STATE OF NEW MEXICO
WATER QUALITY CONTROL COMMISSION

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WQCC

IN THE MATTER OF THE PETITION FOR A VARIANCE TO APPROVE ALTERNATIVE ABATEMENT STANDARDS FOR THE PECOS MINE OPERABLE UNIT

No. WQCC 18-03 (V)

Cyprus Amax Minerals Company,
Petitioner

PETITION FOR A VARIANCE TO APPROVE ALTERNATIVE ABATEMENT STANDARDS

Cyprus Amax Minerals Company ("CAMC") petitions the Water Quality Control Commission ("Commission") to approve Alternative Abatement Standards ("AAS") for the Pecos Mine Operable Unit ("PMOU"), also commonly known as the Terrero Mine, near Terrero, New Mexico in San Miguel County. The enclosed Petition for Alternative Abatement Standards prepared by Daniel B. Stephens & Associates, Inc. ("Petition") contains the information required by 20.6.2.1210.A and 20.6.2.4103.F NMAC.

1. The PMOU is the subject of an Administrative Order on Consent ("AOC") entered into on December 2, 1992 with the New Mexico Environment Department ("Department") by Amax Resource Conservation Company, a predecessor of CAMC, and the State of New Mexico, as Respondents. The State of New Mexico is a Respondent because the New Mexico Department of Game and Fish ("NMDGF") owns the subject property. The Department is responsible for enforcement of the AOC and oversight of the work conducted thereunder.

2. Under the AOC, CAMC was responsible for conducting a Remedial Investigation ("RI") and Feasibility Study ("FS") to assess the extent of groundwater and surface water contamination and the actions to be taken to remediate the PMOU. The RI and FS were

submitted to the Department for review. Based upon the RI/FS and public comments, the Department issued a Decision Document in 1998 specifying the required remediation and abatement. Copies of the Decision Document and the Feasibility Study are provided as appendices to the Petition.

3. CAMC implemented construction of the remedy, including abatement to achieve applicable water quality standards as required under the Decision Document, between 1999 and 2004. The Department has reviewed and approved the completion of that work, and the CAMC has continued to monitor the PMOU as required by the AOC. Monitoring has demonstrated that applicable water quality standards have been met at all but a few monitoring locations.

4. CAMC petitions the Commission to approve AAS within the area defined in the enclosed Petition (Figure 2) to a depth of 1,900 feet below ground surface for barium, cadmium, and fluoride, constituents for which ground water quality standards are established under 20.6.2.3103.A NMAC; iron, manganese, total dissolved solids, and zinc, constituents for which ground water quality standards are established under 20.6.2.3103.B NMAC; and cobalt, for a ground water quality standards is established under 20.6.2.3103.C NMAC.

5. The proposed AAS for the above constituents are set forth in the following table, as further discussed and described in the attached Petition:

CONSTITUENT	STANDARD UNDER 20.6.2.3103 NMAC	PROPOSED ALTERNATIVE ABATEMENT STANDARD
BARIUM	1.0 MG/L	4.0 MG/L
CADMIUM	0.01 MG/L	0.10 MG/L
COBALT	0.05 MG/L	0.10 MG/L
FLUORIDE	1.6 MG/L	2.0 MG/L
IRON	1.0 MG/L	40.0 MG/L
MANGANESE	0.2 MG/L	8.0 MG/L
TOTAL DISSOLVED SOLIDS	1,000 MG/L	1,700 MG/L
ZINC	10 MG/L	40 MG/L

6. This Petition is with the Commission pursuant to 20.6.2.1210.A NMAC. In addition, pursuant to 20.1.3.18.A NMAC. A copy of this petition is being served on the Department through counsel to accomplish filing with the Secretary under 20.6.2.4103(F)(2) and for its review and issuance of its recommendation pursuant to 20.1.3.18.A(3) NMAC. CAMC has shared drafts of this Petition with the Department for its review in advance of this filing, and requests that the Department issue its recommendation as soon as possible.

7. The Game & Fish Department ("NMGDF") has concurred with the filing of the Petition. A copy of the Petition also is being served on NMGDF.

8. If the Commission grants the Petition, CAMC and the Department intend to request that the State Engineer issue an Order restricting the construction of wells within the area covered by AAS in order to assure that compliance with the proposed AAS will not create a present or future has to public health. CAMC, the Department, and NMGDF have consulted with the State Engineer and understand that he is willing to issue such an Order following the Commission's action on the Petition.

9. CAMC respectfully requests that the Commission set a date for a public hearing on the enclosed Petition at its earliest convenience.

Respectfully Submitted,

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CERTIFICATE OF SERVICE

I certify that a copy of the foregoing Petition for a Variance to Approve Alternative Abatement Standards was served on April 27, 2018 via hand delivery to the following:

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Office of General Counsel
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Lara.katz@state.nm.us

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1 Wildlife Way
P.O. Box 25112
Santa Fe, New Mexico 87504
Matthew.Wunder@state.nm.us

Respectfully Submitted,

Dalva L. Moellenberg, Esq.

Petition for
Alternative Abatement Standards

Pecos Mine Operable Unit
San Miguel County, New Mexico

Prepared for **Cyprus Amax Minerals Company**
Phoenix, Arizona

April 12, 2018

Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109

Petition for
Alternative Abatement Standards

Pecos Mine Operable Unit
San Miguel County, New Mexico

April 12, 2018

T. Neil Blandford, P.G.
Senior Vice President/
Principal Hydrologist

Beth Salvas
Senior Hydrologist

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Appendix

1. Introduction

On behalf of Cyprus Amax Minerals Corporation (CAMC), Daniel B. Stephens & Associates, Inc. (DBS&A) has prepared this petition for alternative abatement standards in accordance with the New Mexico Water Quality Control Commission (NMWQCC) Abatement Regulations, particularly 20.6.2.1210 NMAC and Subsection F of 20.6.2.4103 NMAC, for eight constituents that exceed NMWQCC standards in certain areas at the Pecos Mine Operable Unit (PMOU) near Tererro, New Mexico (Figure 1).

In the mid-1980s, a study conducted by the New Mexico Environment Department (NMED) Surface Water Quality Bureau found elevated metals concentrations in springs and other surface water features discharging from around the Pecos Mine area. Subsequent investigations identified that mine waste was also used as early as the 1930s through the 1970s to develop and maintain roads and campgrounds at various locations in the greater Pecos area (Stoller, 1996). In 1992, an Administrative Order on Consent (AOC) was signed, requiring investigation and remediation consistent with the requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as Superfund. The AOC defined five operable units (OUs) within the greater Pecos area:

- Pecos Mine (PMOU)
- El Molino (EMOU)
- State Recreation Use Areas
- State Highway 63
- Lisboa Springs Fish Hatchery

This petition for alternative abatement standards is requested for the PMOU only. As shown on Figure 1, the New Mexico Department of Game and Fish (NMDGF) Willow Creek Campground (NMDGF campground), which was part of the greater Pecos Mine during active operations in the 1930s, is adjacent to PMOU. The campground is located within the Jamie Koch Recreation Area and is one of several NMDGF properties included within the State Recreation Use Areas Operable Unit. Due to the campground's close proximity to PMOU, available records and data for the NMDGF campground are included in this petition.

1.1 PMOU Background

The PMOU consists of a reclaimed historical mining site. Several environmental investigations of the PMOU site were conducted during the 1980s and 1990s. These investigations included a remedial investigation (RI) completed in 1996, a feasibility study (FS) completed in 1997, and a final Decision Document (DD) issued by NMED in 1998, which approved the RI and the FS. The RI required, among other things, characterization of the PMOU, including the extent of groundwater and surface water contamination. The RI is functionally equivalent to and meets the requirements of a Stage 1 Abatement Plan as described in the NMWQCC Abatement Regulations, specifically Subsection C of 20.6.2.4106 NMAC. According to the RI, the primary source of the contaminants was the exposed waste rock piles, which contain multiple metals and acid-generating minerals. The RI indicated that infiltration of precipitation through, and runoff from, the waste rock piles was the primary mechanism for transport of contaminants to downgradient soils, sediments, surface water, and groundwater (Stoller, 1996).

The FS (prepared by CAMC) and the DD (issued by NMED) are functionally equivalent to and serve the same purpose as a Stage 2 Abatement Plan, as described in Subsection D of 20.6.2.4106 NMAC. The DD presents the remedy approved by NMED for the PMOU determined based on the RI, the FS, and public comment. The selected remedy was implemented by CAMC between 1999 and 2004. NMED has reviewed and approved the satisfactory completion of the reclamation and remediation work required under the AOC and DD. The reclamation and remediation measures are functioning as intended.

Monitoring of groundwater and surface water, along with other activities required by the DD, have been conducted since completion of the PMOU remediation. Current groundwater and surface water compliance monitoring locations and analytes are based on the PMOU compliance monitoring plan (CMP) (DBS&A, 2007) approved by the NMED on August 29, 2007, and NMED's approval of three subsequent requests to remove some sampling locations and constituents and to reduce sampling frequency (NMED, 2010, 2013b, and 2016).

CAMC has prepared and submitted a long-term operation and maintenance plan as contemplated under the AOC for the PMOU site, including a schedule for future monitoring and maintenance of the remedy. NMED is currently reviewing the plan.

1.2 Request for Alternative Abatement Standards

Although the work required for the PMOU site under the AOC has been completed and the remedies are functioning as intended, some groundwater monitoring locations continue to exceed the standards of 20.6.2.3103 NMAC for certain constituents. Through preparation of this document, CAMC is presenting a demonstration that it is technically infeasible to achieve the standards of 20.6.2.3103 NMAC, which are the abatement standards under 20.6.2.4103 NMAC, for those constituents. Consequently, for the remaining groundwater sampling locations where groundwater quality standards in 20.6.2.3103 NMAC are exceeded, CAMC requests that the NMWQCC approve alternative abatement standards under Subsection F of 20.6.2.4103 NMAC.

Section 2 presents the alternative abatement standard petition information as required by Subsection F of 20.6.2.4103 NMAC. Section 3 provides background information on the site, including a summary of the site history, previous investigations, and reclamation. Section 4 describes the site hydrogeology and includes an overview of the post-reclamation groundwater monitoring results and current groundwater quality. Section 5 provides additional detail on the requested alternative abatement standards. A summary and conclusions are provided in Section 6.

2. Information Required for Alternative Abatement Standards

The requirements for a petition for alternative abatement standards are listed in Subsection F of 20.6.2.4103 NMAC. As listed in this section, the specific requirements are found in Subsection A of 20.6.2.1210 NMAC and Subsections F.1 and F.2 of 20.6.2.4103 NMAC. The items required by each of these three sections of the NMWQCC regulations specific to alternative abatement standard petitions are provided in the following three subsections for PMOU.

2.1 Information Required by Subsection A of 20.6.2.1210 NMAC

In accordance with Subsection F.2 of 20.6.2.4103 NMAC, the following information is required by Subsection A of 20.6.2.1210 NMAC.

1. Petitioner's name and address

Cyprus Amax Minerals Company
333 N. Central Avenue
Phoenix, AZ 85004

2. Date of the petition

April 12, 2018

3. Description of the facility or activity for which the variance is sought

The facility for which the variance is sought is the PMOU, located in San Miguel County, New Mexico. The PMOU facility consists of a reclaimed waste rock pile and underground workings of the historical Pecos Mine, which ceased active operations in 1939. The area for which the variance is sought consists of 34 acres located in Sections 27 and 28 of Township 18 North, Range 12 East.

4. State the address or description of the property upon which the facility is located

The PMOU is located along New Mexico Highway 63 (NM 63) at the confluence of Willow Creek and the Pecos River, approximately 1 mile north of Tererro, New Mexico.

5. Description of Affected Water Body

The affected water body consists of saturated alluvium/colluvium that occurs along the Pecos River and Willow Creek, and the underlying regional bedrock aquifer that exists below the saturated alluvium/colluvium and the reclaimed waste rock pile. The regional bedrock aquifer is composed of limestone and sandstone of the Pennsylvanian Madera Formation and Precambrian metavolcanic and metasedimentary units. Groundwater occurs primarily within fractured portions of the bedrock units. Groundwater in the regional bedrock aquifer is in direct hydraulic communication with the shallow saturated alluvium/colluvium where the shallow saturated alluvium/colluvium occurs. Additional information on the groundwater beneath the site is provided in Section 4.

6. Abatement Standards for Which Alternative Standards are Requested

CAMC seeks alternative abatement standards in accordance with Subsection F of 20.6.2.4103 NMAC in lieu of the standards of Subsection B(2) of 20.6.2.4103 NMAC, incorporating the groundwater quality standards set forth in Subsections A through C of 20.6.2.3103 NMAC. Specifically, under Subsection A, the relevant standards are as follow:

- Barium (Ba): 1.0 milligram per liter (mg/L)
- Cadmium (Cd): 0.01 mg/L
- Fluoride (F): 1.6 mg/L

Under Subsection B, the relevant standards are as follow:

- Iron (Fe): 1.0 mg/L
- Manganese (Mn): 0.2 mg/L
- Total dissolved solids (TDS): 1,000 mg/L

- Zinc (Zn): 10 mg/L

Under Subsection C, the relevant standard is as follows:

- Cobalt (Co): 0.05 mg/L

7. Alternative Abatement Standard Requested

Within the designated area presented in Figure 2, alternative abatement standards are proposed for barium, cadmium, cobalt, fluoride, iron, manganese, TDS, and zinc at the following concentrations:

- Barium (Ba): 4.0 mg/L
- Cadmium (Cd): 0.10 mg/L
- Cobalt (Co): 0.10 mg/L
- Fluoride (F): 2.0 mg/L
- Iron (Fe): 40.0 mg/L
- Manganese (Mn): 8.0 mg/L
- TDS: 1,700 mg/L
- Zinc (Zn): 40 mg/L

These proposed levels are above expected future maximum concentrations based on over 12 years of groundwater monitoring conducted since reclamation of the PMOU was completed.

8. Unreasonable Burden

Specific criteria are specified in Subsection F of 20.6.2.4103 NMAC for consideration of alternative abatement standards, and CAMC believes that a demonstration that these criteria are met should satisfy the requirement to show an "unreasonable burden" under Subsection A of 20.6.2.1210 NMAC. The specific criteria in Subsection F of 20.6.2.4103 are addressed below. However, in addition, the following is offered as a demonstration that meeting the standards of 20.6.2.3103 NMAC would be an unreasonable burden upon CAMC.

Significant source control measures as identified in the PMOU DD (NMED, 1998), including consolidation of waste rock material, covering and vegetation of the waste rock pile, and implementation of run-on and stormwater controls, have been implemented at the PMOU at substantial cost. These measures were determined to be the best approach to reclamation out of five alternatives considered (NMED, 1998). Installation of the liner and vegetated cover is the best way to reduce infiltration of precipitation through the waste rock pile and reduce or eliminate discharges to groundwater.

Reclamation at PMOU was completed in 2003 and routine monitoring has been conducted to the present time to monitor the effects of the reclamation, including groundwater quality. The effectiveness of the cover is evidenced by greatly reduced (in most cases eliminated) flow at seeps and significant reduction in constituent concentrations at seeps and monitor wells. The remaining volume of flow at seeps, when it does occur, is very small, and the seep water quality is improved relative to pre-reclamation values. The concentrations in groundwater of the constituents requested for alternative abatement standards are generally stable and are not increasing, so risk will not increase in the future.

It is technically infeasible to obtain significant, additional reduction in either seepage volume or constituent concentrations. Further site investigations and remedial actions would come at substantial cost, would likely lead to no significant improvement relative to current conditions, and would be an unwarranted expenditure of funds for CAMC and the State of New Mexico, which shares remediation costs with CAMC. In addition, no existing water sources will be adversely affected by the constituents for which alternative abatement standards are requested, and no future water sources will be affected due to the well construction prohibition discussed in Section 2.3.

Consequently, compliance with the 20.6.2.3103 NMAC water quality standards will pose an unreasonable burden on CAMC.

9. Period for Which the Alternative Abatement Standard is Requested

The alternative abatement standards are requested in perpetuity to facilitate site closure and transfer of property management responsibility from CAMC to NMDGF.

2.2 Information Required by Subsection F.2 of 20.6.2.4103 NMAC

The information required by Subsection F.2 of 20.6.2.4103 NMAC is provided in the following subsections.

2.2.1 Water Contaminants and Proposed Alternative Standards

The water contaminants for which alternative abatement standards are proposed are barium, cadmium, cobalt, fluoride, iron, manganese, TDS, and zinc. The proposed area of alternative abatement standards is provided in Figure 2; the proposed alternative abatement standard values are listed under Section 2.2.3.

2.2.2 Three-Dimensional Body of Water

The horizontal extent of the three-dimensional body of water for which the alternative abatement standards are proposed is illustrated in Figure 2. The alternative standards are proposed to a depth of 1,900 feet below ground surface (bgs) within the areas designated in Figure 2; this is slightly greater than the approximate reported depth of the historical underground mine workings.

2.2.3 Extent to Which Existing Abatement Standards Are and Will be Exceeded

The existing abatement standards will be exceeded for barium, cadmium, cobalt, fluoride, iron, manganese, TDS and zinc. Only barium, cadmium, and fluoride are (human health) constituents under Subsection A of 20.6.2.3103 NMAC. The extent to which the existing standards are or will be exceeded was determined based on observed constituent concentrations at monitor wells. Additional information on constituent concentrations is provided in Section 5 of this report.

2.2.3.1 Barium (Ba)

The 20.6.2.3103 NMAC standard for barium is 1.0 mg/L. Barium concentrations are below the standard at all PMOU monitor wells except for P-7, where the observed concentration is steady and has been between 3 and 4 mg/L. Based on the range of post-reclamation observed concentrations, CAMC proposes the standard of 4.0 mg/L.

2.2.3.2 Cadmium (Cd)

The 20.6.2.3103 NMAC standard for cadmium is 0.01 mg/L. Cadmium concentrations are below the standard at all PMOU monitor wells except for well P-13S, where the observed concentration has been steady since about 2011 at about 0.02 to 0.06 mg/L. Based on the range of post-reclamation observed concentrations, CAMC proposes the standard of 0.10 mg/L.

2.2.3.3 Cobalt (Co)

The 20.6.2.3103 NMAC standard for cobalt is 0.05 mg/L. Cobalt concentrations are below the standard at all PMOU monitor wells except for well P-13S. At P-13S, the observed concentration has been steady since about 2010 at approximately 0.05 to 0.08 mg/L. Based on the range of post-reclamation observed concentrations at well P-13S, CAMC proposes the standard of 0.10 mg/L.

2.2.3.4 Fluoride (F)

The 20.6.2.3103 NMAC standard for fluoride is 1.6 mg/L. Fluoride concentrations may equal or exceed the standard at PMOU monitor wells P-7, P-13, and P-13S. Observed fluoride concentrations over the past several years at wells P-7, P-13, and P-13S averaged between 1.5 mg/L and 1.6 mg/L. Based on the range of post-reclamation observed fluoride concentrations, CAMC proposes the standard of 2.0 mg/L.

2.2.3.5 Iron (Fe)

The 20.6.2.3103 NMAC standard for iron is 1.0 mg/L. Iron concentrations exceed the standard at PMOU monitor wells P-7, P-7S, P-13, and P-13S. The greatest exceedances occur at well P-13, where the iron concentration is approximately 30 to 33 mg/L. Observed iron concentrations at wells P-7S, P-13S, and P-7 average about 15 mg/L, 4 mg/L, and 3 mg/L, respectively. Based on the range of post-reclamation observed iron concentrations at well P-13, CAMC proposes the standard of 40.0 mg/L.

2.2.3.6 Manganese (Mn)

The 20.6.2.3103 NMAC standard for manganese is 0.2 mg/L. Manganese concentrations exceed the standard at PMOU monitor wells P-7, P-7S, P-13, and P-13S. The greatest exceedances occur at well P-13S, where the manganese concentration is approximately 4 to 7 mg/L. Observed manganese concentrations at wells P-7S, P-13, and P-7 average between 1 and 2 mg/L. Observed manganese concentrations at all wells are stable, although greater fluctuation occurs at well P-13S than at the other wells. Based on the range of post-reclamation observed manganese concentrations at well P-13S, CAMC proposes the standard of 8.0 mg/L.

