2018 ANNUAL REPORT

Submit the completed document and any additional information identified to the Division by March 31, 2019.

GENERAL INFORMATION

Company Name	PacifiCorp	Mine Name	Cottonwood/Wilberg
Permit Number	C/015/0019	Permit E xpirationDate	July, 6 2019
Operator Name	Interwest Mining Company	Phone Number	+1 (435) 687-9821
Mailing Address	PO Box 310	Email	ken.fleck@pacificorp.com
City	Huntington		
State	Utah	Zip Code	84528

		DOGM File Location or Annual Report Location
Excess Spoil Piles	☐ Required ☒ Not Required	
Refuse Piles	☐ Required ☒ Not Required	
Impoundments	☐ Required ☒ Not Required	
Other:		

OPERATOR COMMENTS

Impoundments are no longer required for this site. Ponds reclaimed during the mine site reclamation project completed March 2018.

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not meet Requirements

MAPS

Copies of mine maps, current and up-to-date, are to be provided to the Division as an attachment to this report in accordance with the requirements of R645-301-525.240. The map copies shall be made in accordance with 30 CFR 75.1200 as required by MSHA. Mine maps are not considered confidential.

Map Name	Map Number	Included		Confidential	
		Yes	No	Yes	No
		☐	☐	☐	☐
		☐	☐	☐	☐
		☐	☐	☐	☐
		☐	☐	☐	☐
		☐	☐	☐	☐

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

REPORTING OF OTHER TECHNICAL DATA

Please list other technical data or information that was not included in the form above, but is required under the approved plan, which must be periodically submitted to the Division.

Please list attachments:

Attachment A: Vegetation sampling for 2018 season
1) 4th Year TMA and Belt Portal Area
2) 2nd Year Phase II Bond Release Sampling of Leach Field Area

Note: Water monitoring sample sites were sampled as required and on schedule throughout 2018. Data for GWR01, GWR02, GWR03, and TMA001 can be reviewed on the DOGM water quality data base.

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not Meet Requirements

FUTURE COMMITMENTS AND CONDITIONS

The following commitments are not required for the current annual report year, but will be required by the permittee in the future as indicated by the "status" field. These commitments are included for information only, and do not currently require action. If you feel that the commitment is no longer relevant or needs to be revised, please contact the Division.

Title: VEGETATION MONITORING

Objective: To evaluate vegetation success
Frequency: Annual
Status: Pending revegetation
Reports: All vegetation monitoring data will be reported annually. This report will contain a narrative of the actual monitoring methods used, results, and a discussion of the overall success or failure of each area. Raw data sheets will also be included in the annual reports.
Citation: Volume 2, part 4, page 25, Figure 3

VEGETATION MONITORING
FOR PHASE III BOND RELEASE
AT THE LEACH FIELD
FOR THE COTTONWOOD MINE

YEAR TWO

2018

FOR

INTERWEST MINING COMPANY

Prepared by

MT. NEBO SCIENTIFIC, INC.
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Springville, Utah 84663
(801) 489-6937

by
Patrick Collins, Ph.D.

for
INTERWEST MINING COMPANY
a Subsidiary of PacifiCorp
P.O. Box 310
Huntington, Utah 84528

January 2019

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INTRODUCTION

Reasons for the Study

The Leach Field study area, located about 7.5 miles northwest from the town of Orangeville and 1.1 miles south of the Cottonwood Mine in Emery County, Utah (Map A), has been reclaimed long enough that the operator may soon apply for *final* or *Phase III Bond Release*. For this to happen, reclaimed areas must meet specific revegetation success standards. The final bond release process requires at least 10 years of time to pass following final reclamation and revegetation activities at the site. This time-frame is called the *Responsibility Period*. For reclaimed western lands in this precipitation zone, this duration is considered to be enough time for vegetation to become adequately established to be "*diverse, effective, and permanent*" so they can be studied for potential bond release applications. *Phase III Bond Release* is obtained through the State of Utah, Division of Oil, Gas and Mining (DOGM). Because two consecutive years of quantitative data are required for Phase III Bond Release, vegetation sampling was conducted in the growing seasons of 2017 and 2018. That said, **Year 1** sampling was first conducted and reported in 2017. Subsequently, this document contains the **Year 2** results of vegetation sampling that was conducted in 2018. Although a separate report was prepared for Year 1 (*Vegetation Monitoring for Phase III Bond Release at the Leach Field for the Cottonwood Mine: Year One 2017*), some of the data for that year have also been included in this document to facilitate comparisons between years.

METHODS

Methodologies used for sampling were performed in accordance with the *Vegetation Information Guidelines* provided by DOGM.

Transect and Quadrat Placement

Random placement of sample quadrats were designed as an attempt to provide unbiased

accuracy of the data compiled. This was accomplished by establishing several randomly-placed transect lines along the entire length of each study site. Random numbers were generated and used to determine placement from the transect lines. The random numbers selected were high enough to position sample quadrats to the extreme lateral limits of the study areas and low enough to include all areas in-between. This insured that the sample quadrats were placed randomly over the entire study areas.

Cover, Frequency and Composition

Cover estimates were made using ocular methods with meter square quadrats. Species composition and relative frequencies were also assessed from the quadrats. Plant nomenclature follows *A Utah Flora* (Welsh et al. 2008 [(1)]).

Woody Species Density

Woody plant numbers were measured using a distance method called the point-quarter technique. In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. The counts were then summarized and converted into the number of individual woody plants per acre.

Annual Production

Total production was estimated by clipping, drying and weighing current annual growth in sample quadrats. Herbaceous and woody species production samples were recorded separately.

---

[1] Welsh, S.L., N.D. Atwood, S. Goodrich and L.C. Higgins. 2008. A Utah flora. Print Services, Brigham Young University, Provo, UT. 1019 pp.

Sample Size and Adequacy

Sampling adequacy was calculated using the formula given below.

$$nMIN = \frac{t^2 s^2}{(dx)^2}$$

where,

nMIN	= minimum adequate sample
t	= appropriate confidence t-value
s	= standard deviation
x	= sample mean
d	= desired change from mean

Diversity

There are several well-documented methods to assess species diversity in plant communities. The diversity index that was employed to compare the reclaimed and reference areas was *MacArthur's Diversity Index* calculated by the following equation:

$$1/\sum pi^2$$

where,

pi is the proportion of sum frequency contributed by the *i*th species in the sample area of concern.

