis* | MILI3 |
| Colorado four o'clock | *Mirabilis multiflora* | MIMU |
| Sainfoin | *Onobrychis viciifolia* | ONVI |
| Palmer's penstemon | *Penstemon palmeri* | PEPA8 |
| Prostrate knotweed | *Polygonum aviculare* | POAV |
| Upright prairie coneflower | *Ratibida columnifera* | RACO3 |
| Curly dock | *Rumex crispus* | RUCR |
| Tall tumblemustard | *Sisymbrium altissimum* | SIAL2 |
| Scarlet globemallow | *Sphaeralcea coccinea* | SPCO |
| Emory's globemallow | *Sphaeralcea emoryi* | SPEM |
| Fendler's globemallow | *Sphaeralcea fendleri* | SPFE |
| Gooseberryleaf globemallow | *Sphaeralcea grossulariifolia* | SPGR2 |
| Spear globemallow | *Sphaeralcea hastulata* | SPHA |
| Gray globemallow | *Sphaeralcea incana* | SPIN2 |
| Small-leaf globemallow | *Sphaeralcea parvifolia* | SPPA2 |
| Wright's thelypody | *Thelypodium wrightii* | THWR |
| Yellow salsify | *Tragopogon dubius* | TRDU |
| Salsify | *Tragopogon porrifolius* | TRPO |
| Jack-go-to-bed-at-noon | *Tragopogon pratensis* | TRPR |
| **Shrubs, Trees, and Cacti (43)** | | |
| Bigelow sage | *Artemisia bigelovii* | ARBI3 |
| Silver sagebrush | *Artemisia cana* | ARCA13 |
| Prairie sagewort | *Artemisia frigida* | ARFR4 |
| White sagebrush | *Artemisia ludoviciana* | ARLU |
| Black sagebrush | *Artemisia nova* | ARNO4 |
| Big sagebrush | *Artemisia tridentata* | ARTR2 |
| Tubercled saltbush | *Atriplex acanthocarpa* | ATAC |
| Fourwing saltbush | *Atriplex canescens* | ATCA2 |
| Shadscale saltbush | *Atriplex confertifolia* | ATCO |
| Mat saltbush | *Atriplex corrugata* | ATCO4 |
| Gardner's saltbush | *Atriplex gardneri* | ATGA |
| Mound saltbush | *Atriplex obovata* | ATOB |
| Basin saltbush | *Atriplex tridentata* | ATTR3 |
| Longflower rabbitbrush | *Chrysothamnus depressus* | CHDE2 |
| Greene's rabbitbrush | *Chrysothamnus greenei* | CHGR6 |
| Yellow rabbitbrush | *Chrysothamnus viscidiflorus* | CHVI8 |
| Pinkflower hedgehog cactus | *Echinocereus fendleri* | ECFE |
| Russian olive | *Elaeagnus angustifolia* | ELAN |
| Longleaf jointfir | *Ephedra trifurca* | EPTR |
| Mormon tea | *Ephedra viridis* | EPVI |
| Rubber rabbitbrush | *Ericameria nauseosa* | ERNA10 |
| Slenderleaf buckwheat | *Eriogonum leptophyllum* | ERLE10 |
| Broom snakeweed | *Gutierrezia sarothrae* | GUSA2 |
| Hairy false goldenaster | *Heterotheca villosa* | HEVI4 |
| Pingue rubberweed | *Hymenoxys richardsonii* | HYRI |
| Oneseed juniper | *Juniperus monosperma* | JUMO |
| Winterfat | *Krascheninnikovia lanata* | KRLA2 |
| Twistspine pricklypear | *Opuntia macrorhiza* | OPMA2 |
| Tulip pricklypear | *Opuntia phaeacantha* | OPPH |
| Plains pricklypear | *Opuntia polyacantha* | OPPO |
| Twoneedle pinyon | *Pinus edulis* | PIED |
| Mexican cliffrose | *Purshia mexicana* | PUME |
| Antelope bitterbrush | *Purshia tridentata* | PUTR2 |
| Woods' rose | *Rosa woodsii* | ROWO |
| Narrowleaf willow | *Salix exigua* | SAEX |
| Greasewood | *Sarcobatus vermiculatus* | SAVE4 |
| Threadleaf ragwort | *Senecio flaccidus* | SEFL3 |
| Broom-like ragwort | *Senecio spartioides* | SESP3 |
| Saltcedar | *Tamarix ramosissima* | TARA |
| Spineless horsebrush | *Tetradymia canescens* | TECA2 |
| Siberian elm | *Ulmus pumila* | ULPU |
| Banana yucca | *Yucca baccata* | YUBA |
| Soapweed yucca | *Yucca glauca* | YUGL |

Notes:
Bold species are newly observed on O-VMU-5 in 2024

**APPENDIX B**

# Quadrat Photographs

| O-VMU5-T01P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T02P | |
|---|---|
|  |  |
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|  |  |
| Q2 | Q3 |

| O-VMU5-T03P | |
|---|---|
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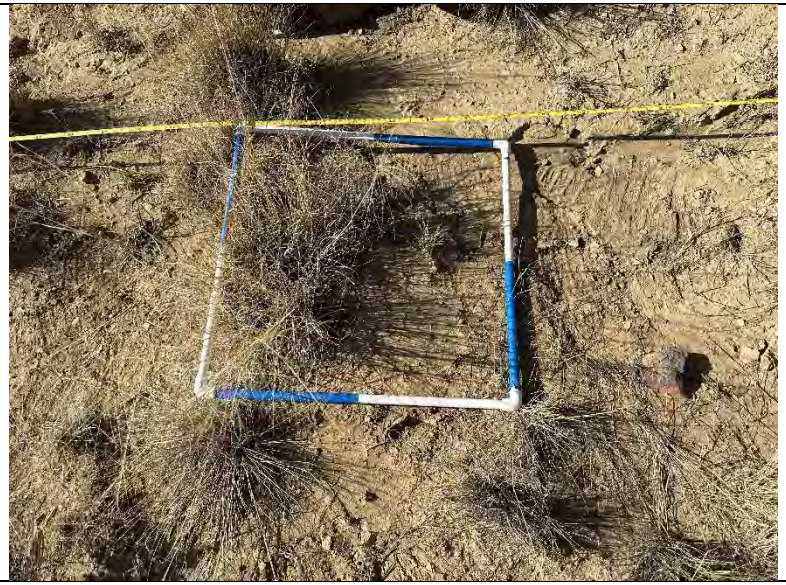
|  |  |
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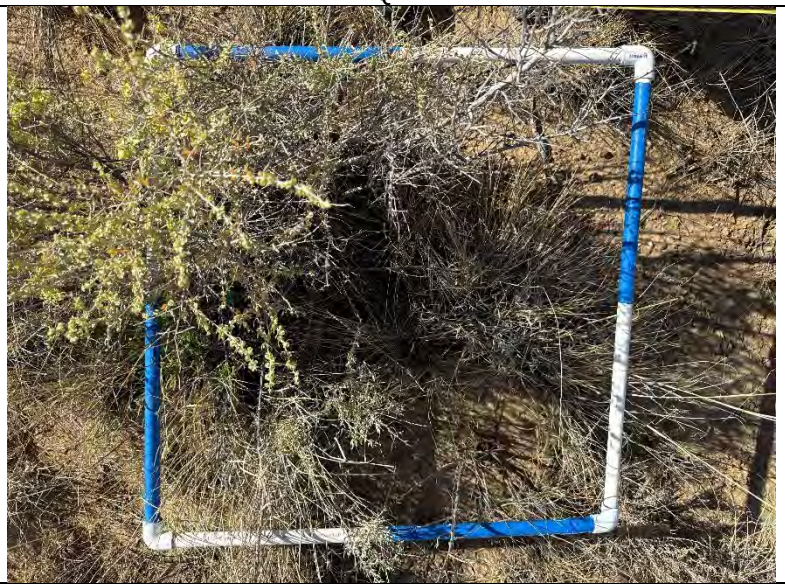
|  |  |
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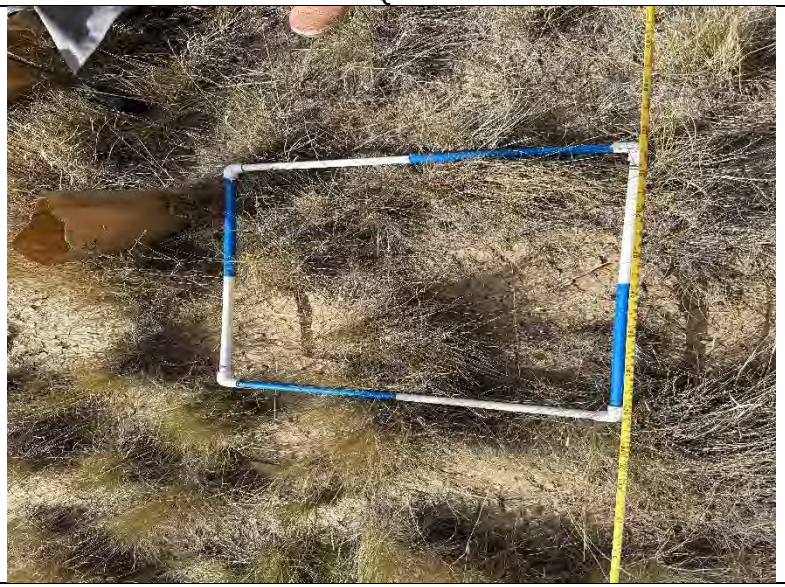
|  |  |
| Q2 | Q3 |

| O-VMU5-T06P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

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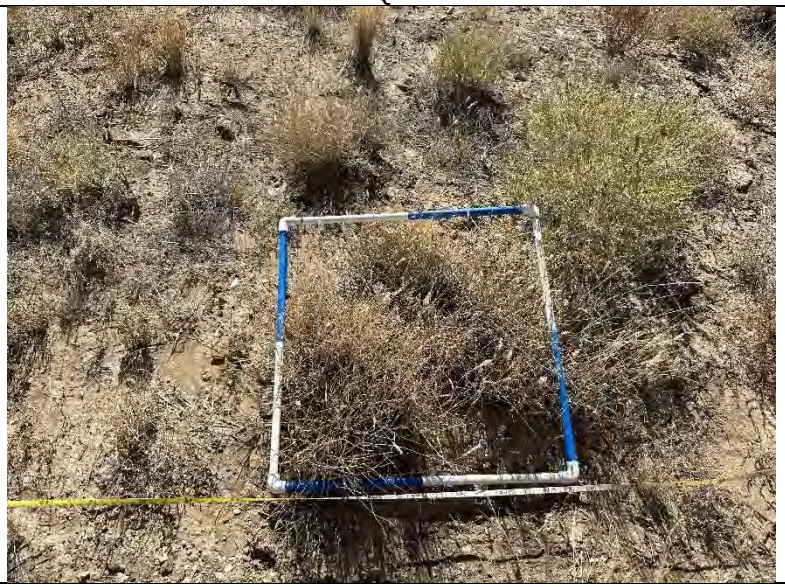
|  |  |
| Q2 | Q3 |

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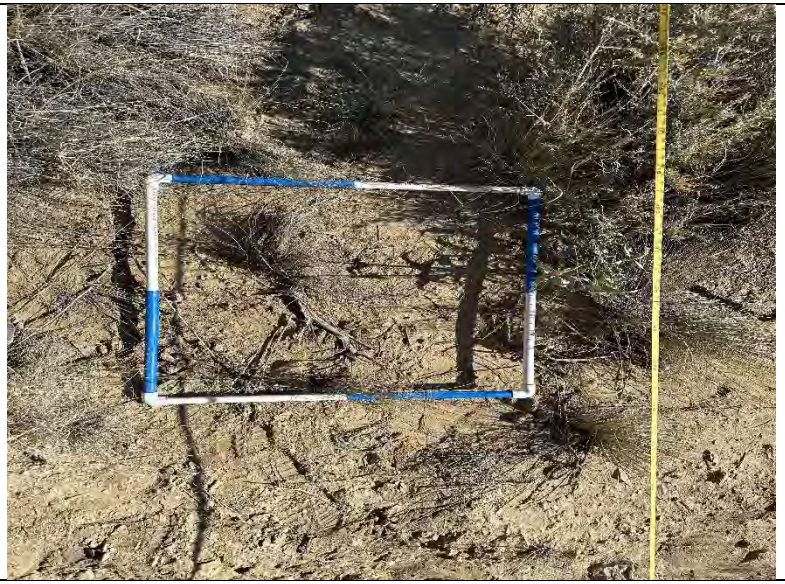
|---|---|
|  |  |
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|  |  |
| Q2 | Q3 |

| O-VMU5-T09P | |
|---|---|
|  |  |
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| Q2 | Q3 |

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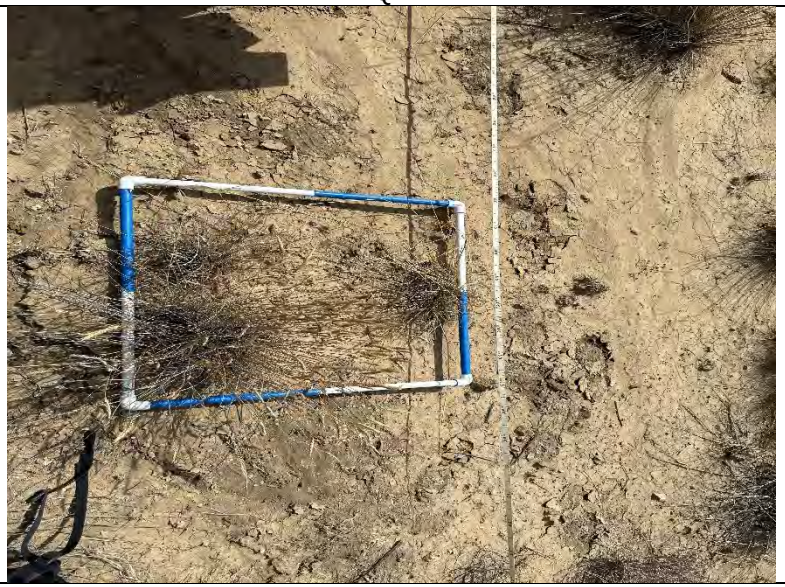
|  |  |
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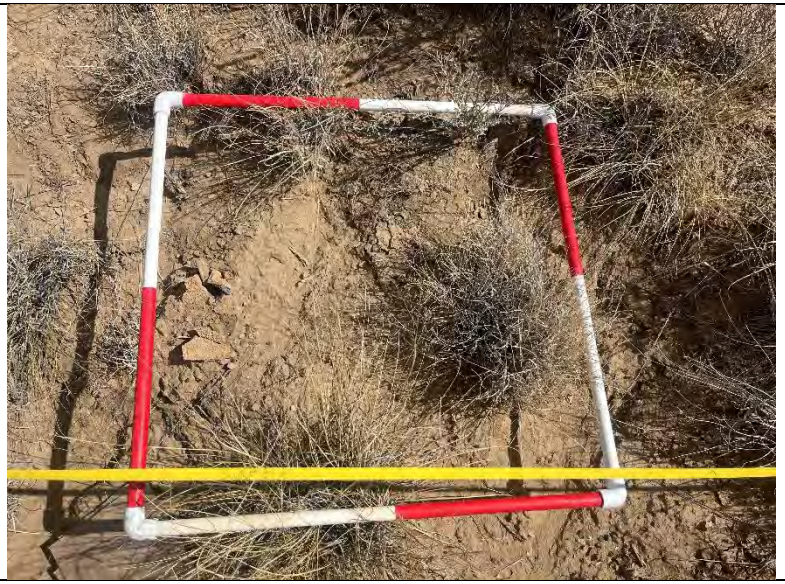
|  |  |
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| Q2 | Q3 |

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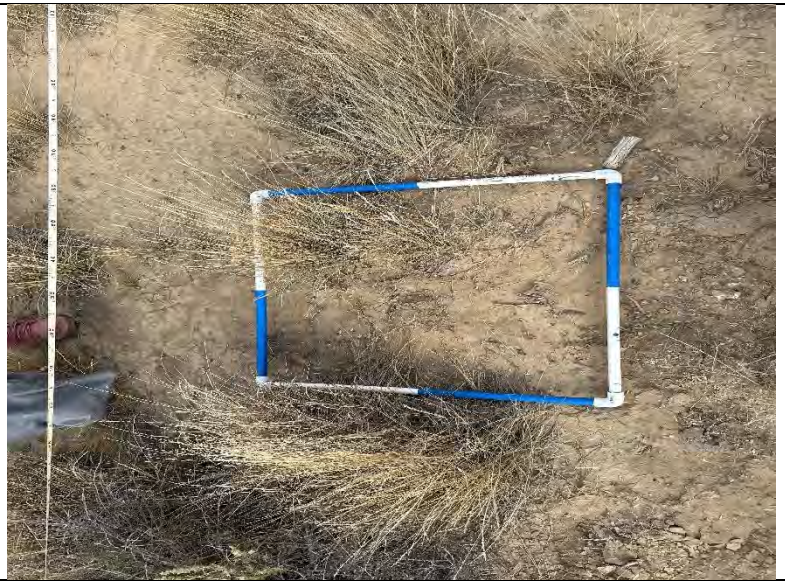
|  |  |
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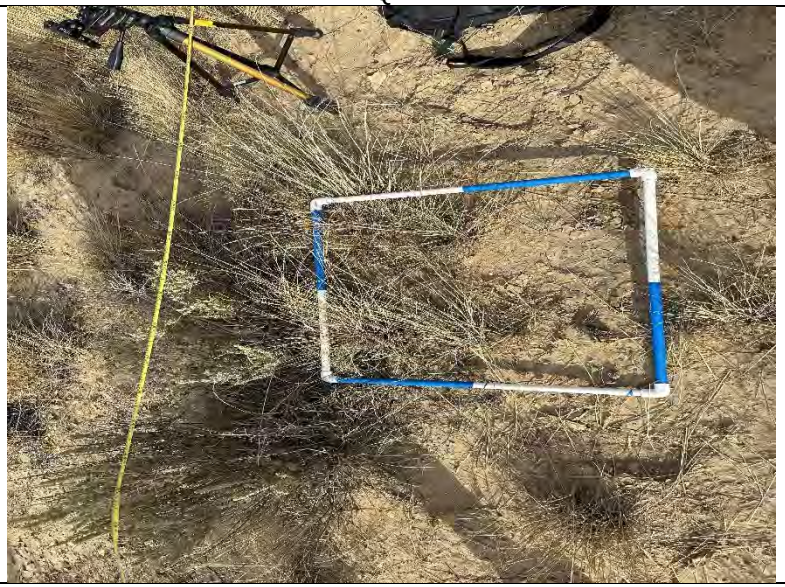
|  |  |
| Q2 | Q3 |

| O-VMU5-T13P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T14P | |
|---|---|
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|  |  |
| Q2 | Q3 |

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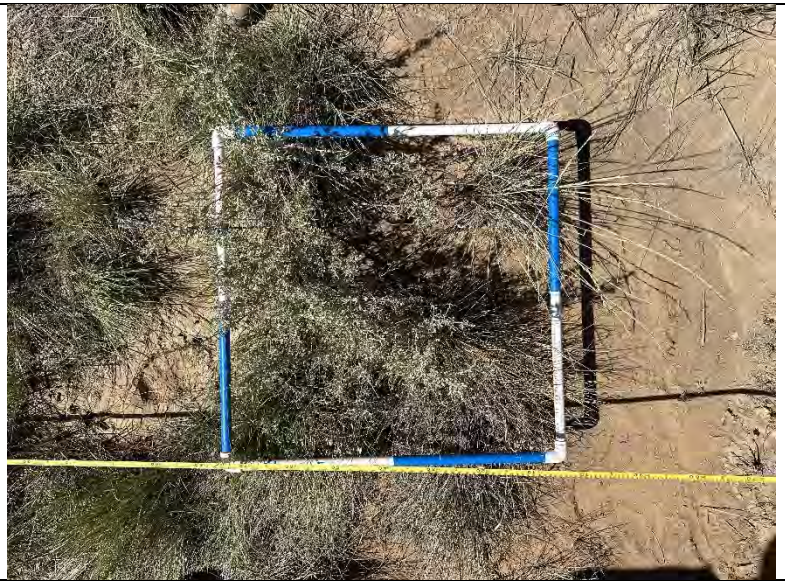
|  |  |
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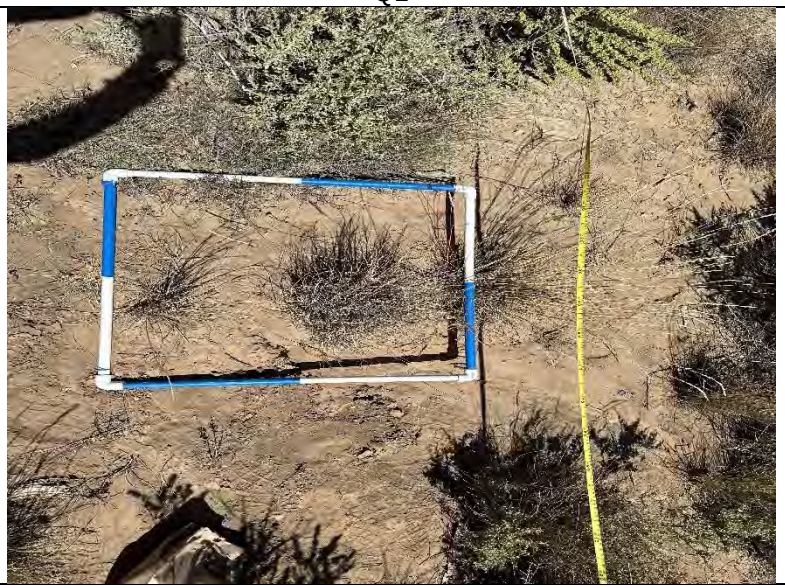
|  |  |
| Q2 | Q3 |

| O-VMU5-T16P | |
|---|---|
|  |  |
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| Q2 | Q3 |

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|---|---|
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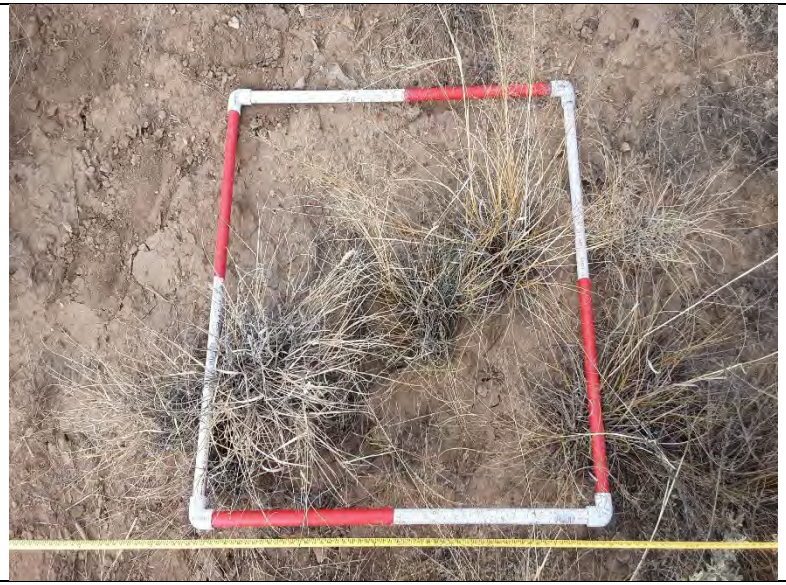
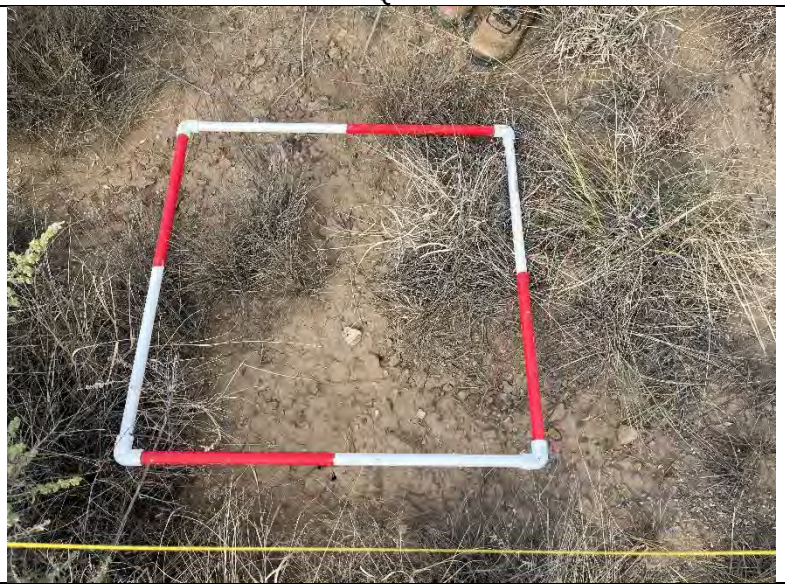
|  |  |
| Q2 | Q3 |