2.2.3.7 Total Dissolved Solids (TDS)

The 20.6.2.3103 NMAC standard for TDS is 1,000 mg/L. TDS concentrations are below the standard at all PMOU monitor wells except for well P-13S, where the observed concentration has been steady since about 2011 between 830 to 1,470 mg/L. Based on the range of post-reclamation observed concentrations at well P-13S, CAMC proposes the standard of 1,700 mg/L.

2.2.3.8 Zinc (Zn)

The 20.6.2.3103 NMAC standard for zinc is 10 mg/L. Zinc concentrations are below the standard at all PMOU monitor wells except for well P-13S, where the observed concentration has been between approximately 12 to 24 mg/L since about 2012. Based on the range of post-reclamation observed concentrations at well P-13S, CAMC proposes the standard of 40 mg/L.

2.3 Information Required by Subsection F.1 of 20.6.2.4103 NMAC

The following information is required by Subsection F.1 of 20.6.2.4103 NMAC.

a) Lack of Reasonable Relationship Between Costs and Benefits

The remedy for the PMOU site has been implemented as required by the DD (NMED, 1998). The final remedy was selected based on a detailed evaluation of five remedial alternatives as documented in the DD (NMED, 1998). The overall strategy for remediation was to minimize contact between water and the acid-generating waste rock so as to minimize the formation of poor-quality seepage that could emanate from the waste rock stockpile. Measures taken to control the discharge of impacted water at the PMOU site include the following:

- Consolidation and grading of the waste rock pile
- Removal of waste rock from the Willow Creek floodplain
- Construction of an underdrain interceptor and a surface drainage channel to intercept and divert upgradient surface water around the waste rock pile
- Construction of a series of grass- and rock-lined surface water control and diversion structures to route runoff across and away from the waste rock pile
- Covering the waste rock pile with a cap system consisting of a geosynthetic clay liner overlain by a 2-foot vegetative layer to minimize infiltration into the waste rock
- Capping of the main shaft

These and other measures are further summarized in Section 3. The costs of implementation and subsequent monitoring and maintenance of remedial measures at the PMOU site total approximately $12,233,674 through 2016.

There is no known feasible, cost-effective technology that would lead to a significant reduction in groundwater contaminant concentrations beyond that achieved at PMOU as a result of existing measures. At the PMOU site, minimization of the infiltration of water through the waste rock pile and diversion of surface water runoff away from or across the pile has been implemented. Further efforts to improve groundwater quality would require disturbance of the waste rock pile cover system and/or NM 63 to construct a groundwater extraction system and, if attempted, may not be effective. Due to the low permeability of the bedrock aquifer at the site, efficient extraction of impacted groundwater is likely infeasible. Even if groundwater extraction were feasible, there is no reasonable relationship between the cost of constructing and implementing such measures and the benefits of treating the small quantity of impacted groundwater (estimated to be approximately 2 gallons per minute [gpm] or less) that flows through the shallow portion of the fractured bedrock aquifer. In addition, construction of such a system would be detrimental to the waste rock cover system that has already been constructed and established, and to the wetland that exists west of the reclaimed water rock pile.

b) Technical Achievability and Cost-Benefit Justification for the Proposed Alternative Abatement Standards

The proposed alternative abatement standards are based on the observed groundwater constituent concentrations at monitor wells collected over a period of more than 20 years, 12 years of which are representative of post-reclamation conditions. The proposed standards are therefore achievable, and because the observed constituent concentrations are relatively steady (not increasing) and source controls have been implemented, future concentrations in groundwater are not expected to exceed the requested alternative abatement standards.

Similarly, as reclamation has already been performed and approximately 12 years of post-reclamation monitoring and maintenance has occurred, the proposed alternative abatement standards are cost-benefit justifiable.

c) No hazard to Public Health or Undue Property Damage

Subsection F.1(c) of 20.6.2.4103 NMAC requires that the petitioner demonstrate that "compliance with the proposed alternative abatement standard(s) will not create a present or future hazard to public health or undue damage to property." There is no hazard to public health or undue property damage to property that will result from the approval of the proposed alternative abatement standards.

The definition of "hazard to public health" is contained in 20.6.2.7.AA NMAC, which states

> **AA. "hazard to public health"** exists when water which is used or is reasonably expected to be used in the future as a human drinking water supply exceeds at the time and place of such use, one or more of the numerical standards of Subsection A of 20.6.2.3103 NMAC . . . .

Of the constituents being requested for alternative abatement standards, only barium, cadmium, and fluoride are listed in Subsection A of 20.6.2.3103 NMAC.

Due to geography, land ownership, and administrative controls, there is no reason to anticipate that groundwater for which the alternative abatement standards are sought will be used for human consumption. A large portion of the area within which the alternative abatement standards are sought consists of the reclaimed waste rock stockpile, which has a steep benched slope, and NM 63 is adjacent to the base of stockpile. The western margin of the proposed alternative abatement standard area west of NM 63 consists primarily of a low-lying marshy area adjacent to the Pecos River, a portion of which is a wetland. It would be impractical and difficult to drill wells within these areas. NMDGF owns the property, and there is no reason that water supply for human consumption would be required in the designated region. The existing campground area just of the north of PMOU contains primitive camp sites with vault toilets available, and no potable water is provided. In addition, the DD (NMED, 1998, p. 3) requires that institutional controls be implemented ". . . to prohibit use of site ground water as a drinking water source, and to prohibit construction of residences on site."

Finally, as part of the current process, institutional controls on well drilling are proposed to be established by the New Mexico Office of the State Engineer (NMOSE); if a water well permit is requested within the designated area as shown on Figure 2, it will be denied once the order of prohibition on well drilling is enacted by NMOSE.

Likewise, there is no undue property damage that will result from the approval of the proposed alternative abatement standards. The site is a historical mining property owned by NMDGF, and the property has been greatly improved through reclamation. Outside of the alternative abatement standard area, water quality standards will be met; there will therefore be no undue damage to adjacent regions.

3. History and Background Information

The site was developed as a lead and zinc mine by the American Metal Company of New Mexico in 1925 and was operational until mine closure in 1939 (Stoller, 1996). Underground workings extended to over 1,800 feet bgs. Mined ore was transported by aerial tramway to a mill in Alamitos Canyon near the town of Pecos, a distance of approximately 12 miles (Figure 1). Primary production from the mine consisted of lead and zinc, with smaller amounts of copper, gold, and silver (NMED, 1998). Mined waste rock was stockpiled at the mine site.

The New Mexico State Game Commission purchased the inactive site (excluding mineral rights) and surrounding area in 1950. Surface ownership of the PMOU property belongs to NMDGF, while CAMC currently retains the subsurface mineral rights. Under the terms of the AOC, upon its termination CAMC would convey the mineral rights to NMDGF. The Commission's approval of alternative abatement standards will facilitate the termination of the AOC under its terms. Figure 3 shows current surface ownership of the PMOU and the surrounding area.

3.1 Investigation, Public Involvement, and Alternatives

In the mid-1980s, a study conducted by the NMED Surface Water Quality Bureau found elevated metals concentrations in springs and other surface water features discharging from around the Pecos Mine area. The PMOU investigation area included the following:

- 12.3 acres of exposed waste rock pile containing the acid-generating minerals pyrite, sphalerite, and galena
- Impacted soils in areas adjacent to the waste rock pile
- Perennial Willow Creek and its floodplain
- 10 acres of wetland area at the confluence of Willow Creek and the Pecos River
- Pecos River adjacent to and below the mine

Subsequent site investigations led to the signing of the AOC by NMED, NMDGF, the New Mexico Highway and Transportation Department, and Amax Resource Conservation Company (predecessor to CAMC) (NMED, 1992).

On behalf of the responsible parties, an RI was conducted at the PMOU by S.M. Stoller Corporation (Stoller, 1996). The investigation determined that the primary source of contaminants was the exposed waste rock piles containing the following metals: arsenic, cadmium, copper, lead, mercury, nickel, silver, and zinc (Stoller, 1996). The PMOU RI indicated that precipitation infiltration through and runoff from the waste rock piles was the primary mechanism for transport of contaminants to downgradient soils, sediments, surface water, and groundwater. Additional PMOU site investigations, assessments, or studies included the following:

- Human health risk assessment (NMED, 1997)
- Ecological risk assessment (Hagler Bailly, 1997a)
- Natural resource damage assessment (Hagler Bailly, 1997b)
- Feasibility study (Schafer and Stoller, 1997)

Public meetings were held to review these documents in addition to the RI. A copy of the PMOU FS is provided in Appendix A1. The FS determined the PMOU site cleanup goals and remedial action objectives (RAOs), identified actions needed to address or satisfy those goals, and developed several potential remediation alternatives. As specified in the PMOU FS, the following RAOs were determined for the PMOU (Schafer and Stoller, 1997):

- Prevent exposure of human and ecologic receptors to metals in waste rock or contaminated soils at levels that exceed remedial action cleanup criteria.
- Minimize generation of acid leachate from migration of water through the waste rock piles.
- Prevent migration of contaminants to groundwater and surface water at levels that would exceed remedial action cleanup criteria.

- Minimize erosional transport of waste rock particulates to downgradient soils and surface water drainages.
- Minimize transport of contaminated soils to downgradient areas and surface water drainages.
- Remove highly contaminated soils in the uplands and wetlands.
- Restore groundwater quality to remedial action cleanup criteria (i.e., 20.6.2.3103 NMAC standards).
- Restore surface water quality to remedial action cleanup criteria.
- Restore natural resources that have incurred injury due to the PMOU site; provide restoration or replacement for those resources that cannot be fully restored.

Prior to development of site-specific alternatives for the PMOU, the following types of general resource actions and technologies were considered (Schafer and Stoller, 1997):

- No action
- Institutional controls
- Treatment
- Containment
- Removal

Based on the site-specific goals for the PMOU and consideration of the above generalized resource actions, the following alternatives were developed and evaluated in the FS (Schafer and Stoller, 1997):

1. No action: No remedial action, a baseline to allow for comparison between the action alternatives based on the PMOU site conditions at the time the FS was conducted. Costs related to this alternative were calculated for monitoring and existing interim actions only.

2. Non-compacted clay soil cap: Consolidate and cover the waste rock and contaminated soils with 2 inches of crushed limestone below a 24-inch non-compacted clay soil cap,

and vegetate with grasses and forbs. Side slopes covered with 48 inches of low-permeability compacted clay overlain by 18-inch vegetated cover layer. Contaminated soils would be consolidated and treated with crushed limestone. Subsurface and run-on surface flow intercepted and diverted around the waste rock pile.

3. Compacted clay cap: Consolidate and cover the waste rock and contaminated soils with 18 inches of compacted clay layer with extremely low permeability, overlain by 2 inches of a rock drainage layer and topped with 18 inches of vegetated soil. Side slopes covered, and subsurface and run-on surface flow intercepted and diverted, as described in Alternative 2.

4. Geomembrane cap: Consolidate and cover the waste rock and contaminated soils with 12 inches of compacted clay layer with extremely low permeability, overlain by 30-mil polyvinyl chloride (PVC) followed by 0.2-inch geonet/geotextile drainage layer, and topped with 18 inches of vegetated soil. Side slopes covered, and subsurface and run-on surface flow intercepted and diverted, as described in Alternative 2.

5. Source removal: All waste rock and contaminated soils excavated at the PMOU transported to the EMOU and deposited on existing tailing piles and capped in accordance with the EMOU approved cap design. Stream channel morphology, gradient, and riparian habitat restored to conditions that would result in natural recovery to resource baseline.

All of the alternatives included ongoing monitoring and restoration or replacement of injured resources. The remediation alternative selection process included public involvement over a three-year period, during which a series of advertised public information meetings were held. NMED also oversaw a technical review group, which held roundtable meetings to discuss the draft documents and planned PMOU site activities prior to their public release (NMED, 1998).

Interviews were conducted by a community relations contractor that encouraged individuals to provide their opinions for the record. The draft DD was presented at a public meeting, which was followed by a 60-day public comment period. The public meeting was recorded and transcribed as an attachment to the final DD. Other state and federal agencies reviewed the draft DD, including the Office of the Natural Resources Trustee and the U.S. EPA (NMED, 1998). Comments provided and NMED responses to comments are documented in the final DD. A copy of the PMOU final DD is provided in Appendix A2.

Based on the results of the PMOU site-related studies and investigations, as well as stakeholder input, NMED issued the final DD (NMED, 1998) documenting the RAOs and approved remedy. The approved remedy was a combination of Alternatives 3 and 4 (low-permeability cap) with some modification and additions, further described in Section 3.2. The remedy specified by the DD met the following criteria:

- Mitigated actual or potential release of contaminants from the PMOU
- Protected human health and the environment
- Complied with the AOC and federal and state standards that are applicable, relevant, and appropriate requirements to the remedial action
- Was cost effective

Under current NMED regulations, the PMOU RI is equivalent to a Stage 1 Abatement Plan, while the FS in combination with the final DD is equivalent to a Stage 2 Abatement Plan.

3.2 Remediation and Reclamation Actions

The selected remedy at the PMOU consists of 18 individual measures that can be generalized as excavation of contaminated soils and waste rock from sensitive areas and capping of the waste rock pile and all consolidated materials with a low-permeability cover. Reclamation construction began in July 1999. Major components of the selected remedy include the following (EMC^2, 2005):

- Consolidating and regrading waste rock and impacted soils and sediments from several areas into a single waste rock pile with maximum 3:1 (horizontal:vertical) slopes
- Development and reclamation of several soil borrow areas

- Restoring Willow Creek and its floodplain corridor in areas where waste rock was removed to approximate pre-mining natural conditions, including construction of a fish barrier at the upgradient end of the Willow Creek restoration area
- Installing an underdrain subsurface interceptor system along the upgradient boundary of the waste rock pile and construction of an upgradient surface drainage channel to intercept and divert upgradient surface water around the waste rock pile
- Covering the waste rock pile with a cap system consisting of a geosynthetic clay liner (GCL) as the primary infiltration barrier overlain by a 2-foot vegetative layer
- Constructing a series of grass and rock lined surface water control and diversion structures to route surface water runoff across and away from the waste rock pile
- Restoring areas disturbed by the remedial action through seeding with native grasses, placement of an erosion control blanket across the entire revegetated waste rock pile, and hand planting of woody vegetation in unlined areas
- Placing a concrete cap over the Main Shaft
- Restoration of the NMDGF campground recreation area

All of the above prescribed remedial and reclamation actions were completed by October 2003, and monitoring of these reclamation actions is ongoing. Figure 4 provides a photographic overview of the PMOU site reclamation; the photographs were taken during spring 2016.

3.3 Post-Reclamation Investigation and Monitoring

In 2005, three additional monitor wells (P-13S, P-13, and P-14) were installed at the PMOU west of the reclaimed waste rock pile to evaluate shallow and deep groundwater (Figure 5). Monitor wells P-13S and P-13 are located in the White Seep Below Drainage Tunnel (WSBDT) area to monitor shallow and deeper groundwater before it discharges at WSBDT. Well P-13S is completed to a depth of 10 feet, while well P-13 is completed to a depth of 30 feet. Regional aquifer monitor well P-14, completed to total depth of 106 feet, is located near the southern end of the reclaimed waste rock pile between the Pecos River and NM 63 (Figure 5). The screen interval in well P-14 targeted the fractured limestone and sandstone above the geologic contact with a schist unit (DBS&A, 2006).

Recent groundwater monitoring requirements and results are summarized in Sections 4.2 and 4.3. Other types of routine environmental monitoring and maintenance have also been conducted, such as monthly inspections to evaluate cover performance and integrity, estimate soil loss from remediated areas, evaluate revegetation, wetland, and riparian area success, and monitor wildlife. Where needed, repairs and routine maintenance of the cover have been completed. All monitoring has been conducted in accordance with NMED requirements, and results are documented in numerous annual reports and correspondences submitted to NMED.

4. Site Hydrogeology

This section presents an overview of the hydrogeology of the site (Section 4.1), water quality monitoring requirements (Section 4.2), and the current nature and extent of groundwater impacts (Section 4.3). Additional details can be found in the PMOU RI (Stoller, 1996), Geochimica (1993), ABC (1991) and numerous groundwater and surface water monitoring reports and status reports submitted to NMED.

4.1 Hydrogeology

Two aquifer units have been identified at the site: (1) a local alluvial/colluvial aquifer that occurs along the Pecos River and Willow Creek at depths of less than 20 feet bgs (shallow aquifer), and (2) an underlying regional aquifer that occurs in multiple bedrock units beneath the entire site (regional aquifer). The regional aquifer is called the bedrock aquifer in the PMOU RI (Stoller, 1996). Both aquifers have been characterized using monitor wells (Figure 5). Over time some monitor wells have been plugged and abandoned due to site reclamation or other factors, and some monitor wells that still exist are no longer monitored because the observed water quality meets all 20.6.2.3103 NMAC standards. PMOU monitor wells completed in the shallow aquifer have an “S” designation (e.g., P-7S), while regional aquifer wells have no letter designation (e.g., P-7). All of the NMDGF campground wells (e.g., WCMW1) are completed in the shallow aquifer. Some of the domestic wells north of the site are completed in the shallow aquifer, and some are completed in the regional aquifer. Observed water level fluctuations in both the shallow and regional aquifer are relatively small, and are attributable to seasonal climate conditions.

There are no known low-permeability geologic units that inhibit the exchange of water between the shallow and regional aquifers. East of PMOU along Willow Creek, water levels in the regional aquifer are lower than those in the shallow aquifer, and the shallow groundwater in the alluvial channel of Willow Creek may be perched above the water table of the regional aquifer by about 10 feet. Within the Pecos River Valley, regional groundwater flows upward into the shallow aquifer, and the two aquifers comprise a single, hydraulically connected groundwater system. The hydrogeology of the shallow and regional aquifers is described in greater detail in Sections 4.1.1 and 4.1.2, respectively.

4.1.1 Shallow Aquifer

The approximate extent of the shallow aquifer at the site is shown in Figure 6, along with observed water levels for the dates indicated. For the PMOU wells, November 2009 water levels were used, as this is the most recent post-reclamation period with comprehensive PMOU monitor well water level coverage. The same is true for the August 2017 values for the NMDGF campground wells. Shallow aquifer water levels for several domestic wells are only available for the date on which the well was completed. Because shallow aquifer water level fluctuations are generally several feet or less with no upward or downward trend, the approach of using observed water levels from different time periods to illustrate the direction of groundwater flow in the shallow aquifer is appropriate.

As documented in Stoller (1996), the shallow aquifer is composed of (1) gravel-rich alluvial deposits that occur within the Pecos River and Willow Creek valleys, (2) lacustrine floodplain deposits present in the wetland area (Figure 6), and (3) colluvial deposits consisting predominantly of sandy clay and clay that cover most of the hillslopes. In the Willow Creek Valley, the alluvium ranges in thickness from 10 to15 feet. Under the waste rock pile, colluvial deposits range in thickness from 0 to 20 feet. At the PMOU the saturated thickness of alluvium is about 7 feet. In the NMDGF campground area, the saturated thickness of the alluvium ranges from near zero to about 10 or 11 feet west of the Pecos River, and from about 3 to 7 feet east of the Pecos River (Intera, 2017).

The hydraulic conductivity of the alluvium is estimated by Stoller (1996) to potentially range from 0.3 to 28 feet per day (ft/d). The hydraulic conductivity of the colluvium measured at two locations was very low at about 4×10^{-5} and 2×10^{-4} ft/d, although Stoller (1996) notes that preferential pathways (e.g., root channels and desiccation cracks) with higher permeability appear to control the flow of water through the colluvium.