The proportional contribution of each species is then squared and the values for all species in the sample areas are summed. This index integrates the number of species and the degree to which frequency of occurrence was equitably distributed among those species.

Photographs

Color photographs of the sample areas were taken at the time of sampling and submitted with this report.

RESULTS

Reclaimed Leach Field

The dominant plant species of the reclaimed Leach Field included storksbill (*Erodium cicutarium*), rubber rabbitbrush (*Chrysothamnus nauseosus*), tumbling mustard (*Sisymbrium altissimum*) and Indian ricegrass (*Stipa hymenoides*). For a list of all species encountered in the sample quadrats, refer to Table 1. The total living cover of the site was measured at 53.70% (Table 2A) which consisted of 55.96% forbs, 33.59% shrubs and 10.46% grasses (Table 2B).

The total number of woody plants per acre was 1,440, comprised mostly of rubber rabbitbrush, but also had a fair representation of broom snakeweed (*Gutierrezia sarothrae*). Refer to Table 3 to see the results. Total annual production of the site was measured at 836.41 pounds per acre and was comprised of 599.75 pounds of woody plants and 276.66 pounds of herbaceous plants (Table 4).

Reference Area

The Cottonwood Mine site has two Pinyon-Juniper Reference Areas that were chosen previously to represent revegetation success standards for different reclaimed areas. The reference area that is nearest the reclaimed Leach Field and most representative of the land prior to disturbance is located adjacent to the reclaimed Old Waste Rock Site (Map A). Sample results show that the dominant species for this reference area included pinyon pine (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*), Mormon tea (*Ephedra viridis*) and alder-leaf mountain-mahogany (*Cercocarpus montanus*). Refer to Table 5 to see all species encountered in the sample quadrats. The total living cover was estimated at 30.30%, 10.40% was from overstory and 19.90% was from understory cover (Table 6A). Understory composition in the sample quadrats was comprised of only woody species (Table 6B).

The total number of woody plants for the reference area was 840 individuals per acre, most of which were pinyon pine, Utah juniper and Mormon tea (Table 7). Annual production here was estimated at a total of 409.05 pounds per acre, which nearly all came from woody plant species (Table 8).

Dataset Comparisons

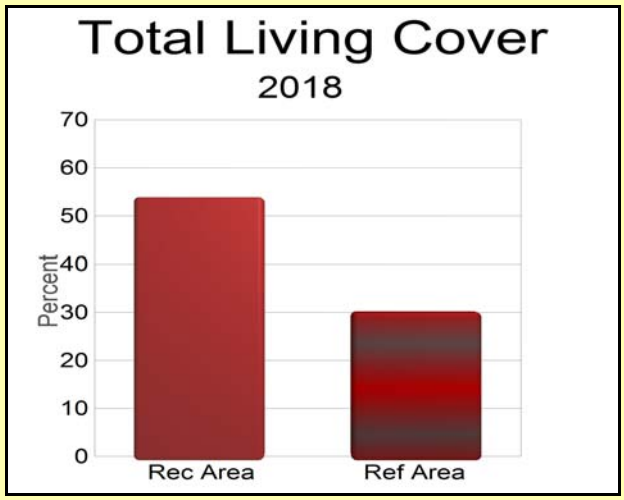
Total Living Cover

When the total living cover of the reclaimed Leach Field was compared statistically with the Pinyon-Juniper Reference Area by employing a Student's t-test, the cover was significantly different – the cover of the reference area, that included both overstory and understory cover combined, was significantly lower than the reclaimed area (Fig. 1).

FIG. 1. STUDENT'S T-TEST - A Total Living Cover Comparison Between the Reclaimed and Reference Areas (2018).

Leach Field Area
Reclaimed Area: $\bar{x}$=53.70; s=15.77; n=50
Reference Area: $\bar{x}$=30.30; s=8.57; n=50
t =9.2189 df =98 ; SL= p<0.001

```
x̄= sample mean,
s = sample standard deviation,
n = sample size,
NS = non-significant,
t = Student's t-value,
df = degrees of freedom,
SL = significance level,
p = probability level
```



Woody Species Density

When the total woody species density of the reference area was compared to the reclaimed area, the later was greater

and the difference was again statistically significant using the same test as mentioned above (Fig. 2).

FIG. 2. STUDENT'S T-TEST - A Woody Species Density Comparison Between the Reclaimed and Reference Areas (2018).

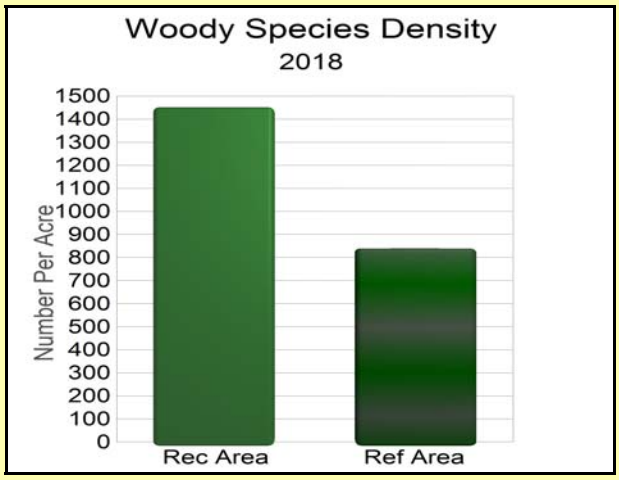
Leach Field Area

Reclaimed Area: $\bar{x}$=1440.31; s=889.23; n=50

Reference Area: $\bar{x}$=839.57; s=258.53; n=50

t =4.5897 df =98 ; SL=p<0.001

```
x̄= sample mean,
s = sample standard deviation,
n = sample size,
NS = non-significant,
t = Student's t-value,
df = degrees of freedom,
SL = significance level,
p = probability level
```



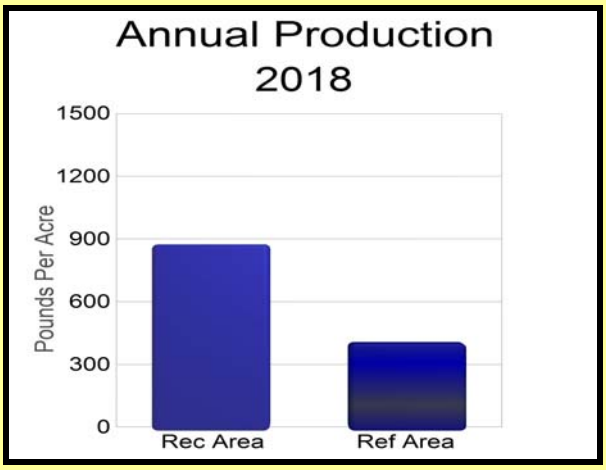
Annual Production

Total annual production of the Leach Field was also greater in the reclaimed area compared to the reference area and this difference was once again statistically significant (Fig. 3).