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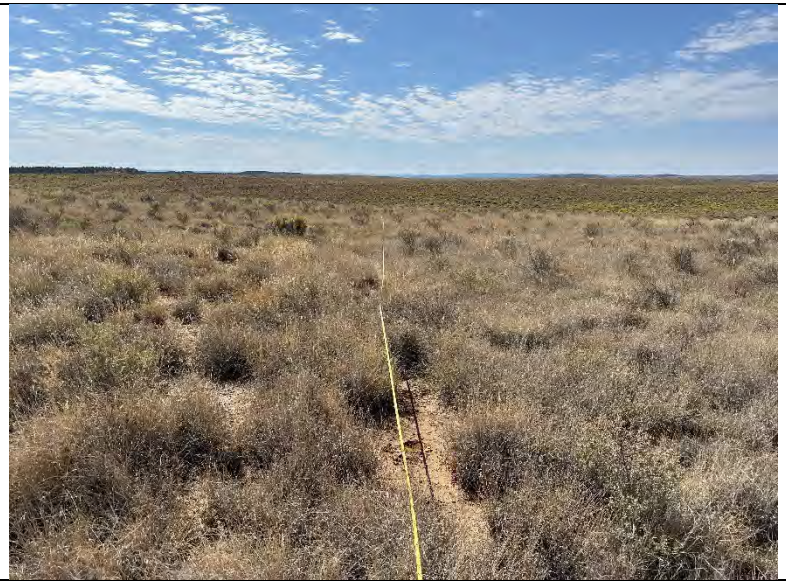
|  |  |
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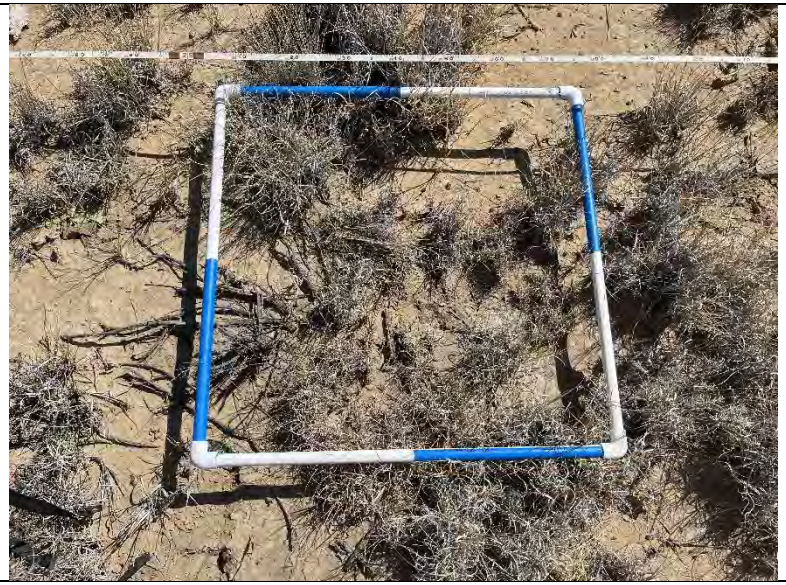
|  |  |
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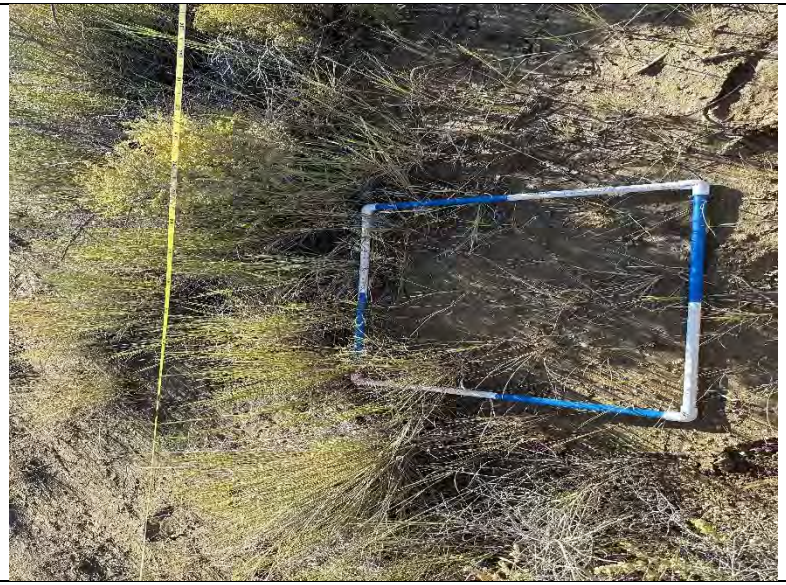
|  |  |
| Q2 | Q3 |

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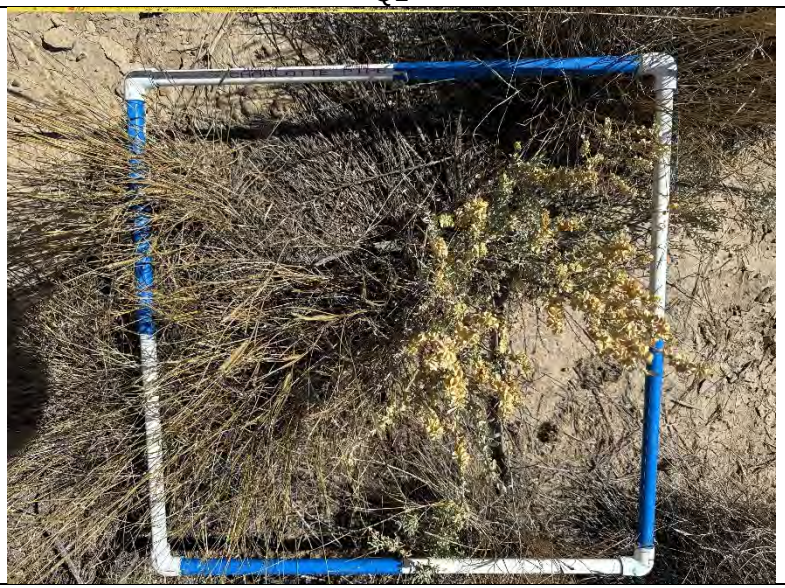
|  |  |
| Q2 | Q3 |

| O-VMU5-T21P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T22P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T23P | |
|---|---|
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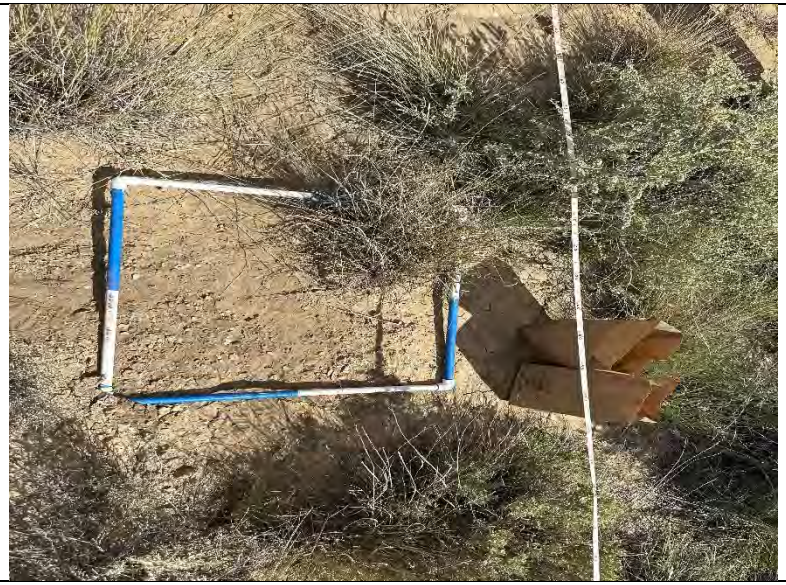
|  |  |
| Q2 | Q3 |

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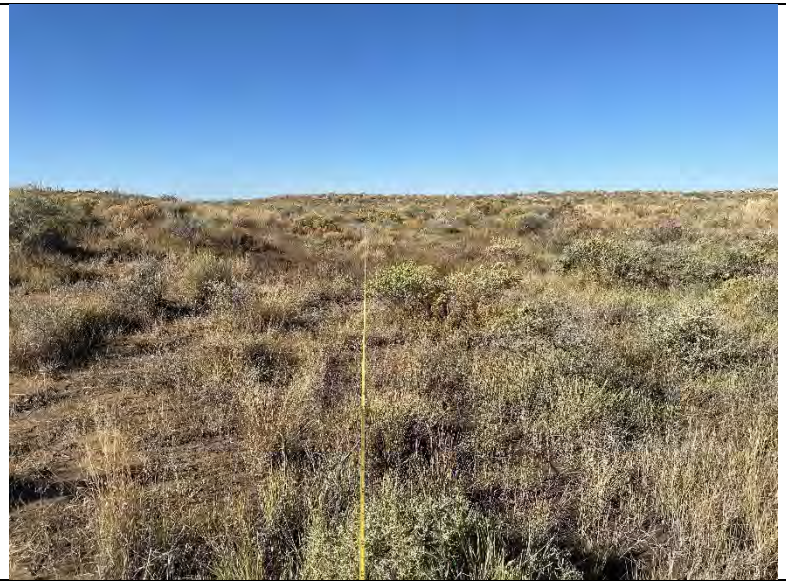
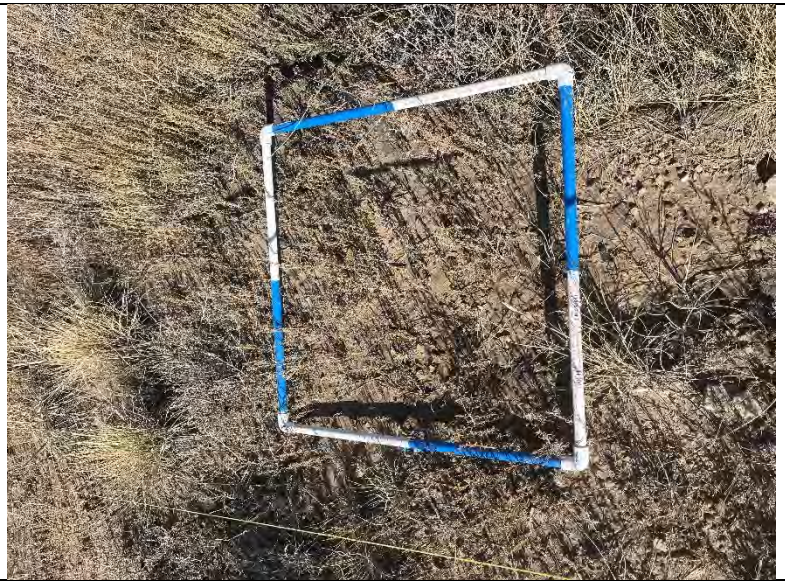
|  |  |
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| Q2 | Q3 |

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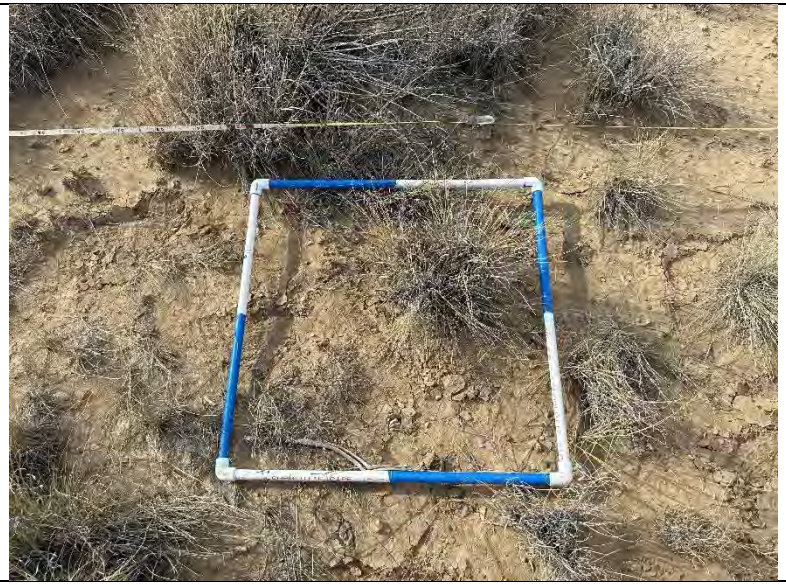
|  |  |
| Q2 | Q3 |

| O-VMU5-T26P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

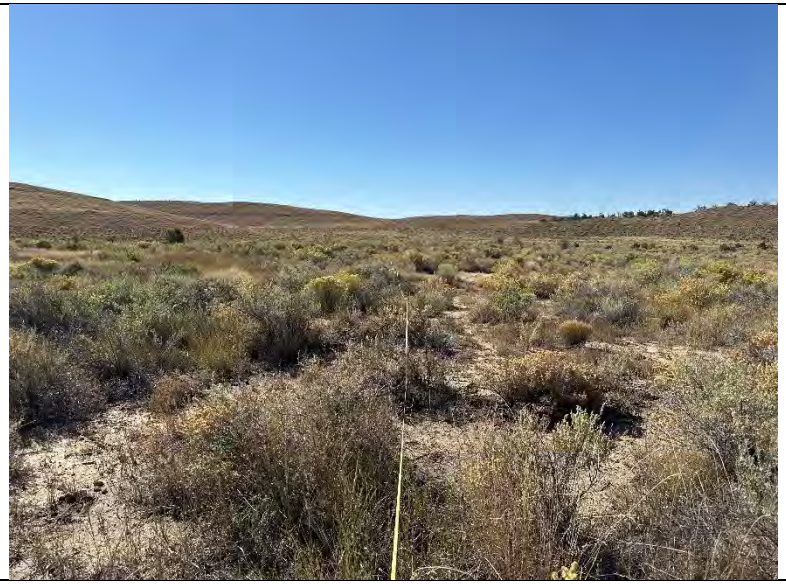
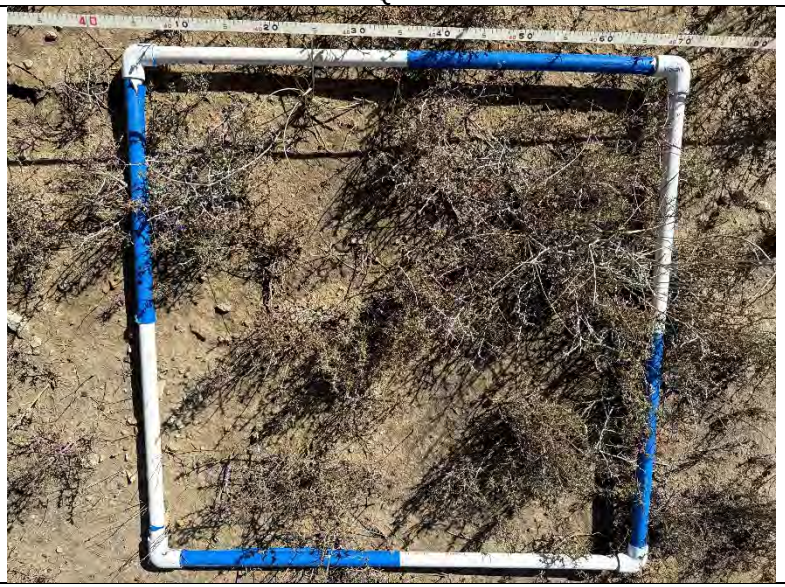
| O-VMU5-T27P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

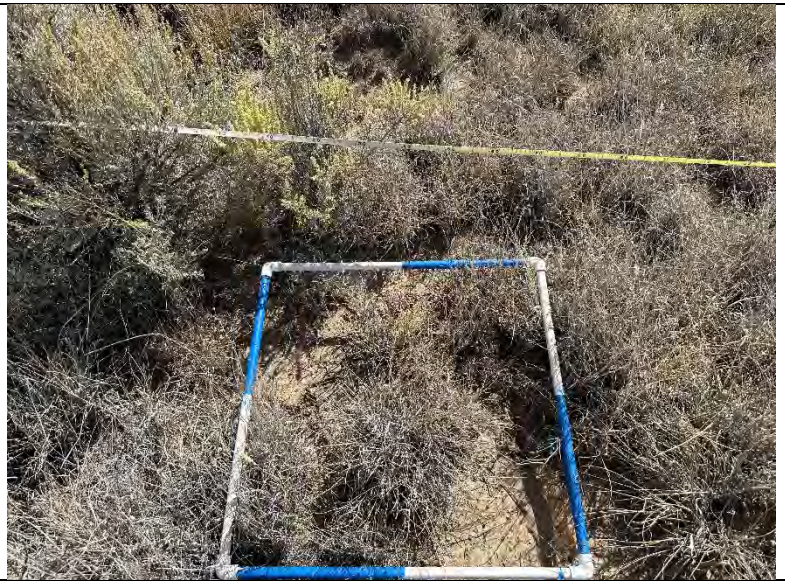
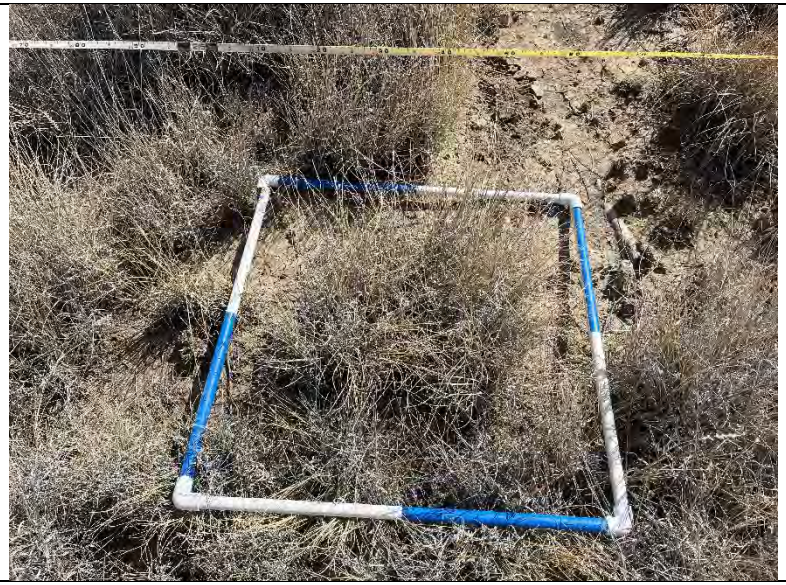
| O-VMU5-T28P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

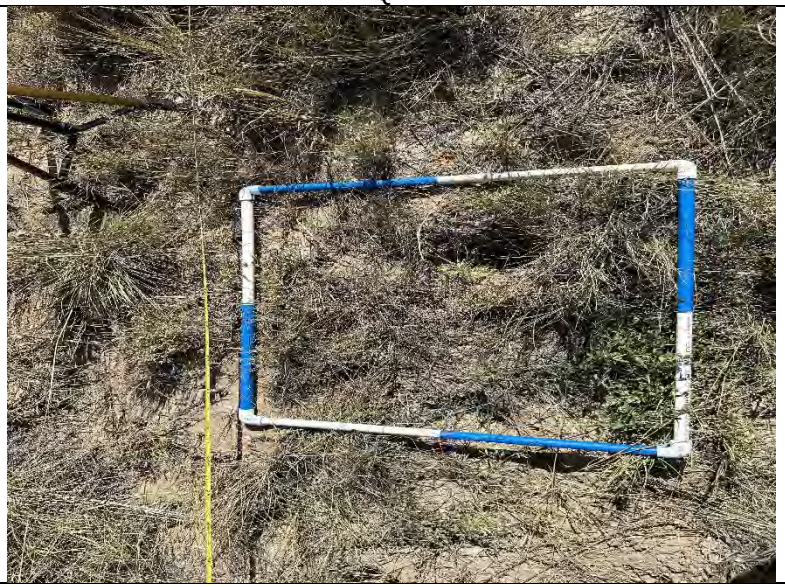
| O-VMU5-T29P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T30P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

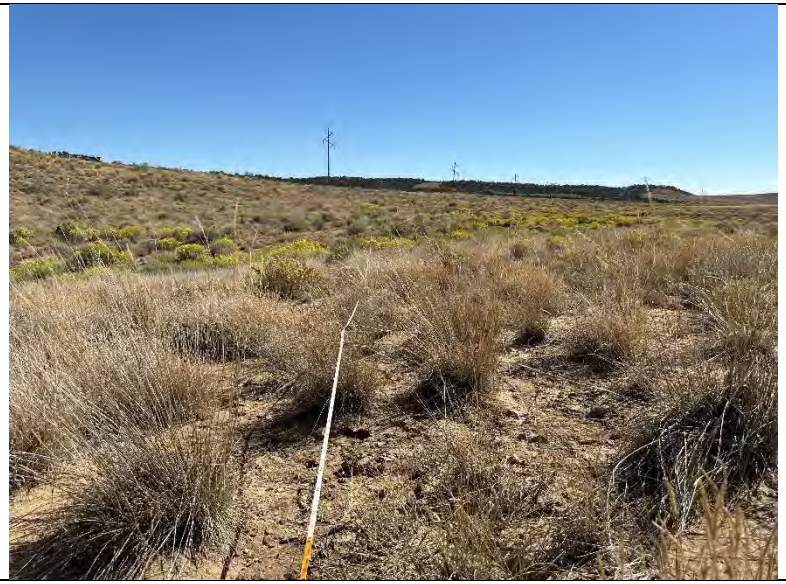
| O-VMU5-T31P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

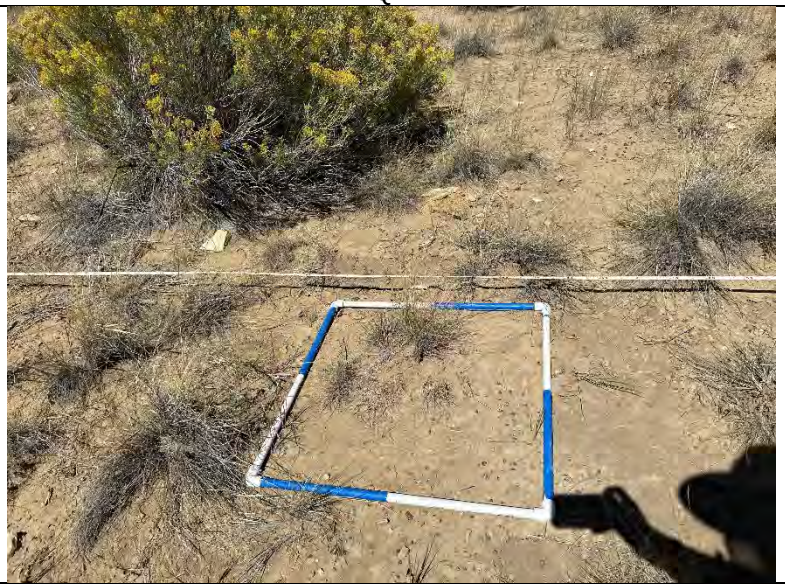
| O-VMU5-T32P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

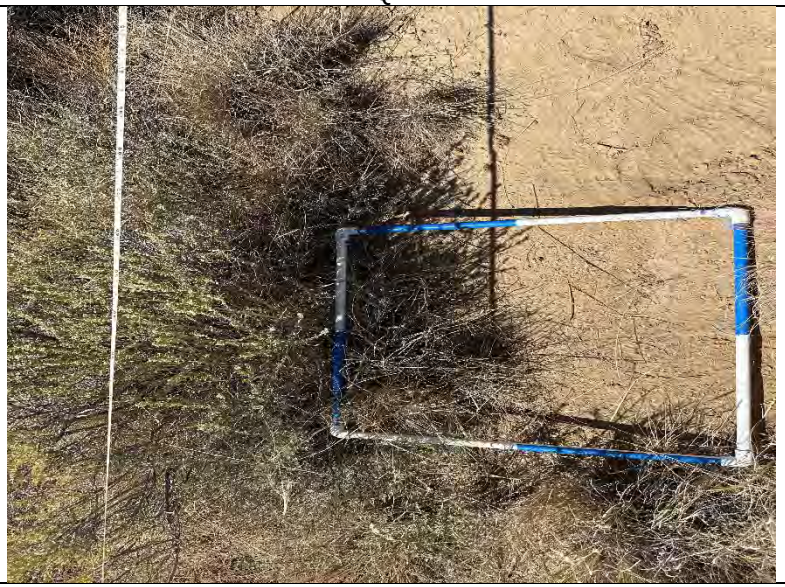
| O-VMU5-T33P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

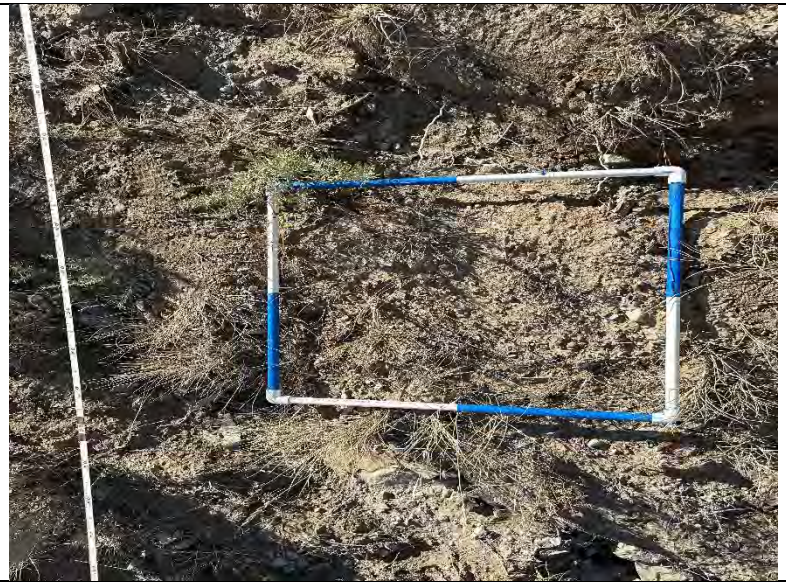
| O-VMU5-T34P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T35P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T36P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T37P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T38P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T39P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

| O-VMU5-T40P | |
|---|---|
|  |  |
| Belt | Q1 |
|  |  |
| Q2 | Q3 |

**APPENDIX C**

# Vegetation Statistical Analysis

**Table C1: Equations for Vegetation Data Analysis**

| Attribute | Equation | Where |
|---|---|---|
| Mean | $\bar{x} = \frac{\sum x}{n}$ | $\bar{x}$ = sample mean<br>$\sum$x = sum of values for variable<br>n = number of samples |
| Standard Deviation | $s = \sqrt{\frac{\sum(\bar{x} - x)^2}{n-1}}$ | s = standard deviation<br>$\sum$ = sum<br>$\bar{x}$ = sample mean<br>n = number of samples |
| Variance (sample) | $s^2 = \frac{\sum_{(x_i - \bar{x})^2}}{n-1}$ | $s^2$ = variance<br>$\sum$ = sum<br>$x_i$ = Value of variable for sample *i*<br>$\bar{x}$ = sample mean<br>n = number of samples |
| 90% Confidence Interval | $\bar{x} \pm z\frac{s}{\sqrt{n}}$ | $\bar{x}$ = sample mean<br>z = the critical value from the normal distribution with α/2 in each tail<br>s = standard deviation<br>n = number of samples |
| $N_{min}$ (Sample Adequacy - Normal Data) | $N_{min} = \frac{t^2 s^2}{(\bar{x}D)^2}$ | $N_{min}$ = number of samples required<br>t = two tailed t-distribution value based on a 90% level of confidence with n-1 degrees of freedom<br>s = standard deviation ($s^2$ = variance)<br>$\bar{x}$ = sample mean<br>D = the desired level of accuracy, which is 10 percent of the mean |
| Logarithmic Transformation | Y' = log(Y + k) | log = logarithmic function<br>Y = attribute value<br>k = constant, here we use 1 |
| one-sample, one-sided t test | $t^* = \frac{\bar{x} - 0.9\ (technical\ std)}{s/\sqrt{n}}$ | t* = calculated t-statistic<br>$\bar{x} = sample\ mean$<br>s = standard deviation<br>n = sample size |
| one-sample, one-sided sign test | $z = \frac{(k+0.5)-0.5n}{0.5\sqrt{n}}$ | z = sign test statistic<br>k = test statistic resulting from the number of values falling below 90% of the technical standard<br>n = sample size |
| Relative Cover (Perennial/Biennial Species) | Rp/b-cvr = Cvrp/b-sp. / Cvrp/b-abs. | $R_{p/b\text{-}cvr}$ = Calculated Relative Cover for a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}sp.}$ = Mean Absolute Cover of a Perennial/Biennial Species<br>$Cvr_{p/b\text{-}abs.}$ = Mean Absolute Perennial/Biennial Cover |
| Relative Cover (All Species) | Rcvr = Cvrsp. / CvrAbs. | $R_{cvr}$ = Calculated Relative Cover for a species<br>$Cvr_{sp.}$ = Mean Absolute Cover of ANY species<br>$Cvr_{abs.}$ = Mean Absolute Cover for All Species |