Recharge to the shallow aquifer occurs from seepage along the eastern portion of Willow Creek, precipitation, seepage through the waste rock pile that leads to saturation above or within the colluvium, and upward groundwater flow from the underlying regional aquifer. As explained below, site reclamation has greatly reduced the waste rock pile component of seepage to groundwater. Pecos River flows may also contribute local recharge to limited portions of the alluvium adjacent to the river during periods of high flows. Pecos River water that recharges the alluvium would return to the river within a short distance downstream.

Shallow aquifer discharge occurs through evapotranspiration and as diffuse seepage to the Pecos River and the lower (western) portion of Willow Creek. Historically, discharge of poor quality seepage from the colluvium beneath the waste rock pile occurred at multiple seeps along the eastern margin of the wetland (Figure 6); two of the largest of these seeps were the Explosive Shed Seep (ESS) and WSBDT. Stoller (1996) documents a significant barren area at WSBDT and several immediately adjacent seeps. In April 1995, observed sulfate concentrations at the seeps near WSBDT ranged from 2,090 to 15,340 mg/L and zinc concentrations ranged from 531 to 1,480 mg/L (Stoller, 1996). PMOU site reclamation has effectively eliminated ESS and multiple smaller seeps that occurred at or near the base of the waste rock pile. ESS has been dry since May 2010. In addition, flow at WSBDT occurs only sporadically at very low rates (i.e., a small fraction of a gpm). Flow at this location has been observed during recent annual monitoring conducted in November 2015, October 2016, and November 2017. WSBDT was dry between spring 2011 and November 2015. Constituent concentrations have also been greatly reduced. For example, the most recent water sample from WSBDT collected in November 2017 had sulfate and zinc concentrations of 200 mg/L and 4.04 mg/L, respectively.

The direction of groundwater flow in the shallow aquifer is generally toward the Pecos River (Figure 6).

4.1.2 Regional Aquifer

Regional groundwater occurs within multiple geologic units beneath the site, including Paleozoic limestone, dolomite, and sandstone, and underlying Precambrian schists, amphibolites, and metavolcanics (Stoller, 1996). The sulfide deposits targeted by the historical mining operations occur within the Precambrian rocks (Stoller, 1996). Groundwater in these geologic units occurs predominantly in fractures. Although several lithologic units comprise the regional bedrock aquifer, as evidenced by consistent water levels, the units are hydraulically connected and are considered to be a single aquifer unit. The depth of the aquifer is unknown; it extends to the depth at which the permeability of the rocks is sufficiently small that appreciable groundwater will not flow to a well. The hydraulic conductivity of the aquifer is low at about 0.11 ft/d based on an aquifer test conducted at well P-3 (ABC, 1991; Stoller, 1996).

The regional aquifer is recharged through precipitation and subsequent infiltration along drainages. Stoller (1996) states that most recharge to the regional aquifer occurs east of the site, and attributed only small amounts of recharge to infiltration through the waste rock pile before it was reclaimed. Groundwater in the regional aquifer generally flows from east to west beneath the site (Figure 7). The volumetric flux of groundwater in the upper 50 feet of the regional aquifer beneath the reclaimed waste rock pile is calculated to be about 2 gpm.

The regional aquifer discharges to the Pecos River and the adjoining shallow aquifer, as illustrated in Figure 8. This fact is evidenced through comparison of the observed water levels in the paired shallow and deep monitor wells (e.g., P-7 and P-7S), where the observed hydraulic head in the deeper well is consistently higher than that in the shallow well, indicating upward groundwater flow.

4.2 Groundwater Monitoring Requirements

Figure 5 shows the PMOU compliance monitor well and surface water sampling locations, as well as the NMDGF campground monitor wells. PMOU compliance monitoring locations and analytes are based on the CMP (DBS&A, 2007) approved by NMED in 2007. The CMP was modified in 2010 to remove certain monitoring locations and constituents based on compliance with Section 3103 standards (NMED, 2010). Quarterly compliance monitoring was conducted from 2005 through mid-2013, followed by semiannual compliance monitoring from mid-2013 through 2014, and annual monitoring during 2015 through 2017.

In 2013, CAMC proposed annual sampling with a reduced constituent list and use of the HydraSleeve® sampling methodology at the PMOU to more efficiently collect representative groundwater quality samples and reduce monitoring costs. The revised monitoring proposal was discussed with NMED and subsequently documented by ARCADIS (2013). The proposed

HydraSleeve® sampling methodology approach was to be followed up by an evaluation to assess the comparability between the historical bailing or low-flow sampling methodologies, and the new HydraSleeve® methodology was approved by NMED in September 2013 (NMED, 2013a and 2013b). In order to establish comparability between analytical results obtained from the current sampling methods and the proposed Hydrasleeve® implementations, CAMC collected samples from each well using the HydraSleeve® sampling methodology for two consecutive semiannual sampling events. The comparison semiannual sampling events were conducted during the fourth quarter of 2013 and the second quarter of 2014.

A draft evaluation and comparison report with data for five monitor wells at the PMOU was provided to NMED in October 2014 (DBS&A, 2014). NMED provided comments on this draft report acknowledging that the comparison methodology documented by ARCADIS (2013) was followed, but concluded that “NMED does not regard the results obtained to show acceptable comparability” (NMED, 2014). Groundwater samples from the PMOU monitor wells were collected using HydraSleeve® sampling methodology during three semiannual sampling events (fourth quarter of 2013, second and fourth quarters of 2014). The HydraSleeve® sample results are included in the annual monitoring report (Appendix B) to show that compliance monitoring was completed, but the data are not used for comparison with other sample results.

Annual groundwater quality monitoring at PMOU is currently required at four monitor wells: P-7, P-7S, P-13, and P-13S (Figure 5). Groundwater at these monitor wells is currently analyzed for the following constituents (NMED, 2016):

- Barium (monitor wells P-7 and P-7S only)
- Cadmium, cobalt, total dissolved solids (TDS), and zinc (monitor well P-13S only)
- Fluoride (monitor wells P-7 and P-13S only)
- Iron
- Manganese

During 2017, quarterly groundwater quality monitoring resumed at the NMDGF campground monitor wells. All six NMDGF campground monitor wells were sampled during the first and second quarters. Based on the results of the first two quarters of sampling, only wells WCMW1 and WCMW2A were sampled during the third and fourth quarters of 2017 for cobalt, fluoride, and manganese. A table of historical groundwater monitoring data for the NMDGF campground wells is provided as Appendix C.

4.3 Nature and Extent of Current Groundwater Impacts

The site has been fully characterized (e.g., ABC, 1991; Geochimica, 1993; Stoller, 1996) and PMOU post-reclamation compliance monitoring has been conducted since 2005. The most recent annual compliance monitoring report for the PMOU is provided as Appendix B. This routine monitoring has generated a sufficient time-series of groundwater quality data to confidently evaluate the occurrence, patterns, and trends of the contaminants of concern. Appendix B provides time-series plots of concentrations of required constituents for groundwater at PMOU at the currently sampled monitor wells. Where constituents were not detected in a given sample, data points in the time-series plots are plotted at one-half the method detection limit (MDL). For some constituents (i.e., bromide, cadmium, and cobalt), this procedure resulted in the one-half MDL data points plotting directly on top of one another. For this reason, not all of the results reported at one-half the MDL are visible on the time-series plots.

A comparison of the currently monitored constituent concentrations to 20.6.2.3103 NMAC standards for the last 10 PMOU sampling events is summarized as follows:

- Water quality at downgradient monitor well P-14 meets standards for all required constituents.
- Detected barium concentrations meet the standard of 1.0 mg/L at monitor wells P-7S, P-13, and P-13S, and exceed the standard only at monitor well P-7.
- Detected cadmium concentrations meet the standard of 0.01 mg/L at monitor wells P-7, P-7S, P-13, and P-14, and exceed the standard only at monitor well P-13S.
- Detected concentrations of cobalt, TDS, and zinc meet the standards of 0.05 mg/L, 1,000 mg/L, and 10 mg/L, respectively, at monitor wells P-7, P-7S, P-13, and P-14.

Detected cobalt concentrations equal or exceed the standard at well P-13S. TDS and zinc concentrations exceed the standard at monitor well P-13S.

- Detected fluoride concentrations meet or equal the standard of 1.6 mg/L at monitor wells P-7S, P-13, and P-14, and exceed the standard at monitor wells P-7 and P-13S.
- Detected concentrations of iron and manganese meet the standards of 1.0 mg/L and 0.2 mg/L, respectively, at monitor well P-14, and exceed these standards at monitor wells P-7, P-7S, P-13, and P-13S.

At most wells where one or more 20.6.2.3103 NMAC standards are exceeded, the magnitude of the exceedance is relatively small at less than two times the standard. In addition, at some wells for some constituents, such as fluoride at wells P-7, P-13, and P-13S, the standard is not exceeded on a continual basis, but is only exceeded by a small margin intermittently.

4.4 Geochemical Controls on Metal Concentrations in Groundwater

Groundwater in the regional aquifer appears to occur under reducing (oxygen limited) conditions, unlike in the shallow aquifer, which is oxidizing. The reducing conditions in the regional aquifer are evident in the observed water chemistry, in that sulfate is often not detected and metals that are mobile under reducing conditions, such as iron and manganese, are detected in many of the regional aquifer groundwater samples. These geochemical conditions would have been present before mining operations began at the site. The discharge areas for the regional aquifer groundwater, including the Pecos River and the adjacent wetlands, have probably been receiving groundwater with elevated iron, manganese, and other metals for a considerable time. When discharging under natural conditions, exposure of the reduced regional groundwater to the atmosphere would oxidize the metals dissolved in the water, allowing them to precipitate out of solution as solids in the shallow aquifer and the wetlands. As oxidized water from the waste rock pile infiltrated into the shallow aquifer, a transition (mixing) zone would have developed consisting of shallow oxidized water and regional reduced water between the waste rock pile and the wetlands area within the area proposed for alternative abatement standards.

Mixing of the reduced and oxidized waters impacts the solubility of several contaminants proposed for alternative abatement standards. For example, barium concentrations are elevated at well P-7. Barium concentrations in groundwater are usually controlled by solubility of the mineral barite, $BaSO_4$ (Hem, 1985). At well P-7, sulfate (SO_4) concentrations are non-detect; without dissolved sulfate, barite is unlikely to form, and barium will not be removed from the water through precipitation. As the barium is transported downgradient with the groundwater, the barium concentrations are expected to decrease due to the mixing of the regional groundwater with oxidized shallow water that contains sulfate, thereby allowing barite to precipitate from solution.

Iron and manganese have limited solubility under oxidizing conditions, but slow kinetic reactions may inhibit their removal from oxidized solutions by mineral precipitation reactions. Iron is elevated at wells P-7, P-7S, P-13, and P-13S; the groundwater sampled at these wells is most likely a mixture of deeper reduced groundwater and shallow, oxidized groundwater. Under oxidizing conditions, as the dissolved metals are transported downgradient, precipitation of solid phases will help immobilize them and lower their concentration in groundwater. The iron will precipitate out of the oxidized solution as amorphous minerals such as hydrous ferric oxide or ferrihydrite. These minerals have a relatively large surface area with an affinity for surface complexation (retention) of metals—in particular lead, zinc, cobalt, and oxyanions (Langmuir, 1997). This affinity for metal adsorption will limit the dissolved fraction of metals in solution.

Cobalt has been detected at elevated concentrations in monitor well P-13S (Section 2.2.3.3), and the groundwater also contains soluble iron and manganese at elevated concentrations. Cobalt concentrations in water tend to be controlled by co-precipitation into, or adsorption onto, iron and manganese hydroxide or oxide minerals (Hem 1985; Clark 2016). Because these hydroxide and oxide minerals are soluble in groundwater at P-13S, cobalt is expected to be dissolved into solution with the iron and manganese minerals. As iron and manganese are removed from solution by precipitation reactions, cobalt will also be attenuated.

At monitor well P-13S, zinc and cadmium concentrations have been decreasing since reclamation (Appendix B). Zinc and cadmium have similar chemical characteristics, and originate in pyrite and sphalerite minerals. The concentrations of these metals in solution will be controlled by adsorption reactions with iron minerals and the solubility of zinc or cadmium carbonate minerals (Hem, 1985). The concentrations of dissolved iron and carbonate species (alkalinity) appear to be great enough to control solubility of zinc and cadmium at the western edge of the reclaimed waste rock pile.

Fluoride concentrations are expected to be controlled by the solubility of the mineral fluorite (CaF_2), and fluoride concentrations range from 1.3 to 1.7 mg/L in monitor well P-13S (Section 2.2.3.4). This solubility control requires sufficient calcium to be in solution for equilibrium conditions to develop; since 2009, calcium concentration has ranged from 179 to 317 mg/L at well P-13S. The presence of dissolved sulfate at well P-13S may interfere with the precipitation of fluorite due to the common ion effect. Both fluorite and gypsum ($CaSO_4$-$2H_2O$) require calcium in order to form in solution. Based on the solubility products for gypsum and fluoride, dissolved fluoride concentration in the presence of gypsum are predicted to be approximately 1.4 mg/L (Appelo and Postma, 2005) and sulfate concentrations are predicted to be approximately 450 mg/L (Appelo and Postma, 2005). These predicted concentrations are in good agreement with the observed concentrations in well P-13S for November 2015 of 1.3 and 413 mg/L for fluoride and sulfate, respectively.

5. Proposed Alternative Abatement Standards

The proposed alternative abatements standards, including constituent trends observed at the site monitor wells, are presented in Section 5.1. The lack of effects on adjacent water users is discussed in Section 5.2, and the lack of need for additional abatement actions is provided in Section 5.3.

5.1 Proposed Alternative Abatement Standards

This section presents the requested alternative abatement standards for which CAMC is petitioning the NMWQCC for approval. Figures 9 through 16 provide time-series plots for the eight constituents for which alternative abatement standards are requested for wells that are currently monitored at the PMOU site. The figures show the 20.6.2.3103 NMAC groundwater standard and the proposed alternative abatement standard for each constituent. Figure 2 shows the proposed area for the alternative abatement standards. The following alternative abatement standards are proposed in accordance with Subsection E of 20.6.2.4103 NMAC:

- Barium: 4 mg/L (3 mg/L higher than the NMWQCC standard of 1 mg/L) in the regional aquifer
- Cadmium: 0.10 mg/L (0.09 mg/L higher than the NMWQCC standard of 0.01 mg/L) in the shallow aquifer
- Cobalt: 0.10 mg/L (0.05 mg/L higher than the NMWQCC standard of 0.05 mg/L) in the shallow aquifer
- Fluoride: 2 mg/L (0.4 mg/L higher than the NMWQCC standard of 1.6 mg/L) in the shallow and regional aquifers
- Iron: 40 mg/L (39 mg/L higher than the NMWQCC standard of 1 mg/L) in the shallow and regional aquifers
- Manganese: 8 mg/L (7.8 mg/L higher than the NMWQCC standard of 0.2 mg/L) in the shallow and regional aquifers

- TDS: 1,700 mg/L (700 mg/L higher than the NMWQCC standard of 1,000 mg/L) in the shallow aquifer

- Zinc: 40 mg/L (30 mg/L higher than the NMWQCC standard of 10 mg/L) in the shallow aquifer

Many of the observed constituent concentrations in groundwater requested for alternative abatement standards (e.g., iron, manganese, and barium) exhibit relatively consistent concentrations through time, including (where available) pre-reclamation values. This result is consistent with the rock pile draindown analysis provided in the PMOU RI (Stoller, 1996). The analysis presented in the PMOU RI identified the waste rock pile as a double porosity medium, consisting of both macropores (large pores) formed by cobbles and rock fragments, and small-diameter pores formed by fine-grained material interspersed in the pile. Drainage of water from the macropores was estimated to occur rapidly, within about a week. Drainage from the fine-grained materials was expected to have a much higher residence time—on the order of 70 years. Consequently, elevated constituent concentrations in groundwater can be expected to last for decades in some cases. Furthermore, based on the geochemical overview presented in Section 4.4 and the groundwater chemistry observed at the site since reclamation, the constituents with requested alternative abatement standards are not likely to increase over time, but are expected to decrease and/or stabilize due to chemical reactions in the shallow groundwater and sediments.

It is also worth noting that some of the elevated constituent concentrations (e.g., barium, fluoride, and manganese) may be attributable to elevated background concentrations of native groundwater within the ore body, as opposed to groundwater that has been impacted by seepage of meteoric water that infiltrated through the waste rock pile. However, sufficient information is not available to make this determination, so alternative standards based on elevated background concentrations are not being pursued at PMOU.

To support this petition for alternative abatement standards, a statistical evaluation was conducted to quantitatively determine observed trends in constituent concentrations through time (Appendix D). The trend evaluation was conducted using the Mann-Kendall test (GSI, 2012). Results of the Mann-Kendall test indicate no trend for barium at well P-7, for iron at well

P-7S, and for manganese at wells P-7 and P-7S. Stable trends are indicated for fluoride at well P-7, for cobalt and TDS at well P-13S, and for manganese at wells P-13 and P-13S. Decreasing trends are indicated for cadmium and zinc at well P-13S. Probable decreasing trends are indicated for fluoride at well P-13S. For iron, an increasing trend was indicated at wells P-7, P-13, and P-13S. The identified increasing trends for iron (Figure 13) are small and within historical concentration fluctuations; iron concentrations are expected to remain below the requested alternative abatement standard of 40 mg/L.

All constituents for which alternative abatement standards are requested will continue to be monitored under the long-term operation and maintenance plan. The long-term operation and maintenance plan developed by CAMC is currently under review and will be finalized upon approval by NMED.

5.2 Effects of Granting the Proposed Alternative Abatement Standards on Adjacent Groundwater and Surface Water Users

There will be no adverse effects of granting the proposed alternative abatement standards on adjacent users of groundwater or surface water. The closest wells of other ownership used for water supply are illustrated in Figure 3. Table 1 provides available information from NMOSE for nearby private wells and the distances from the wells to the proposed alternative abatement standard area. Three of the seven wells for which well depth is available are shallow (18 feet or less) and obtain water from saturated alluvial sediments adjacent to the Pecos River. Four of the wells are deeper (97 to 125 feet) and obtain water from bedrock units that underlie the alluvium. None of these wells have been impacted by site groundwater that exceeds 20.6.2.3103 NMAC standards, and they will not be impacted in the future because groundwater in the shallow and regional aquifers does not flow toward these wells (Figures 6 and 7).

Likewise, there will be no impacts to groundwater users downstream (south) of the site. The pathway for impacted groundwater to move south would be the Pecos River, as the groundwater system discharges to the river (Figures 6 through 8). The Pecos River has not exceeded any 20.6.2.3103 NMAC water quality standards or surface water quality standards at the Pecos River downstream (PD) sampling location (Figure 5) post-reclamation.

Water quality in the Pecos River is protected in part by natural processes that occur in the wetlands area between the P-13 wells and the river (Figure 6). Wetlands have long been recognized as an effective means to improve water quality by retaining metals (e.g., Mays and Edwards, 2001; Yeh, 2008). The wetlands area is sustained in part by upwelling groundwater that is likely under reducing (low oxygen) conditions, as evidenced by the difference in sulfate concentrations at deep well P-13 (sulfate concentrations typically near the detection limit) and shallow well P-13S (sulfate concentrations around 400 mg/L). Iron and manganese present in the regional groundwater reach the ground surface, and through geochemical and microbial oxidation form iron oxides and manganese oxides. These precipitates have excellent metal sorption capabilities to retain other elevated metals present in PMOU groundwater (i.e., cadmium, cobalt, and zinc). Stoller (1996, p. 5-41) also notes that ". . . normal conditions in Willow Creek and the wetland favor precipitation or adsorption of most metals of concern." Section 4 provides a more detailed description of geochemical controls on metal concentrations in groundwater at PMOU.

5.3 Additional Abatement Actions are Unwarranted

Additional abatement investigations or measures are unwarranted because it is technically infeasible to enhance (speed up) the drainage of impacted water that exists within the finer-grained sediments in the reclaimed waste rock pile. Likewise, there is no technically feasible way to significantly reduce the infiltration of precipitation into the waste rock pile beyond the reduction that has already been achieved.