FIG. 3. STUDENT'S T-TEST - A Total Annual Production Comparison Between the Reclaimed and Reference Areas (2018).

Leach Field Area
Reclaimed Area: $\bar{x}$=836.41; s=419.28; n=50
Reference Area: $\bar{x}$=409.05; s=198.89; n=50
t =6.5118 df =98 ; SL= p<0.001

```
x̄= sample mean,
s = sample standard deviation,
n = sample size,
NS = non-significant,
t = Student's t-value,
df = degrees of freedom,
SL = significance level,
p = probability level
```



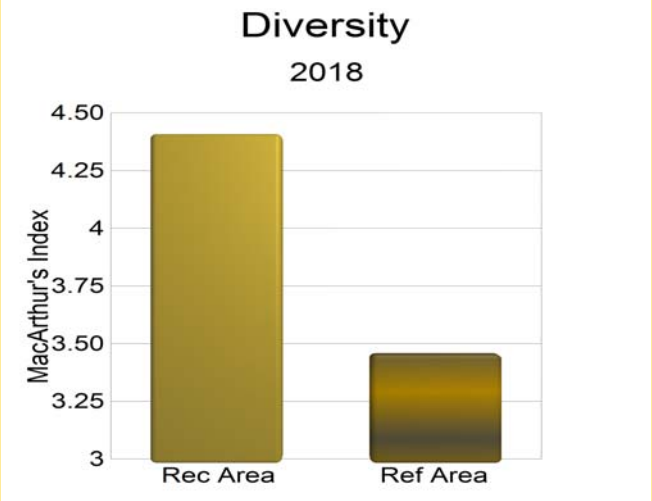
Diversity

Diversity of the two areas was also compared and was greater in reclaimed Leach Field compared to the Pinyon-Juniper Reference Area (Fig. 4).

FIG. 4. MacARTHUR'S INDEX - A Comparison Between the Selected Reclaimed and Reference Areas.

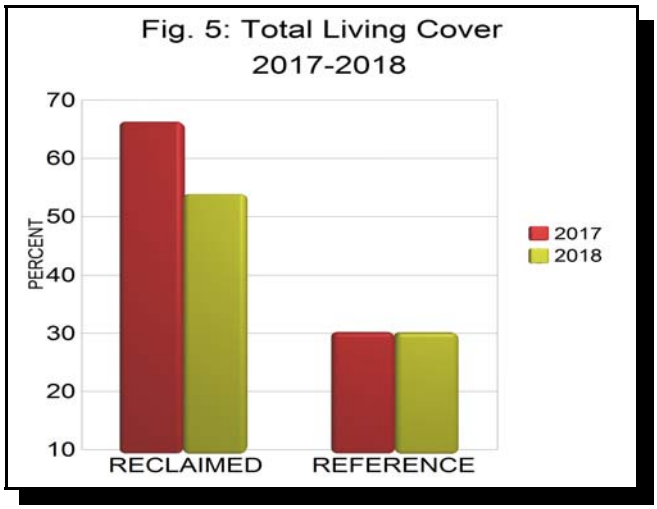
$$1/\sum pi^2 =$$

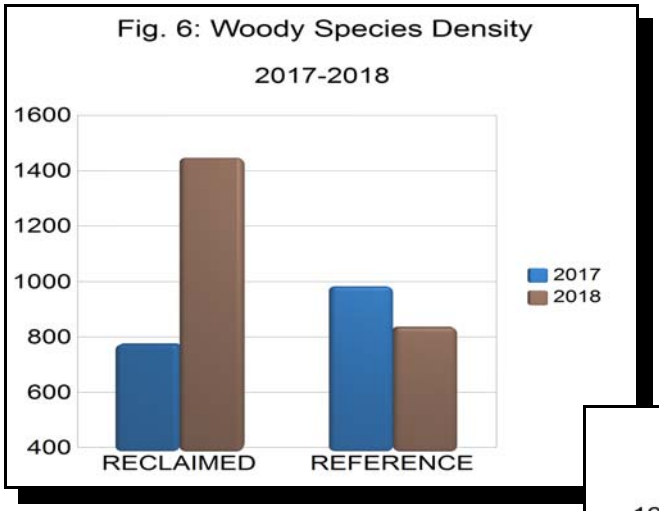
Leach Field Area
Reclaimed Area: 4.399
Reference Area: 3.461

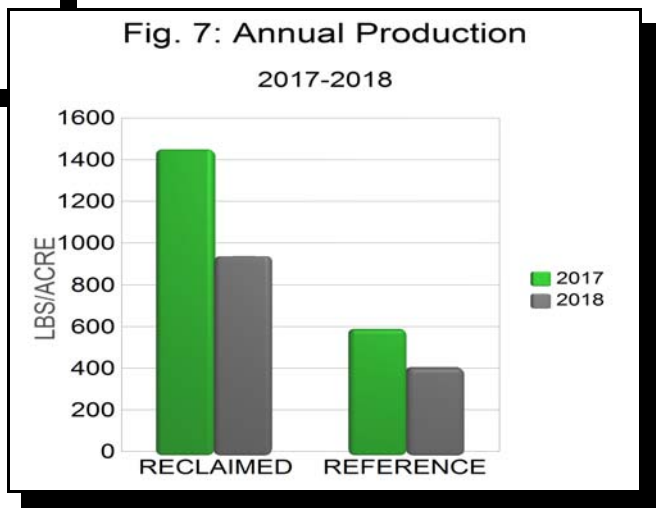


Comparisons Between Sample Years

This report provides the results from quantitative sampling the vegetation of the reclaimed Leach Field located near the Cottonwood Mine in 2018 ten years after reclamation and revegetation operations were performed at the site. The same sites were also sampled in 2017 and as mentioned, a report was submitted showing those results. Even though a separate report was submitted for the 2017 sample period, some of the results for that year have been included in the graphs below to facilitate comparison with the 2018 sample year for total living cover (Fig. 5), woody species density (Fig. 6) and total annual production (Fig. 7).