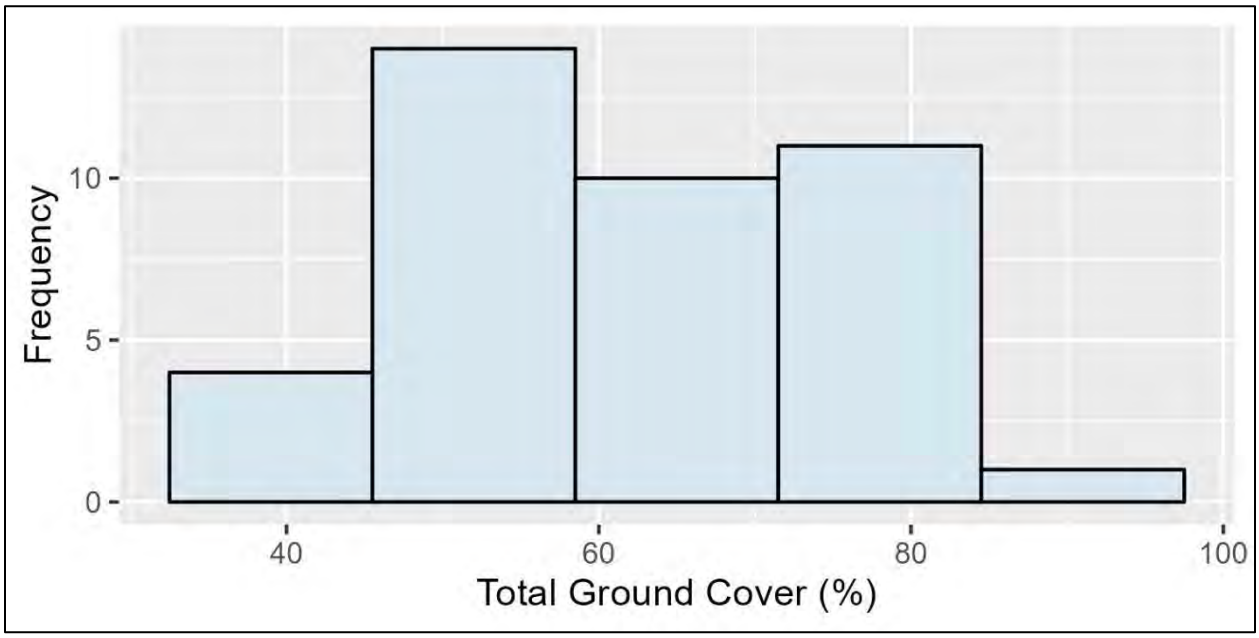
Notes:
All Appendix C analysis, tables, and figures computed using R software: (R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

**Table C-2: Data for Normal Distribution and Variance Analysis, O-VMU-5, 2024**

| Transect | Raw Data | | | | Log-Transformed Data | |
|---|---|---|---|---|---|---|
| | Total Ground Cover (%) | Perennial Vegetation Cover (%) | Annual Forage Production (lbs/ac) | Woody Plant Density (#/ac) | Log - Woody Plant Density | Log - Perennial Vegetation Cover |
| O-VMU5-T01P | 54 | 40 | 1,428 | 647 | 3.20 | 1.58 |
| O-VMU5-T02P | 66 | 46 | 265 | 607 | 3.00 | 1.60 |
| O-VMU5-T03P | 44 | 32 | 615 | 526 | 1.76 | 1.51 |
| O-VMU5-T04P | 56 | 40 | 901 | 4,209 | 2.75 | 1.62 |
| O-VMU5-T05P | 66 | 36 | 886 | 931 | 2.88 | 1.51 |
| O-VMU5-T06P | 50 | 26 | 279 | 809 | 2.90 | 1.51 |
| O-VMU5-T07P | 80 | 30 | 831 | 1,457 | 2.34 | 1.38 |
| O-VMU5-T08P | 54 | 40 | 912 | 809 | 2.73 | 1.70 |
| O-VMU5-T09P | 34 | 22 | 986 | 850 | 2.96 | 1.51 |
| O-VMU5-T10P | 46 | 32 | 800 | 1,457 | 2.66 | 1.68 |
| O-VMU5-T11P | 72 | 64 | 806 | 3,318 | 2.65 | 1.41 |
| O-VMU5-T12P | 60 | 38 | 529 | 1,659 | 2.67 | 1.66 |
| O-VMU5-T13P | 54 | 24 | 498 | 3,278 | 2.85 | 1.53 |
| O-VMU5-T14P | 52 | 46 | 846 | 1,214 | 3.31 | 1.75 |
| O-VMU5-T15P | 52 | 40 | 1,476 | 3,116 | 2.72 | 1.51 |
| O-VMU5-T16P | 66 | 40 | 552 | 1,255 | 3.09 | 1.58 |
| O-VMU5-T17P | 84 | 82 | 879 | 2,833 | 2.76 | 1.56 |
| O-VMU5-T18P | 80 | 72 | 700 | 1,214 | 3.25 | 1.53 |
| O-VMU5-T19P | 60 | 36 | 932 | 2,104 | 2.87 | 1.56 |
| O-VMU5-T20P | 72 | 48 | 1,152 | 769 | 2.85 | 1.34 |
| O-VMU5-T21P | 76 | 50 | 1,167 | 647 | 2.55 | 1.48 |
| O-VMU5-T22P | 60 | 34 | 316 | 2,145 | 2.68 | 1.81 |
| O-VMU5-T23P | 62 | 52 | 577 | 2,023 | 3.06 | 1.78 |
| O-VMU5-T24P | 52 | 26 | 595 | 1,862 | 2.80 | 1.56 |
| O-VMU5-T25P | 40 | 34 | 1,374 | 567 | 2.67 | 1.38 |
| O-VMU5-T26P | 82 | 58 | 1,657 | 6,394 | 3.39 | 1.64 |
| O-VMU5-T27P | 52 | 26 | 469 | 1,659 | 3.02 | 1.41 |
| O-VMU5-T28P | 52 | 36 | 976 | 1,578 | 3.03 | 1.79 |
| O-VMU5-T29P | 60 | 40 | 819 | 2,671 | 3.42 | 1.73 |
| O-VMU5-T30P | 86 | 72 | 1,485 | 1,052 | 2.95 | 1.64 |
| O-VMU5-T31P | 58 | 26 | 204 | 1,052 | 2.82 | 1.64 |
| O-VMU5-T32P | 64 | 30 | 378 | 1,619 | 3.05 | 1.48 |
| O-VMU5-T33P | 82 | 64 | 1,051 | 1,416 | 2.73 | 1.62 |
| O-VMU5-T34P | 76 | 30 | 1,236 | 4,087 | 2.84 | 1.53 |
| O-VMU5-T35P | 76 | 42 | 557 | 1,902 | 2.97 | 1.64 |
| O-VMU5-T36P | 58 | 50 | 1,613 | 890 | 2.59 | 1.45 |
| O-VMU5-T37P | 58 | 42 | 507 | 1,740 | 2.51 | 1.45 |
| O-VMU5-T38P | 70 | 56 | 959 | 2,752 | 3.09 | 1.78 |
| O-VMU5-T39P | 42 | 24 | 378 | 5,787 | 2.58 | 1.79 |
| O-VMU5-T40P | 76 | 68 | 1,592 | 971 | 2.60 | 1.56 |
| Mean | 62.10 | 42.35 | 854.52 | 1896.97 | 2.84 | 1.58 |
| Standard Deviation | 13.2 | 15.0 | 403.0 | 1367.4 | 0.3 | 0.1 |
| Count | 40 | 40 | 40 | 40 | 40 | 40 |
| Variance | 174 | 225 | 162374 | 1869774 | 0 | 0 |
| 90% Confidence Interval | 3 | 4 | 105 | 356 | 0 | 0 |
| Technical Standard | 52% | 24% | 550 | 400 | 2.74 | 1.38 |
| **90% of Standard** | 46.8% | 21.6% | 495 | 360 | 2.70 | 1.33 |

Notes:
2024 Data are found in Appendix A

Appendix C: Statistics Exhibit 1: Total Ground Cover

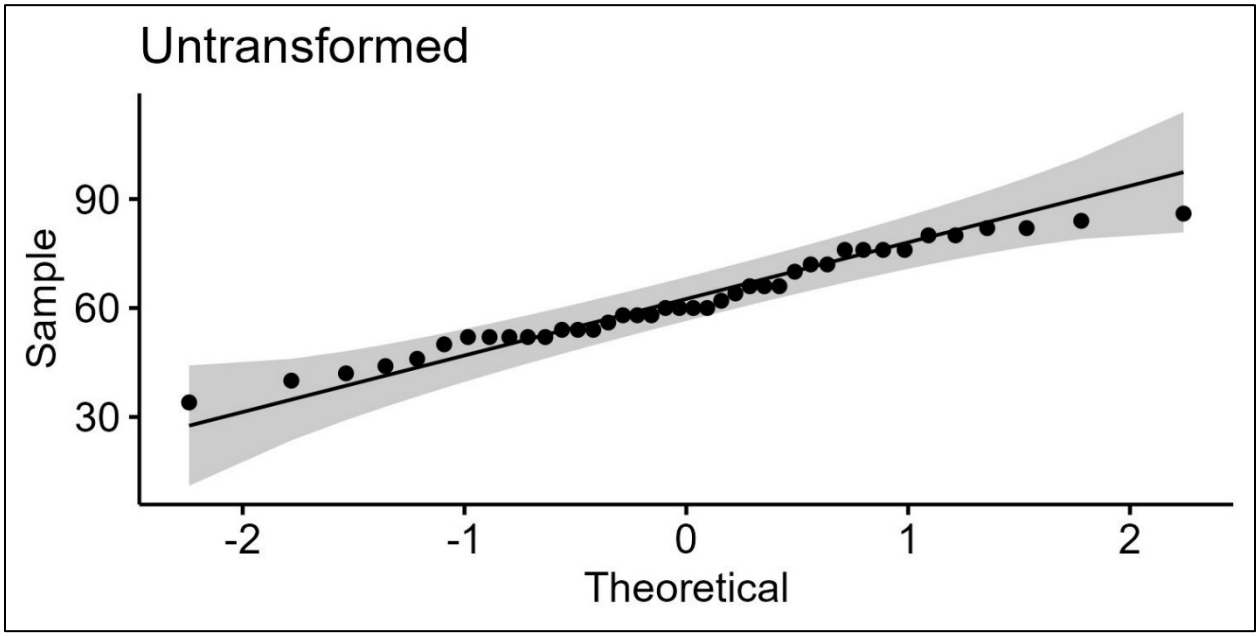



| N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 62.1 | 58.7 | 65.5 | 0.33 | 13.2 | 0.051 | 2.20 | 52 | 60 | 73 |

Sample adequacy is 13 samples.

Normality

Q-Q Plot



Normality (cont.)

Shapiro-Wilk Test

| W statistic | P value |
|---|---|
| 0.9695 | 0.348 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed, and sample adequacy has been met, therefore the statistical test was performed using a standard t-test under classic null hypothesis:

$H_0$: Reclaim ≥ 90% of the Performance Standard

$H_a$: Reclaim < 90% of the Performance Standard

Therefore,

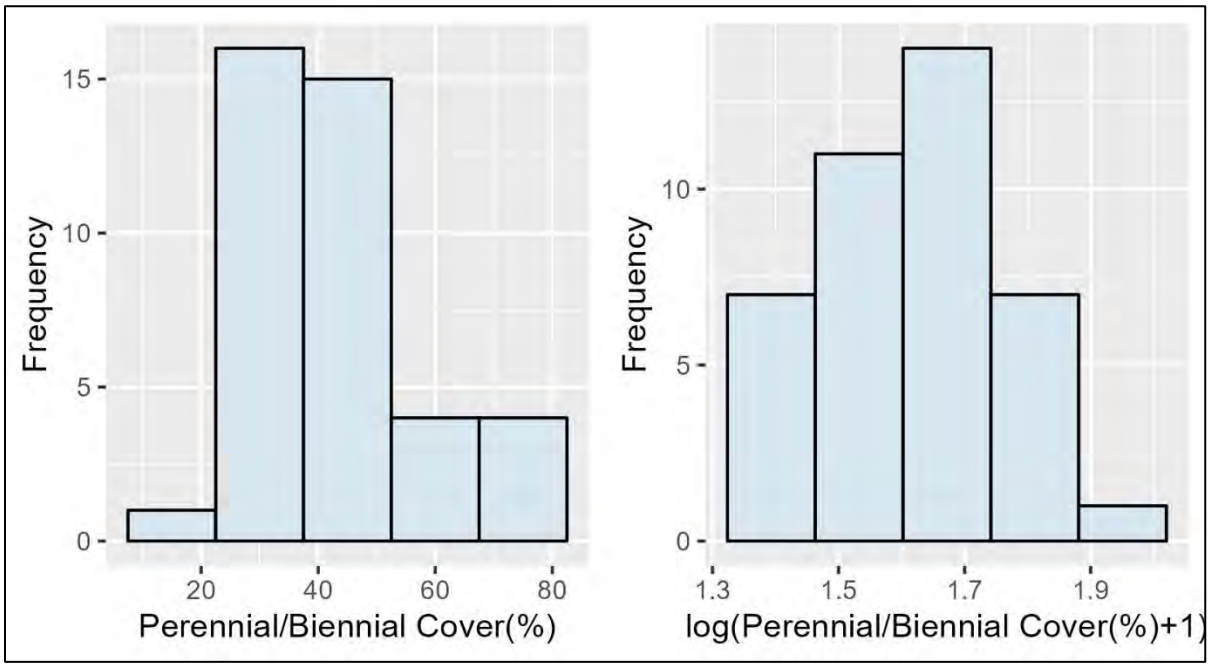
If $t^* \geq t_{(\alpha; n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha; n-1)}$, conclude failure to meet the performance standard.

| Total Ground Cover (%) | |
|---|---|
| Mean (%) | 62.1 |
| Standard Deviation (%) | 13.2 |
| Sample Size | 40 |
| Technical Standard (%) | 52 |
| t* | 7.33 |
| 1-tail t (0.1, 39) | -1.304 |
| p-value | 1 |

t*(7.33) ≥ t(-1.304) and p>0.1, the performance standard is met

## Appendix C: Statistics Exhibit 2: Perennial Ground Cover

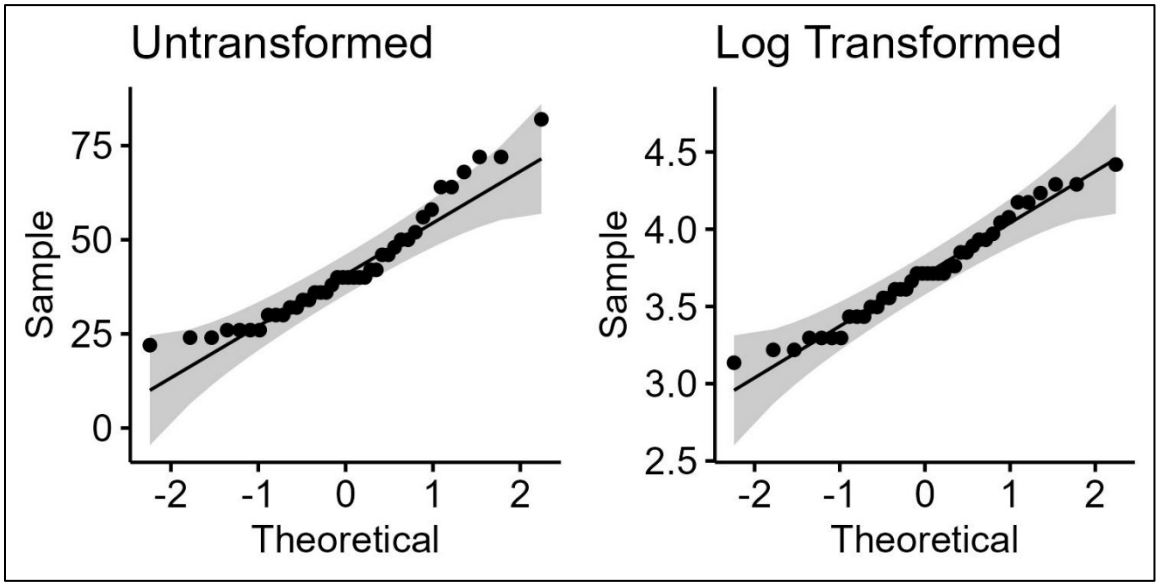



| Data | N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Data | 40 | 42.4 | 38.5 | 46.2 | 0.37 | 15.0 | 0.86 | 3.01 | 31.5 | 40 | 50 |
| log(X+1) | 40 | 1.61 | 1.58 | 1.65 | 0.004 | 0.14 | 0.26 | 2.3 | 1.51 | 1.61 | 1.71 |

Sample adequacy is 36 samples.

## Normality

Q-Q Plot




## Normality (cont.)

Shapiro-Wilk Test

| Data | W statistic | P value |
|---|---|---|
| Data | 0.922 | 0.009 |
| Log | 0.971 | 0.390 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed with a logarithmic transformation, and sample adequacy has been met, therefore the statistical test was performed using a standard t-test under classic null hypothesis:

$H_0$: Reclaim ≥ 90% of the Performance Standard

$H_a$: Reclaim < 90% of the Performance Standard

Therefore,

If $t^* \geq t_{(1-\alpha;\, n-1)}$, conclude that the performance standard was met.

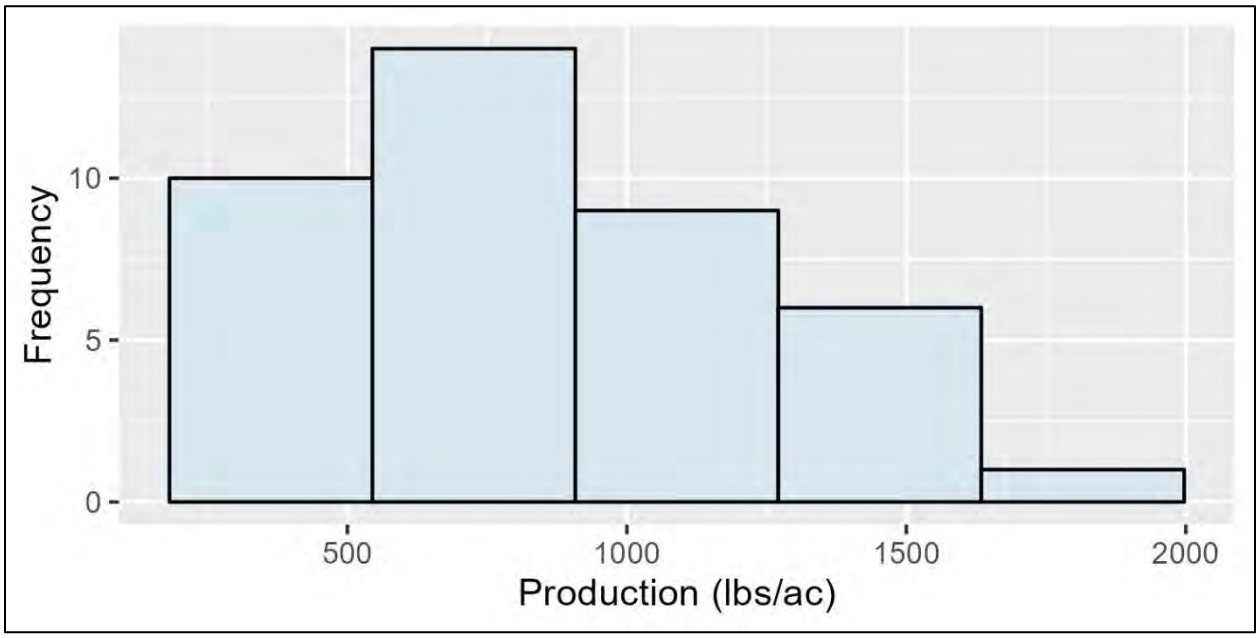
If $t^* < t_{(1-\alpha;\, n-1)}$, conclude failure to meet the performance standard.

| Perennial/Biennial Cover (%) | |
|---|---|
| Mean | 1.61 |
| Standard Deviation | 0.14 |
| Sample Size | 40 |
| Technical Standard[1] | 1.35 |
| t* | 11.75 |
| 1-tail t (0.1, 39) | -1.304 |
| p-value | 1 |

t*(11.75) ≥ t(-1.304) and p < 0.1, the performance standard is met

[1]Note the value reported is log(X)+log(0.9) not just the log(X)

Appendix C: Statistics Exhibit 3: Production

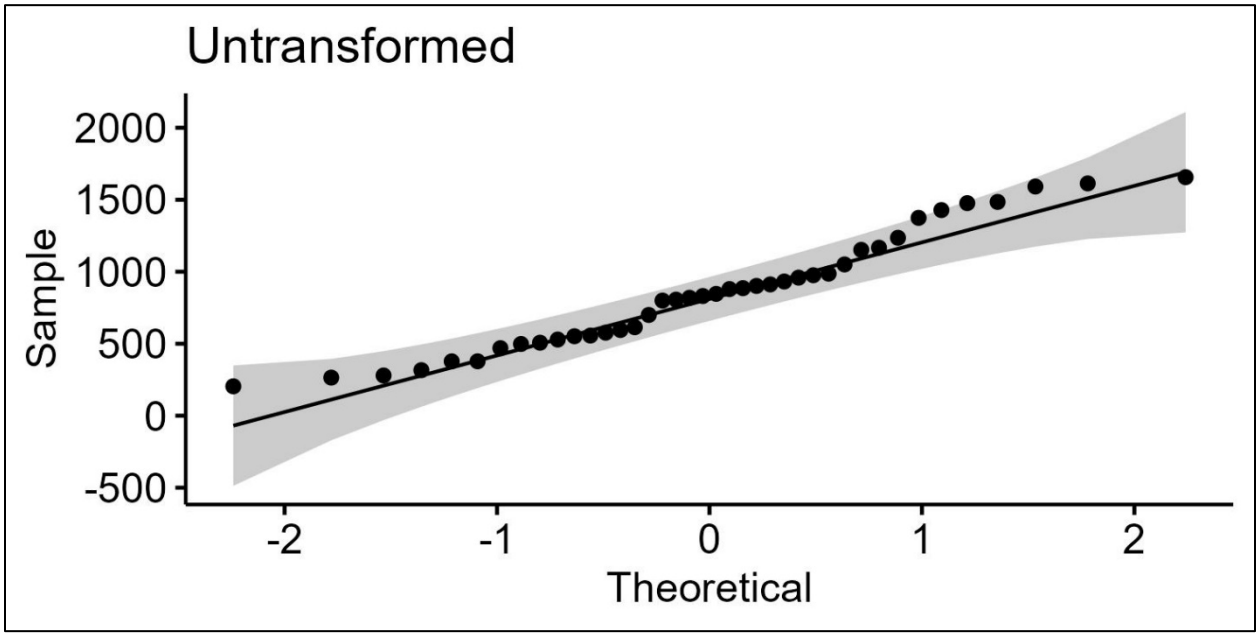



| N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 854.5 | 749.7 | 959.3 | 10.1 | 403.0 | 0.383 | 2.26 | 546.2 | 838.8 | 1075.9 |

Sample adequacy is 63 samples.

Normality

Q-Q Plot



Normality (cont.)

Shapiro-Wilk Test

| W statistic | P value |
|---|---|
| 0.955 | 0.113 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed, and sample adequacy has not been met, therefore the statistical test was performed using a standard t-test under reverse null hypothesis:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

Therefore,

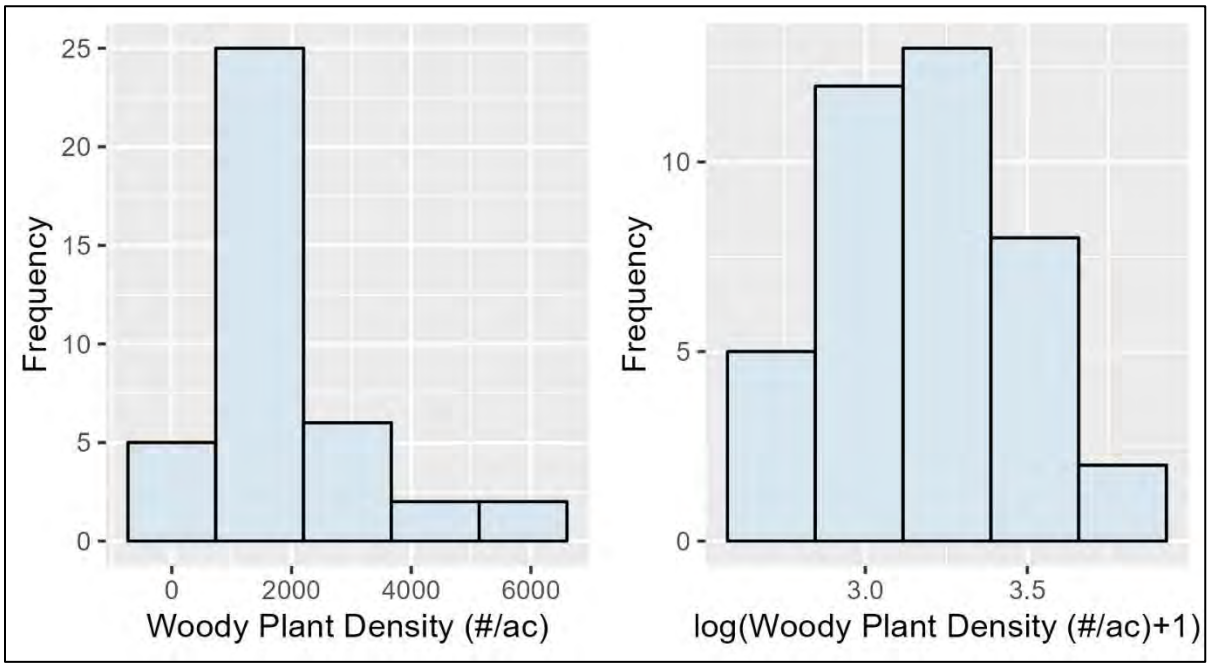
If $t^* \geq t_{(\alpha; n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(\alpha; n-1)}$, conclude failure to meet the performance standard.

| Production (lbs/ac) | |
|---|---|
| Mean | 854.5 |
| Standard Deviation | 403.0 |
| Sample Size | 40 |
| Technical Standard | 550 |
| t* | 5.64 |
| 1-tail t (0.9, 39) | 1.304 |
| p-value | P < 0.001 |

t*(5.64) ≥ t(1.304) and p<0.1, the performance standard is met

## Appendix C: Statistics Exhibit 4: Woody Plant Density

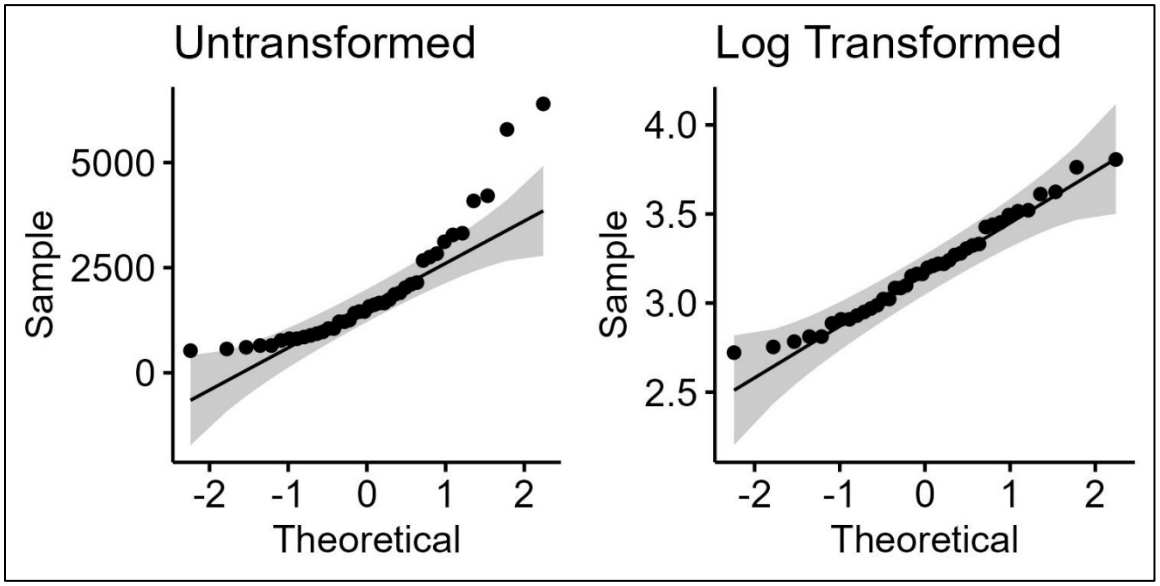



| Data | N | Mean | 90% CI | | SE | SD | Skew | Kurtosis | 1st Quartile | Median | 3rd Quartile |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Data | 40 | 1897.0 | 1541.3 | 2252.6 | 34.2 | 1367.4 | 1.63 | 5.46 | 920.7 | 1517.6 | 2276.4 |
| log(X+1) | 40 | 3.19 | 3.11 | 3.26 | 0.001 | 0.28 | 0.32 | 2.37 | 2.96 | 3.18 | 3.36 |

Sample adequacy is 148 samples.