The only remaining actions that could potentially be pursued would be implementation of some type of groundwater extraction system in the vicinity of monitor wells that exceed 20.6.2.3103 NMAC standards, with subsequent treatment of the extracted water. Such an approach is likely infeasible due to the low permeability of the bedrock at the PMOU; it would be extremely difficult to extract the small volume of impacted groundwater that occurs along the western edge of the reclaimed waste rock pile. In addition, construction of such a system would be disruptive to the existing reclamation and in some locations the wetland that occurs between NM 63 and the Pecos River. The costs of additional actions at the site, both in terms of dollars and negative environmental effects on reclamation already completed, far outweigh the limited benefit that might be achieved.

6. Summary

CAMC requests that the NMWQCC approve the alternative abatement standards proposed in this petition in accordance with Subsection F of 20.6.2.4103 NMAC. The site has been thoroughly characterized, alternative remedial options were developed and presented to the public, and the preferred PMOU alternative was implemented in 2003. Subsequent groundwater and surface water monitoring completed over approximately 12 years has demonstrated the effectiveness of site reclamation.

It is technically infeasible to obtain significant, additional reduction in either seepage volume or constituent concentrations in groundwater. Further site investigations and remedial actions would come at substantial cost, would likely lead to no significant improvement relative to current conditions, and would be an unwarranted expenditure of funds for CAMC and the State of New Mexico, which shares remediation costs with CAMC. Finally, there are no existing or future water sources that will be adversely affected if the NMWQCC approves this request for alternative abatement standards.

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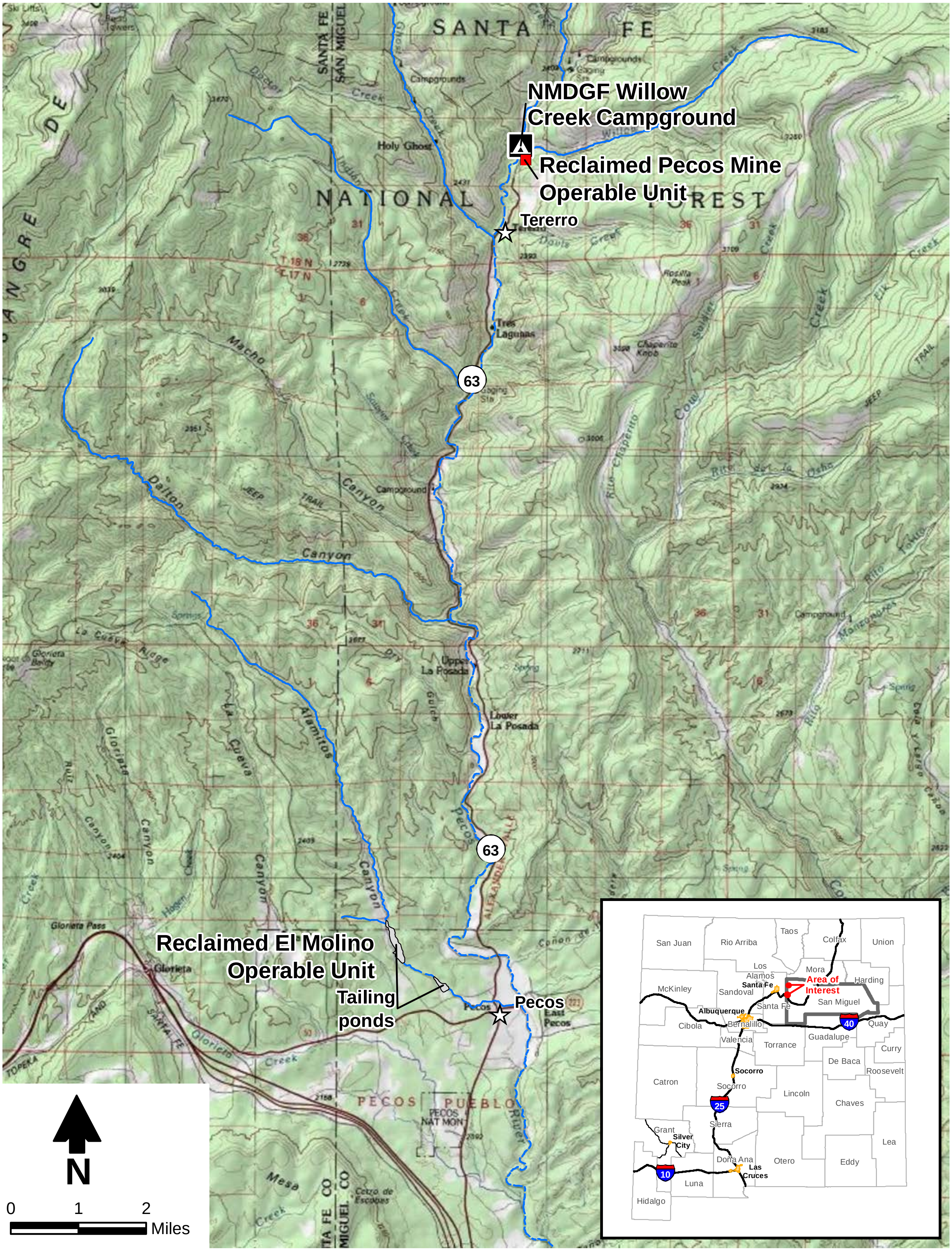
Figures



S:\PROJECTS\ES06.0038_PMOU\GIS\MXDS\REPORT\AAS\2017_09\FIG01_SITE_LOCATION.MXD

PECOS MINE OPERABLE UNIT

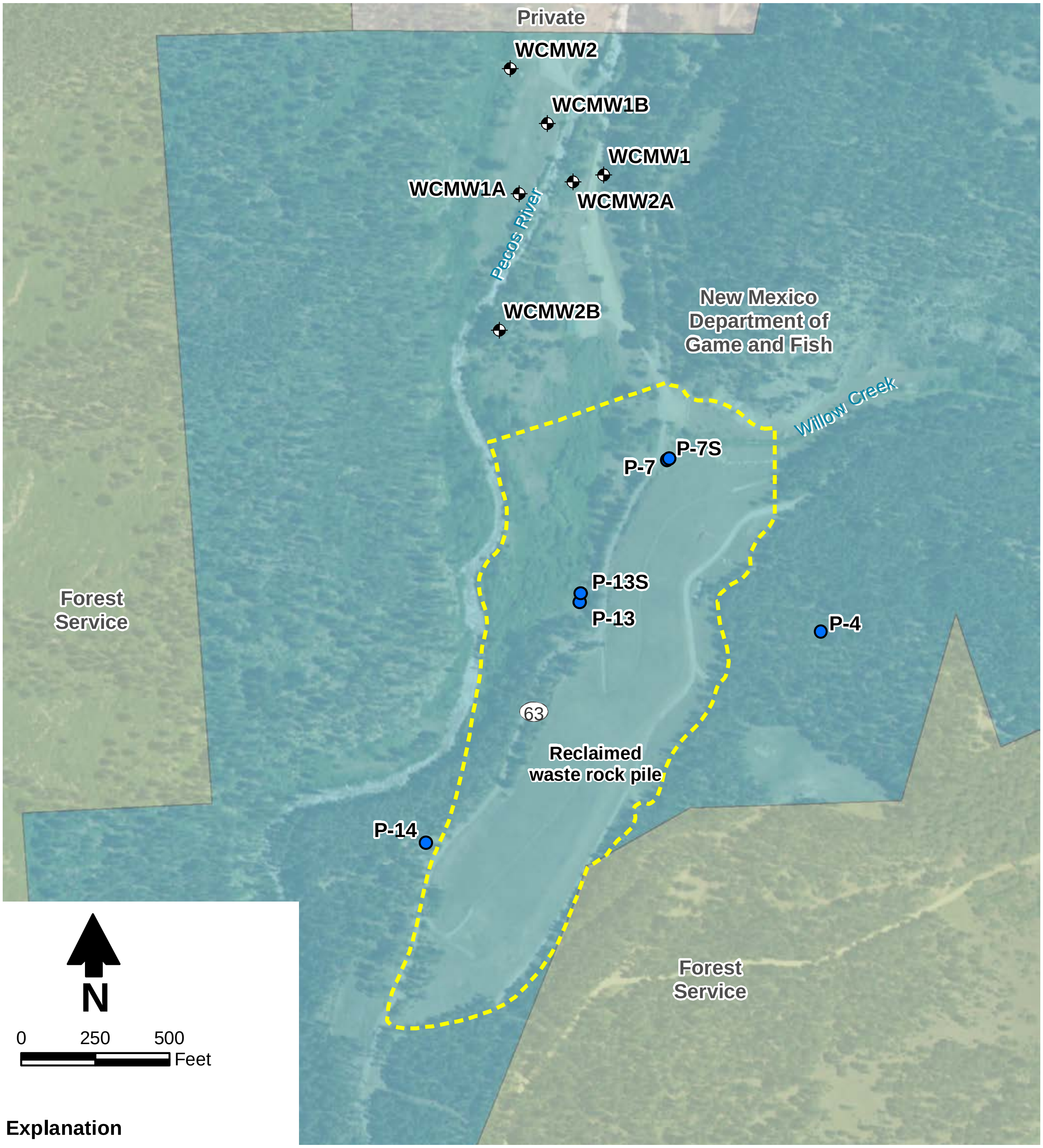
Site Location Map

Daniel B. Stephens & Associates, Inc.

4/11/2018

JN ES06.0038

Figure 1



Source: National Agricultural Imagery Program, publication date: 7/7/2016

Explanation

- PMOU monitor well
- NMDGF campground well
- Proposed area of alternative abatement standards
- Forest Service
- New Mexico Department of Game and Fish
- Private

PECOS MINE OPERABLE UNIT

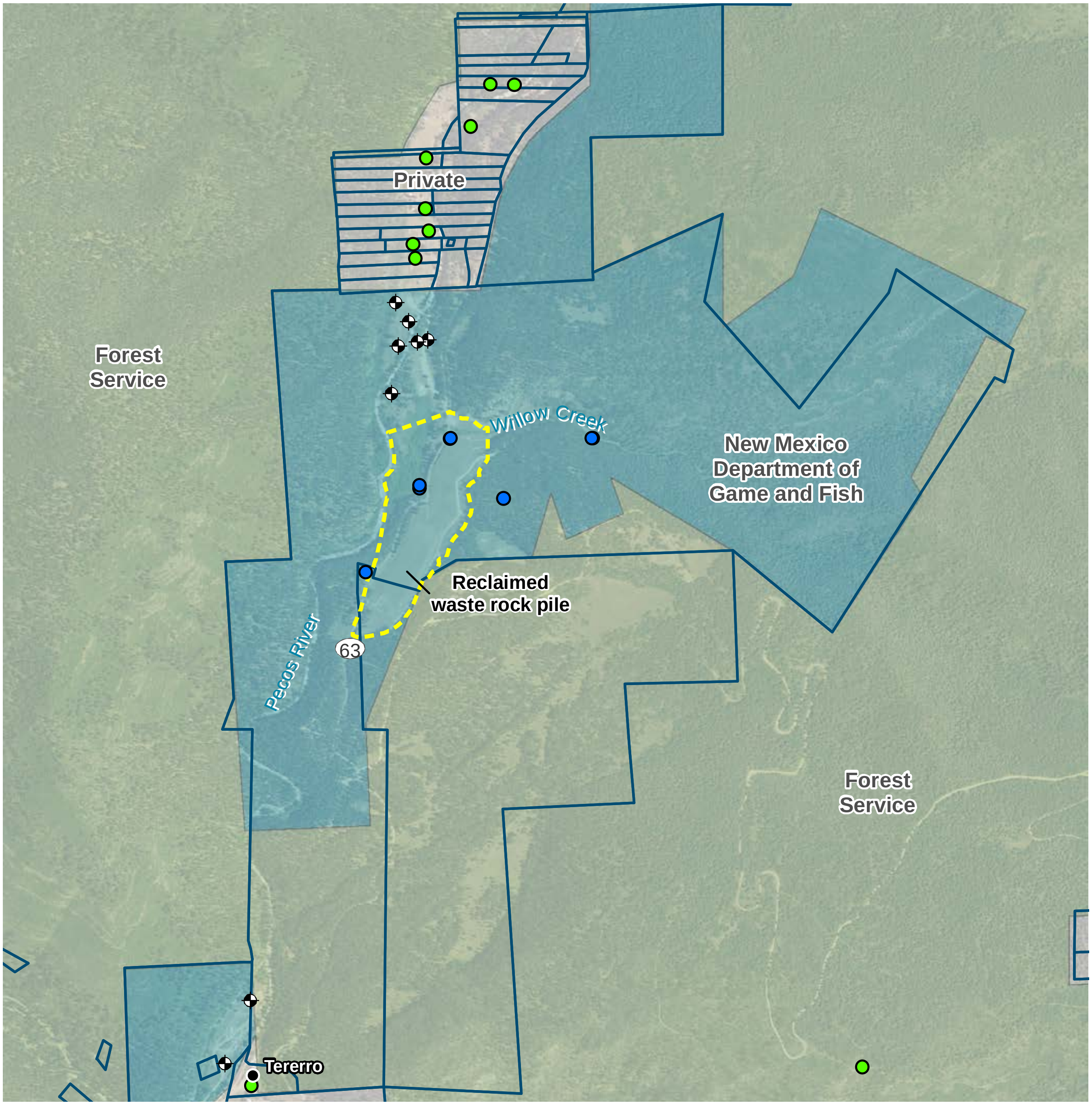
Proposed Alternative Abatement Standard Area and Surface Ownership

Daniel B. Stephens & Associates, Inc.

4/11/2018 JN ES06.0038

Figure 2

S:\PROJECTS\ES06.0038_PMOU\GIS\MXDS\REPORT\AAS\2018_02\FIG02_PROPOSED_ALTERNATIVE_ABATEMENT_STANDARD_AREA_AND_SURFACE_OWNERSHIP.MXD



Source: National Agricultural Imagery Program, publication date: 7/7/2016

N

0 750 1500 Feet

Explanation

- NMDGF campground well
- Private well
- PMOU monitor well
- Proposed area of alternative abatement standards
- San Miguel County parcel
- Forest Service
- New Mexico Department of Game and Fish
- Private

PECOS MINE OPERABLE UNIT

Surface Ownership and Nearby Wells

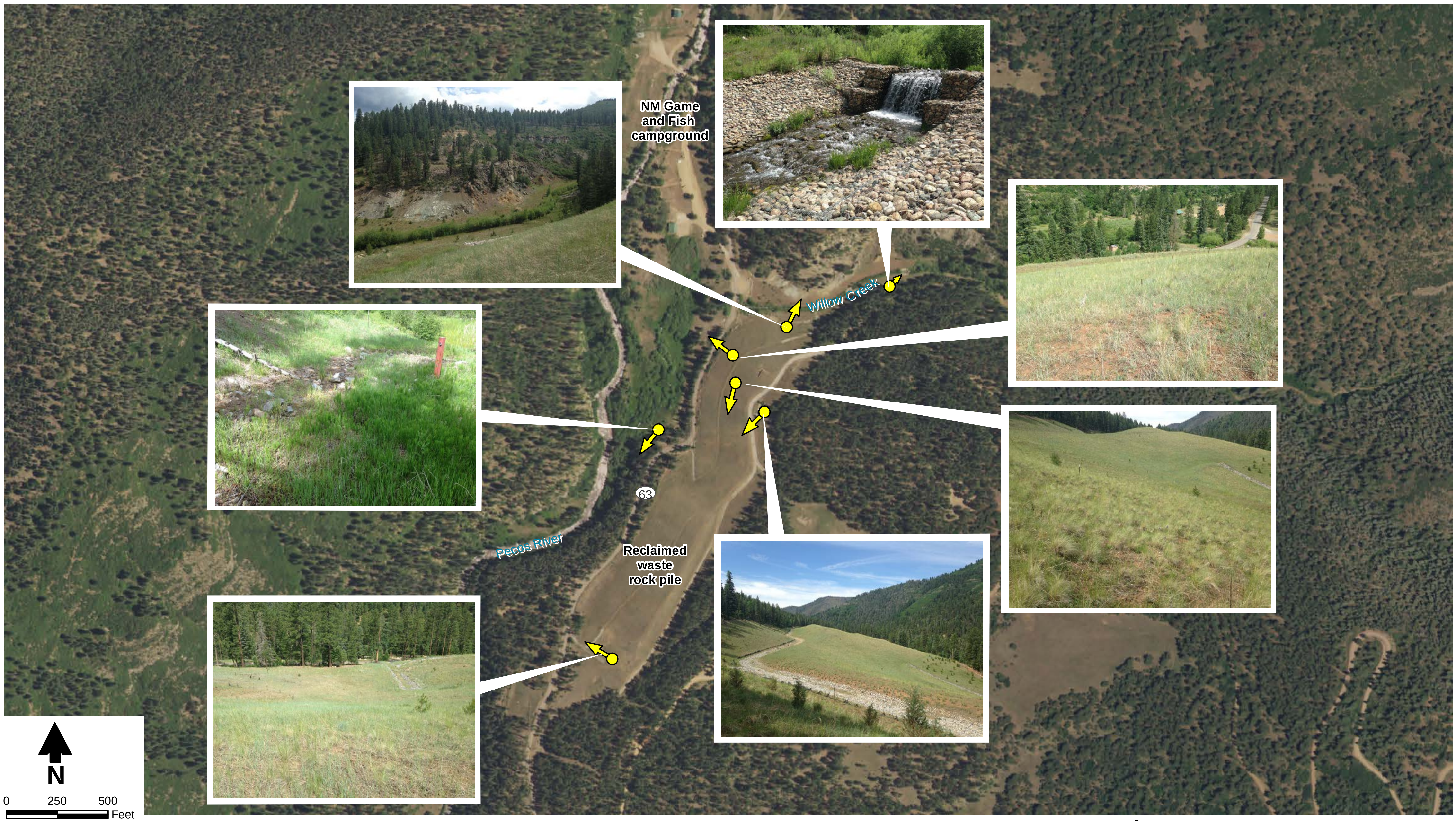
Daniel B. Stephens & Associates, Inc.