SUMMARY & DISCUSSION

In 2017 and 2018, quantitative sampling was conducted at the reclaimed Cottonwood Mine Leach Field and Pinyon-Juniper Reference Area to complete the required two consecutive sample years necessary for final bond release. Comparisons between the datasets for the restored vegetation and the area chosen to represent final revegetation success standards, the reference area, were made and presented in this report. When **total living cover** of the two areas were compared, the reclaimed area was greater, the difference being statistically significant. Next, the **woody species densities** of the datasets were compared – the results were similar - the reclaimed area had significantly more individual plants per acre. The **annual production** was also greater in the reclaimed area when compared to the reference area. Finally, the **diversity** of the reclaimed area was compared to the reference area using MacArthur's Index and the reclaimed area also had greater species diversity.

Even though a subset of data recorded in 2017 (Year 1) have also been presented herein, another complete report was submitted previously for that sample year. This report was called: *Vegetation Monitoring for Phase III Bond Release at the Leach Field for the Cottonwood Mine, Year One, 2017*.

One remark mentioned in the report for the 2017 dataset was that there was *a notable component in the vegetative cover of the reclaimed Leach Field – most of the forbs present were "weedy"or exotic species*. This was also the case for the 2018 dataset. When this fact was discussed with a biologist from DOGM with the question as to whether the bond release sampling should continue for the second consecutive year because of the "weedy" species present, the following statement was made in an email dated March 2, 2018 from Joe Helfrich (DOGM) to Dennis Oakley (InterWest Mining Company):

> "*I spoke with Pat Collins yesterday, 3/1/18, and several weeks earlier at his office with Todd Miller regarding 1st year vegetation results for the CTW leach field. I also spoke with Priscilla Burton in that regard. The species composition data indicated that there were several weedy species present at the reclaimed leach field site. Since they currently do not pose a threat to the overall success (phase III bond release) of the other species, the Division is recommending the reclaimed leach field be left as is for the second consecutive year of quantitative sampling*".

With the above results and considerations in mind, sample datasets from Year 1 *(2017) and* Year 2 (2018) suggest that when applicable parameters of the reclaimed Leach Field and Pinyon-Juniper Reference Area were compared, the reclaimed area has met or exceeded the requirements necessary for Phase III or Final Bond Release.

DATA SUMMARY TABLES

Table 1: Cottonwood Mine. Total cover, standard deviation and frequency by species (2018).

Reclaimed Leach Field n=50

	Mean Percent	Standard Deviation	Percent Frequency
SHRUBS			
Artemisia nova	0.80	3.92	4.00
Artemisia tridentata	1.50	10.50	2.00
Chrysothamnus nauseosus	13.50	14.40	60.00
Gutierrezia sarothrae	3.10	9.05	18.00
FORBS			
Cryptantha flava	0.40	1.96	4.00
Erodium cicutarium	21.80	18.02	70.00
Sisymbrium altissimum	7.00	15.49	32.00
GRASSES			
Bromus tectorum	1.00	7.00	2.00
Hordeum jubatum	0.20	1.40	2.00
Stipa hymenoides	4.40	11.43	18.00

Table 2: Cottonwood Mine. Total Cover and composition (2018).

Reclaimed Leach Field n=50

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Understory	53.70	15.77
Litter	18.04	10.23
Bareground	12.20	7.74
Rock	16.06	11.36
B. COMPOSITION		
Shrubs	33.59	27.69
Forbs	55.96	33.50
Grasses	10.46	24.73

Table 3: Cottonwood Mine. Woody Species Density (2018).

Reclaimed Leach Field

(n=50)

SPECIES	Number/Acre
Artemisia nova	21.60
Artemisia tridentata	21.60
Chrysothamnus nauseosus	1152.24
Gutierrezia sarothrae	244.85
TOTAL	**1440.31**

Table 4: Cottonwood Mine.
Annual Production (2018).
Reclaimed Leach Field

(n=50; double sampling n=200)

Pounds/Acre **LIFEFORM**	**MEAN**	**STD. DEV.**
Herbaceous	276.66	374.60
Woody	599.75	552.14
TOTAL	**836.41**	**419.28**

Table 5: Cottonwood Mine. Total cover, standard deviation and frequency by species (2018).

Pinyon-Juniper Reference Area
(Located near the Old Waste Rock Site) n=50

	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
Juniperus osteosperma	5.50	11.28	20.00
Pinus edulis	4.90	9.87	22.00
UNDERSTORY			
TREES & SHRUBS			
Cercocarpus montanus	4.00	9.64	16.00
Ephedra viridis	5.40	10.67	22.00
Juniperus osteosperma	2.60	5.77	24.00
Opuntia polyacantha	0.20	1.40	2.00
Pinus edulis	7.70	10.83	48.00
FORBS			
GRASSES			

Table 6: Cottonwood Mine. Total Cover and composition (2018).

Pinyon-Juniper Reference Area
(Located near the Old Waste Rock Site) n=50

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Overstory (O)	10.40	13.07
Understory (U)	19.90	11.34
Litter	27.80	17.27
Bareground	27.80	18.71
Rock	24.50	18.15
O + U	30.30	8.57
B. COMPOSITION		
Trees & Shrubs	100.00	0.00
Forbs	0.00	0.00
Grasses	0.00	0.00

Table 7: Cottonwood Mine. Woody Species Density (2018).

Pinyon-Juniper Reference Area

(n=50)

SPECIES	Number/Acre
Cercocarpus montanus	79.76
Ephedra viridis	235.08
Juniperus osteosperma	209.89
Opuntia polyacantha	8.40
Pinus edulis	306.44
TOTAL	**839.57**

Table 8: Cottonwood Mine. Annual Production (2018).