### Normality

Q-Q Plot



Normality (cont.)

Shapiro-Wilk Test

| Data | W statistic | P value |
|---|---|---|
| Data | 0.824 | $2.27x10^{-5}$ |
| Log | 0.975 | 0.500 |

H0: F(Y) = N(μ, σ)

The population is normally distributed.

H1: F(Y) ≠ N(μ, σ)

The population is not normally distributed

Statistical Analysis

The data are normally distributed with a logarithmic transformation, and sample adequacy has not been met, therefore the statistical test was performed using a standard t-test under reverse null hypothesis:

$H_0$: Reclaim ≤ 90% of the Performance Standard

$H_a$: Reclaim > 90% of the Performance Standard

Therefore,

If $t^* \geq t_{(1-\alpha;\, n-1)}$, conclude that the performance standard was met.

If $t^* < t_{(1-\alpha;\, n-1)}$, conclude failure to meet the performance standard.

| Woody Plant Density (#/ac) | |
|---|---|
| Mean | 3.19 |
| Standard Deviation | 0.28 |
| Sample Size | 40 |
| Technical Standard[1] | 2.56 |
| t* | 14.23 |
| 1-tail t (0.9, 39) | 1.304 |
| p-value | p < 0.001 |

t*(14.23) ≥ t(1.304) and p < 0.1, the performance standard is met

[1]Note the value reported is log(X)+log(0.9) not just the log(X)



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## Appendix A8: Wildlife Enhancements

Survey Date: 10/29-30/24 & 6/30-7/1/25

| | | Coyote | | | | | | | Woody Seed Mix | Mule Deer Mix | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cottonwood | Willow | Woods Rose | Licorice | Bulrush | Sedge | Pond AdMix | Riparian Mix | Mule Deer Mix | Species Observed | Wildlife Fence | Cattle Ramp |
| Structure | Live Poles | Live Whips | Seedlings | Seedlings | (From Seed) | (From Seed) | (Seed) | (Seed) | (Seed) | | | |
| | | | | | | | | | | | | |
| PI 2-3 | | y | y | | | | | | P-y | Rubber rabbitbrush | y | y |
| PI 2-8 | P-y | P-y | P-y | y | y | y | P-y | | P-y | Rubber rabbitbrush | P-y | P-y |
| PI 2-9 | P-y | P-y | P-y | y | y | y | P-y | | P-y | Rubber rabbitbrush | P-y | P-y |
| PI 2-10 | P-y | P-y | P-y | y | y | y | P-y | | P-y | | P-y | P-y |
| PI 2-11 | P-y | P-y | P-y | y | y | y | P-y | | P-y | Rubber rabbitbrush | P-y | P-y |
| PI 2-12 | y | y | y | | y | y | y | | y | Rubber rabbitbrush | y | y |
| PI 2-13 | P-y | P-y | P-y | | y | y | P-y | | P-y | Rubber rabbitbrush | P-y | P-y |
| PI 2-21 | P-y | P-y | P-y | y | P-y | P-y | P-y | y | P-y | Rubber rabbitbrush | P-y | P-y |
| PI 3-5 | y | P-y | P-y | y | y | P-y | P-y | | | Rubber rabbitbrush | P-y | P-y |

Notes:

Letter "P" indicates that the activity was proposed for the structure in the permit.

Letter "y" indicates that the activity occurred at a structure

Plant species (one or more) observed alive in impoundment including mature species from previous plantings, seed mixes or volunteer growth.

Plant materials do not appear like they survived.

Plant species not observed.

Mule Deer Shrub Enhancement Mix: Permit Table 5.5-10

Pond admix and Riparian Seed Mix: Permit Table 5.5-5

Bulrush and Sedge in the Pond Admix

**Species Observed 2024-2025**

| Scientific Name | Common Name | 2-3 | 2-8 | 2-9 | 2-10 | 2-11 | 2-12 | 2-13 | 2-21 | 3-5 |
|---|---|---|---|---|---|---|---|---|---|---|
| *Salixa exigua* | Coyote Willow | -- | ● | ● | ● | ○ | ● | ● | -- | ○ |
| *Populus freemontii* | Freemont Cottonwood | -- | ○ | -- | ○ | -- | ○ | ○ | ○ | ○ |
| *Rosa woodsii* | Woods Rose | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Glycerhiza lepidota* | American Licorice | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ephedra viridis* | Green Mormon Tea | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Purshia mexicana* | Mexican Cliffrose | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Purshia tridentata* | Antelope Bitterbrush | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ericameria nauseosa* | Rubber Rabbitbrush | ● | ● | ● | -- | ● | ● | ● | ○ | ● |
| *Typha domingensis* | Southern Cattail | -- | ● | ● | ● | -- | ● | ● | -- | ● |
| *Scripus maratima* | Saltmarsh Bulrush | -- | -- | ● | -- | -- | -- | ● | ● | ● |
| *Scirpus acutus* | Hardstem Bulrush | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Tamarisk* | Salt cedar | -- | -- | -- | -- | -- | -- | -- | ●* | -- |
| *Helinathus annuus* | Common Sunflower | -- | ● | ● | ● | ● | ● | ● | ● | ● |
| *Hordeum jubatum* | Foxtail Barley | ● | ● | -- | ● | ● | -- | ● | ● | ● |
| *Grindelia squarrosa* | Curlycup Gumweed | ● | ● | ● | -- | ● | ● | ● | ● | ● |
| *Psathyrostachys juncea* | Russian Wildrye | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Bromus inermis* | Smooth Brome | ● | ● | ● | -- | -- | ● | ● | -- | -- |
| *Xanthium strumarium* | Rough Cocklebur | -- | -- | -- | -- | ● | -- | -- | ● | -- |
| *Rumex crispus* | Curly Dock | -- | -- | ● | ● | ● | ● | ● | ● | -- |
| *Cirsium vulgare* | Bull Thistle | -- | -- | -- | -- | ● | -- | ● | -- | -- |
| *Atriplex canescens* | Fourwing Saltbush | ● | ● | -- | -- | -- | ● | ● | -- | ● |
| *Achnantherum hymenoides* | Indian Ricegrass | ● | -- | -- | -- | -- | -- | -- | -- | -- |
| *Achillea millefolium* | Common Yarrow | -- | ● | -- | -- | -- | -- | -- | -- | -- |
| *Mellilotus officianalis* | Yellow Sweetclover | -- | ● | ● | -- | -- | ● | -- | -- | -- |
| *Gutierrezia sarothrae* | Broom Snakeweed | -- | -- | -- | -- | -- | -- | -- | -- | ● |
| *Salsola tragus* | Russian Thistle | -- | ● | -- | -- | -- | ● | -- | ● | -- |
| *Elymus lanceolatus* | Thickspike Wheatgrass | -- | -- | -- | -- | -- | -- | -- | -- | ● |
| *Elymus canadensis* | Canada Wildrye | -- | -- | -- | -- | ● | -- | -- | -- | -- |
| *Amaranthus retroflexus* | Redroot Pigweed | -- | -- | -- | -- | -- | -- | -- | -- | ● |
| *Conyza canadensis* | Canadian Horseweed | ● | ● | ● | -- | ● | -- | ● | -- | -- |
| *Machaeranthera canescens* | Hoary Tansyaster | -- | -- | -- | -- | ● | ● | -- | -- | -- |
| *Polypogon monspeliensis* | Annual Beard-Grass | -- | -- | ● | -- | -- | -- | -- | -- | -- |
| *Eragrostis cilianensis* | Stinkgrass | -- | -- | -- | ● | -- | -- | -- | -- | -- |
| *Zannichellia palustris* | Horned Pondweed | -- | -- | ● | -- | -- | -- | -- | -- | -- |
| *Thinopyrum intermedium* | Intermediate Wheatgrass | ● | ● | -- | -- | ● | -- | -- | -- | -- |
| *Erodium cicutarium* | Common Stork's Bill | -- | ● | -- | ● | -- | -- | -- | -- | -- |
| *Sonchus asper* | Spiny Sowthistle | -- | -- | ● | ● | -- | -- | -- | -- | -- |
| *Verbensina encelioides* | Golden Crownbeard | -- | ● | -- | -- | -- | -- | -- | -- | -- |
| *Sphaeralcea sp.* | Globemallow | -- | ● | -- | -- | -- | -- | -- | -- | ● |
| *Bahia dissecta* | Ragleaf Bahia | -- | -- | -- | ● | -- | -- | -- | -- | -- |
| *Eleocharis compressa* | Compact Spikerush | -- | -- | -- | -- | -- | ● | ● | -- | -- |
| *Chyrsothamnus greenii* | Green's Rabbitbrush | -- | -- | -- | -- | -- | -- | ● | -- | -- |
| *Sporobolus cryptandrus* | Sand Dropseed | -- | -- | -- | -- | -- | ● | -- | -- | -- |
| *Bassia scoparia* | Summer Cypress | ● | -- | -- | -- | ● | -- | -- | -- | -- |
| *Pascopyrum smithii* | Western Wheatgrass | -- | ● | -- | -- | ● | -- | -- | -- | ● |
| *Artemisia frigida* | Wild Sage | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Ratibida columnifera* | Prarie Coneflower | -- | ● | -- | -- | -- | -- | -- | -- | -- |
| *Phleum pratense* | Timothy Grass | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Lactuca serriola* | Prickly Lettuce | -- | -- | ● | ● | -- | -- | -- | -- | -- |
| *Linum lewisii* | Blue Flax | -- | -- | -- | ● | -- | -- | -- | -- | -- |

Notes:

● Denotes species observed alive

○ Denotes planted species observed but did not survive

-- Not Observed

* Salt cedar observed at 2-21 was removed Oct 2025 by HMI Subcontractor

Live planted

In Riparian Mix

In Pond Ad mix

**Fall 2024 2-3**





**Fall 2024 2-3**



**Summer 2025 2-3**





**Fall 2024 2-8**





**Fall 2024 2-8**



**Summer 2025 2-8**





**Fall 2024 2-9**





**Summer 2025 2-9**





**Fall 2024 2-10**

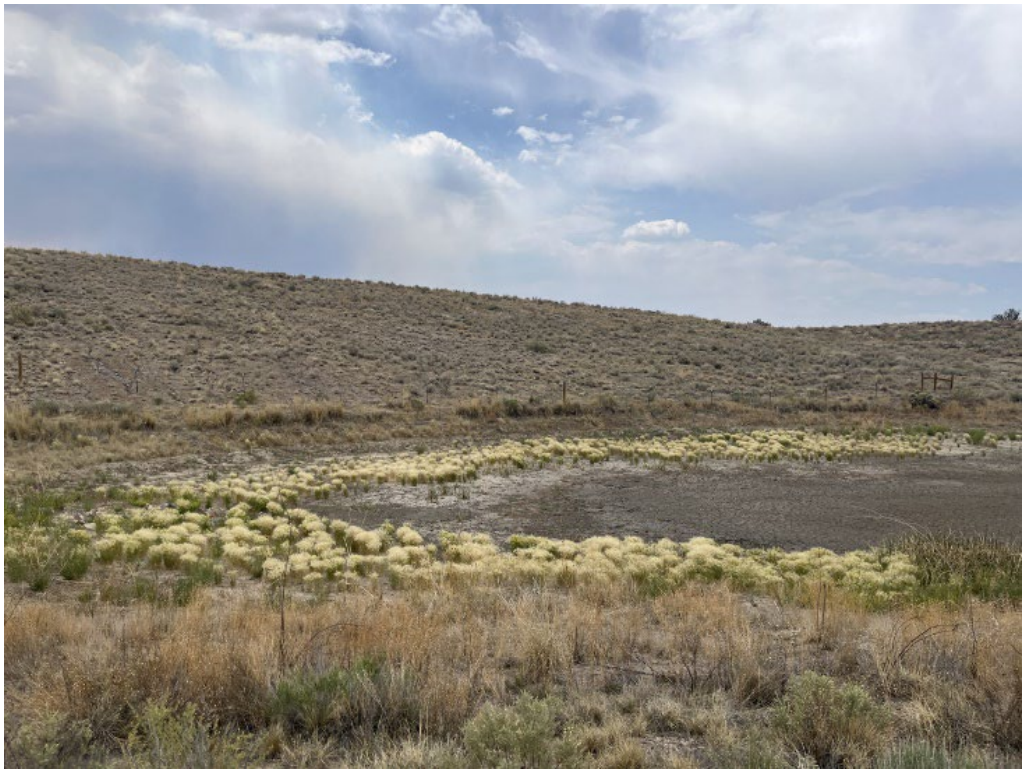




**Fall 2024 2-10**



**Summer 2025 2-10**





**Fall 2024 2-11**





**Summer 2025 2-11**





**Fall 2024 2-12**





**Fall 2024 2-12**



**Summer 2025 2-12**





**Fall 2024 2-13**





**Fall 2024 2-13**



**Summer 2025 2-13**





**Fall 2024 2-21**





**Fall 2024 2-21**





**Summer 2025 2-21**





**Fall 2024 3-5**





**Fall 2024 3-5**





**Summer 2025 3-5**





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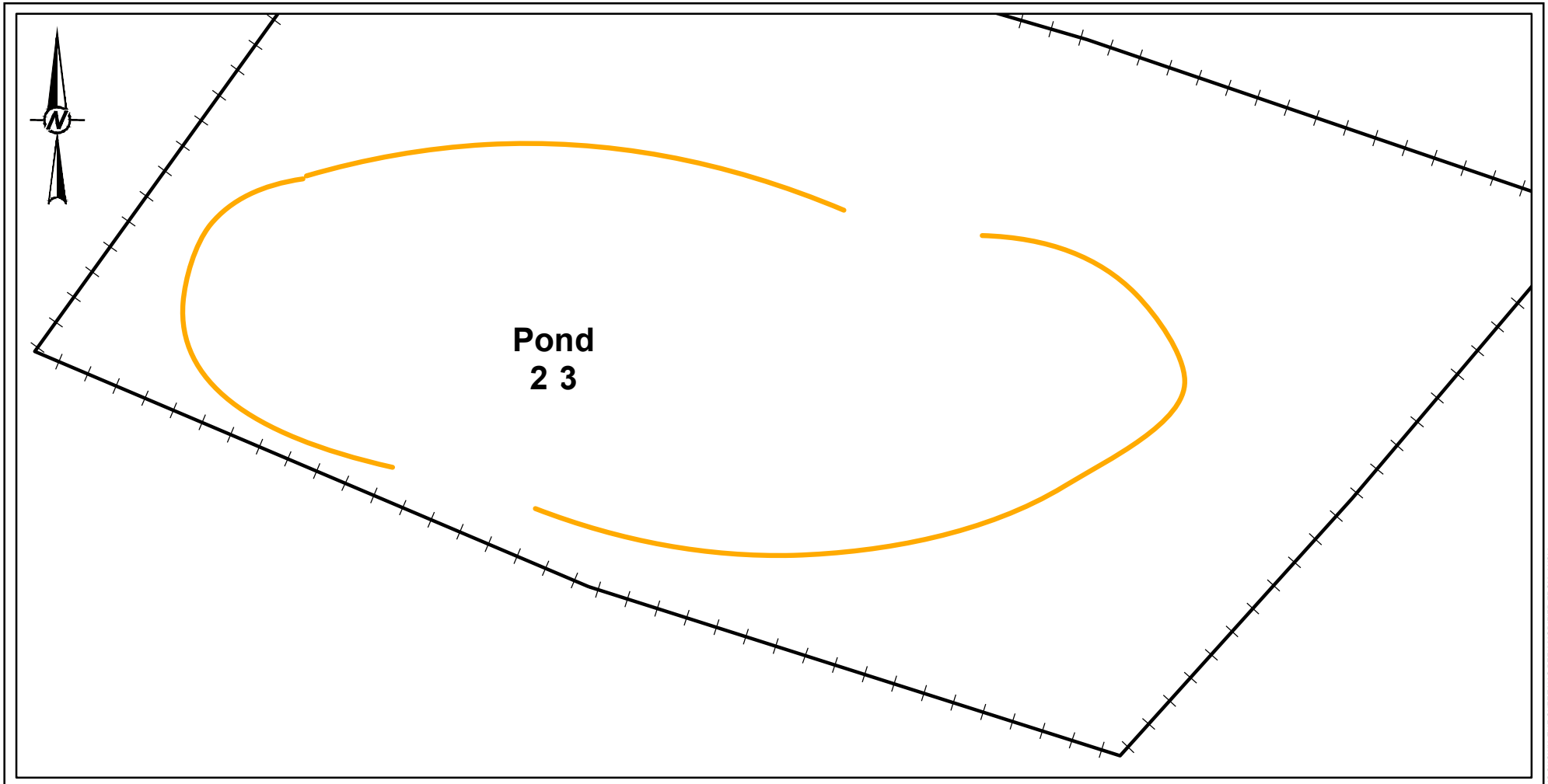


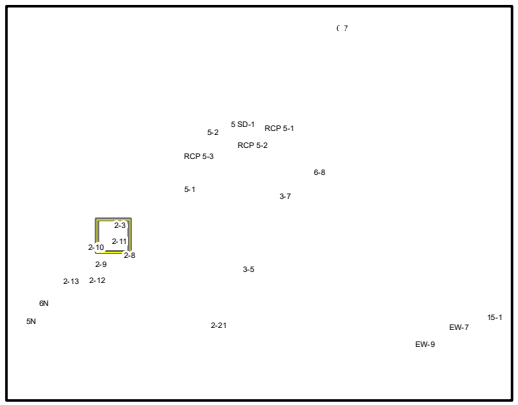


**LEGEND**

POND ENHANCEMENT TYPE
- WILLOW

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 25 50
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
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| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | FR |

PROJECT
OSM 2022 ANNUAL REPORT

TITLE
**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2022 (POND 2-3)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1c |

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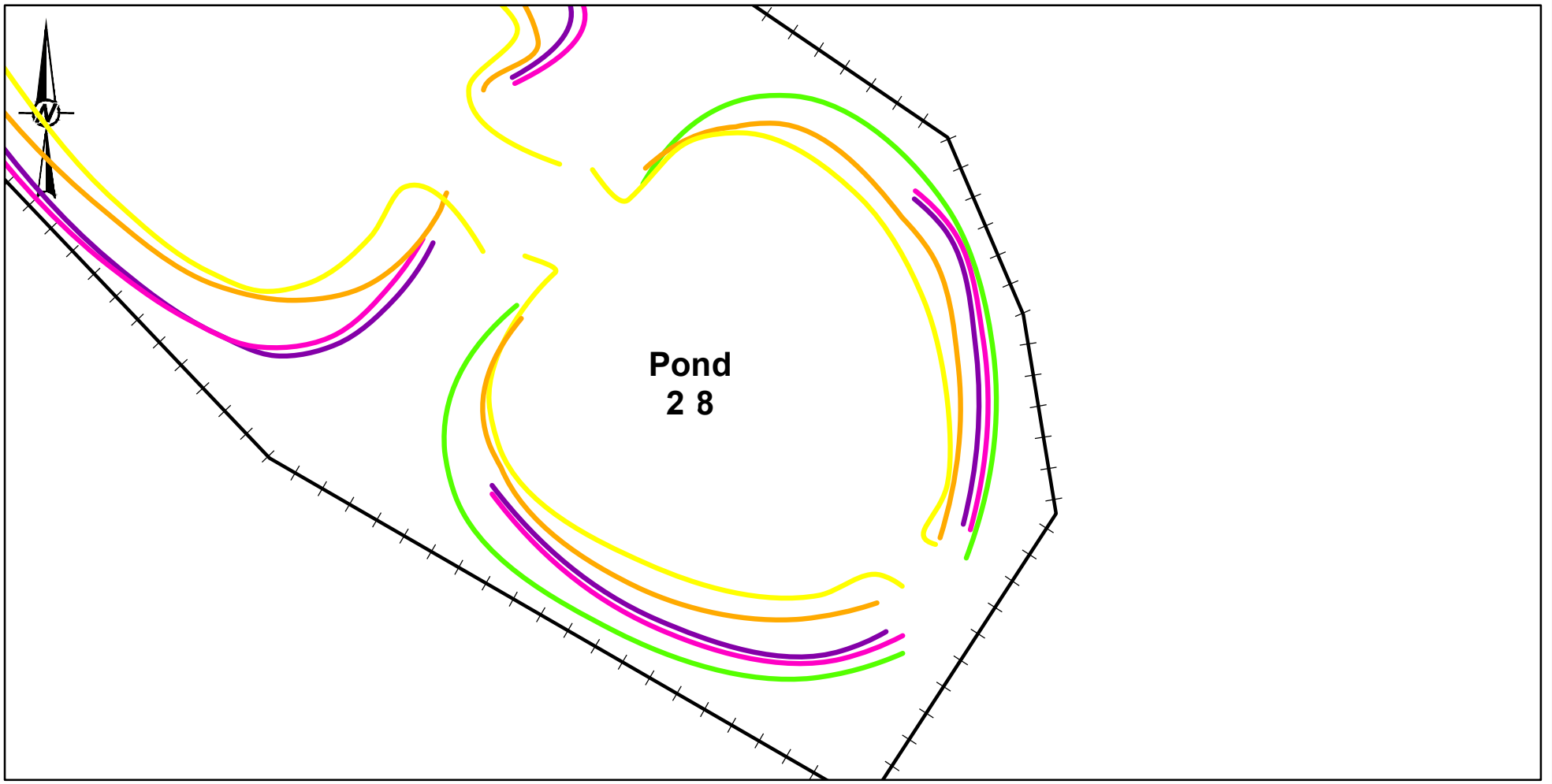


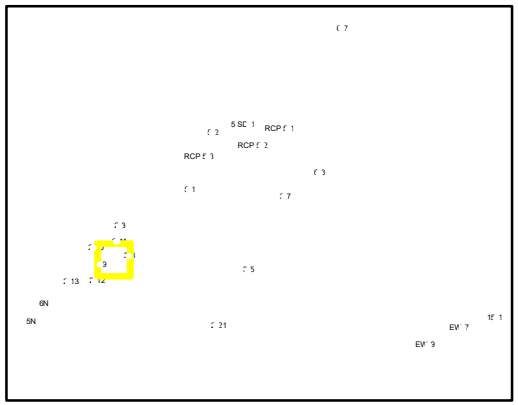

**LEGEND**

POND ENHANCEMENT TYPE
- WOODS ROSE
- LICORICE
- COTTONWOOD
- WILLOW
- POND ADMIX

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 40 80
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
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| APPROVED | FR |

TITLE
**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2022 (POND 2-8)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
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| 31406184.000 | | A | 1g |