4/11/2018

JN ES06.0038

Figure 3

S:\PROJECTS\ES06.0038_PMOU\GIS\MXDS\REPORT\AAS\2018_02\FIG03_PMOU_SURFACE_OWNERSHIP_OSE_WELLS.MXD



Explanation

Approximate photograph location and viewing direction

Sources: 1. Photographs by DBS&A, 2016
2. National Agricultural Imagery Program, publication date: 7/7/2016

PECOS MINE OPERABLE UNIT

Site Photographs, Spring 2016

Daniel B. Stephens & Associates, Inc.
4/11/2018 JN ES06.0038

Figure 4

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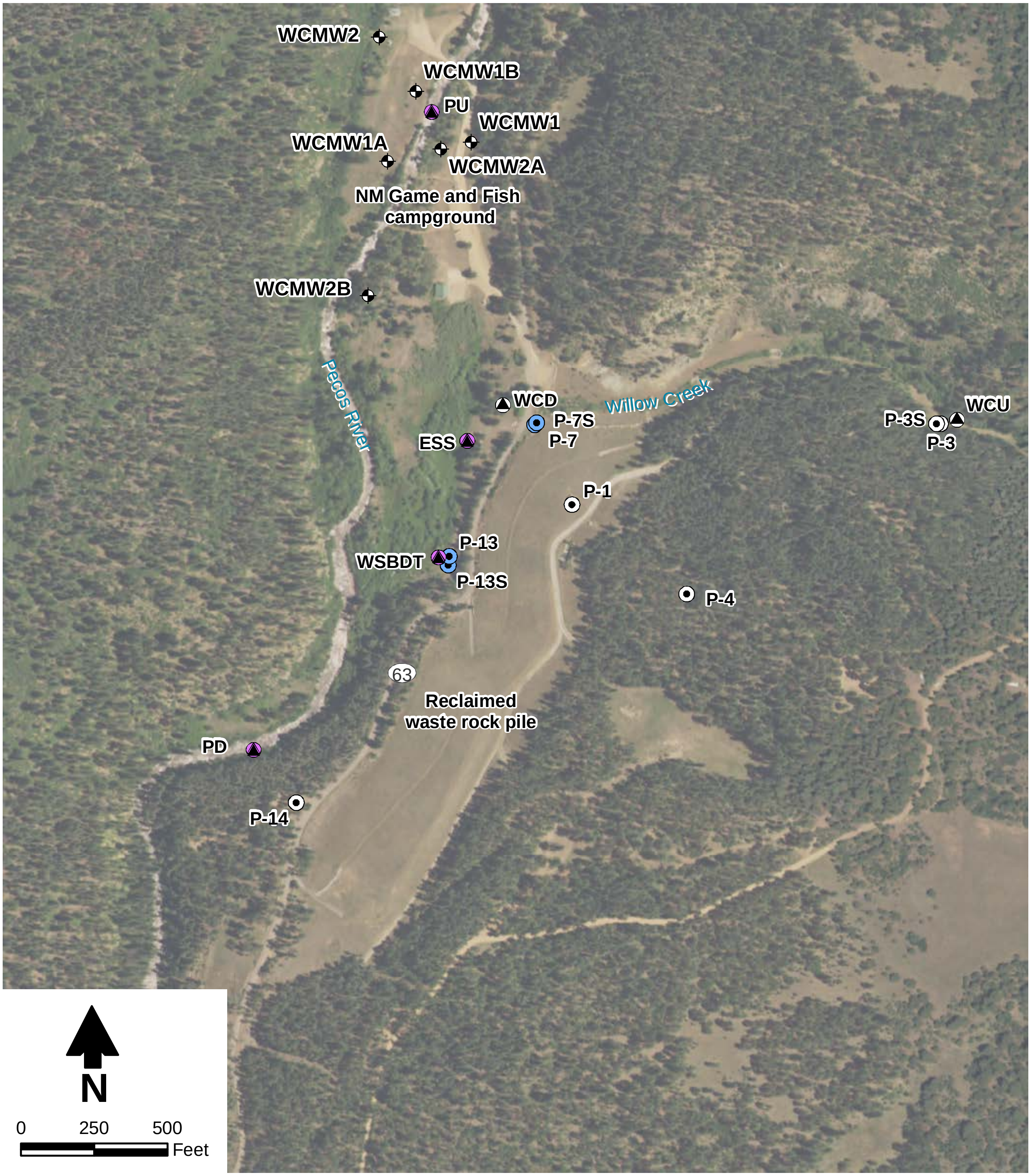


Source: National Agricultural Imagery Program, publication date: 7/7/2016

Explanation

- PMOU monitor well and sample location
- PMOU surface water or seep sample location (sample if flowing)
- PMOU monitor well (no longer monitored)
- PMOU surface water (no longer monitored)
- NMDGF campground well

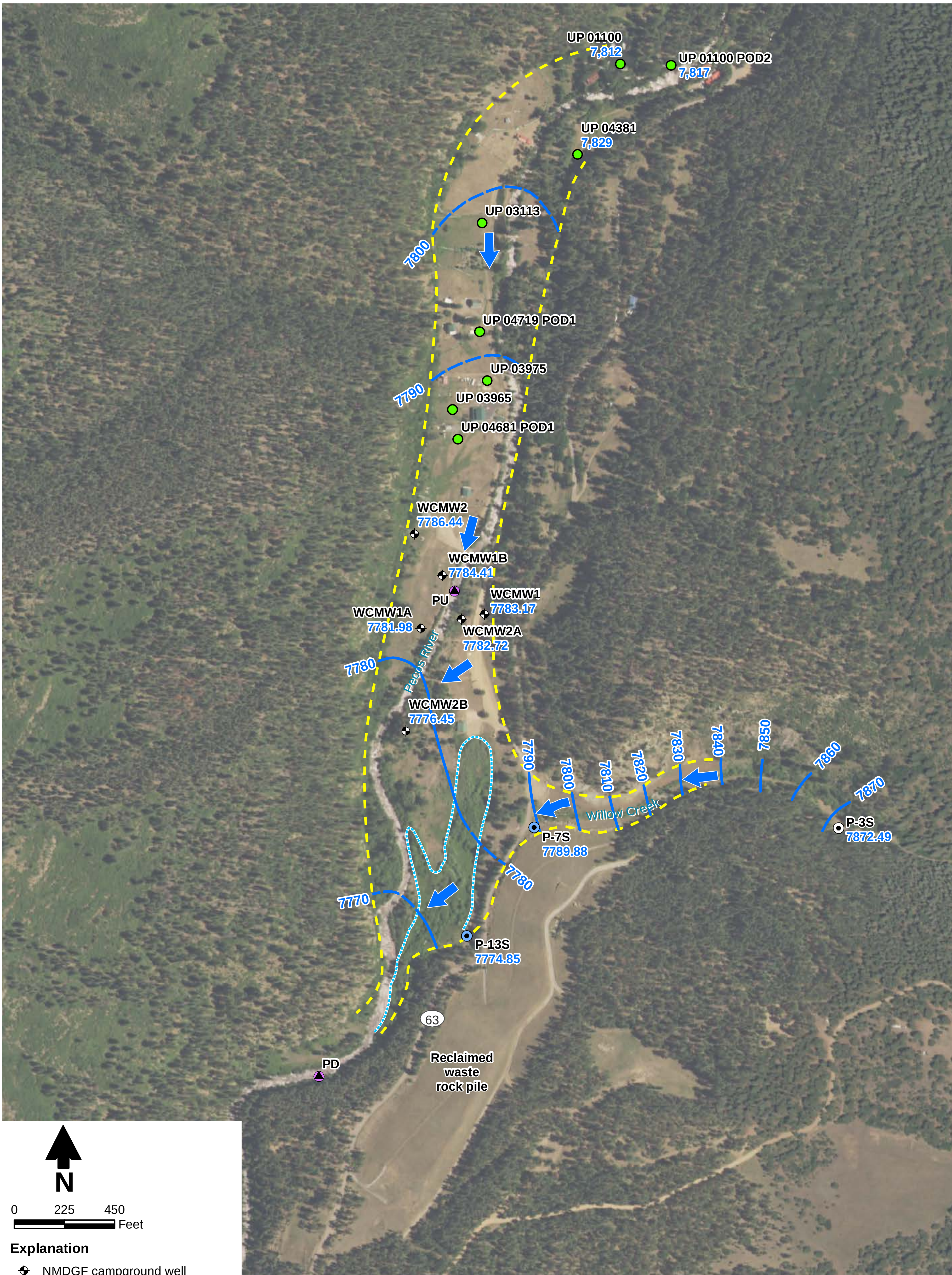
S:\Projects\ES06.0038_PMOU\GIS\MXDs\Report\AAS\2018_02\Fig05_Groundwater_and_Surface_Water_Monitoring_Locations.mxd

PECOS MINE OPERABLE UNIT

Groundwater and Surface Water Monitoring Locations

Daniel B. Stephens & Associates, Inc.
4/11/2018
JN ES06.0038

Figure 5



Explanation

- NMDGF campground well
- Private well
- PMOU monitor well and sample location
- PMOU monitor well (no longer monitored)
- PMOU surface water sample location
- Potentiometric surface elevation (ft msl)
- Approximate extent of wetlands (Stoller, 1996)
- Approximate extent of shallow aquifer

P-13S Well designation
7774.85 Groundwater elevation (ft msl)
Groundwater flow direction

Source: National Agricultural Imagery Program, publication date: 7/7/2016

Notes:
1. PMOU water levels from November 2009
2. Willow Creek Campground water levels from August 2017
3. Private well water levels from well completion date

PECOS MINE OPERABLE UNIT
Shallow Aquifer Potentiometric Surface

Figure 6

Daniel B. Stephens & Associates, Inc.
4/11/2018
JN ES06.0038

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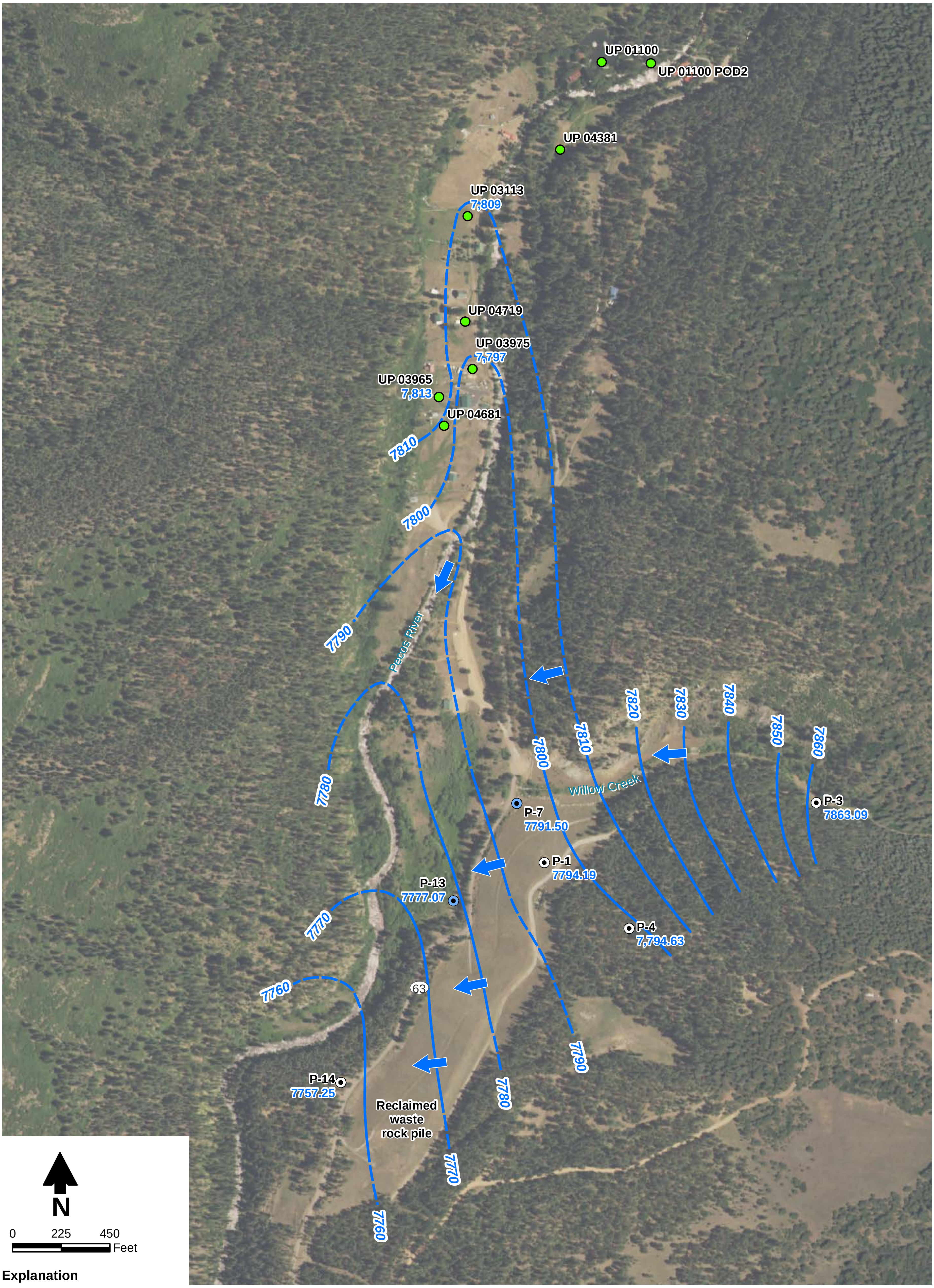


Source: National Agricultural Imagery Program, publication date: 7/7/2016

Explanation

- Private well
- PMOU monitor well and sample location
- PMOU monitor well (no longer monitored)
- Potentiometric surface elevation contour (ft msl)

P-14 Well designation
7757.25 Groundwater elevation (ft msl)
Groundwater flow direction

Notes:
1. PMOU water levels from November 2009
2. Private well water levels from well completion date

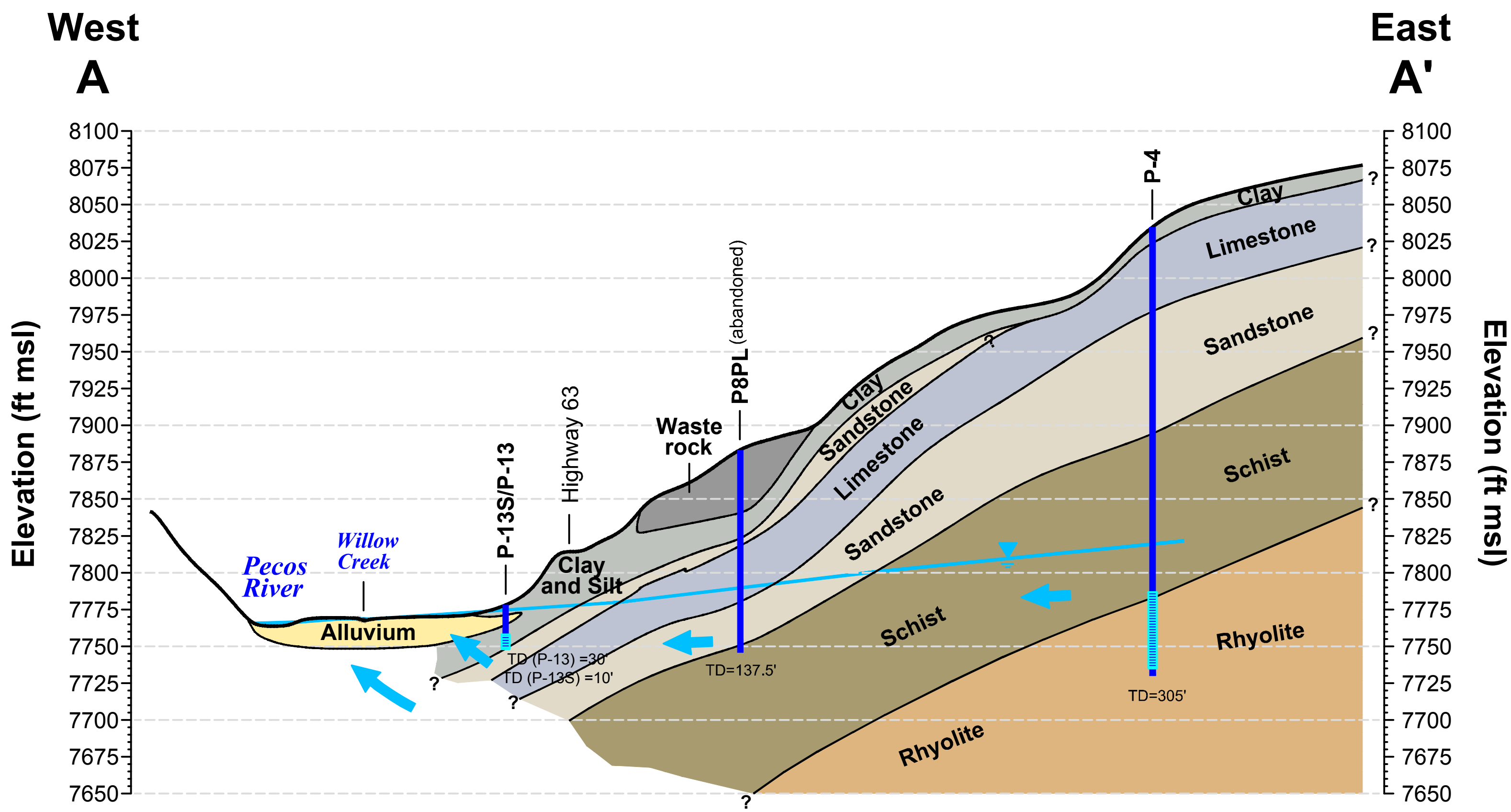
PECOS MINE OPERABLE UNIT

Regional Aquifer Potentiometric Surface

Daniel B. Stephens & Associates, Inc.
4/11/2018
JN ES06.0038

Figure 7

S:\Projects\ES06.0038_PMOU\VR\Cross_section\Fig08_West_to_east_hydrogeo_cross_sec_A-A'.dwg

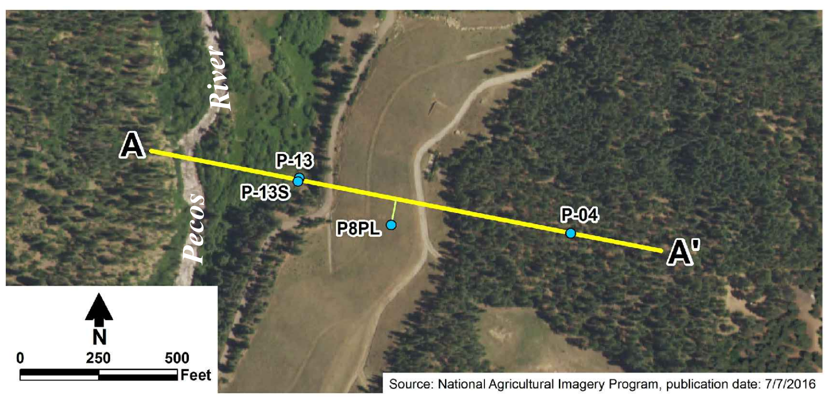


0 250 ft

Vertical exaggeration 2x

Explanation

- P-4 Well/boring identification
- Screened interval
- Water level elevation
- Direction of groundwater flow



Source: National Agricultural Imagery Program, publication date: 7/7/2016

PECOS MINE OPERABLE UNIT

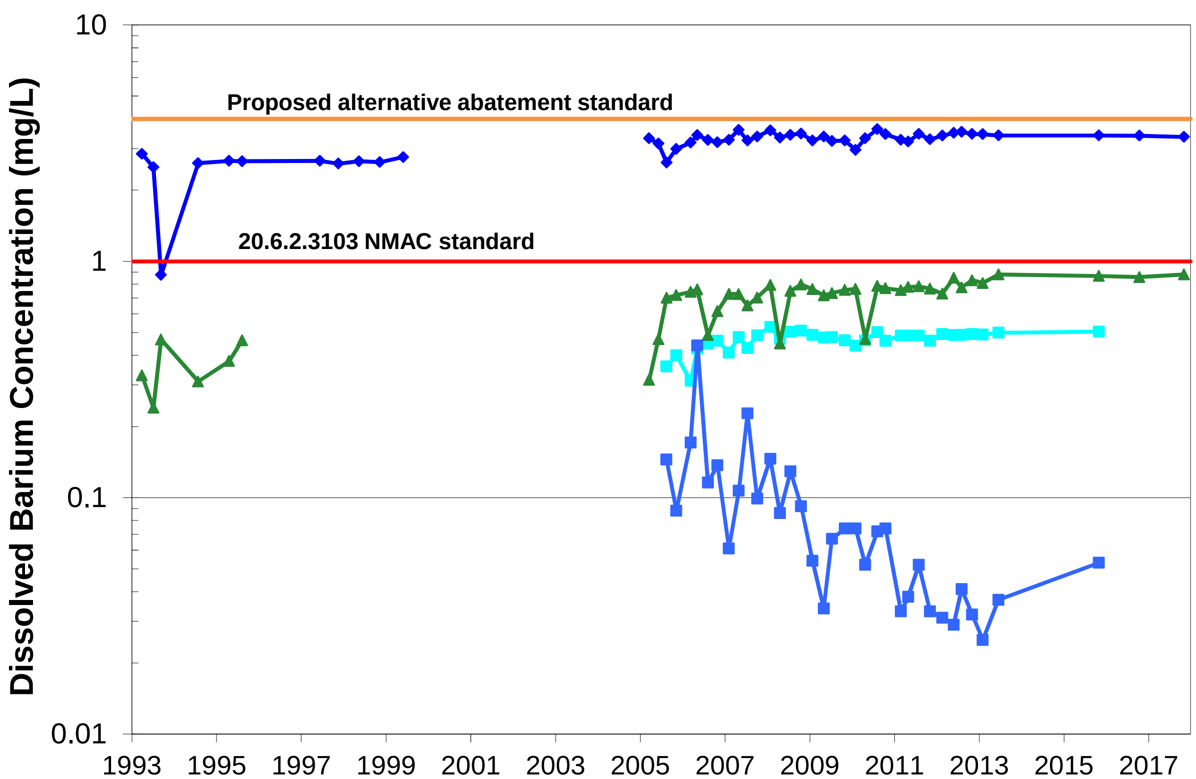
West to East Hydrogeologic Cross Section A-A'