Pinyon-Juniper Reference Area

(Located near the Old Waste Rock Site)

(n=50)

Pounds/Acre LIFEFORM	MEAN	STD. DEV.
Herbaceous	9.28	46.71
Woody	399.77	211.65
TOTAL	**409.05**	**198.89**

COLOR PHOTOGRAPHS OF THE SAMPLE AREAS

Photo 1: Reclaimed Leach Field

Photo 2: Reclaimed Leach Field

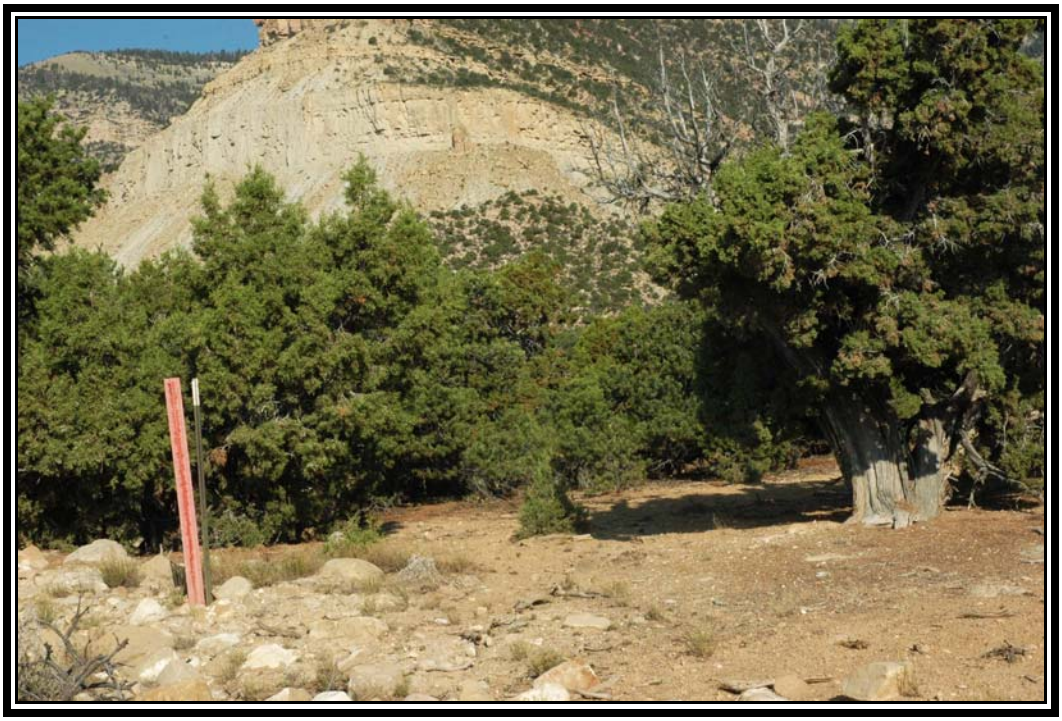
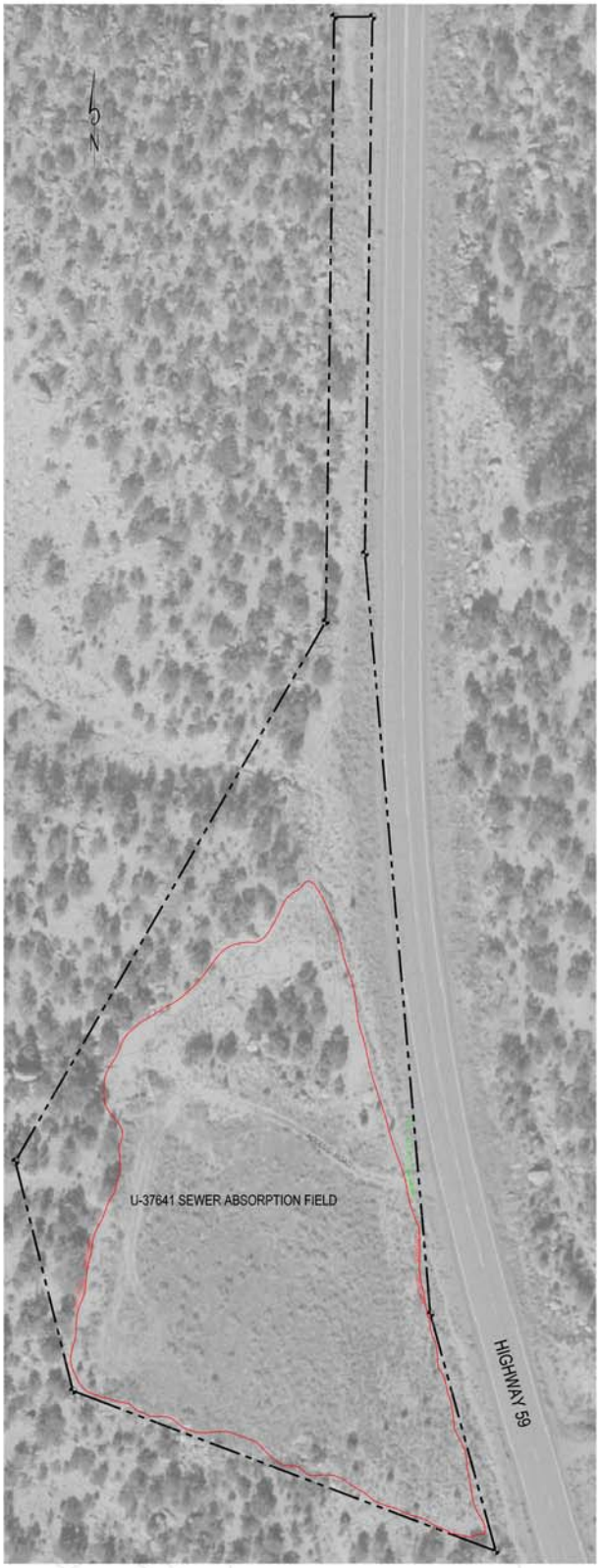
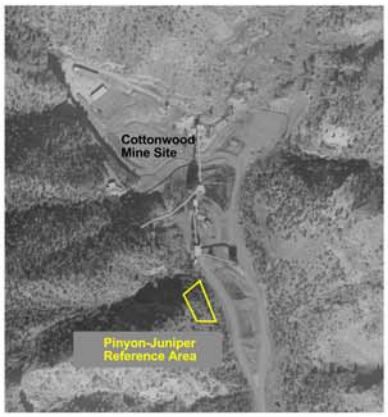