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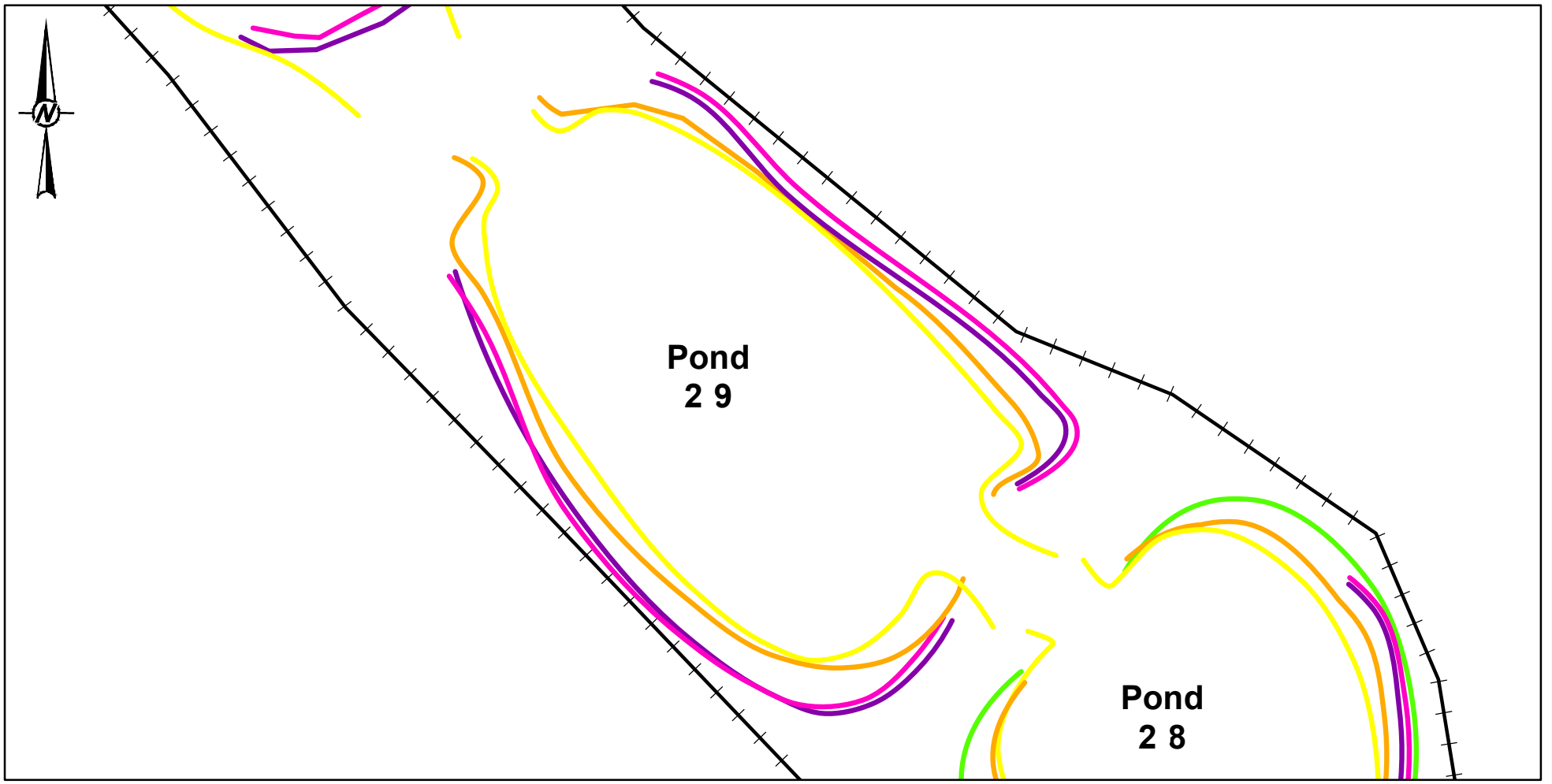


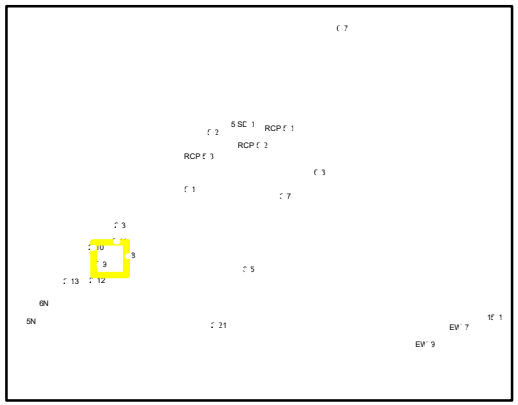

**LEGEND**

POND ENHANCEMENT TYPE
- WOODS ROSE
- LICORICE
- COTTONWOOD
- WILLOW
- POND ADMIX

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 50 100
Feet

**REFERENCE(S)**

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TITLE
**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2022 (POND 2-9)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
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| 31406184.000 | | A | 1f |

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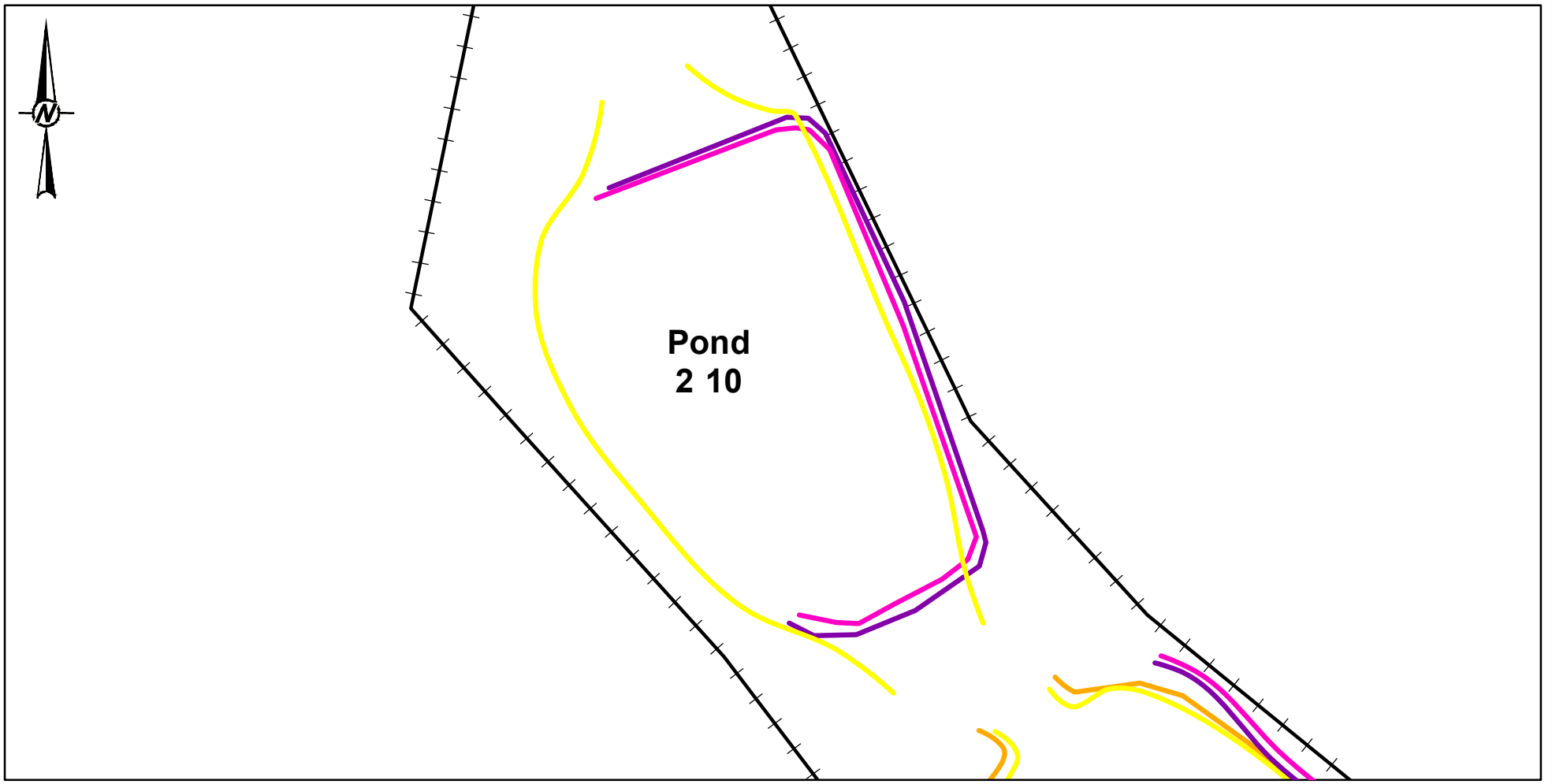


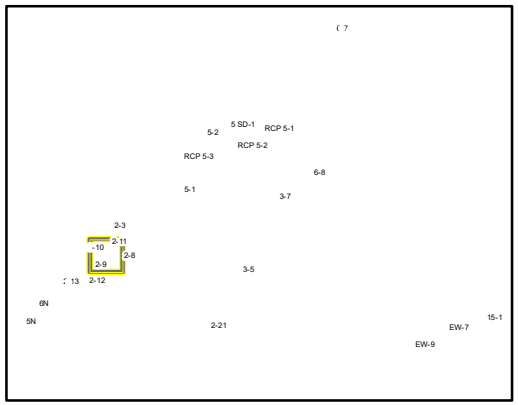


**LEGEND**

POND ENHANCEMENT TYPE
- WOODS ROSE
- LICORICE
- WILLOW
- POND ADMIX

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 60 120
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
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TITLE
**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2022 (POND 2-10)**

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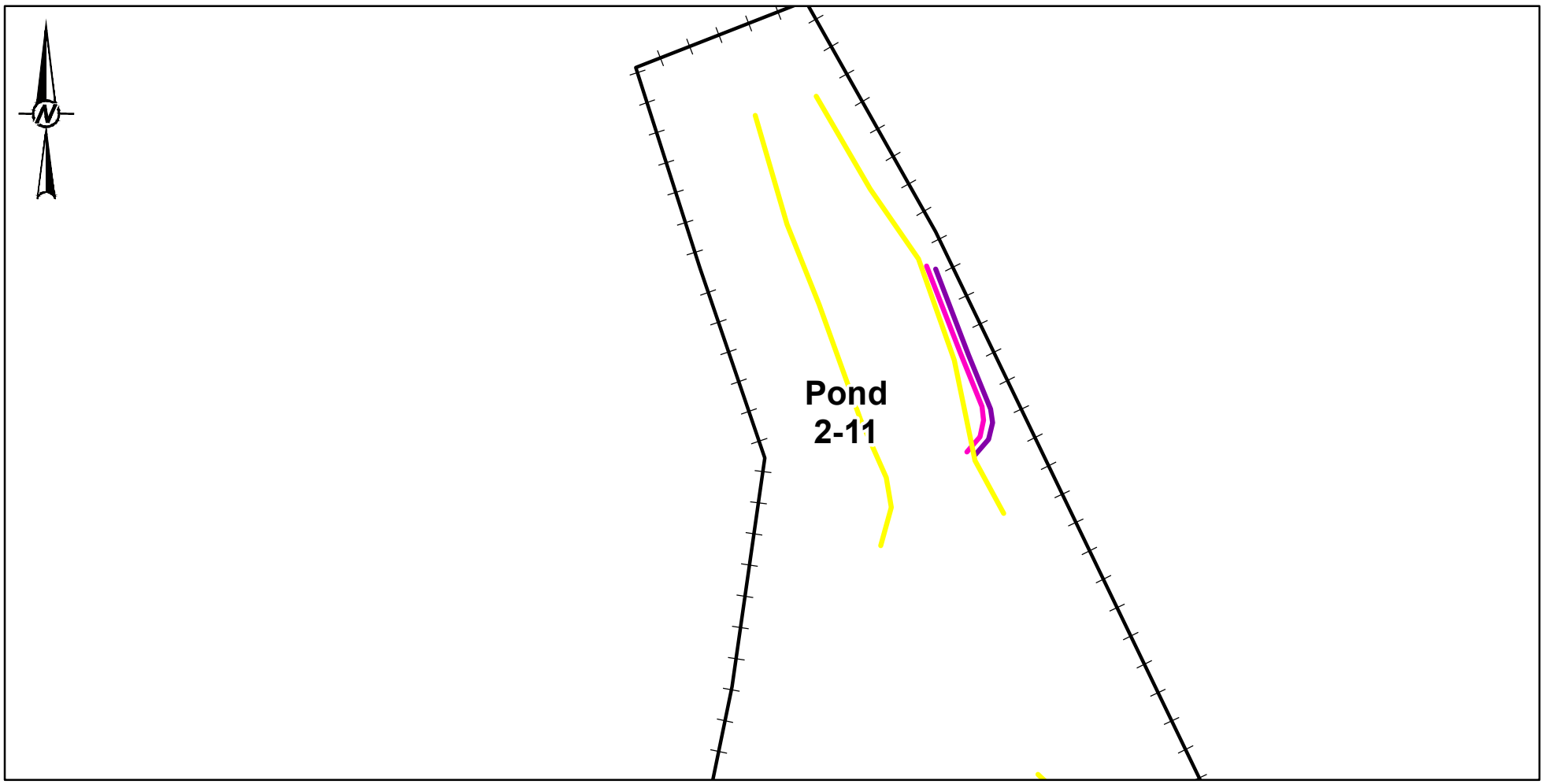


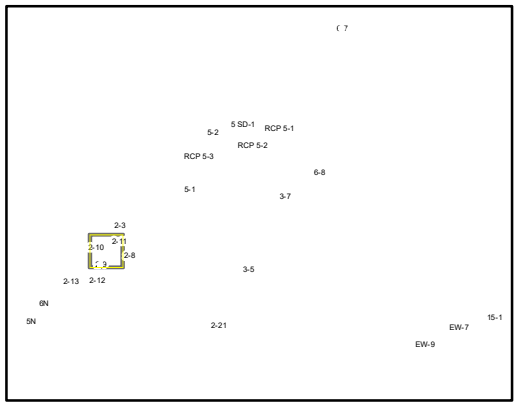


**LEGEND**

POND ENHANCEMENT TYPE
- WOODS ROSE
- LICORICE
- POND ADMIX

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 40 80
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
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TITLE

**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2022 (POND 2-11)**

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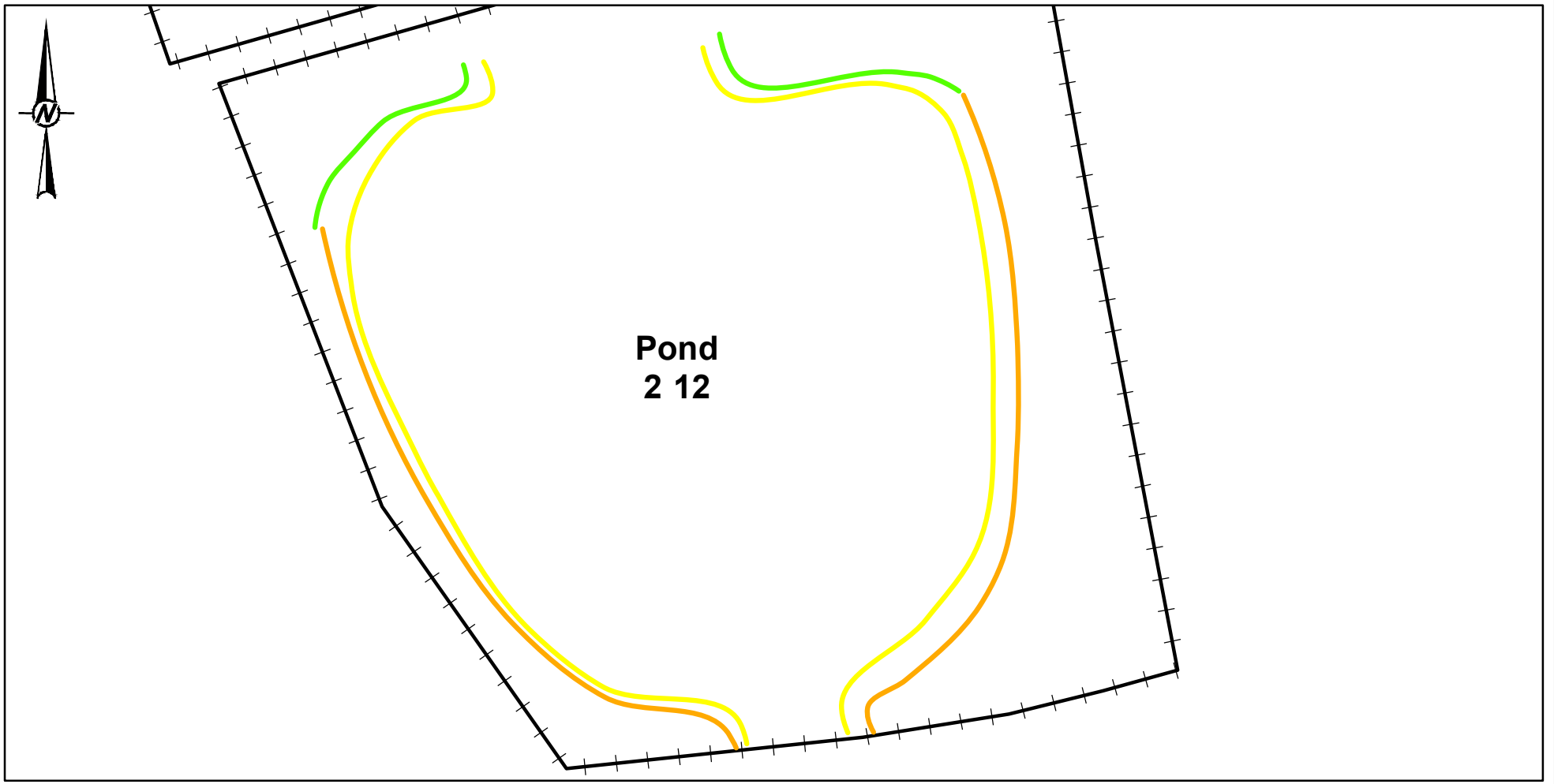


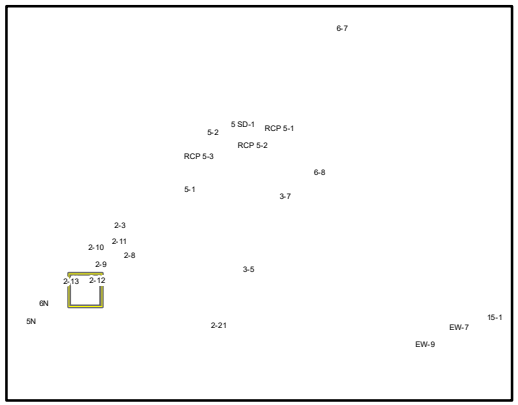


**LEGEND**

POND ENHANCEMENT TYPE
- COTTONWOOD
- WILLOW
- POND ADMIX

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 30 60
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
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PROJECT
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TITLE
**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2022 (POND 2-12)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
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| 31406184.000 | | A | 1i |

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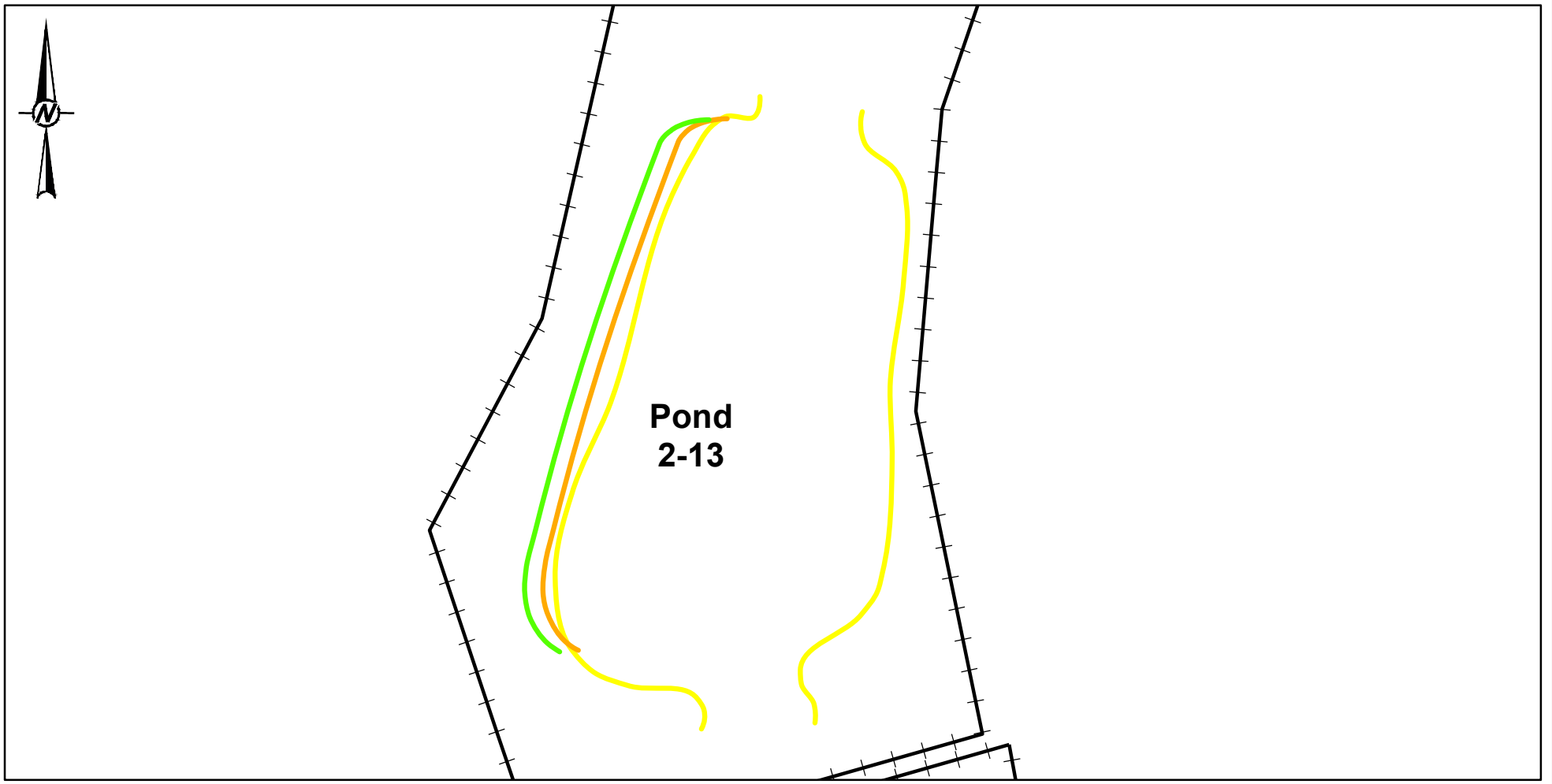


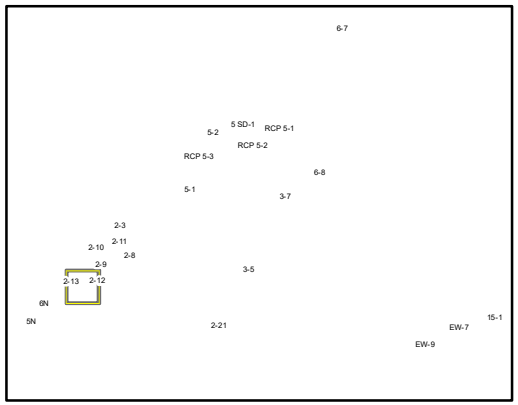


**LEGEND**

POND ENHANCEMENT TYPE
- COTTONWOOD
- WILLOW
- POND ADMIX

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 50 100
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
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**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2022 (POND 2-13)**

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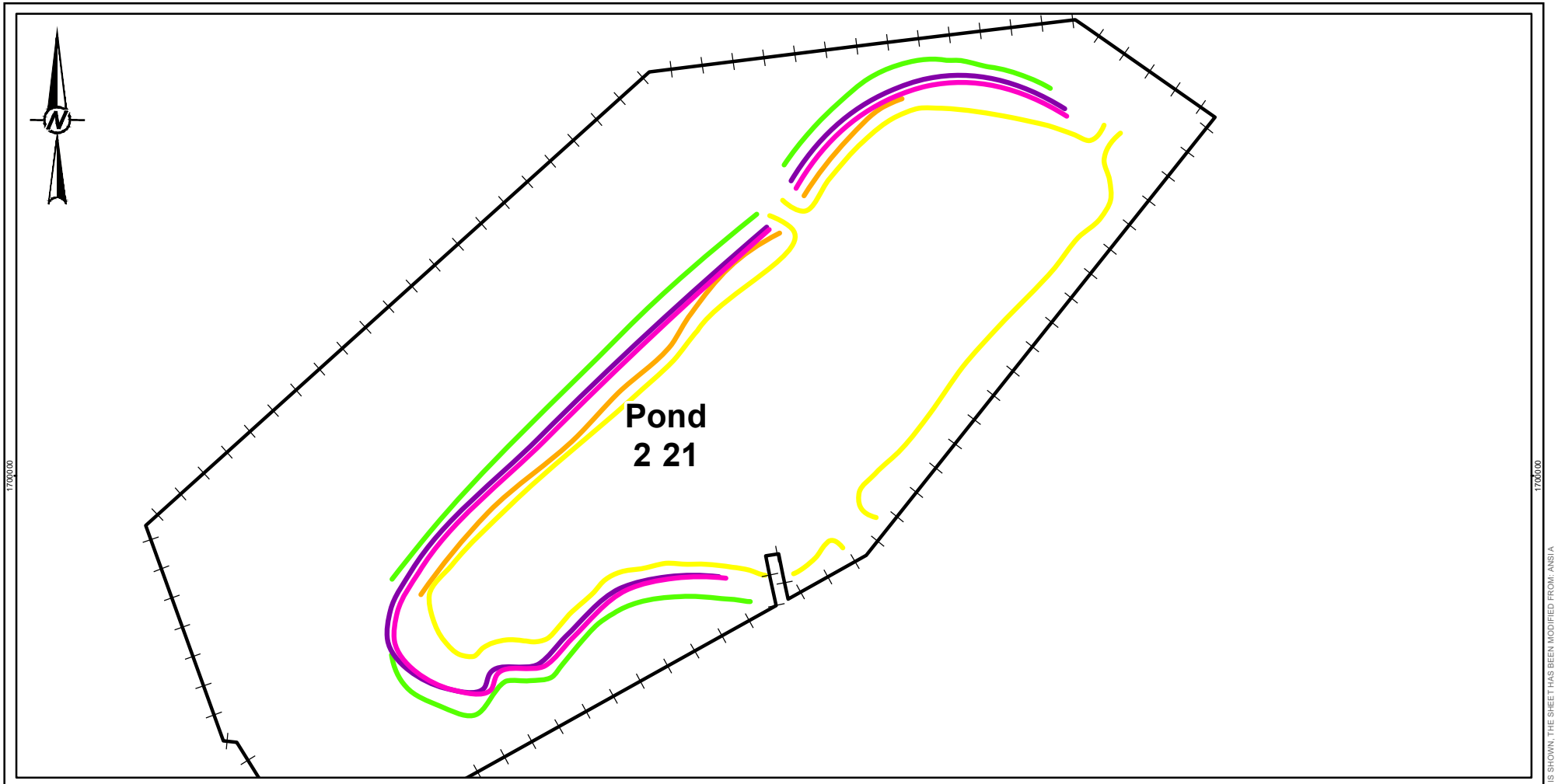


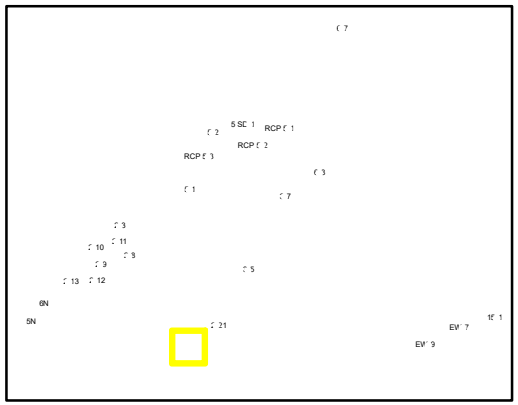

**LEGEND**

POND ENHANCEMENT TYPE
- WOODS ROSE
- LICORICE
- COTTONWOOD
- WILLOW
- POND ADMIX

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 220 440
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

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CONSULTANT

[redacted]

PROJECT
OSM 2022 ANNUAL REPORT

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| YYYY-MM-DD | 3-30-2023 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | FR |