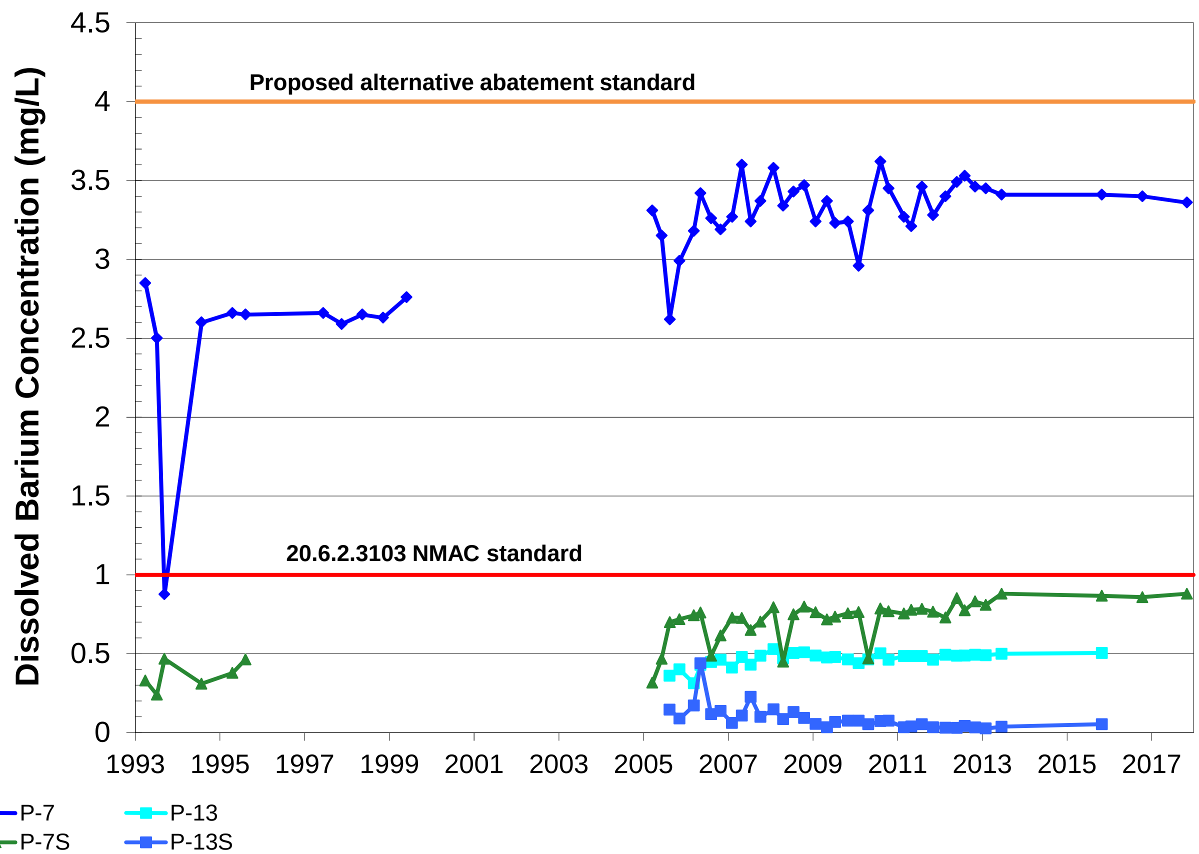
Figure 8

Daniel B. Stephens & Associates, Inc.

11/17/2016

JN ES06.0038





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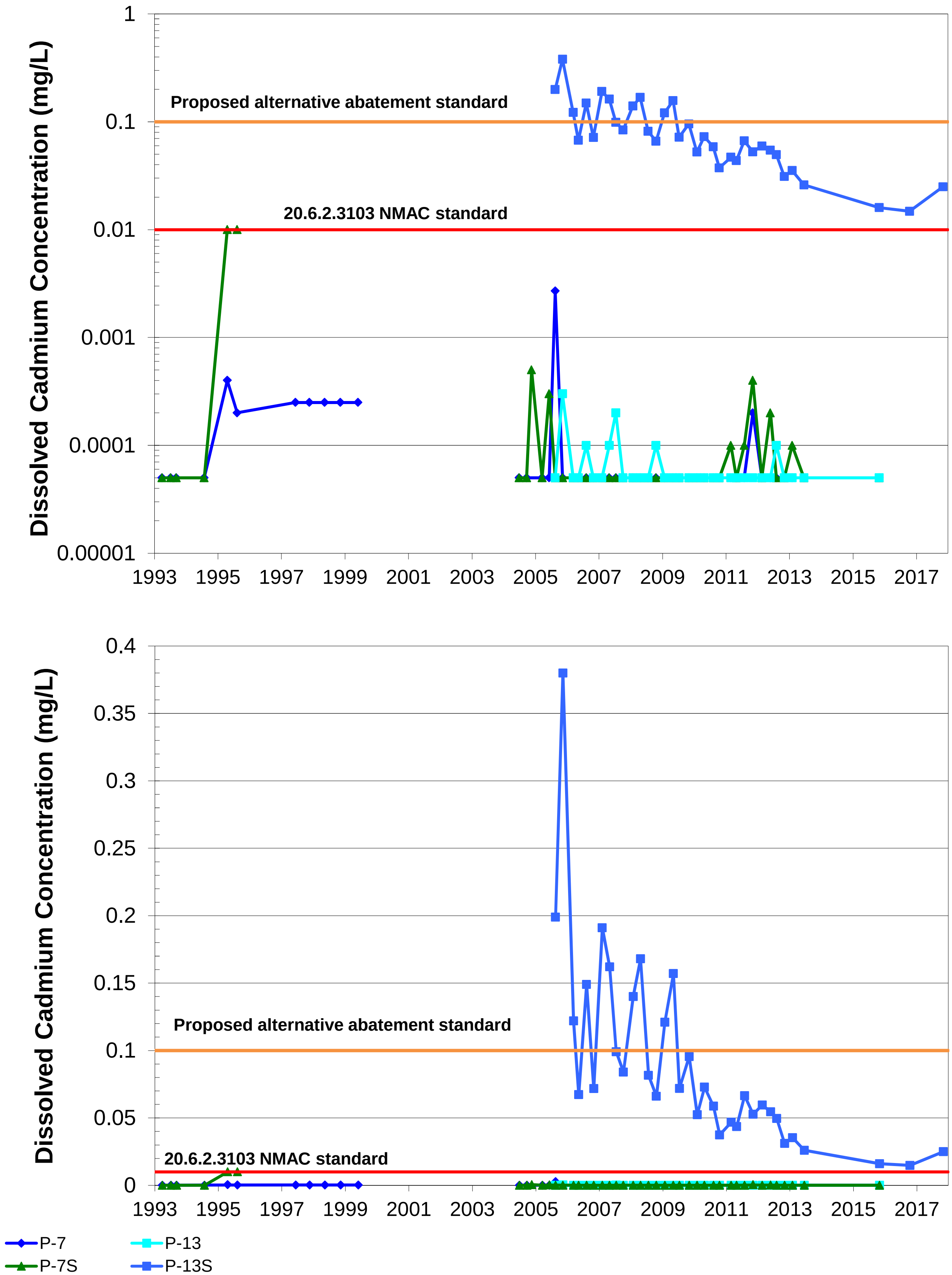
PECOS MINE OPERABLE UNIT

Dissolved Barium in Groundwater

Daniel B. Stephens & Associates, Inc.

2/21/18

Figure 9



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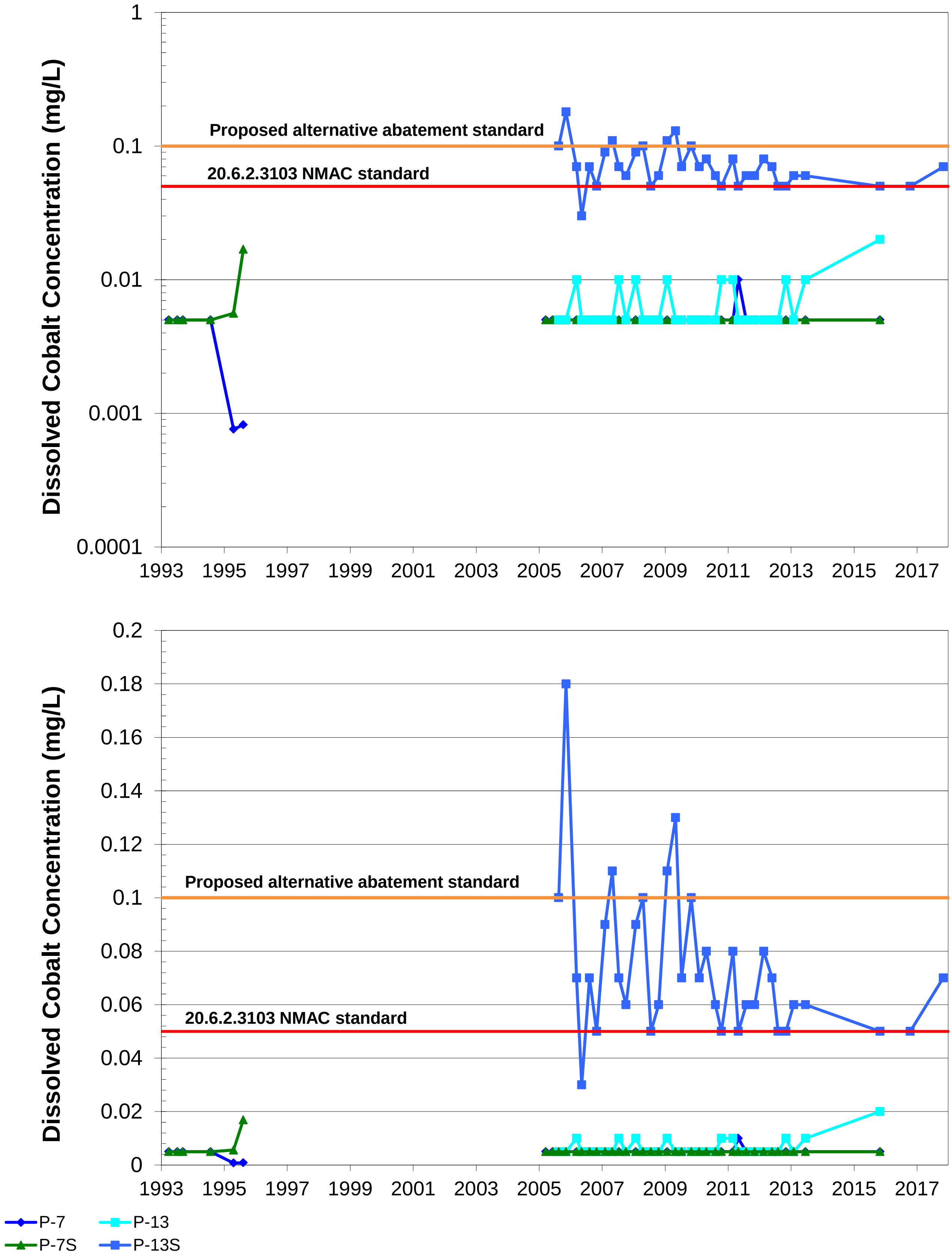
PECOS MINE OPERABLE UNIT

Dissolved Cadmium in Groundwater

Daniel B. Stephens & Associates, Inc.

2/21/18

Figure 10



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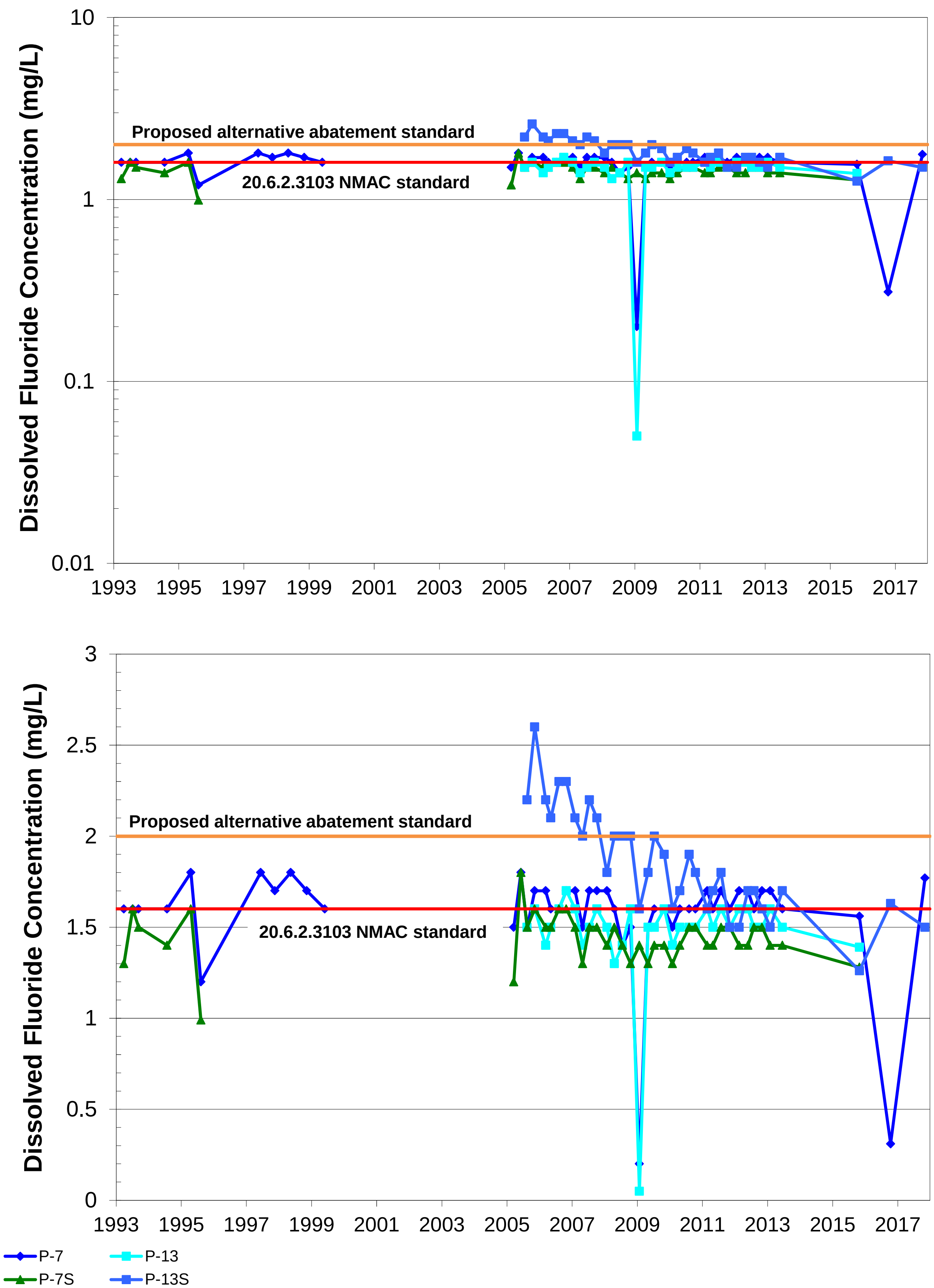
Daniel B. Stephens & Associates, Inc.

2/21/18

PECOS MINE OPERABLE UNIT

Dissolved Cobalt in Groundwater

Figure 11



PECOS MINE OPERABLE UNIT

Dissolved Fluoride in Groundwater

Daniel B. Stephens & Associates, Inc.

2/22/18

Figure 12

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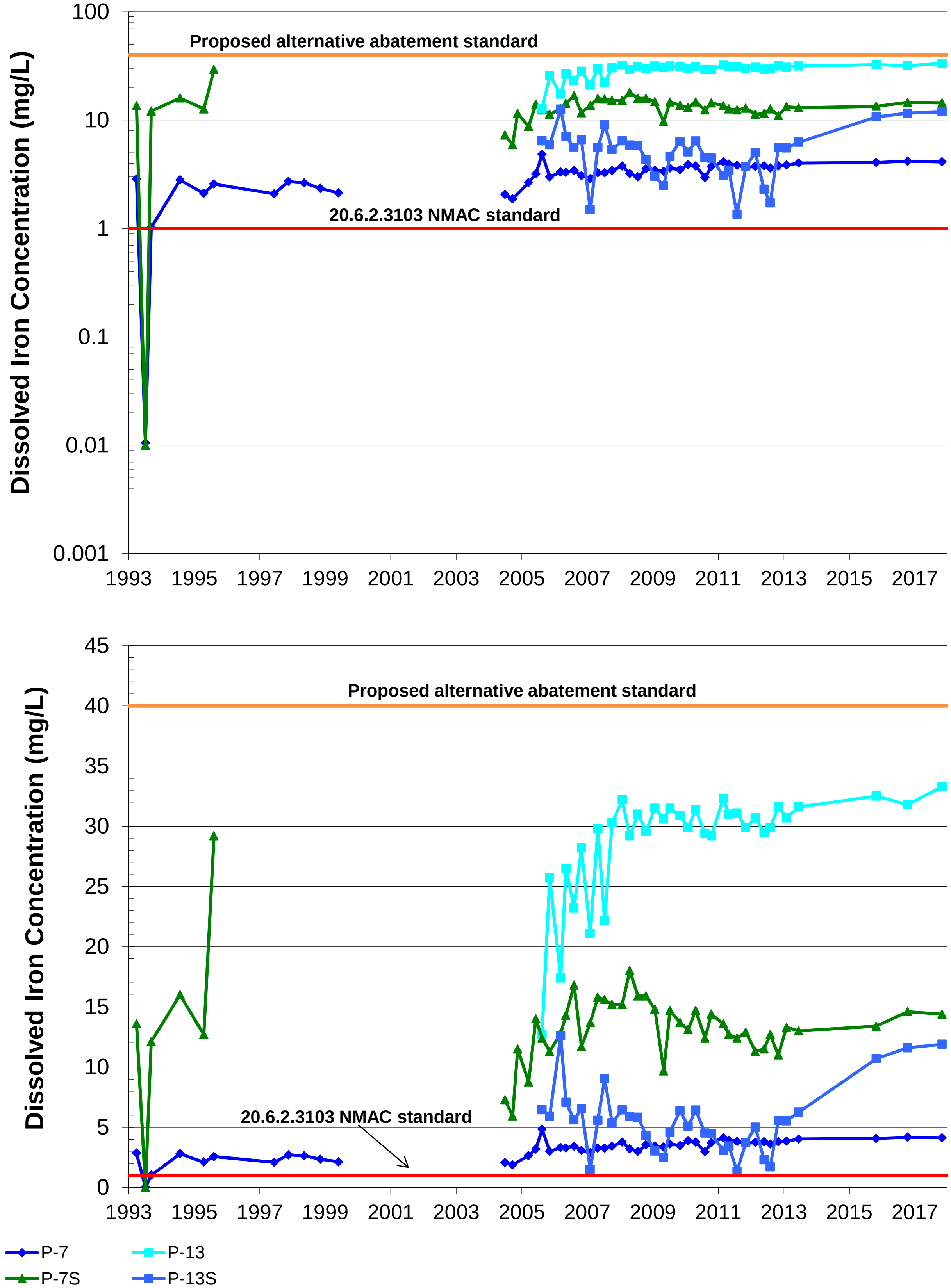