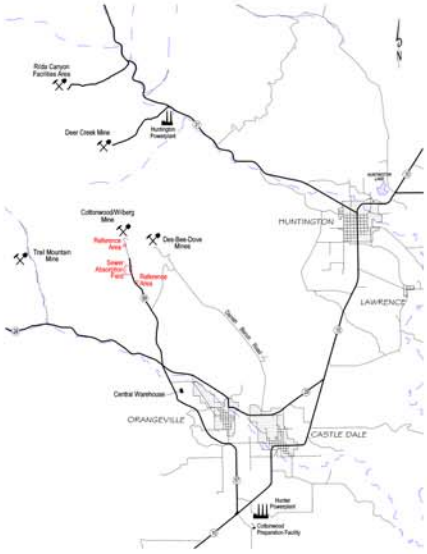
Photo 3: Pinyon-Juniper Reference Area

Photo 4: Pinyon-Juniper Reference Area



PLAN OF MAIN ABSORPTION FIELD





GENERAL LOCATION MAP
Not to Scale

PACIFICORP

COTTONWOOD/WILBERG MINE
MAIN ABSORPTION FIELD

DRAWN BY:	K. LARSEN	MAP A
SCALE:	1" = 40'	
DATE:	AUGUST 7, 2017	SHEET 1 OF 1 REV.

Revised by: P. COLLINS
Date: December 20, 2017

VEGETATION MONITORING
AT THE
TRAIL MOUNTAIN RECLAIMED
ACCESS & BELT PORTAL AREA
OF THE COTTONWOOD MINE

YEAR FOUR

2018

FOR
INTERWEST MINING COMPANY

Old Johnson Mine Office Building in Cottonwood Canyon

Prepared by

MT. NEBO SCIENTIFIC, INC.
330 East 400 South, Suite 6
P.O. Box 337
Springville, Utah 84663

by
Patrick Collins, Ph.D.

for
INTERWEST MINING COMPANY
a Subsidiary of PacifiCorp
P.O. Box 310
Huntington, Utah 84528

January 2019

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INTRODUCTION

The **reclaimed** Trail Mountain Access and Belt Portal Area for the Cottonwood Mine is located in Cottonwood Canyon approximately 12 miles northwest of the town of Orangeville, Utah. In 2018 the site reached its 4th year of the *Responsibility Period*. The Responsibility Period is the 10-year time-frame required before the mine operator is eligible to apply for *final* or *Phase III Bond Release*. For reclaimed western lands in this precipitation zone, this duration is considered to be enough time for vegetation to become adequately established and as state regulations say, to be "*diverse, effective, and permanent*". This is also when the areas can be studied for potential bond release applications. Phase III Bond Release is obtained through the State of Utah, Division of Oil, Gas & Mining (DOGM). Monitoring the restored vegetation during the 4th year following reclamation activities is often important because state regulations require that "*at the time of bond release, (such) trees and shrubs will be healthy, and at least 80 percent will have been in place for at least 60 percent of the applicable minimum period of responsibility*" (State Rule: R645-301-356.232).

A **reference area** to be used as standards for final revegetation success of the reclaimed site was chosen previously. The Pinyon-Juniper Reference Area, located near the reclaimed site, is an undisturbed plant community chosen for its similarities to the restored site prior to being disturbed by coal mining activities.

The reclaimed and reference areas were sampled in 2018 to monitor the status of the restored vegetation as well as to make initial comparisons between them. Results from quantitatively sampling both areas are provided in this report. An Interwest Mining Company base map has been included that shows the 2018 sample areas (MAP A).

METHODS

Methodologies used for sampling were performed in accordance with the *Vegetation Information Guidelines* provided by DOGM.

Transect and Quadrat Placement

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Cover estimates were made using ocular methods with meter square quadrats. Species composition and relative frequencies were also assessed from the quadrats. Plant nomenclature follows *A Utah Flora* (Welsh et al. 2008 [(1)]).

Woody Species Density

Woody plant numbers were measured using a distance method called the point-quarter technique. In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. The counts were then summarized and converted into the number of individual woody plants per acre.

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Diversity

There are several well-documented methods to assess species diversity in plant communities. The diversity index that was employed to compare the reclaimed and reference areas was *MacArthur's Diversity Index* calculated by the following equation:

$$1/\sum pi^2$$

where,

pi is the proportion of sum frequency contributed by the *i*th species in the sample area of concern.

The proportional contribution of each species is then squared and the values for all species in the sample areas are summed. This index integrates the number of species and the degree to which frequency of occurrence was equitably distributed among those species.

Photographs

Color photographs of the sample areas were taken at the time of sampling and submitted with this report.

RESULTS

Reclaimed Area

As shown by the cover and frequency values in Table 1, the reclaimed Trail Mountain Belt Portal and Access Area of the Cottonwood Mine was dominated by fourwing salt bush (*Atriplex canescens*), Great Basin wildrye (*Elymus cinereus*), bluebunch wheatgrass (*E. spicatum*) and western wheatgrass (*E. smithii*).

The total living cover of the site was estimated at 54.37% (Table 2-A) and was comprised of 44.82% grasses, 41.16% shrubs and 14.03% forbs (Table 2-B). The total number of woody plants per acre was measured at 2,718, most of which was fourwing saltbush, rubber rabbitbrush (*Chrysothamnus nauseosus*), big sagebrush (*Artemisia tridentata*) and black sagebrush (*A. nova*). The woody species density values are shown on Table 3. Color photographs of this sample area are shown in Photos 1 through 3.

Reference Area

The Pinyon-Juniper Reference Area chosen to be compared to the reclaimed area was dominated by Salina wildrye (*Elymus salinus*), Mormon tea (*Ephedra viridis*) and pinyon pine (*Pinus edulis*). For a list of all species encountered in the sample quadrats by their cover and frequency values, refer to Table 4.

The total living cover of the reference area was estimated at 34.35%, 28.35% coming from understory and 6.00% from overstory cover (Table 5-A). Lifeform composition of the understory cover was comprised of 61.85% grasses, 37.32% woody plants and less than 1% (0.83%) forbs (Table 5-B). Total woody species density was measured at 944 individuals per acre and dominated by pinyon pine, Mormon tea and rubber rabbitbrush (Table 6). Photographs of this sample area are shown in Photos 4 through 6.