TITLE
**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2022 (POND 2-21)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1j |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
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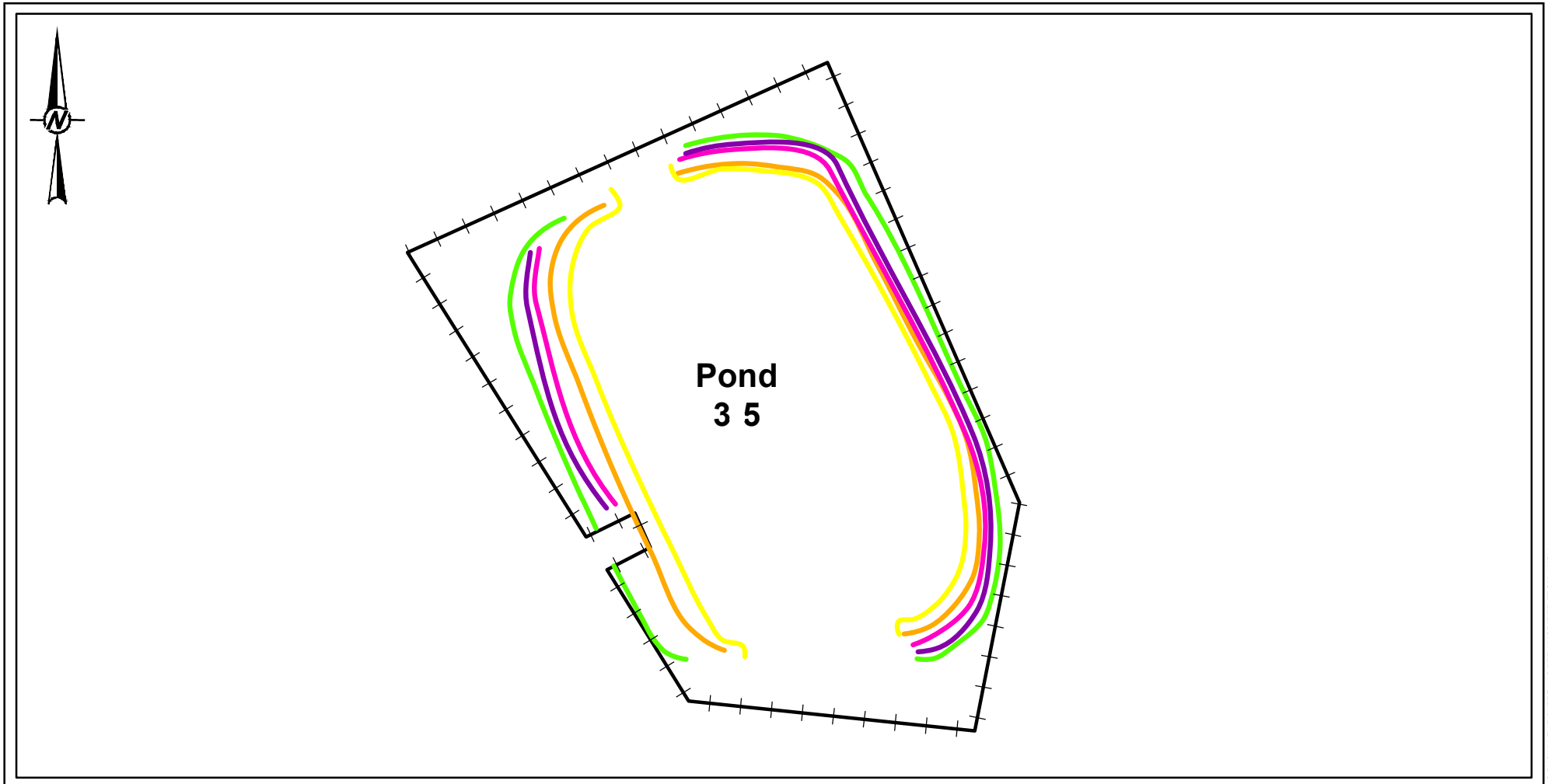
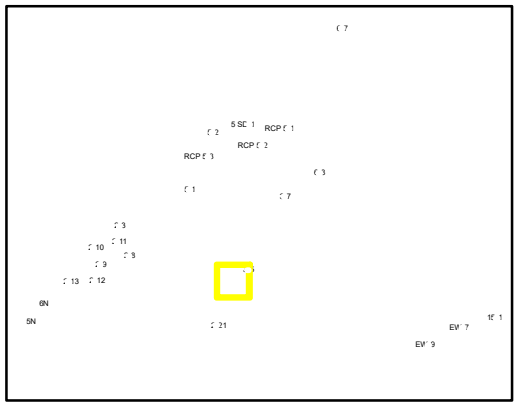
0

PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0025_OSM_AnnualReport_2022\Riparian_planting_2022.mxd PRINTED ON: 2023-03-29 AT: 9:28:20 PM



**LEGEND**

POND ENHANCEMENT TYPE
- WOODS ROSE
- LICORICE
- COTTONWOOD
- WILLOW
- POND ADMIX

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 70 140
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

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| YYYY-MM-DD | 3-30-2023 |
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| PREPARED | HJ |
| REVIEWED | FR |
| APPROVED | FR |

PROJECT
OSM 2022 ANNUAL REPORT

TITLE
**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2022 (POND 3-5)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1k |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
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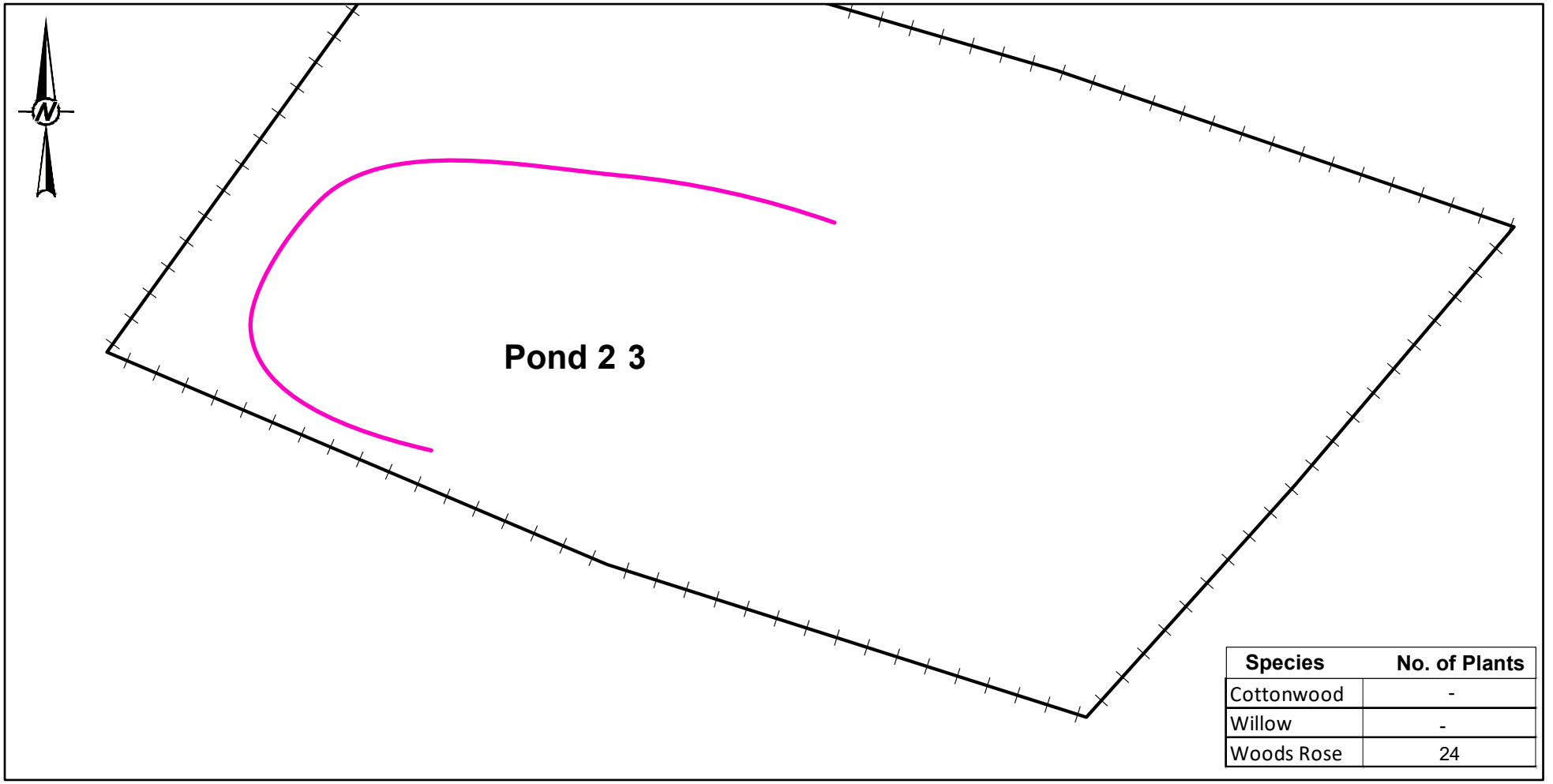
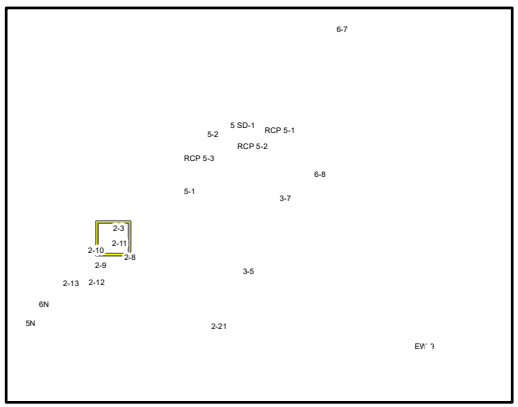



| Species | No. of Plants |
|---|---|
| Cottonwood | - |
| Willow | - |
| Woods Rose | 24 |




**LEGEND**

**Pond Enhancement Type**

Woods Rose

WILDLIFE-FRIENDLY FENCING

OSM BOUNDARY

MMD BOUNDARY

0 25 50

Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

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PROJECT

OSM 2023 ANNUAL REPORT

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|---|---|
| YYYY-MM-DD | 12-28-2023 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | NB/OD |
| APPROVED | FR |

TITLE

**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2023 (POND 2-3)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1d |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

1 in

0

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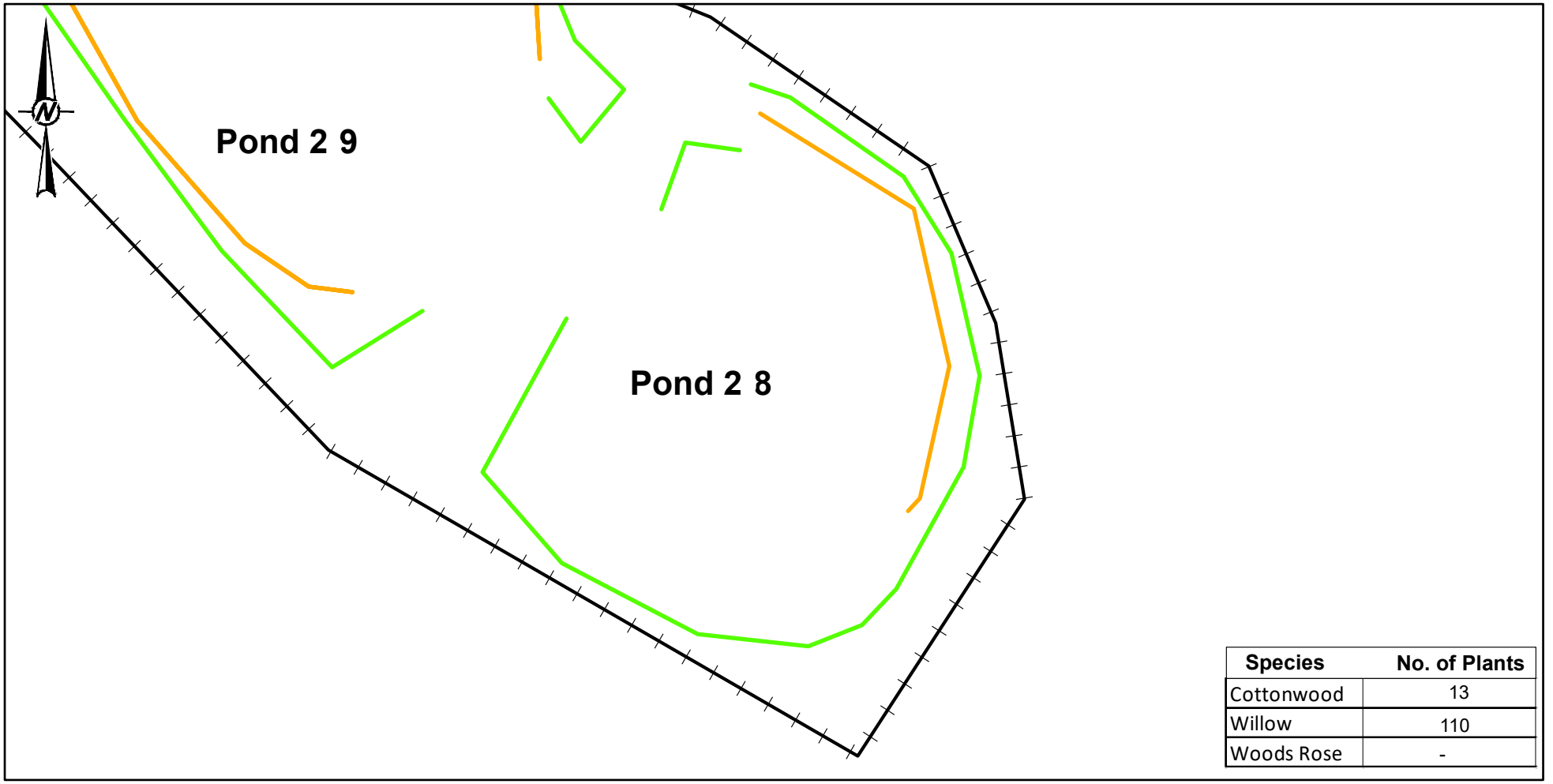
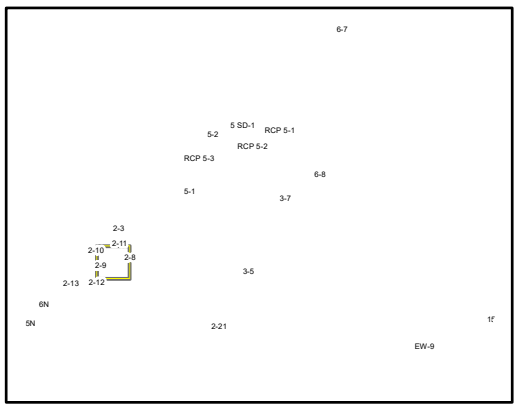



| Species | No. of Plants |
|---|---|
| Cottonwood | 13 |
| Willow | 110 |
| Woods Rose | - |




**LEGEND**

**Pond Enhancement Type**
- Cottonwood
- Willow

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 50 100
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

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PROJECT

OSM 2023 ANNUAL REPORT

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| YYYY-MM-DD | 12-28-2023 |
| DESIGNED | - |
| PREPARED | HJ |
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| APPROVED | FR |

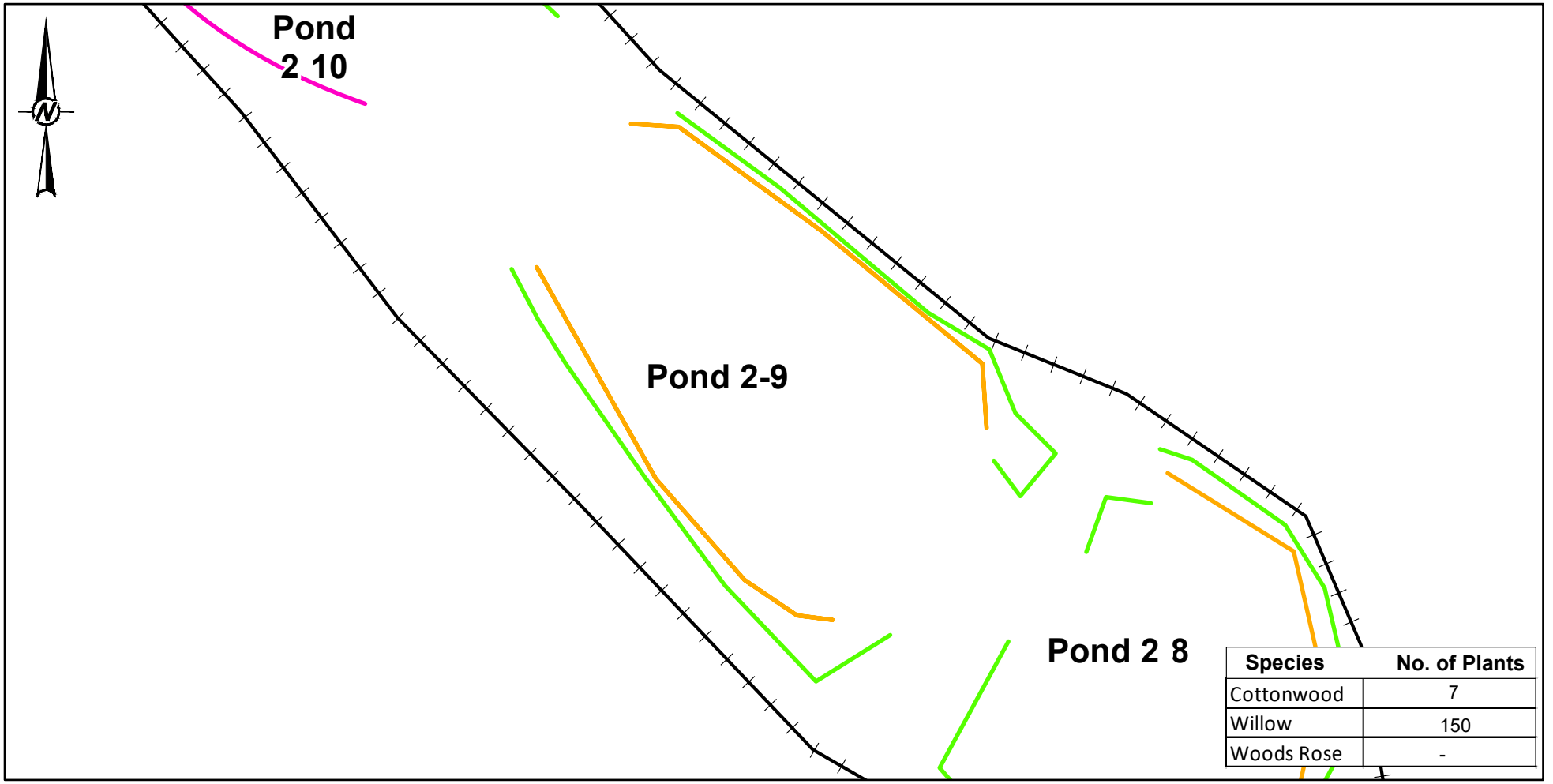
TITLE

**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2023 (POND 2-8)**

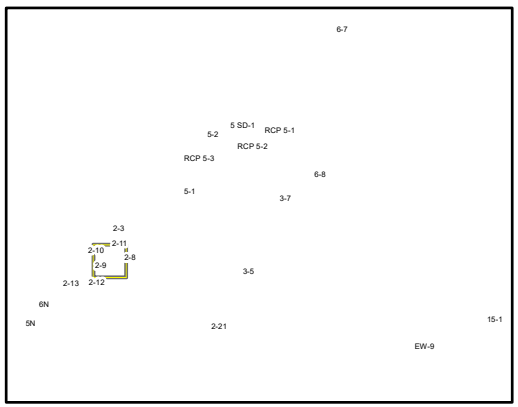
| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1h |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
1 in
0

PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0034_OSM_AnnualReport_2023\2023_OSM_RiparianPlanting_RevA_NAD83.mxd PRINTED ON: 2024-03-22 AT: 11:59:12 AM




| Species | No. of Plants |
|---|---|
| Cottonwood | 7 |
| Willow | 150 |
| Woods Rose | - |




**LEGEND**

**Pond Enhancement Type**
- Cottonwood
- Willow
- Woods Rose

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 60 120
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

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| YYYY-MM-DD | 12-28-2023 |
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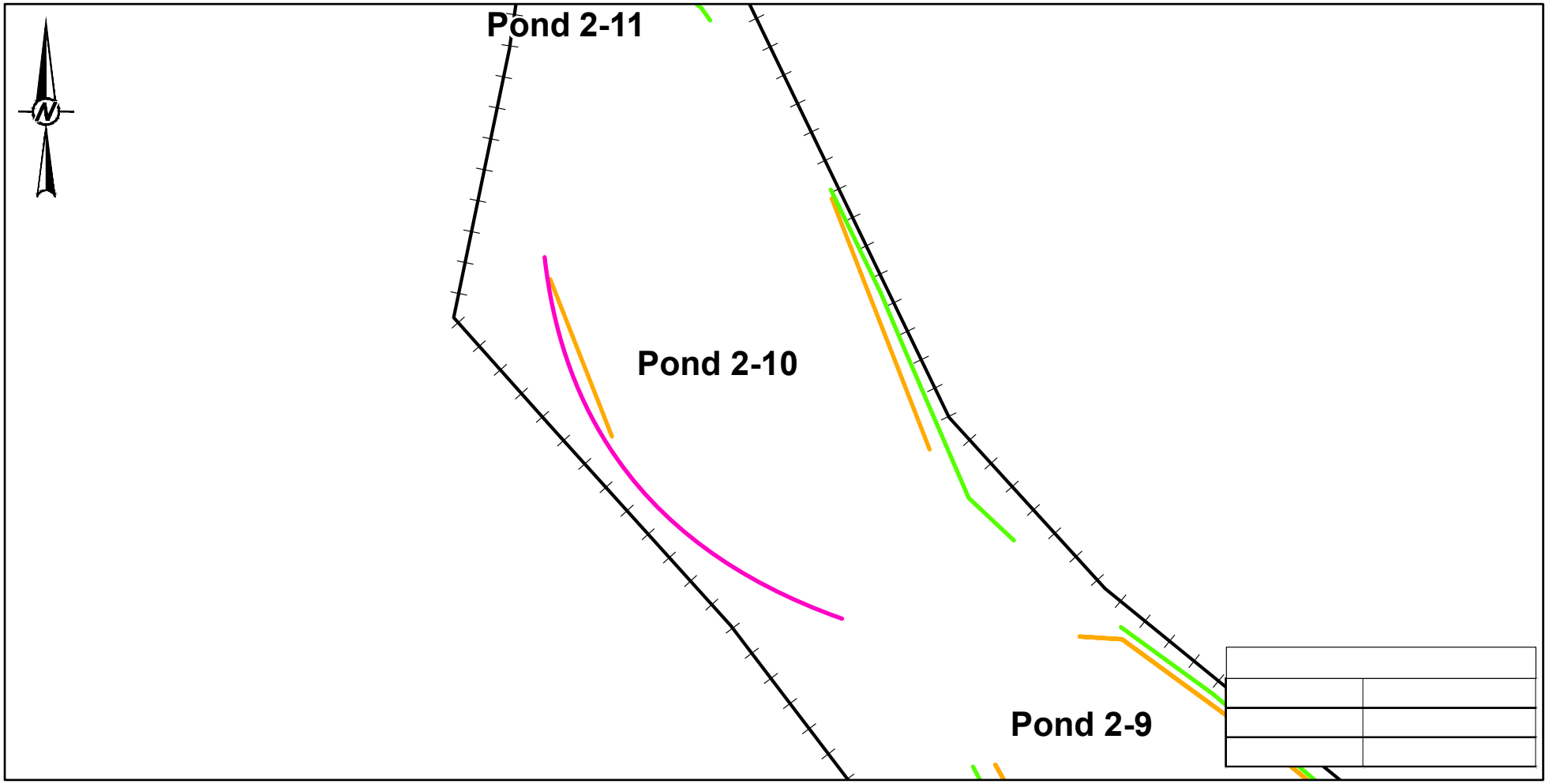
PROJECT
OSM 2023 ANNUAL REPORT

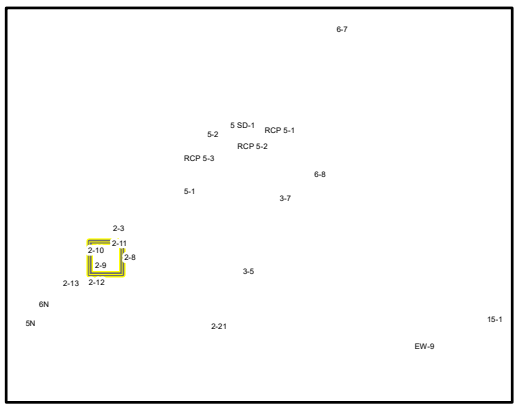
TITLE
**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2023 (POND 2-9)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1g |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
1 in
0

PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0034_OSM_AnnualReport_2023\2023_OSM_RiparianPlanting_RevA_NAD83.mxd PRINTED ON: 2024-03-22 AT: 11:59:19 AM




**LEGEND**

**Pond Enhancement Type**
- Cottonwood
- Willow
- Woods Rose

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 75 150
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

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|---|---|
| YYYY-MM-DD | 12-28-2023 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | NB/OD |
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PROJECT