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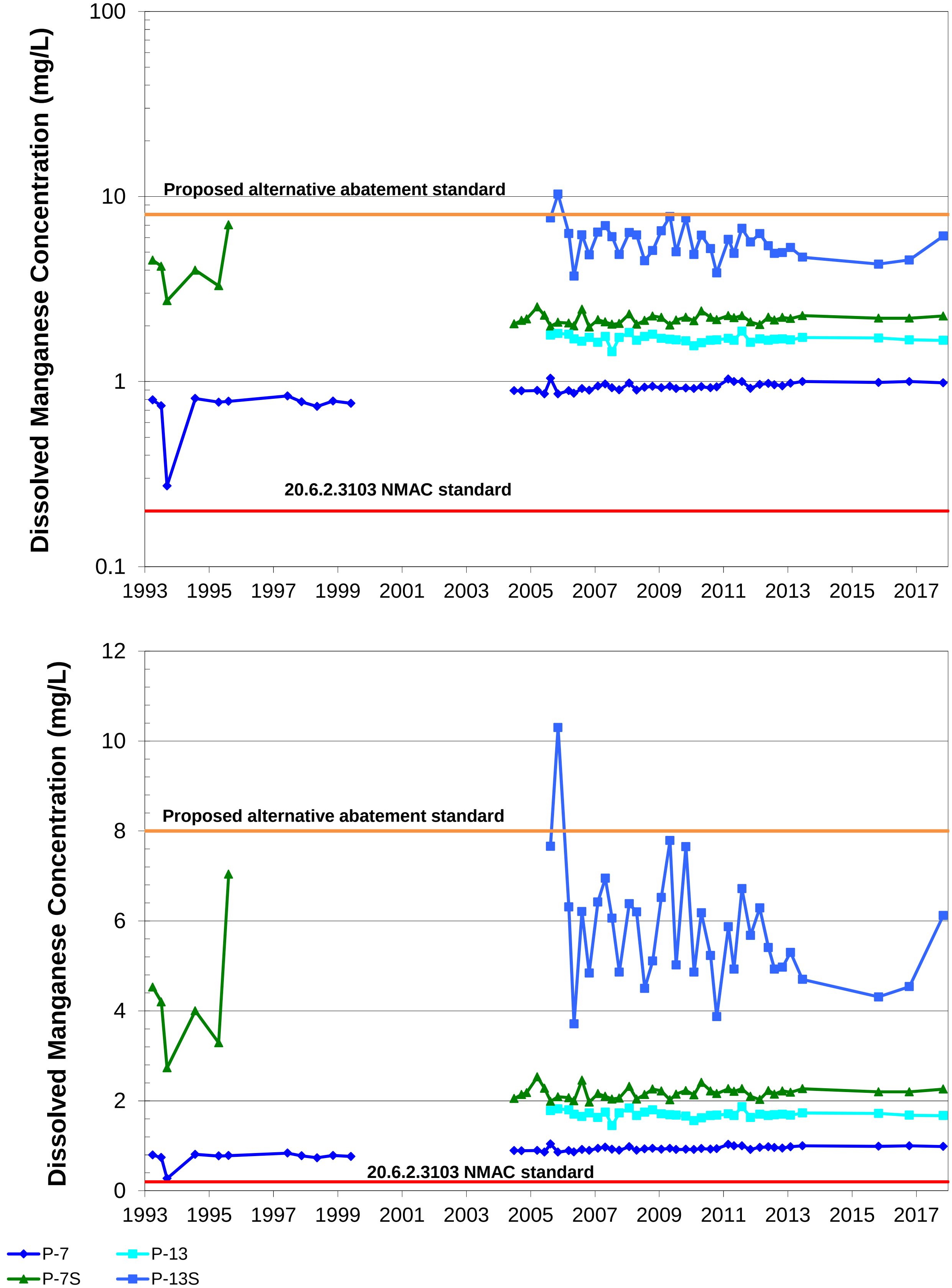
PECOS MINE OPERABLE UNIT

Dissolved Iron in Groundwater

Daniel B. Stephens & Associates, Inc.

2/21/18

Figure 13



PECOS MINE OPERABLE UNIT

Dissolved Manganese in Groundwater

Daniel B. Stephens & Associates, Inc.

2/21/18

Figure 14

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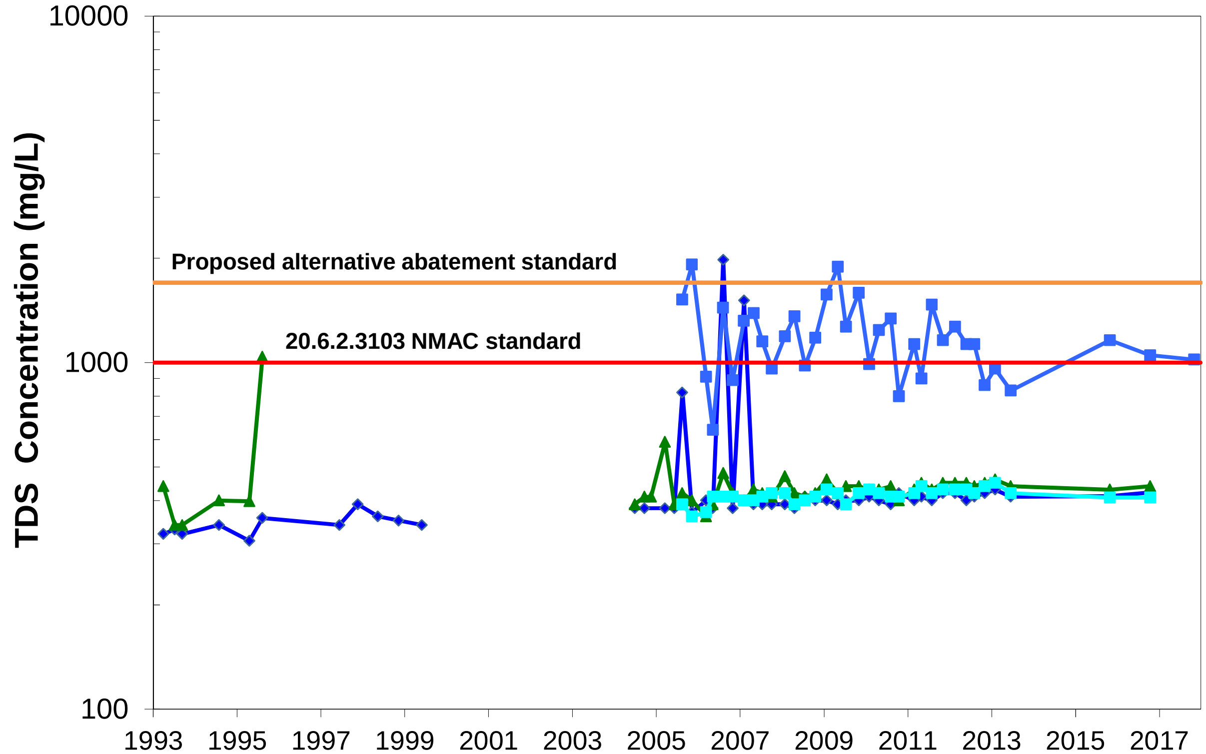

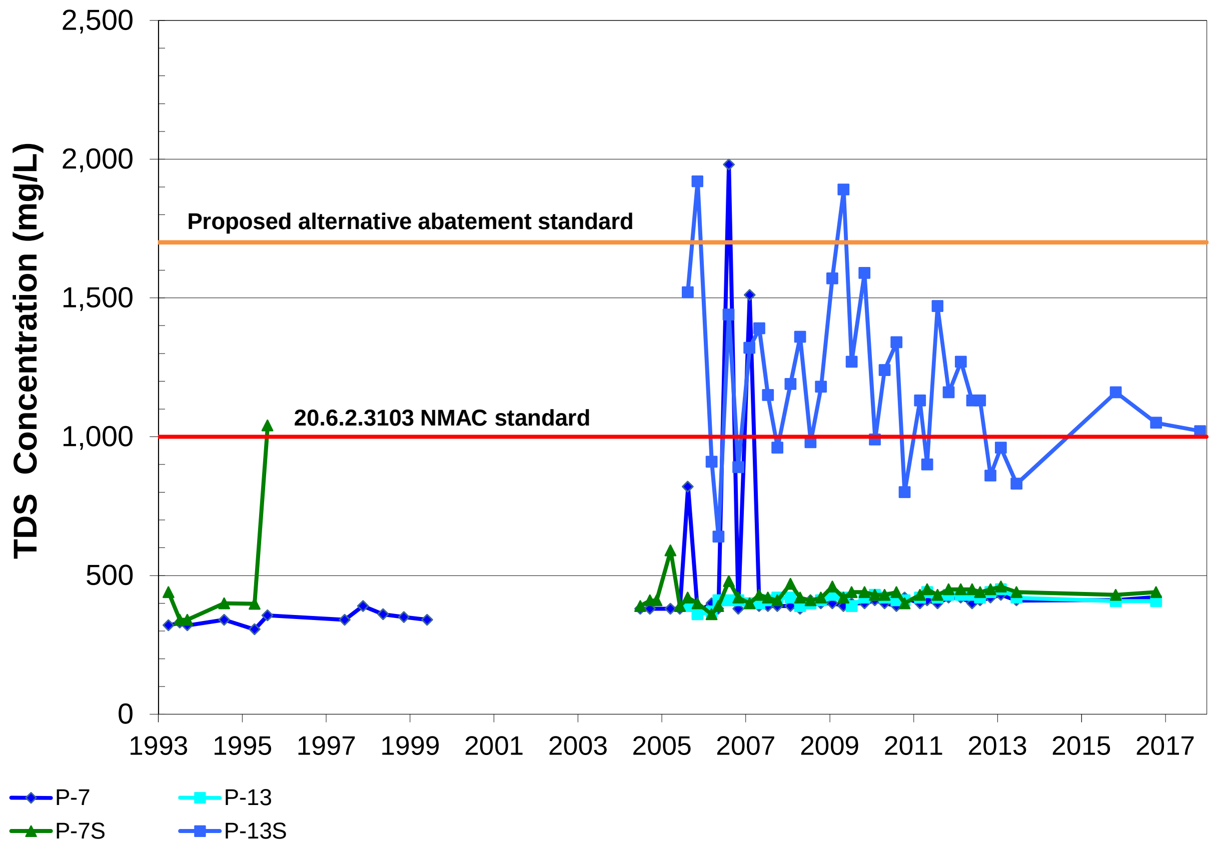

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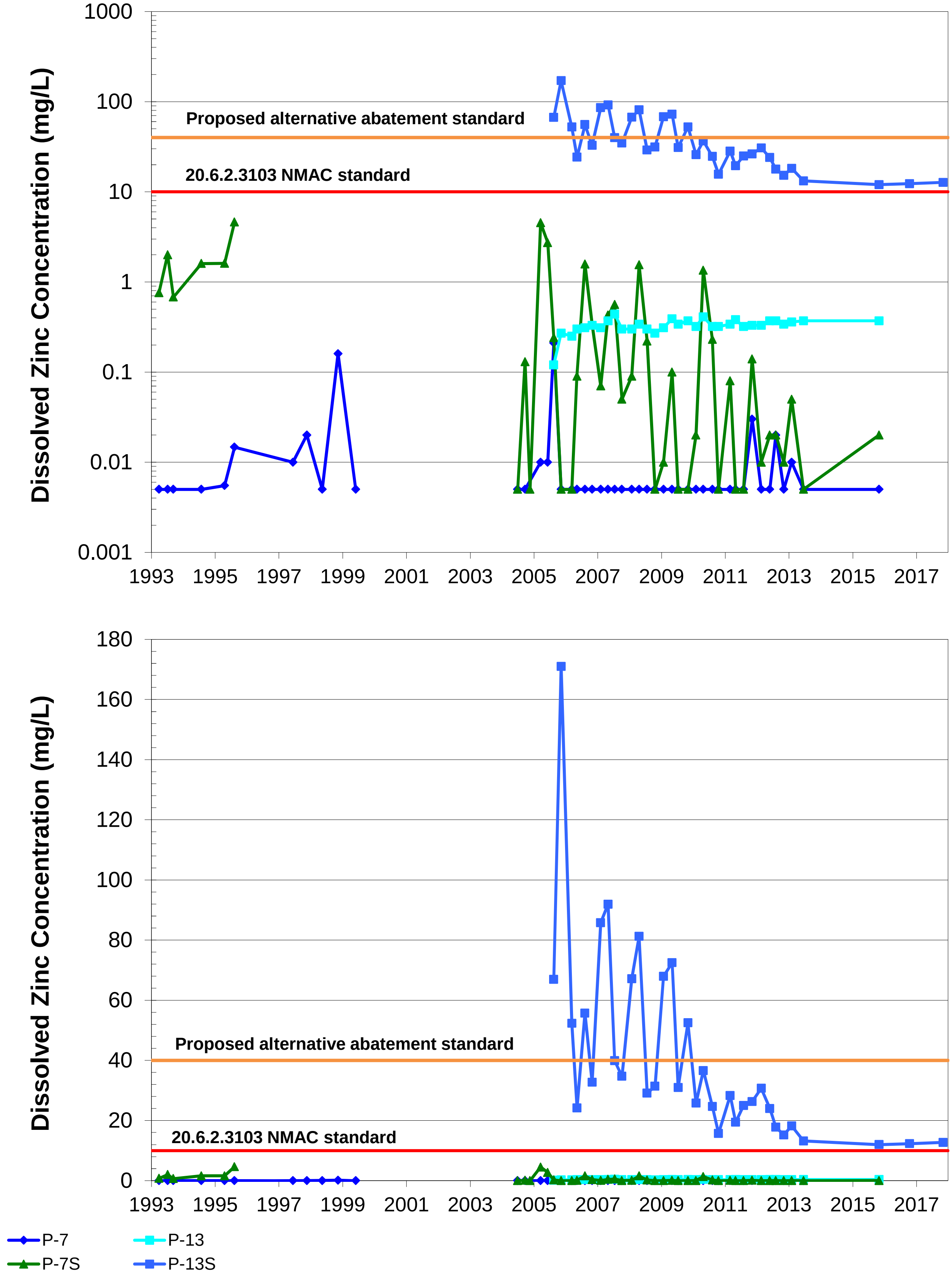
PECOS MINE OPERABLE UNIT

Total Dissolved Solids in Groundwater

Daniel B. Stephens & Associates, Inc.

2/21/18

Figure 15



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Daniel B. Stephens & Associates, Inc.

2/21/18

PECOS MINE OPERABLE UNIT

Dissolved Zinc in Groundwater

Figure 16

Table

Table 1. Private Wells Near PMOU

Well ID	Water Usage	Permitted Diversion (ac-ft/yr)	Distance from Proposed AAS Boundary (feet)	Elevation [a] (feet msl)	Water Level Elevation (feet msl)	Depth to Water (feet bgs)	Total Depth (feet bgs)	Screen Interval (feet bgs)	Year Drilled
UP 01100	Domestic	3	3,188	7,819	7,812	7	10	5–8	1984
UP 01100 POD2 [b]			3,219	7,824	7,817	6.5	10	6–10	1998
UP 03113	Domestic	3	2,461	7,820	7,809	11	97	57–97	2006
UP 03535 [c]	Domestic	3	4,453	7,689	7,679	10	105	—	1958
UP 03965	Domestic	3	1,653	7,820	7,813	7	100	60–100	2006
UP 03975	Domestic	1	1,755	7,815	7,797	18	125	85–125	2006
UP 04381	Domestic	1	2,766	7,834	7,829	5	18	8–18	2011
UP 04681 [d]	Multiple domestic	2	1,519	7,816	—	—	—	—	2017
UP 04719 [e]	Domestic	1	1,976	7,809	—	—	—	—	—

Source: NMOSE, 2017

[a] Elevation estimated from the USGS National Elevation Dataset (http://ned.usgs.gov).

[b] Previously listed as UP 02672.

[c] Well located near Tererro.

[d] Well log filed in August 2017; online document not yet available.

[e] Application filed in April 2017; no well log filed. Well may not exist.

ac-ft/yr = Acre-feet per year
msl = Above mean sea level
bgs = Below ground surface
— = Unknown

Appendix A

PMOU Feasibility Study and Decision Document

Appendix A1

PMOU Feasibility Study

Schafer & Associates, Inc.
801 Fourteenth Street
Golden, CO 80401-1866

303-216-1600
FAX 303-216-1316

RECEIVED
SEP 12 1997

September 10, 1997

Stephen Wust, Ph.D.
Project Manager, Tererro Remediation Unit
New Mexico Environment Department
1190 St. Francis Drive, Room N2209
Santa Fe, New Mexico 87502

RE: Response to comments on the Pecos Mine Operable Unit Feasibility Study (Draft; May 22, 1997)

Dear Dr. Wust:

On behalf of Cyprus Amax Minerals Company (Cyprus Amax), Schafer & Associates is submitting responses to your most recent comments (July 18, 1997) on the Feasibility Study for the Pecos Mine Operable Unit (FS). Response to the comments has two components: (1) written responses to each comment and (2) revisions to the FS that incorporate changes requested by NMED and agreed to by Cyprus Amax. Both components are enclosed with this letter.

The following components of the FS report were revised and are enclosed:

- Revised Sections 1 through 5. Transmitting the entire text was necessary because some comments required addition of text that altered pagination.
- Revised Tables 2-1, 2-3, and 2-4.
- New Figure 3-3 added to illustrate an alternative regrading plan for the dump.
- Renumbered Figures 3-4 through 3-11 (figures numbers changed to account for new Figure 3-3)
- Revised Table of Contents
- Revised report covers and spines
- Revised title page

Recipients of these revisions should replace the indicated sections of the report with the revised sections. We realize that a large portion of the report was replaced. However, this approach is still the most expedient way to transmit the revised document.

As we discussed, Cyprus Amax anticipates that, pending your approval, these are the final revisions to the Pecos Mine FS. As usual, please do not hesitate to call me (303/216-1600) if you have any questions or requests regarding the FS Report. Thank you.

Sincerely,

Mark C. Lewis
Senior Biologist
Schafer & Associates

cc: Joseph Cde Baca, *Mayor, Village of Pecos*
Johnnie Greene, *Cyprus Amax Minerals Company*
Ed Kelley, *Director, Water and Waste Management Division, New Mexico Environment Department*
Kathy Kretz, *New Mexico State Highway and Transportation Department*
Manu Patel, *Legislative Finance Committee (cover letter only)*
Kenneth Paulsen, *Kenneth R. Paulsen Consulting*
Andrew Sandoval, *New Mexico Game and Fish Department*
Virginia Trujillo, *San Miguel County Manager*
Mark Weidler, *Secretary, New Mexico Environment Department*
Don Williams, *New Mexico Team Leader, U.S. Environmental Protection Agency*

MEMORANDUM

October 9, 1997

To: Stephen Wust, Terrero Remediation Project

From: Dennis Slifer, Surface Water Quality Bureau DWS

RE: Comments on Responses to Comments for draft Feasibility Study, Terrero Mine Site

---

I have reviewed the responses to comments for the draft feasibility study of the Terrero Mine site prepared by S.M. Stoller Corporation on May 22, 1997. It appears that the respondent has adequately addressed all of the comments and concerns that were raised in the initial review process. The only area to which I would draw attention is the section on Short-term Effectiveness: Environmental Impacts, on page 12. The language here regarding erosion and sedimentation states that "Effects on Willow Creek should only last as long as the remedial action in the creek is occurring, which will not be for the entire remediation." Cyprus Amax's response is that clarification will be provided in a draft text for NMED to review and approve prior to inclusion in the revised FS. It is important to specify that at all times during any construction work that takes place within the channel of Willow Creek, that the conditions of the CWA 404 Permit and 401 certification be adhered to. There must be no measurable effects on Willow Creek water quality due to the construction-related disturbances. If there are questions about this matter, especially prior to and during construction activities, please contact me at 827-2841, or Cecilia Brown at 827-0106

cc: Cecilia Brown, SWQB

RESPONSES TO COMMENTS
STATE OF NEW MEXICO ENVIRONMENT DEPARTMENT
PECOS MINE OPERABLE UNIT, TERRERO SITE, SAN MIGUEL COUNTY

INTRODUCTION

This document contains Cyprus Amax Minerals Company (Cyprus Amax) responses to New Mexico Environment Department (NMED) comments on the draft Feasibility Study (FS) for the Pecos Mine Operable Unit (OU) at the Tererro Mine Site. The NMED comments were transmitted to Mr. Johnnie Greene of Cyprus in a letter from Dr. Stephen L. Wust of NMED dated July 18, 1997. The draft FS, dated May 22, 1997, was prepared by the S. M. Stoller Corporation.