DISCUSSION

When the total living cover of the reclaimed Trail Mountain Access and Belt Portal was compared to the nearby Pinyon-Juniper Reference Area, the former was appreciably greater (Figure 1).

Similarly the woody species density in the reclaimed area was much greater than the reference area (Figure 2).

Finally, the reclaimed area had greater species diversity than the reference area (Figure 3).

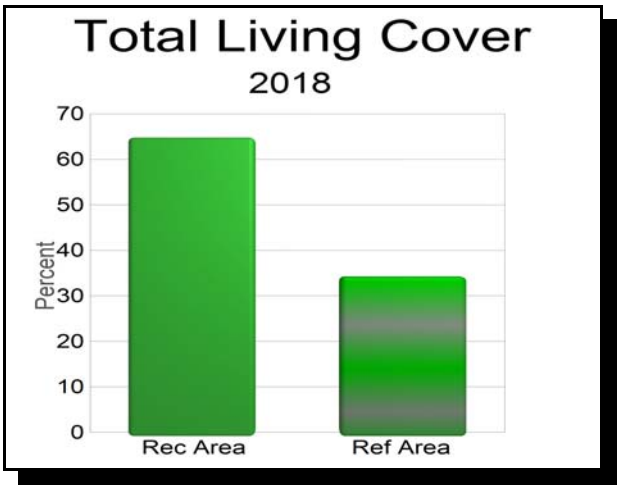


Figure 1

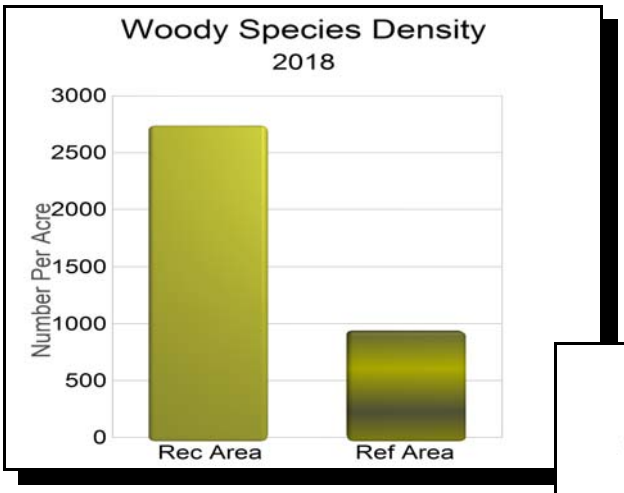


Figure 2

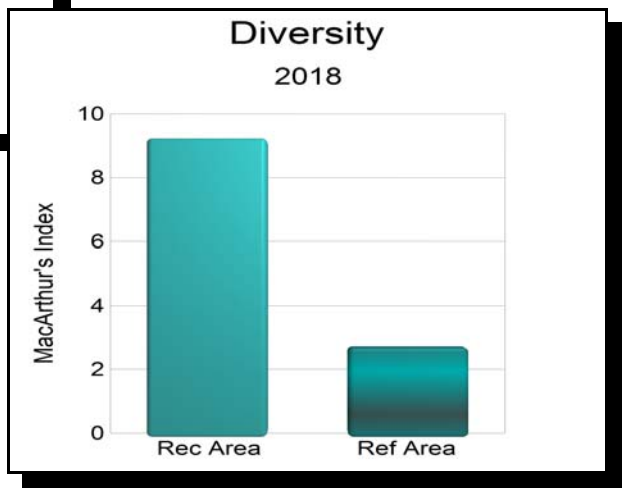


Figure 3

Another attribute of the reclaimed area worth noting is the fact that the species present in the quadrats were comprised of desirable perennial plants and not "weedy" exotics that are often common on recently reclaimed lands.

In summary, when the reclaimed Trail Mountain Access and Belt Portal Area of the Cottonwood Mine was compared with the plant community chosen to represent future revegetation success standards, or the Pinyon-Juniper Reference Area, the reclaimed site has progressed well enough to meet the state regulations required for the 4th year of the Responsibility Period. In other words, at least 80% of the woody plants necessary to meet the revegetation success standards will be in-place for 60% (final 6 years) of the Responsibility Period if they persist for the remainder of that time. The reclaimed site is expected to persist and improve over time and provide a good chance to meet revegetation success standards for Phase III Bond Release.

Summary Tables

Table 1: Reclaimed Trail Mountain Access and Belt Portal Area of the Cottonwood Mine. Total Cover, Standard Deviation and Frequency by Species (2018).

	Mean Percent	Standard Deviation	Percent Frequency
SHRUBS			
Artemisia nova	1.00	3.00	10.00
Artemisia tridentata	1.33	3.14	16.67
Atriplex canescens	17.33	20.60	53.33
Atriplex confertifolia	1.33	6.32	6.67
Chrysothamnus nauseosus	4.17	12.59	16.67
FORBS			
Aster foliaceus	4.20	8.16	33.33
Hedysarum boreale	0.33	1.80	3.33
Linum lewisii	0.50	1.50	10.00
Penstemon palmeri	0.67	2.49	6.67
GRASSES			
Bromus tectorum	0.17	0.90	3.33
Elymus cinereus	7.17	11.16	50.00
Elymus lanceolatus	2.83	4.78	33.33
Elymus smithii	5.83	8.95	50.00
Elymus spicatum	6.67	12.41	30.00
Stipa hymenoides	0.83	3.18	6.67

Table 2: Reclaimed Trail Mountain Access and Belt Portal Area of the Cottonwood Mine. Total Cover and Composition (2018)

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Total Living Cover	54.37	18.73
Litter	7.70	3.01
Bareground	19.73	12.87
Rock	18.20	9.22
B. COMPOSITION		
Shrubs	41.16	28.02
Forbs	14.03	20.72
Grasses	44.82	22.23

Table 3: Reclaimed Trail Mountain Access and Belt Portal Area of the Cottonwood Mine. Woody Species Density (2018).