OSM 2023 ANNUAL REPORT

TITLE

**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2023 (POND 2-10)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1f |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
1 in
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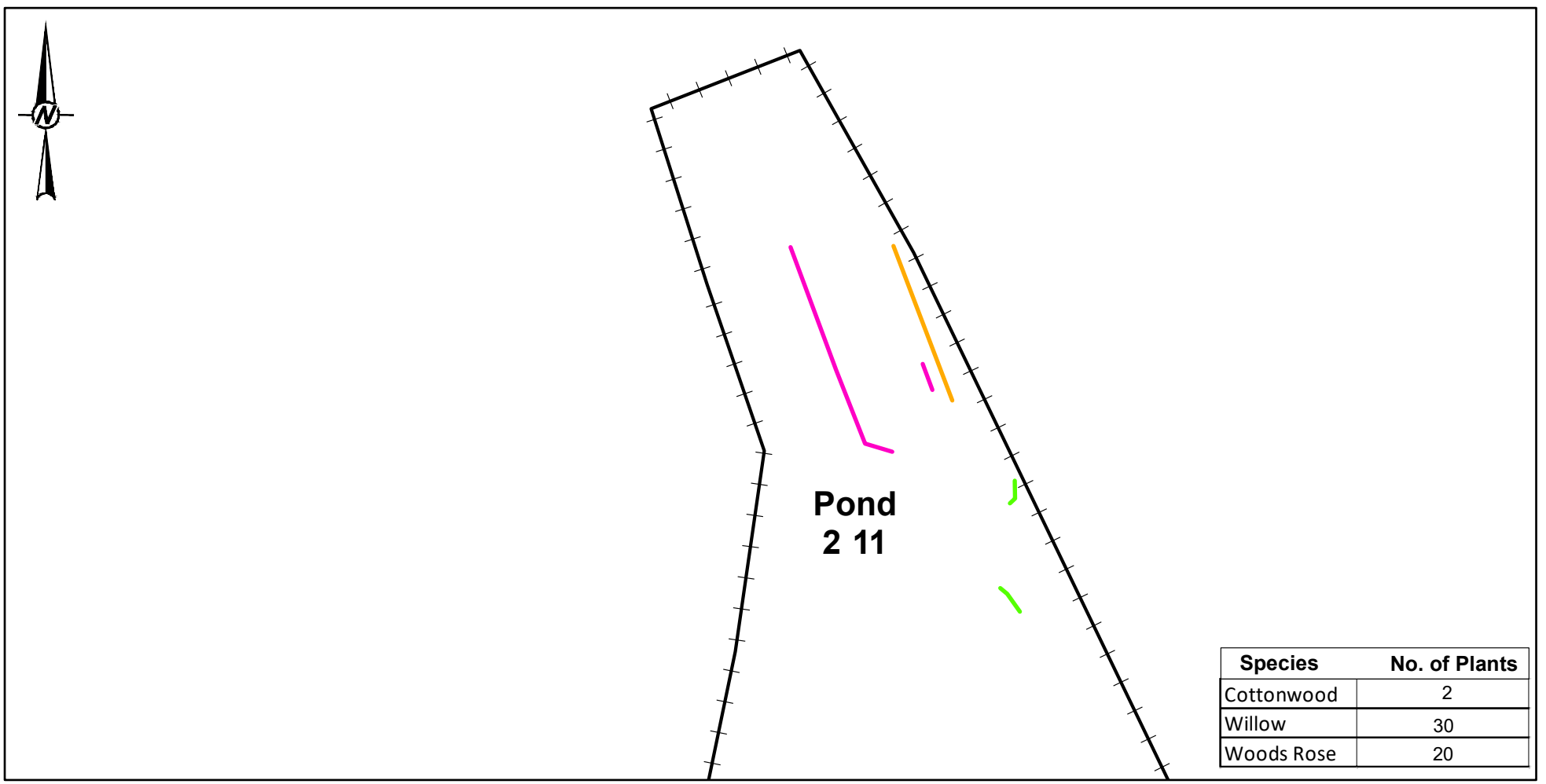
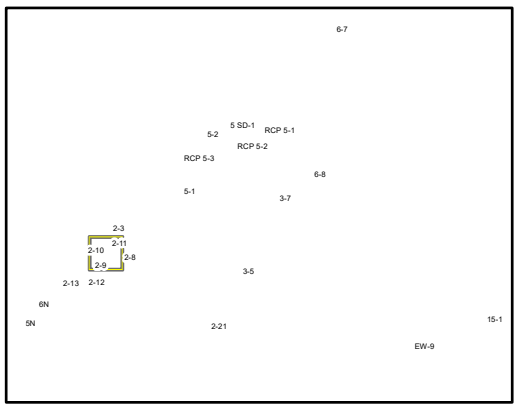
PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0034_OSM_AnnualReport_2023\2023_OSM_RiparianPlanting_RevA_NAD83.mxd PRINTED ON: 2024-03-22 AT: 11:59:26 AM




| Species | No. of Plants |
|---|---|
| Cottonwood | 2 |
| Willow | 30 |
| Woods Rose | 20 |




**LEGEND**

**Pond Enhancement Type**
- Cottonwood
- Willow
- Woods Rose

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 50 100
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

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| YYYY-MM-DD | 12-28-2023 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | NB/OD |
| APPROVED | FR |

PROJECT

OSM 2023 ANNUAL REPORT

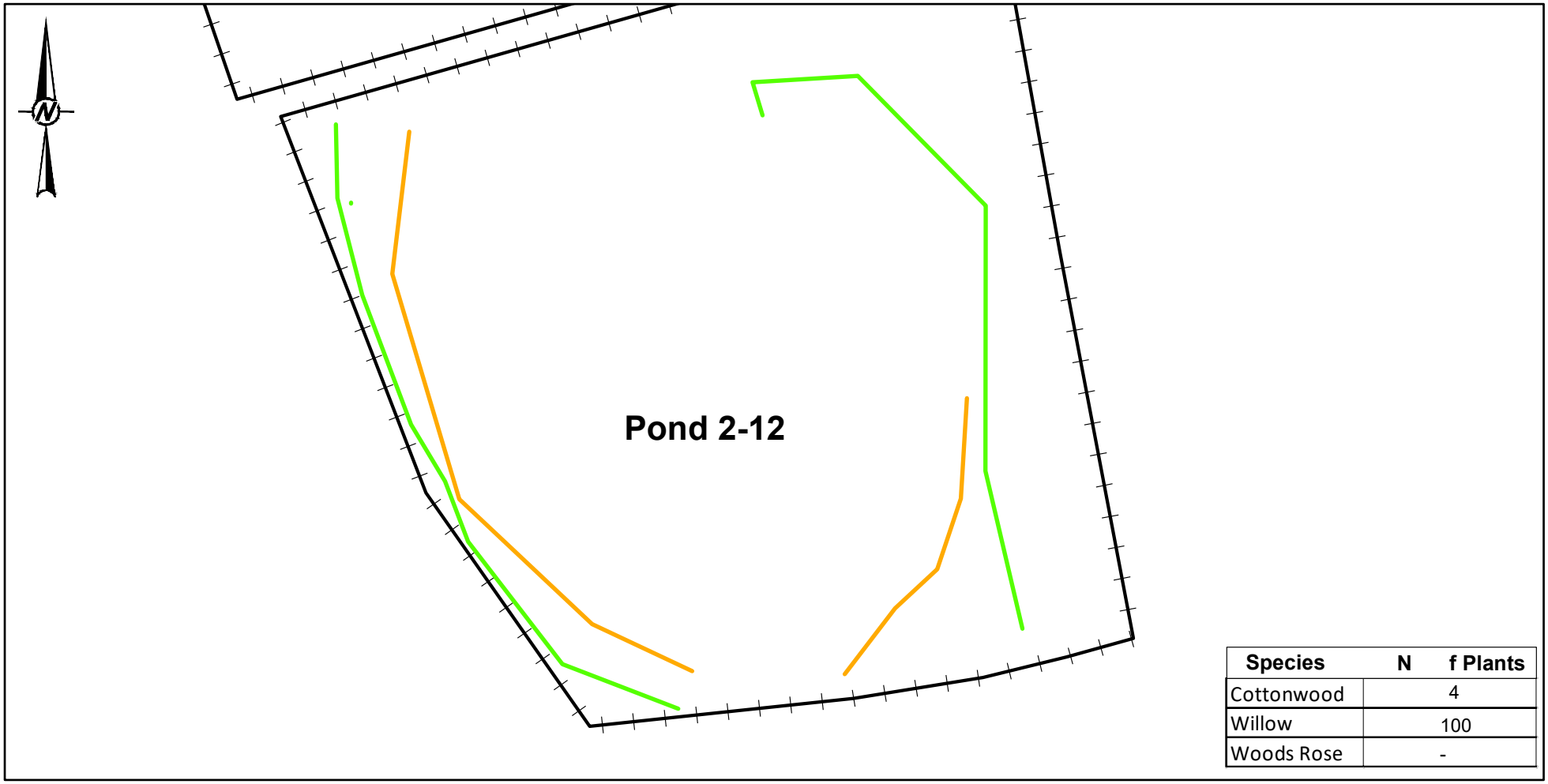
TITLE

**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2023 (POND 2-11)**

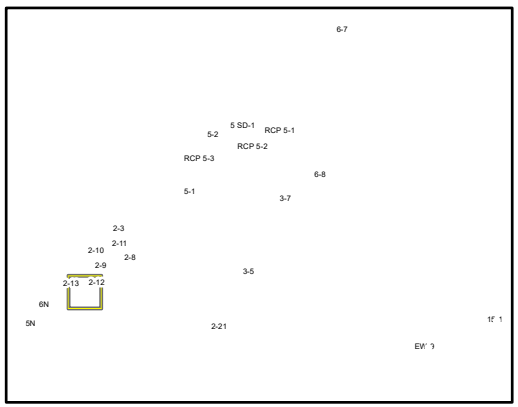
| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1e |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
1 in
0

PATH: P:\Projects\Chevron\McKinley_Mine\99_PROJECTS\1338105207_McKinley_Mine\0034_OSM_AnnualReport_2023\2023_OSM_RiparianPlanting_RevA_NAD83.mxd PRINTED ON: 2024-03-22 AT: 11:58:24 AM




| Species | N | f Plants |
|---|---|---|
| Cottonwood | | 4 |
| Willow | | 100 |
| Woods Rose | | - |




**LEGEND**

**Pond Enhancement Type**
- Cottonwood
- Willow

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 30 60
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

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OSM 2023 ANNUAL REPORT

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| YYYY-MM-DD | 12-28-2023 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | NB/OD |
| APPROVED | FR |

TITLE

**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2023 (POND 2-12)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1k |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
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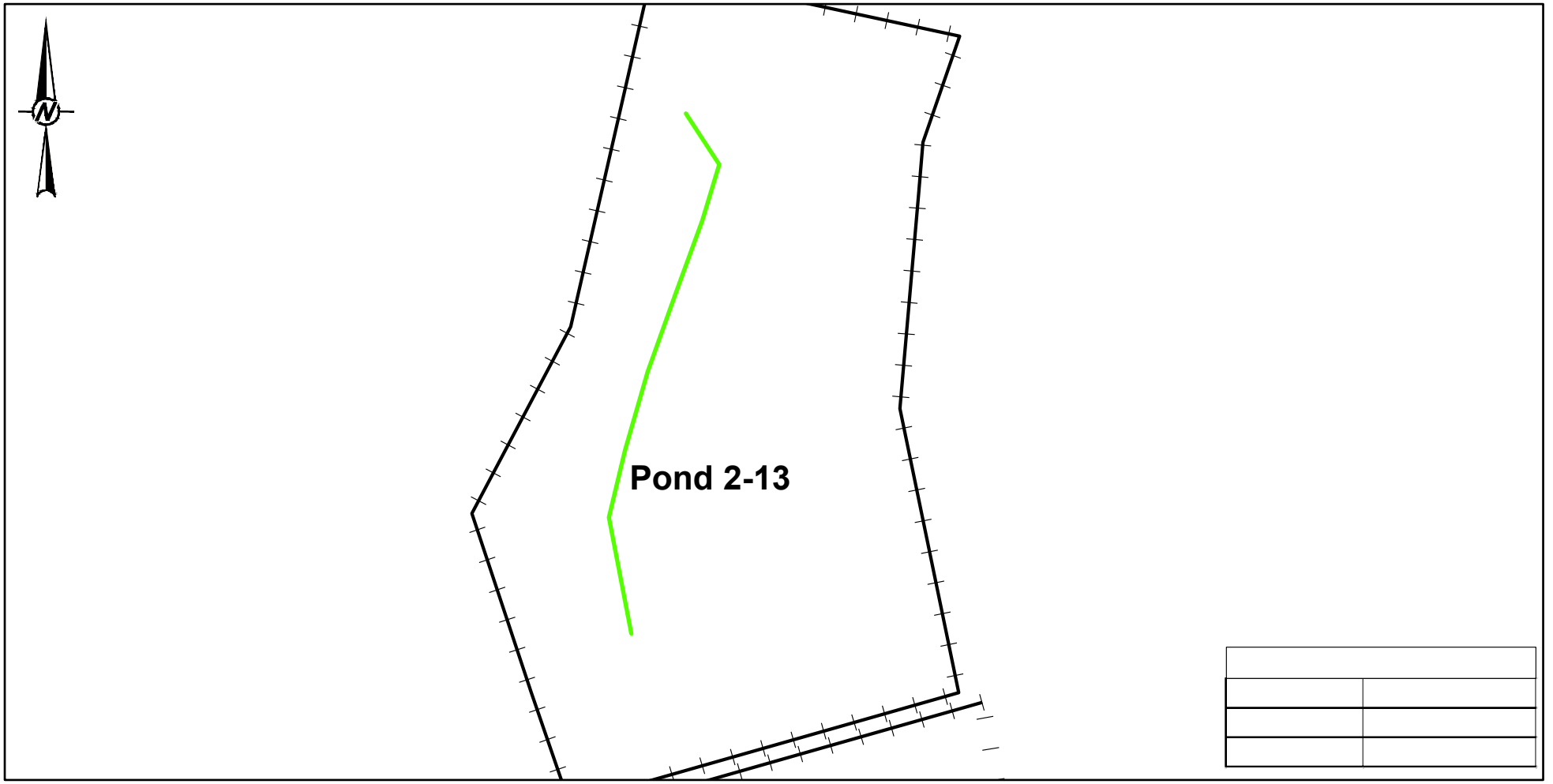


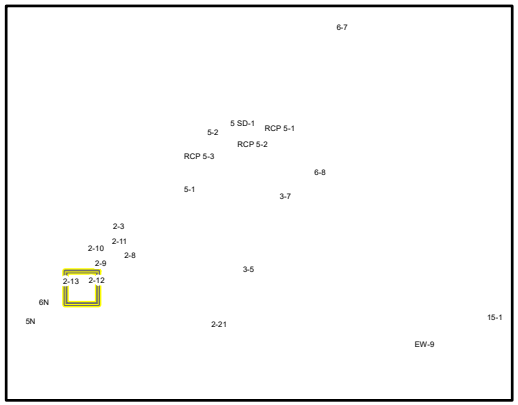


**LEGEND**

**Pond Enhancement Type**

Cottonwood

WILDLIFE-FRIENDLY FENCING

OSM BOUNDARY

MMD BOUNDARY

0 60 120

Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

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| YYYY-MM-DD | 12-28-2023 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | NB/OD |
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PROJECT

OSM 2023 ANNUAL REPORT

TITLE

**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2023 (POND 2-13)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1i |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

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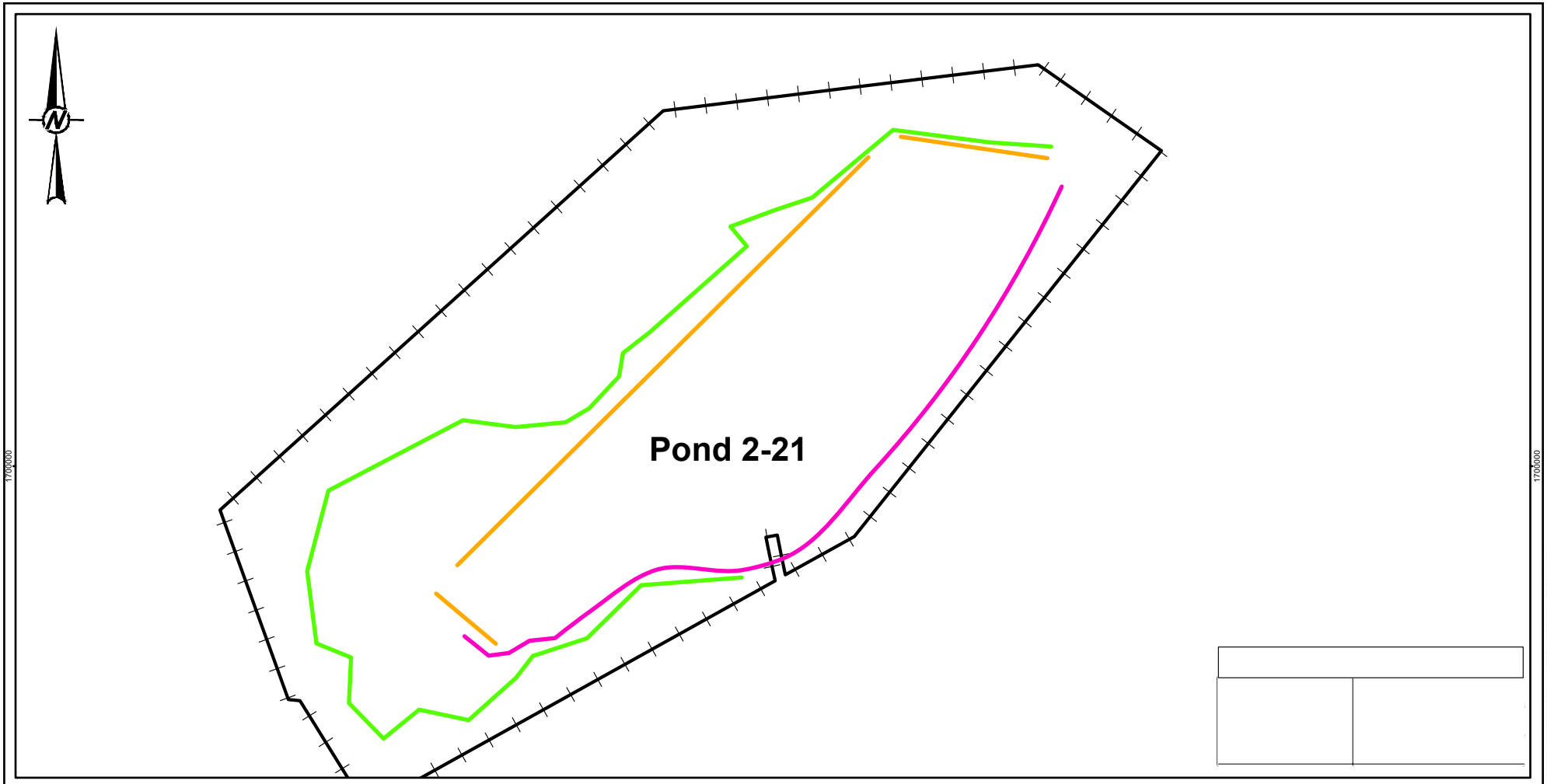


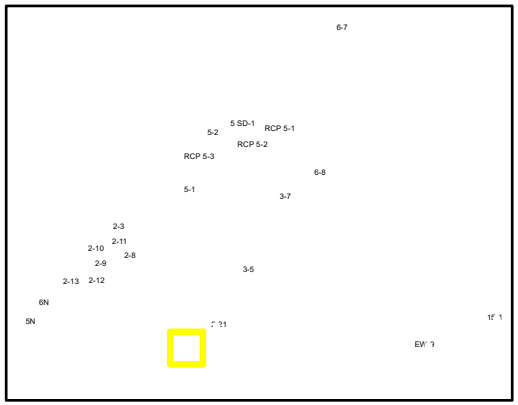


**LEGEND**

**Pond Enhancement Type**
- Cottonwood
- Willow
- Woods Rose

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 250 500
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
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|---|---|
| YYYY-MM-DD | 12-28-2023 |
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| PREPARED | HJ |
| REVIEWED | NB/OD |
| APPROVED | FR |

PROJECT

OSM 2023 ANNUAL REPORT

TITLE

**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2023 (POND 2-21)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1l |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
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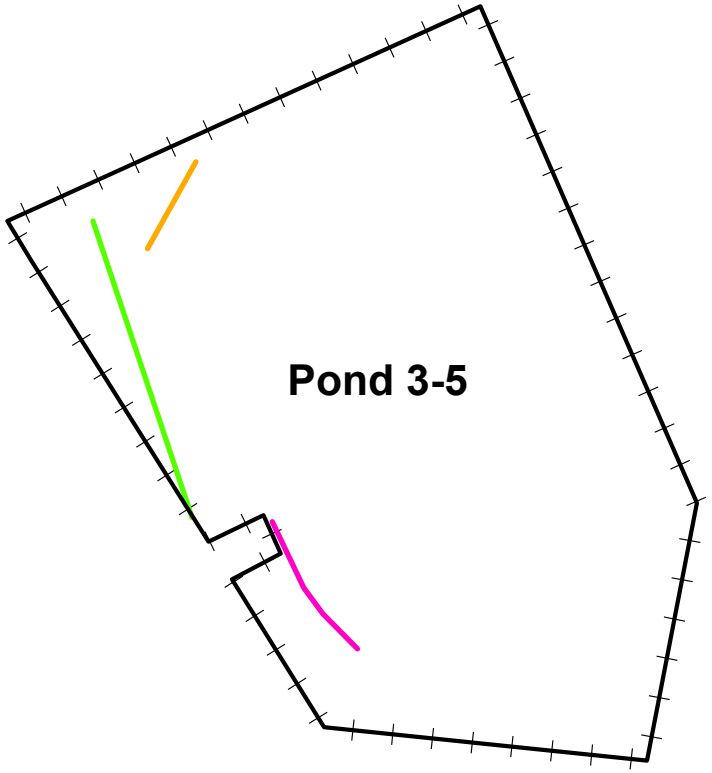
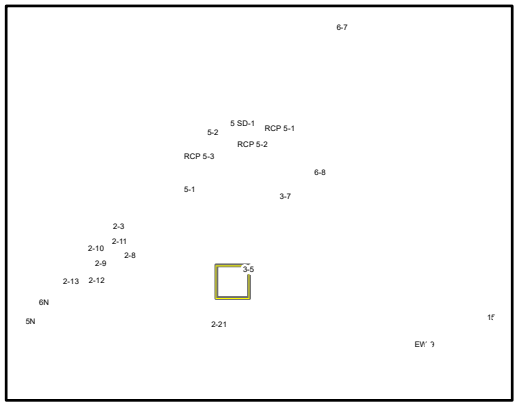



| Species | N | f Plants |
|---|---|---|
| Cottonwood | | 8 |
| Willow | | 80 |
| Woods Rose | | 20 |




**LEGEND**

**Pond Enhancement Type**
- Cottonwood
- Willow
- Woods Rose

- WILDLIFE-FRIENDLY FENCING
- OSM BOUNDARY
- MMD BOUNDARY

0 80 160
Feet

**REFERENCE(S)**

1. SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY

CLIENT

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CONSULTANT

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|---|---|
| YYYY-MM-DD | 12-28-2023 |
| DESIGNED | - |
| PREPARED | HJ |
| REVIEWED | NB/OD |
| APPROVED | FR |

PROJECT
OSM 2023 ANNUAL REPORT

TITLE
**APPROXIMATE LOCATIONS OF RIPARIAN PLANTING 2023 (POND 3-5)**

| PROJECT NO. | CONTROL | REV. | FIGURE |
|---|---|---|---|
| 31406184.000 | | A | 1m |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
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## Appendix A9: Performance Bond

| **OSMRE Bond Cost Summary (2024 dollars as noted)** | | | |
|---|---|---|---|
| Performance Bond After VMU 2 Phase IIII Deduction | | | |
| Red font indicates direct changes made to this spreadsheet | | | |
| **Mining Areas** | | | |
| 2N (included below) | | | |
| 2 | | | $1,099,386 |
| 3, 3A Plug (A&T, TS, Reveg) and 5 (Reveg) | | | $933,444 |
| 3A Plug (A&T, TS, Reveg) (Included above) | | | |
| 5 (reveg) (Included above) | | | |
| 6 | | | $1,231,952 |
| 10 | | | $449,861 |
| 12 | | | $1,997,973 |
| 12 Box-Cut | | | $643,577 |
| 14 | | | $981,006 |
| 14 and 15 Box-Cut | | | $401,751 |
| 15 | | | $1,278,805 |
| A16 Ponds and Hydro | | | $92,750 |
| 16 + Box-cut (Not Mined) | | | $0 |
| EW Mitigation pile | | | $0 |
| | Orig. Total Ac. | Orig Total | |
| P. Roads (470 ac total) (Gr, A&T, TS & Reveg) | 470 | $7,714,481 | $1,495,290 |
| A. Roads (40.7 ac total) (TS & Reveg) | 40.7 | $96,378 | $70,747 |
| Facilities | | | $4,658,117 |
| | | Quantity | |
| Ponds (Cost/Pond included in Mining Areas): 2-3, 3-5 | $14,750 | -2 | -$29,500 |
| Earthmoving Support Equip. | | | $2,046,664 |
| Diversions (No Name and Tse Bonita [Area 2]) | | | $0 |
| | | PP Acres | |
| Revegetation Cost/Ac VMU 2 Deduction | $822 | -770 | -$632,940 |
| Renewal Total Direct Costs (1999 Dollars) | | | $16,718,883 |
| Inflation Factor (to Sept 06) | 17.632% | | |
| Renewal Total Direct Costs (2006 Dollars) | | | $19,666,818 |
| | | | |
| Additional Current Dollar Direct Costs | | | |
| 10B Truck Pod (in 06 Dollars) | | | $0 |
| 14A Truck Pod (in 06 Dollars) | | | |
| 14A Truck Pod Expansion (in 06 Dollars) | | | $1,138,920 |
| 15E Additional 1000' Corridor (in 06 Dollars) | | | $487,185 |
| 2B Truck Pod (in 06 Dollars) | | | $0 |
| Total Direct Costs (2006 Dollars) | $102,985,116 | | $21,292,923 |
| | Orig Tot Above | | |
| 10 yr Inflation Factor (Based on 10 yrs.06-16) | 36.660% | | $29,098,909 |
| | | | |
| Sep 16 to Mar 19 Inf Factor RSMeans (2.5 yrs) | 4.649% | | $30,451,717 |
| Mar 19 to Sep 21 inf Factor RSMeans (2.5 yrs) | 5.390% | | $32,093,064 |
| Sept 21 to Mar 24 inf Factor RSMeans (2.5 yrs) | 16.65% | | $37,436,560 |
| | | | |
| **Total Direct costs (2024 dollars)** | | | $37,436,560 |
| Indirect Costs | | | |
| Mob/Demobilization | 1.0% | | $374,366 |
| Contingency Fund | 3.0% | | $1,123,097 |
| Eng. Redesign Fee | 2.5% | | $935,914 |
| Profit and Overhead | 15.0% | | $5,615,484 |
| Project Management | 2.5% | | $935,914 |
| **Total Indirect Costs** | | | **$8,984,774** |
| | | | |
| **Total W/O Gross Receipts tax** | | | **$46,421,334** |
| Gross Receipts Tax 6.4375% | 6.43750% | | $2,988,373 |
| Navajo Nation Sales Tax 3.0 % | 3.00% | | $1,392,640 |
| Navajo Fuel Excise Tax @ $0.18/gal | $1,747,486 | | $375,547 |
| Fuel Tax Pro-rated on orig Tot direct costs & tax total | Orig Tot above | | |
| **Total Bond Amount** | | | **$51,177,894** |
| | | | |
| **Recommended Bond Amount (Rounded)** | | | **$51,178,000** |
| Supplemental Contingency Bond Amount | | | $883,545 |
| **Updated Grand Total with Contingency** | | | **$52,061,545** |
| Current Bond Amount | | | $53,921,545 |
| **Bond Reduction** | | | $1,860,000 |
| Note: VMU 2 acreage for revegetation deduction excludes 1 ac for 2 impoundments since no revegetation cost associated | | | |
| with permanent impoundments | | | |
| Although mining in Area 16 is not bonded, the area has ponds, hydrologic structures and roads that are bonded. | | | |

| **OSMRE Bond Cost Summary (2024 dollars as noted)** | | | |
|---|---|---|---|
| Performance Bond After VMU 3 Phase IIII Deduction | | | |
| Red font indicates direct changes made to this spreadsheet | | | |
| **Mining Areas** | | | |
| 2N (included below) | | | |
| 2 | | | $1,099,386 |
| 3, 3A Plug (A&T, TS, Reveg) and 5 (Reveg) | | | $933,444 |
| 3A Plug (A&T, TS, Reveg) (Included above) | | | |
| 5 (reveg) (Included above) | | | |
| 6 | | | $1,231,952 |
| 10 | | | $449,861 |
| 12 | | | $1,997,973 |
| 12 Box-Cut | | | $643,577 |
| 14 | | | $981,006 |
| 14 and 15 Box-Cut | | | $401,751 |
| 15 | | | $1,278,805 |
| A16 Ponds and Hydro | | | $92,750 |
| 16 + Box-cut (Not Mined) | | | $0 |
| EW Mitigation pile | | | $0 |
| | Orig. Total Ac. | Orig Total | |
| P. Roads (470 ac total) (Gr, A&T, TS & Reveg) | 470 | $7,714,481 | $1,495,290 |
| A. Roads (40.7 ac total) (TS & Reveg) | 40.7 | $96,378 | $70,747 |
| Facilities | | | $4,658,117 |
| | | Quantity | |
| Ponds (Cost/Pond included in Mining Areas): None | $14,750 | 0 | $0 |
| Earthmoving Support Equip. | | | $2,046,664 |
| Diversions (No Name and Tse Bonita [Area 2]) | | | $0 |
| | | PP Acres | |
| Revegetation Cost/Ac VMU 3 Deduction | $822 | -450 | -$369,900 |
| Renewal Total Direct Costs (1999 Dollars) | | | $17,011,423 |
| Inflation Factor (to Sept 06) | 17.632% | | |
| Renewal Total Direct Costs (2006 Dollars) | | | $20,010,940 |
| | | | |
| Additional Current Dollar Direct Costs | | | |
| 10B Truck Pod (in 06 Dollars) | | | $0 |
| 14A Truck Pod (in 06 Dollars) | | | |
| 14A Truck Pod Expansion (in 06 Dollars) | | | $1,138,920 |
| 15E Additional 1000' Corridor (in 06 Dollars) | | | $487,185 |
| 2B Truck Pod (in 06 Dollars) | | | $0 |
| Total Direct Costs (2006 Dollars) | $102,985,116 | | $21,637,045 |
| | Orig Tot Above | | |
| 10 yr Inflation Factor (Based on 10 yrs.06-16) | 36.660% | | $29,569,185 |
| | | | |
| Sep 16 to Mar 19 Inf Factor RSMeans (2.5 yrs) | 4.649% | | $30,943,857 |
| Mar 19 to Sep 21 inf Factor RSMeans (2.5 yrs) | 5.390% | | $32,611,731 |
| Sept 21 to Mar 24 inf Factor RSMeans (2.5 yrs) | 16.65% | | $38,041,584 |
| | | | |
| **Total Direct costs (2024 dollars)** | | | $38,041,584 |
| Indirect Costs | | | |
| Mob/Demobilization | 1.0% | | $380,416 |
| Contingency Fund | 3.0% | | $1,141,248 |
| Eng. Redesign Fee | 2.5% | | $951,040 |
| Profit and Overhead | 15.0% | | $5,706,238 |
| Project Management | 2.5% | | $951,040 |
| **Total Indirect Costs** | | | **$9,129,980** |
| | | | |
| **Total W/O Gross Receipts tax** | | | **$47,171,564** |
| Gross Receipts Tax 6.4375% | 6.43750% | | $3,036,669 |
| Navajo Nation Sales Tax 3.0 % | 3.00% | | $1,415,147 |
| Navajo Fuel Excise Tax @ $0.18/gal | $1,747,486 | | $375,547 |
| Fuel Tax Pro-rated on orig Tot direct costs & tax total | Orig Tot above | | |
| **Total Bond Amount** | | | **$51,998,927** |
| | | | |
| **Recommended Bond Amount (Rounded)** | | | **$51,999,000** |
| Supplemental Contingency Bond Amount | | | $883,545 |
| **Updated Grand Total with Contingency** | | | **$52,882,545** |
| Current Bond Amount | | | $53,921,545 |
| **Bond Reduction** | | | $1,039,000 |
| Note: Although mining in Area 16 is not bonded, the area has ponds, hydrologic structures and roads that are bonded. | | | |

| **OSMRE Bond Cost Summary (2024 dollars as noted)** | | | |
|---|---|---|---|
| Performance Bond After VMU 5 Phase IIII Deduction | | | |
| Red font indicates direct changes made to this spreadsheet | | | |
| **Mining Areas** | | | |
| 2N (included below) | | | |
| 2 | | | $1,099,386 |
| 3, 3A Plug (A&T, TS, Reveg) and 5 (Reveg) | | | $933,444 |
| 3A Plug (A&T, TS, Reveg) (Included above) | | | |
| 5 (reveg) (Included above) | | | |
| 6 | | | $1,231,952 |
| 10 | | | $449,861 |
| 12 | | | $1,997,973 |
| 12 Box-Cut | | | $643,577 |
| 14 | | | $981,006 |
| 14 and 15 Box-Cut | | | $401,751 |
| 15 | | | $1,278,805 |
| A16 Ponds and Hydro | | | $92,750 |
| 16 + Box-cut (Not Mined) | | | $0 |
| EW Mitigation pile | | | $0 |
| | Orig. Total Ac. | Orig Total | |
| P. Roads (470 ac total) (Gr, A&T, TS & Reveg) | 470 | $7,714,481 | $1,495,290 |
| A. Roads (40.7 ac total) (TS & Reveg) | 40.7 | $96,378 | $70,747 |
| Facilities | | | $4,658,117 |
| | | Quantity | |
| Ponds (Cost/Pond included in Mining Areas): 2-8 to 2-13, & 2-21 | $14,750 | -7 | -$103,250 |
| Earthmoving Support Equip. | | | $2,046,664 |
| Diversions (No Name and Tse Bonita [Area 2]) | | | $0 |
| | | PP Acres | |
| Revegetation Cost/Ac VMU 5 Deduction | $822 | -814 | -$669,108 |
| Renewal Total Direct Costs (1999 Dollars) | | | $16,608,965 |
| Inflation Factor (to Sept 06) | 17.632% | | |
| Renewal Total Direct Costs (2006 Dollars) | | | $19,537,519 |
| | | | |
| Additional Current Dollar Direct Costs | | | |
| 10B Truck Pod (in 06 Dollars) | | | $0 |
| 14A Truck Pod (in 06 Dollars) | | | |
| 14A Truck Pod Expansion (in 06 Dollars) | | | $1,138,920 |
| 15E Additional 1000' Corridor (in 06 Dollars) | | | $487,185 |
| 2B Truck Pod (in 06 Dollars) | | | $0 |
| Total Direct Costs (2006 Dollars) | $102,985,116 | | $21,163,624 |
| | Orig Tot Above | | |
| 10 yr Inflation Factor (Based on 10 yrs.06-16) | 36.660% | | $28,922,208 |
| | | | |
| Sep 16 to Mar 19 Inf Factor RSMeans (2.5 yrs) | 4.649% | | $30,266,802 |
| Mar 19 to Sep 21 inf Factor RSMeans (2.5 yrs) | 5.390% | | $31,898,182 |
| Sept 21 to Mar 24 inf Factor RSMeans (2.5 yrs) | 16.65% | | $37,209,230 |
| | | | |
| **Total Direct costs (2024 dollars)** | | | $37,209,230 |
| Indirect Costs | | | |
| Mob/Demobilization | 1.0% | | $372,092 |
| Contingency Fund | 3.0% | | $1,116,277 |
| Eng. Redesign Fee | 2.5% | | $930,231 |
| Profit and Overhead | 15.0% | | $5,581,384 |
| Project Management | 2.5% | | $930,231 |
| **Total Indirect Costs** | | | **$8,930,215** |
| | | | |
| **Total W/O Gross Receipts tax** | | | **$46,139,445** |
| Gross Receipts Tax 6.4375% | 6.43750% | | $2,970,227 |
| Navajo Nation Sales Tax 3.0 % | 3.00% | | $1,384,183 |
| Navajo Fuel Excise Tax @ $0.18/gal | $1,747,486 | | $375,547 |
| Fuel Tax Pro-rated on orig Tot direct costs & tax total | Orig Tot above | | |
| **Total Bond Amount** | | | **$50,869,402** |
| | | | |
| **Recommended Bond Amount (Rounded)** | | | **$50,870,000** |
| Supplemental Contingency Bond Amount | | | $883,545 |
| **Updated Grand Total with Contingency** | | | **$51,753,545** |
| Current Bond Amount | | | $53,921,545 |
| **Bond Reduction** | | | $2,168,000 |
| Note: VMU 5 acreage for revegetation deduction excludes 15 ac for 7 impoundments since no revegetation cost associated | | | |
| with permanent impoundments | | | |
| Although mining in Area 16 is not bonded, the area has ponds, hydrologic structures and roads that are bonded. | | | |

## Appendix A10: Landowner Notification

# NOTIFICATION ADDRESS LIST

| NAME | ADDRESS | CITY | ST | ZIP | OTHER |
|---|---|---|---|---|---|
| Navajo Nation Minerals Dept. | P.O. Box 1910 | Window Rock | AZ | 86515 | Rowena Cheromiah, Department Manager |
| Navajo Nation Land Dept. | P.O. Box 9000 | Window Rock | AZ | 86515 | Mike Halona, Dept. Manager |
| Public Service Co. Of NM | PNM Main Offices | Albuquerque | NM | 87158 | |
| Navajo Nation EPA Public Water Systems Supevision Program | P.O. Box 339 | Window Rock | AZ | 86515 | Yolanda Barney |
| Navajo Nation EPA Water Quality / NPDES Program | P.O. Box 339 | Window Rock | AZ | 86515 | Patrick Antonio |
| Navajo Tribal Utility Authority | P.O. Box 170 | Ft. Defiance | AZ | 86504 | Walter Haase, General Manager |
| Continental Divide Electric Corp. | P.O. Box 786 | Gallup | NM | 87305 | |
| Kinder Morgan | P.O. Box 103 | Rehoboth | NM | 87322 | Gallup District Office |
| Bureau of Land Management | 6251 College Blvd. | Farmington | NM | 87402 | |
| BIA-Navajo Regional Office | P.O. Box 1060 | Gallup | NM | 87305 | Bertha Spencer |
| New Mexico State Land Office | P.O. Box 1148 | Santa Fe | NM | 87504-1148 | |
| Ft Defiance Chapter | P.O. Box 366 | Ft. Defiance | AZ | 86504 | Wilson Stewart, Jr., Chapter President |
| Tsayatoh Chapter | P.O. Box 86 | Mentmore | NM | 87319 | Walter Hudson, Chapter President |
| McKinley County Manager | P.O. Box 70 | Gallup | NM | 87305 | Anthony Dimas, Jr., County Manager |

**Armando Martinez**
Remediation Ops
Specialist

**Chevron Environmental Management Company**

P.O. Box 469
Questa, NM 87564
Tel (575) 585-7639
Cell (505) 690-5408
amarti@chevron.com

**RE: McKinley Mine Permit No. NM-0001K**
**Vegetation Management Unit 2, 3, and 5**
**Application for a Permanent Program Bond Release and**
**Prelaw and Initial Program Reclamation Liability Release & Termination of Jurisdiction**

This notice is being provided to you since you or your organization may have an interest in the action described in this letter.

Chevron Mining Inc. (CMI) has filed an application for bond release of Permanent Program Lands and a reclamation liability release and termination of jurisdiction (TOJ) of Initial Program lands for reclaimed lands in Vegetation Management Units 2, 3, and 5 (VMU 2, VMU 3 and VMU 5) contained in the McKinley Mine's mining and reclamation Permit No. NM-0001K (Permit NM-0001K) approved 09-07-2016, located in McKinley County, New Mexico.

VMU 2: The application includes a request for a Phase I, II and III bond release on two permanent impoundments in VMU 2 and Phase III bond release for the remaining area. The application contains information to demonstrate that 1,078 acres meet applicable requirements contained in the McKinley Mine's Permit NM-0001K, and the regulatory performance standards in 30 CFR 715, 800 and 816. The current performance bond is $53,921,545 and with this reclamation complete, the application includes calculations to reduce the associated reclamation performance bond by $1,860,000.

VMU 3: The application includes a request for a Phase III bond release for the entire VMU 3 area. The application contains information to demonstrate that 858 acres meet applicable requirements contained in the McKinley Mine's Permit NM-0001K, and the regulatory performance standards in 30 CFR 715, 800 and 816. The current performance bond is $53,921,545 and with this reclamation complete, the application includes calculations to reduce the associated reclamation performance bond by $1,039,000.

VMU 5: The application includes a request for a Phase I, II and III bond release on seven permanent impoundments in VMU 5 and Phase III bond release for the remaining area. The application contains information to demonstrate that 1,049 acres meet applicable requirements contained in the McKinley Mine's Permit NM-0001K, and the regulatory performance standards in 30 CFR 715, 800 and 816. The current performance bond is $53,921,545 and with this reclamation complete, the application includes calculations to reduce the associated reclamation performance bond by $2,168,000.

The McKinley Mine is located approximately 22 miles northwest of Gallup, NM, and 2 miles east of Window Rock, AZ, on NM State Highway 264. Figure 1 shows the location and configuration of VMU 2, 3, and 5. The McKinley Mine is currently permitted by CMI (formerly the Pittsburg & Midway Coal Mining Co.) but

now managed by Chevron Environmental Management Company (CEMC). CEMC is located at 6001 Bollinger Canyon Road, Building C-2144, San Ramon, CA, 94583. The application was filed with the Office of Surface Mining Reclamation and Enforcement (OSMRE) Western Region Office in Denver, Colorado, which has jurisdiction for the McKinley Mine on Navajo Nation lands.

VMU 2, 3, and 5 are situated on land leased from the Navajo Nation to conduct mining and reclamation on lands in the Navajo Reservation. These lands are generally located in former Mining Areas 1, 2, 3, and 5 in the western part of the McKinley Mine. Mining has been completed as have required reclamation activities that include backfilling and grading, installation of hydrologic controls, topdressing, and revegetation. The Office of Surface Mining has previously approved Phase I and II applications for these lands that included all categories of reclamation with the exception of a demonstration that the mine has successfully revegetated the land to meet the revegetation success standards in Permit No. NM-0001K. This application contains information that the revegetation success standards have been met and that the land can be released from further reclamation liability.

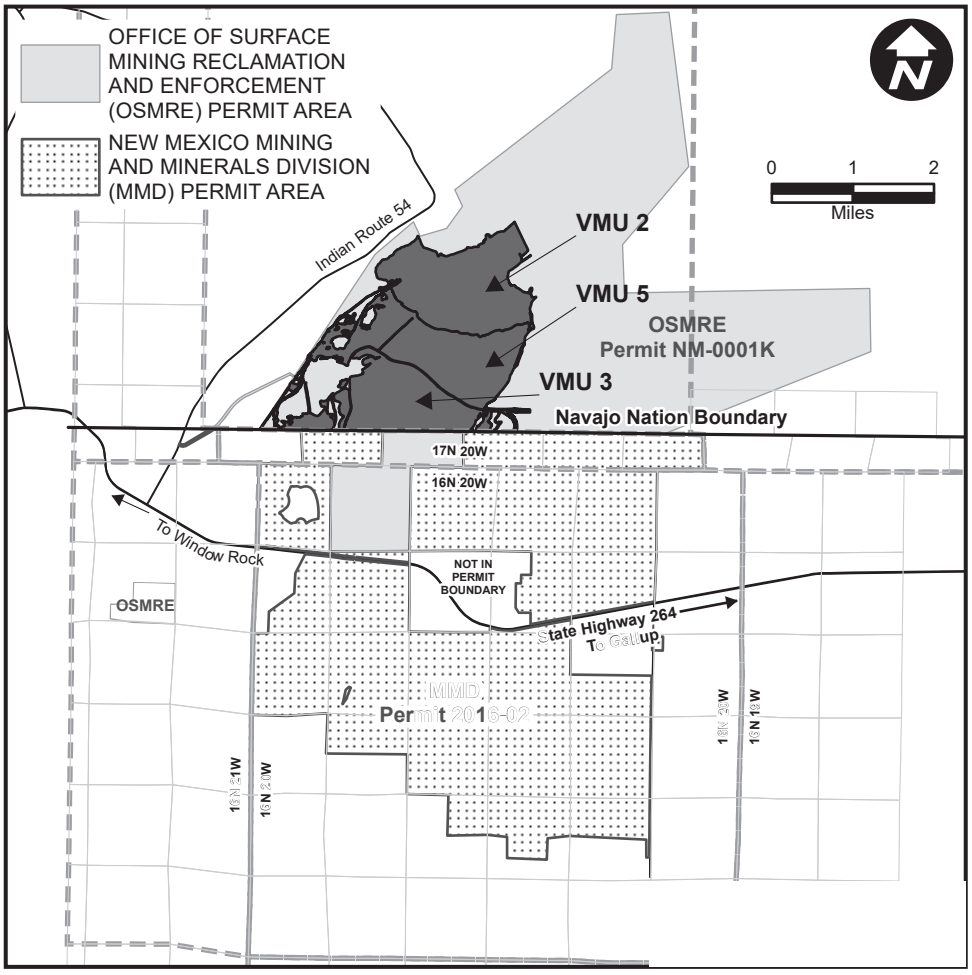
A copy of the reclamation liability release and termination of jurisdiction application is available for public inspection at the following locations:

Mr. Jacob Mulinix and Ms. Christy Luciani
Western Region Office
Office of Surface Mining Reclamation and Enforcement
https://www.osmre.gov/programs/regulating-active-coal-mines/indian-lands

County Clerk's Office
McKinley County Courthouse
207 W. Hill Ave.
Gallup, NM 87301

The Navajo Nation Minerals Department – Office of Surface Mining Program
Window Rock Blvd
Window Rock, AZ 86515

Within 30 days of the fourth and final publication of the bond release application notice in the Gallup Independent or Navajo Times newspaper, written comments, objections, or requests for a public hearing and informal conference on this bond release application shall be submitted to: Mr. Jacob Mulinix and Ms. Christy Luciani, Western Region Office, Office of Surface Mining Reclamation and Enforcement. https://www.osmre.gov/programs/regulating-active-coal-mines/indian-lands


OFFICE OF SURFACE MINING RECLAMATION AND ENFORCEMENT (OSMRE) PERMIT AREA
NEW MEXICO MINING AND MINERALS DIVISION (MMD) PERMIT AREA
N
0 1 2
Miles
Indian Route 54
VMU 2
VMU 5
VMU 3
OSMRE
Permit NM-0001K
Navajo Nation Boundary
17N 20W
16N 20W
To Window Rock
NOT IN PERMIT BOUNDARY
OSMRE
State Highway 264
To Gallup
MMD
Permit 2016-02
16N 21W
16N 20W
16N 19W

## Appendix A11: Newspaper Advertisement

**McKinley Mine Permit No. NM-0001K**
**Vegetation Management Unit 2, 3, and 5**
**Application for a Permanent Program Bond Release and**
**Prelaw and Initial Program Reclamation Liability Release & Termination of Jurisdiction**

Chevron Mining Inc. (CMI) has filed an application for a Phase III bond release of Permanent Program Lands and a reclamation liability release and termination of jurisdiction (TOJ) of Initial Program lands for reclaimed lands in Vegetation Management Units 2, 3, and 5 (VMU 2, VMU 3 and VMU 5) contained in the McKinley Mine's mining and reclamation Permit No. NM-0001K (Permit NM-0001K) approved 09-07-2016, located at the McKinley Mine, in McKinley County, New Mexico.

VMU 2: The application includes a request for a Phase I, II and III bond release on two permanent impoundments in VMU 2 and Phase III bond release for the remaining area. The application contains information to demonstrate that 1,073 acres meet applicable requirements contained in the McKinley Mine's Permit NM-0001K, and the regulatory performance standards in 30 CFR 715, 800 and 816. The current performance bond is $53,921,545 and with this reclamation complete, the application includes calculations to reduce the associated reclamation performance bond by $1,860,000.

VMU 3: The application includes a request for a Phase III bond release for the entire VMU 3 area. The application contains information to demonstrate that 858 acres meet applicable requirements contained in the McKinley Mine's Permit NM-0001K, and the regulatory performance standards in 30 CFR 715, 800 and 816. The current performance bond is $53,921,545 and with this reclamation complete, the application includes calculations to reduce the associated reclamation performance bond by $1,039,000.

VMU 5: The application includes a request for a Phase I, II and III bond release on seven permanent impoundments in VMU 5 and Phase III bond release for the remaining area. The application contains information to demonstrate that 1,049 acres meet applicable requirements contained in the McKinley Mine's Permit NM-0001K, and the regulatory performance standards in 30 CFR 715, 800 and 816. The current performance bond is $53,921,545 and with this reclamation complete, the application includes calculations to reduce the associated reclamation performance bond by $2,168,000.

The McKinley Mine is located approximately 22 miles northwest of Gallup, NM, and 2 miles east of Window Rock, AZ, on NM State Highway 264. Figure 1 shows the location and configuration of VMUs 2, 3, and 5. The McKinley Mine is currently permitted by CMI (formerly the Pittsburg & Midway Coal Mining Co.) but now managed by Chevron Environmental Management Company (CEMC). CEMC is located at 6001 Bollinger Canyon Road, Building C-2144, San Ramon, CA, 94583. The application was filed with the Office of Surface Mining Reclamation and Enforcement (OSMRE) Western Region Office in Denver, Colorado, which has jurisdiction for the McKinley Mine on Navajo Nation lands.

VMU 2, 3, and 5 are situated on land leased from the Navajo Nation to conduct mining and reclamation on lands in the Navajo Reservation. These lands are generally located in former Mining Areas 1, 2, 3, and 5 in the western part of the McKinley Mine. Mining has been completed as have required reclamation activities that include backfilling and grading, installation of hydrologic controls, topdressing, and revegetation. The Office of Surface Mining has previously approved Phase I and II applications for these lands that included all categories of reclamation with the exception of a demonstration that the mine has successfully revegetated the land to meet the revegetation success standards in Permit No. NM-0001K. This application contains information that the revegetation success standards have been met and that the land can be released from further reclamation liability.

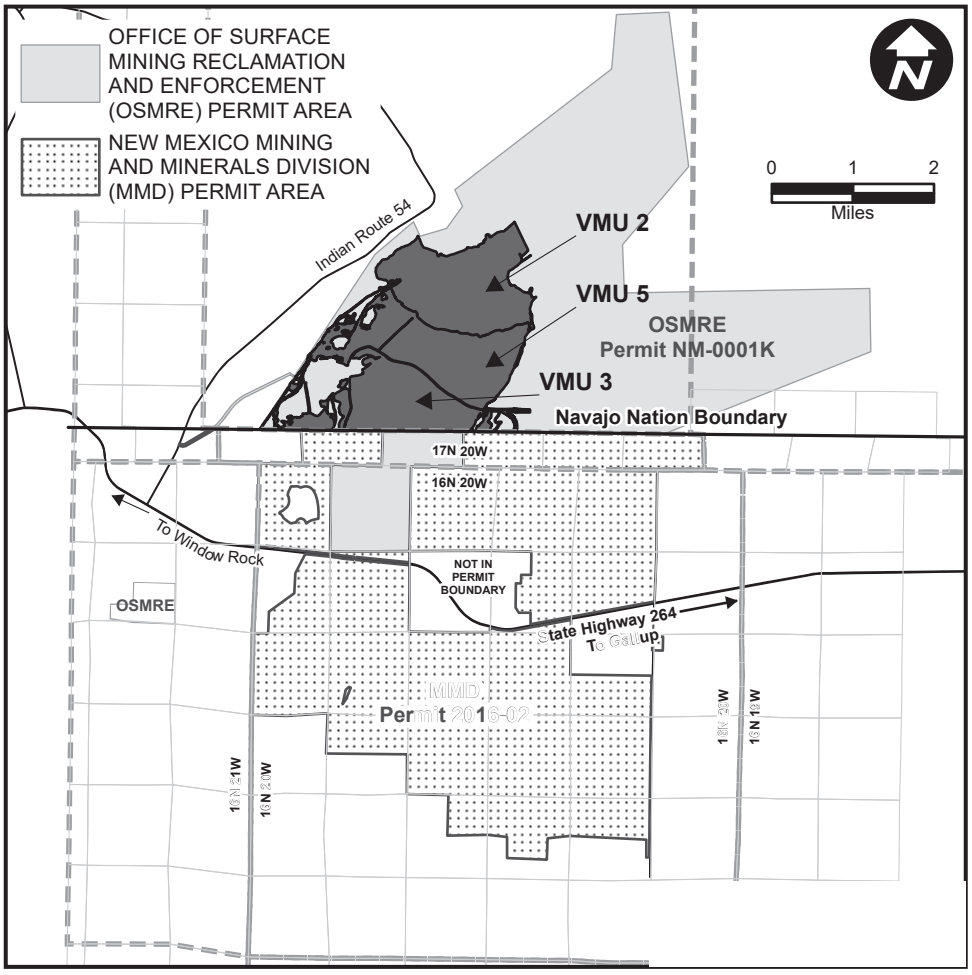
A copy of the reclamation liability release and termination of jurisdiction application is available for public inspection at the following locations:

Mr. Jacob Mulinix and Ms. Christy Luciani
Western Region Office
Office of Surface Mining Reclamation and Enforcement
https://www.osmre.gov/programs/regulating-active-coal-mines/indian-lands

County Clerk's Office
McKinley County Courthouse
207 W. Hill Ave.
Gallup, NM 87301

The Navajo Nation Minerals Department – Office of Surface Mining Program
Window Rock Blvd
Window Rock, AZ 86515

Within 30 days of the fourth and final publication of this bond release application notice in the Gallup Independent or Navajo Times newspaper, written comments, objections, or requests for a public hearing and informal conference on this reclamation liability release application shall be submitted to: Mr. Jacob Mulinix and Ms. Christy Luciani, Western Region Office, Office of Surface Mining Reclamation and Enforcement. https://www.osmre.gov/programs/regulating-active-coal-mines/indian-lands


OFFICE OF SURFACE MINING RECLAMATION AND ENFORCEMENT (OSMRE) PERMIT AREA
NEW MEXICO MINING AND MINERALS DIVISION (MMD) PERMIT AREA
N
0 1 2
Miles
Indian Route 54
VMU 2
VMU 5
VMU 3
OSMRE
Permit NM-0001K
Navajo Nation Boundary
17N 20W
16N 20W
To Window Rock
NOT IN PERMIT BOUNDARY
OSMRE
State Highway 264
To Gallup
MMD
Permit 2016-02
16N 21W
16N 20W
16N 19W