SPECIES	Number/Acre
Artemisia nova	158.54
Artemisia tridentata	249.14
Atriplex canescens	1676.04
Atriplex confertifolia	22.65
Brickellia longifolia	90.60
Chrysothamnus nauseosus	498.28
Gutierrezia sarothrae	22.65
TOTAL	**2717.91**

Table 4: Trail Mountain Pinyon-Juniper Reference Area. Total Cover, Standard Deviation and Frequency by Species (2018).

	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
Pinus edulis	3.75	7.56	30.00
Juniperus osteosperma	1.25	5.45	5.00
Pseudotsuga menziesii	1.00	4.36	5.00
UNDERSTORY			
TREES & SHRUBS			
Atriplex confertifolia	1.50	6.54	5.00
Chrysothamnus nauseosus	1.25	5.45	5.00
Ephedra viridis	5.75	10.87	25.00
Juniperus osteosperma	0.75	3.27	5.00
Pinus edulis	1.25	3.49	15.00
FORBS			
Stanleya pinnata	0.25	1.09	5.00
GRASSES			
Elymus salinus	16.10	14.12	85.00
Stipa hymenoides	1.50	6.54	5.00

Table 5: Trail Mountain Pinyon-Juniper Reference Area. Total Cover and Composition (2018)

	Mean Percent	Standard Deviation
A. TOTAL COVER		
Overstory (O)	6.00	9.30
Understory (U)	28.35	10.43
Litter	20.65	16.81
Bareground	11.00	5.15
Rock	40.00	14.14
O + U	34.35	6.33
B. COMPOSITION		
Trees/Shrubs	37.32	38.25
Forbs	0.83	3.63
Grasses	61.85	38.69

Table 6: Trail Mountain Pinyon-Juniper Reference Area. Woody Species Density (2018).

SPECIES	**Number/Acre**
Abies concolor	11.80
Amelanchier utahensis	59.01
Atriplex confertifolia	23.60
Chrysothamnus nauseosus	141.62
Ephedra viridis	271.44
Gutierrezia sarothrae	47.21
Juniperus osteosperma	47.21
Pinus edulis	318.65
Pseudotsuga menziesii	23.60
TOTAL	**944.13**

Photo 1: Reclaimed Area

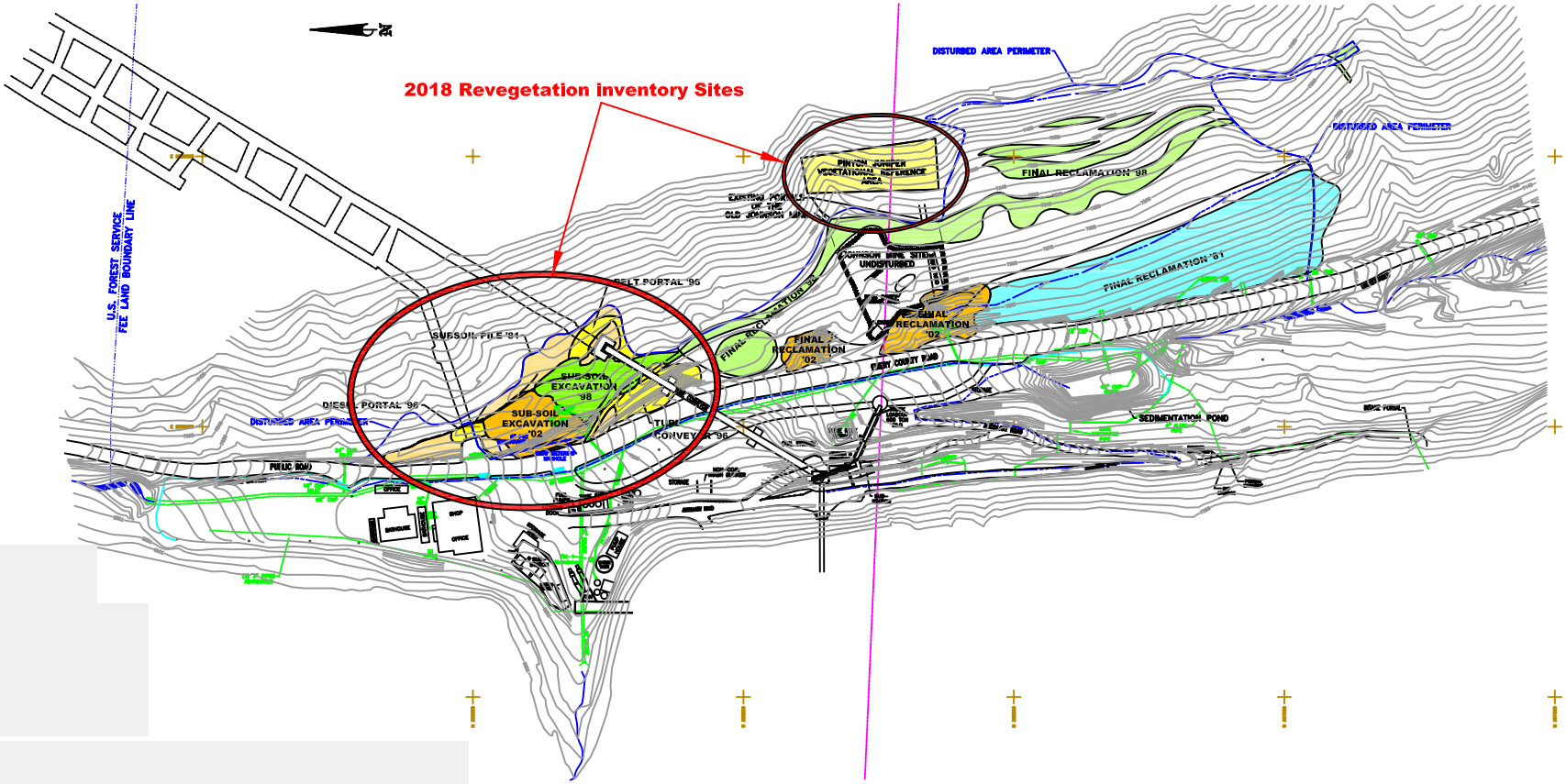
Photo 2: Reclaimed Area

Photo 3: Reclaimed Area

Photo 4: Reference Area

Photo 5: Reference Area

Photo 6: Reference Area



Revegetation Monitoring Sites
2018
MT. NEBO SCIENTIFIC, INC.
Springville, UT

ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

MAP A