SPECIFIC RESPONSES

1.4.3 Groundwater

Comments:

Second paragraph: State which wells were completed in the underground mine workings, as was done for the other completions.

Third paragraph, first sentence: List the wells completed in the shallow aquifer.

Response:

The text has been corrected to identify wells completed in the underground workings.

1.4.4.1 Willow Creek

Comment:

First paragraph, second sentence; second paragraph, first sentence: List those metals that exceeded water quality standards

Response:

Cyprus Amax agrees to list the specified metals, as requested.

2.1 Remedial Action Objectives

In general, Cyprus agrees with suggested changes to wording and requests for inclusion of additional information. As an exception, however, Cyprus Amax does not agree with some of NMED's suggested text revisions in the listing of Remedial Action Objectives (RAOs) for various media. Our primary concern is with some suggested uses of the words "eliminate" and "prevent" in describing the RAOs for various media. EPA guidance for CERCLA Feasibility Studies (EPA 1988) defines RAOs as follows:

"Remedial action objectives consist of medium-specific or operable unit-specific goals for protecting human health and the environment....Remedial action objectives for protecting human receptors should express both a contaminant level and an exposure route....[RAOs] for protecting environmental receptors...should be expressed in terms of the medium of interest and target cleanup levels, whenever possible" (Section 4.1.2.1, page 4-3).

Cyprus Amax interprets this guidance to say two things: (1) RAOs are *goals*, not compliance criteria, and (2) the thrust of RAOs should be to attain risk-based cleanup levels. It is our understanding that NMED representatives agree with this interpretation in general. However, we think that it is critical for language that defines RAOs in the FS to be written in such a way that different interpretations do not arise at some unknown time in the future.

The words "eliminate" and "prevent" describe absolutes that may be difficult and unreasonable to achieve unless they are coupled with explanatory text. This is reflected in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) regulations concerning the RI/FS and remedy selection processes (40CFR300.430). The introduction to this section of the NCP says that the purpose of remedy selection is to "eliminate, reduce, or control risks to *human health and the environment*" [emphasis added]. Note that this section indicates that the reduction or control of risks are acceptable objectives and indicates the emphasis is on *risks*, not the elimination or prevention of offsite movement of contaminants. The program goal for the NCP remedy selection process adds that the goal "is to select remedies that are *protective of human health and the environment.*" Again, the goal is not to eliminate or prevent movement of contaminants.

NMED comments on Section 2.1 of the FS generally consist of three suggested changes: (1) replacing words such as "minimize" or "reduce" with the more absolute terms "eliminate" and "prevent," (2) deleting explanatory language such as "exceeding acceptable risk levels" when "eliminate" or "prevent" are used, and (3) deleting phrases that seek to define the point at which cleanup criteria should be evaluated.

With regard to the third point, Cyprus Amax is concerned that the notion may become instilled in readers of the FS that cleanup will be considered effective only if *no* contaminants occur outside the physical limits of the remediated waste rock dump. Again, this is neither reasonably feasible nor necessary to protect human health and the environment, and it is not supported by the language used in the NCP regulations.

Finally, we point out that the NCP regulations recognize that some level of risk is acceptable. For example, Section 300.430(e)(2)(i)(A)(1) sets an appropriate cleanup level for noncarcinogens as "concentration[s]...to which the human population...may be exposed without adverse effect." Section 300.430(e)(9)(iii)(A) uses the standard of protecting "human health and the environment...from *unacceptable* risks [emphasis added]." Cyprus Amax believes that this type of phraseology was included in the NCP regulations to avoid the interpretation that *elimination* or *prevention* of releases were necessarily appropriate objectives.

2.1.1 Waste Rock

<u>Comment:</u>

"RAOs for waste rock are:

1. Prevent exposure of human receptors to metals in rock

Eliminate generation of acid....

Prevent migration of contaminants to surface water or groundwater.

Eliminate erosional transport...."

Response:

RAOs for waste rock are **to**:

1. *Prevent exposure of human receptors to metals in waste rock at levels that exceed RACCs.*

2. *Minimize generation of acid leachate from percolation of water through the waste rock dump.*

3. *Prevent migration of contaminants to surface water or groundwater at levels that would exceed RACCs.*

4. *Minimize erosional transport of waste rock particulates to downgradient soils and surface water drainages.*

2.1.2 Affected Soils

Comments:

First paragraph: "Soils in some areas...in restricted areas, *and may act as a secondary source of contamination.*"

Second paragraph, last sentence: "No unacceptable exposure in the soil pathway was observed for recreational or residential use of the site."

Response:

Cyprus Amax agrees to the recommended revisions.

Comment:

"RAOs directly involving soils are *to*:

Response:

"RAOs directly involving soils are **to**:

1. *Prevent exposure of human receptors to metals in soils that exceed RACCs.*

2. *Prevent toxic exposure of ecological receptors to site contaminants that could result in significant effects on local plant and/or soil fauna communities.*

3. *Minimize transport of waste rock contaminated soils to downgradient areas and waterways that would result in exceedence of RACCs.*

4. *Revegetate areas in which vegetation has been impacted due to toxic effects of waste rock or leachate in soils.*

2.1.3 Groundwater

Comment:

Third paragraph: "Results of the HERA…not experience *unacceptable risk levels*."

Response:

Cyprus Amax agrees to the requested revision.

Comment:

"RAOs for protection of groundwater are:

1. Restore groundwater quality to state standards.
2. Prevent transport of contaminants from groundwater flow systems to surface water."

Response:

"RAOs for protection of groundwater are *to*:

1. Restore groundwater quality to *conform with RACCs*.
2. Reduce transport of contaminants from groundwater to surface water to levels that *conform with RACCs.*

2.1.4 Surface Water

Comment:

First Paragraph, last sentence: "As a result…is attenuation *of* metal loading."

Response:

Cyprus Amax agrees that the word "of" should have been included in the sentence where indicated.

Comment:

"The RAO for seep water and surface water is:

1. Eliminate site-related loading of metals to surface water."

Response:

"The RAO for seep water and surface water is *to*:

1. *Reduce* site-related loading of metals to surface water *will allow conformance with RACCs.*

2.1.5 Wetland Soils

Comment:

First paragraph, last sentence: "Metal precipitates in the soils around WSBDT may also be a source for dissolution and transport of metals to the Pecos River."

Response:

Cyprus Amax agrees with the suggested revision.

Comment:

"The RAO for wetland sediment refers to *the* area around WSBDT:

Prevent release of contaminants to wetland sediments."

Response:

"The RAOs for wetland sediment, which refers to an area around seep WSBDT, is to:

1. *Prevent release of contaminants that would result in release of contaminants to wetland soils at levels that would result in exceedence of RACCs.*

2. *Prevent movement of contaminated soils that would result in exceedence of RACCs in surface water.*

2.1.6 Willow Creek Bed Material

Comment:

RAOs: "1. *Prevent* contact of stream water with waste rock to prevent metal concentrations from contaminating stream water."

Response:

RAOs: "1. *Minimize* contact of stream water with waste rock to prevent metal concentrations in surface water from *exceeding RACCs.*"

Comment:

Note that Table 2-2 lists treatment for waste rock (Does the reprocessing refer to onsite? If offsite, should it then not be within the removal alternative?), although the text does not. Include a section for the waste rock dumps (Section 2.3.1.4 Treatment) and the soils (add to 2.3.2) discussing the treatment options and their effectiveness for this site. Also revise the introductory sentence of 2.3.1: "*Four* response actions...containment, *treatment*, and removal (Table 2-2)." Revise Table 2-2 to show all the reasonable treatment options, in addition to processing.

Response:

Reprocessing of the waste rock is assumed to be an offsite process and therefore, as indicated in the NMED comment, should be treated as a removal variant. Cyprus Amax agrees to clarify this point, add the supplemental text, and revise Table 2-2 as requested by NMED in the comment. A draft of the new or revised material will be provided to NMED for review and approval prior to preparation of the revised FS document.

2.1.7 Air

Comment:

RAOs: "1. Prevent concentrations...at the Pecos Mine."

Response:

RAOs. "1. Prevent concentrations...*for nonworker (i.e., offsite) exposures* during earthmoving or construction activities associated with remediation at the Pecos Mine."

Comment:

Decisions regarding remediation and cleanup levels at the site will be based on information derived from the RI, the Ecological Risk Assessment, the Ecological Risk Assessment, and the Feasibility Study, and will be specified in the Decision Document produced by NMED. Any comments or approvals of FS language do not constitute agreement to cleanup decisions at the Pecos Mine Operable Unit.

Response:

Cyprus Amax recognizes that the comment is correct.

2.2 General Response Actions

Comment:

Third sentence: Response actions need to be identified for groundwater also.

Response:

Cyprus Amax will include treatment options for groundwater, as requested. A draft of the additional text will be provided to NMED for review and approval prior to preparation of the revised FS document.

2.3 Identification and Screening of Technology Types and Process Options

2.3.1 Waste Rock Dumps

Comments:

"*Four* response actions...containment, *treatment*, and removal (Table 2-2)."

Add **2.3.1.3 Treatment**

Response:

The text has been revised to expand the discussion of treatment options for waste rock.

2.3.2 Affected Soils

Comment:

An additional remedial alternative is treatment, for example by solidification, stabilization, neutralization, or processing. Include a discussion of different treatment options in this section.

Response:

The original text contained description of soil treatment through neutralization of pH using limestone or agricultural lime. The text was revised to more clearly show the response actions considered and includes a brief discussion of technologies such as solidification and stabilization.

Comment:

It does not appear throughout the rest of the document that treatment of groundwater was "considered." Groundwater treatment options will need to be discussed, similarly to seep treatment options.

Response:

Cyprus Amax agrees to provide the additional discussion as requested. Additional discussion has been included in Section 2.3.3.2 and Section 3.1.4.

2.3.4.2 Treatment

Comment:

Fourth paragraph, middle; typo: "In addition, the wetland portion...Scenic Rivers Act and *is* an area of heavy recreational use."

Response:

Cyprus Amax agrees with the addition of the word "is."

2.3.6.3 Containment

Comment:

Last sentence: "This approach would also not prevent human or ecological receptors from contacting soils, *nor eliminate soils as a potential secondary source of contaminants*."

Response:

Cyprus Amax agrees to the requested revision.

Comment:

Table 2-1

Include an estimate of volume of groundwater affected by contaminants, and an estimate of volume of contaminants per day (similar to metals loading to the Pecos River) for the affected aquifers.

Response:

Cyprus Amax agrees to the requested revision.

3.1.4 Groundwater

Comment:

Fourth Bullet: Application for variance should only be a consideration if technical infeasibility or impracticability is demonstrated for the contaminant release. It should not be considered as a primary remediation alternative. Remove it from this list, although it would be acceptable to include a paragraph discussing technical infeasibility and the alternatives available under such a scenario.

Response:

A paragraph discussing the WQCC regulations regarding application for variance from groundwater standards was included in the text.

In addition, a discussion of groundwater treatment technologies was included in this section to address comments on Section 2.3.3.2.

3.1.5 Seep Water

Comments:

There has been general agreement that if the remedial alternative enacted at the mine site fails to sufficiently reduce contaminant release, further remedial action will be taken. This must be reflected in the FS.

Third paragraph: "If loading is not sufficiently reduced, collection and treatment of seep water *will be implemented.*"

Response:

The appropriate revision to the subject statement was discussed in the telephone conference call on August 6, 1997. It was agreed that *may be considered* will be changed to *may be required.*

Comment:

Last paragraph, last sentence: Write out "sulfate-reducing bacteria' for "SRB" the first time in each chapter.

Response:

Cyprus Amax agrees to the requested revision.

3.1.5.3 Anoxic Limestone Drain

Comment:

Second paragraph, first sentence: "The ALD will be ...(south) of *sampling location* RPS."

Response:

Cyprus Amax agrees with the suggested revision.

3.1.6 Seep Area Soils

Comment:

Second paragraph, first sentence: "Criteria for remov*ing* (or removal *of*) wetland soils ..."

Response:

Cyprus Amax agrees with the comment. The sentence has been revised to read: *Criteria for deciding whether or not wetland soils should be removed will be based on visual examination of* current and past years' vegetation growth in the area.

Comment:

Last paragraph: This paragraph implies that an excavated hole will be left until it is decided whether or not to include a seep treatment system. Please clarify the proposal regarding the excavated wetland soils.

Response:

The text has been clarified to indicate that the excavation will be filled and revegetated as soon as possible after removal.

4. Detailed Analysis of Alternatives

Comment:

It is not clear why Alternatives 2, 3, and 4 must assume a recreational use. If remediation is effective, then the risk from exposure in a residential setting would be acceptable. NMED will not consider removing groundwater from remedial consideration on the basis of assuming a continued recreational use. If the proposed remedial alternatives do not effect a remediation of groundwater, then further remedial actions will be considered. The FS should not assume institutional controls as part of the active remediation; imposing recreational use only is an institutional control.

Response:

The text of the report has been revised to remove inference that institutional controls are a baseline assumption of the alternatives. The text now states that an added layer of protection would be afforded by actions from NMGF that would prohibit sale of the property. NMGF currently does not allow residential use of properties that they manage. Therefore, prohibition of sale would effectively prohibit residential use of the site and the accompanying exposure to groundwater.

Comment:

Cover alternatives need to include a design to prevent Willow Creek and groundwater from entering the waste rock pile under the northern edge of the diversion channel to the low end of the pile. There is also a possibility of water movement along the contact between the Precambrian and Paleozoic units through the waste rock pile to the white seep (see geologic map). The design of the diversion extension might take the form of a liner along the creek and a continuation of the french drain around the northern side and keyed into bedrock. There might also be a consideration of moving waste rock farther south away from the Willow Creek drainage and geologic contact. Cyprus Amax may wish to propose additional or alternative designs to accomplish this remedial task.

Response:

The text has been revised to include an alternative configuration of the waste rock dump that excludes waste rock and cap sections from the 100-year floodplain of Willow Creek (See the new Figure 3-3). In addition, the alternative configuration distributes waste rock into two dumps that will be capped separately. In addition to removal of waste rock from the floodplain, this configuration would allow waste rock to be distributed over a wider area, reducing the slopes and height of the dump. The dump was divided into two sections to allow clearing of the drainage that currently passes beneath the dump under its current configuration.

4.2.2.1 Threshold Criteria: Chemical-Specific ARARs

Comment:

Third paragraph, second sentence typo: "Therefore *t*he proposed remediation ..."

Response:

Cyprus Amax agrees to the requested revision.

4.2.2.2 Balancing Criteria: Magnitude of Residual Risk

Comment:

Second paragraph typo: "Remediation of the waste rock and other site controls are adequate to neutral*ize* ..."

Response:

The suggested correction has been made.

Comment:

Short-term effectiveness: Environmental Impacts

First paragraph after the second set of bullets: "If adequate improvement in water quality ...treatment system *will be implemented.* Decisions on the period of monitoring and installation of *a* seep treatment system will be made by NMED.

Response:

As discussed, the language "*may be necessary*" has been revised to "*may be required.*"

4.2.3.1 Threshold Criteria: Human Health

Comment:

Last sentence: Are the remedial procedures also the same as for Alternative 2? This needs to be stated. In addition, a similar statement as seen in the next paragraph for ecological health and surface water could also be made for human health and groundwater: "Protection of human health under Alternative 3 is greater ...surface water *and groundwater* quality ...."

Response:

Greater impermeability of the clay cap implies greater protection of groundwater quality. The paragraph has been revised to reflect the concomitant effects on human health risk.

4.2.3.2 Balancing Criteria: Magnitude of Residual Risk

Comment:

First paragraph: There should be no reason to assume institutional controls. The objective in the remedial alternative is to prevent exposure of human receptors to contaminants. Remedial alternatives should be designed to meet this objective.

Response:

The text has been revised to remove inference that institutional controls are assumed as a baseline condition. See also response to the first comment under Section 4—Detailed Analysis of Alternatives.

4.2.4 Alternative 4 – Geomembrane Cap

Comment:

First paragraph typo: "The permeability of the geomembrane cap *is* approximately ...."

Response:

The correction has been made.

4.2.5.1 Threshold Criteria: Human Health

4.2.5.2 Balancing Criteria: Magnitude of Residual Risk

Comment:

There should be no reason to assume institutional controls. The objective in the remedial alternatives is to prevent exposure of human receptors to contaminants. Remedial alternatives should be designed to meet this objective.

Response:

The text has been revised to remove inference that institutional controls are assumed as a baseline condition. See also response to the first comment under Section 4—Detailed Analysis of Alternatives.

Short-term Effectiveness: Environmental Impacts

Comment:

Interim actions will be in place to minimize erosion and sedimentation. Effects on Willow Creek should only last as long as the remedial action in the creek is occurring, which will not be for the entire remediation. Clarify this section to demonstrate the nature of environmental impacts and interim actions that will mitigate these impacts

Response:

Cyprus Amax will provide the requested clarification. We will provide draft text to NMED for review and approval prior to inclusion in the revised FS document.

Time Until RAOs are Achieved

Comment:

Add to paragraph: "Seep quality should start to improve during excavation as contaminated material is removed. If all contaminated material is removed, seep quality should improve quickly."

Response:

Waste rock is the source of contamination, but is not necessarily of itself contaminated. Therefore, the statement that seep water quality will improve as *contaminated* materials are removed may not necessarily be true because the source will still be in place. In addition, the period required for removal is longer than for other alternatives. Revision has been made to the text that indicates that improvement in seep water quality may be observed before removal is complete.

Availability of Services and Materials

Comment:

Second sentence: "A large volume of clean fill and topsoil will be required to reclaim the excavated portion of the *mine* site."

Response:

Cyprus Amax agrees with this comment.

4.3.1.1 Overall protection of human health and the environment: Human Health

Comment:

First paragraph: There should be no reason to assume institutional controls. The objective in the remedial alternatives is to prevent exposure of human receptors to contaminants. Remedial alternatives should be designed to meet this objective.

Response:

The text has been revised to remove inference that institutional controls are assumed as a baseline condition. See also response to the first comment under Section 4—Detailed Analysis of Alternatives.

4.3.1.2 Compliance with ARARs: Chemical-Specific ARARs: Surface Water

Comment:

Second paragraph: "However, if remediation … treat seep water *will be implemented*."

Response:

As discussed, the language has been revised to read "*may be required.*"

4.3.2.1 Long-term effectiveness and permanence: Magnitude of Residual Risk

Comment:

First paragraph: There should be no reason to assume institutional controls. The objective in the remedial alternatives is to prevent exposure of human receptors to contaminants. Remedial alternatives should be designed to meet this objective.

Response:

The text has been revised to remove inference that institutional controls are assumed as a baseline condition. See also response to the first comment under Section 4—Detailed Analysis of Alternatives.

Comment:

Second paragraph: "Exposure to affected soils is *prevented* in Alternatives 3, 4, and 5."

Response:

Cyprus Amax agrees to the requested revision.

4.3.2.4 Implementability: Technical Feasibility

Comment:

Second paragraph, first sentence grammatical: "Besides No Action …use of geomembranes *in Alternative 4* that require …."

Response:

Cyprus Amax agrees to the requested revision.

Administrative Feasibility

Comment:

Second sentence grammatical: "Permits required …alternatives because *the* activities *that* are included …."

Response:

Cyprus Amax agrees to the requested revision.

Costs

Comment:

Because seep treatment systems are discussed in the FS, it would be helpful to include a range of cost estimates for installing such a system.

Response:

Cyprus Amax agrees to include a general costs estimate for the seep treatment system. However, the size and configuration of the system will depend on the volume and chemistry of water to be treated.

4.4 Preferred Alternative

Comment:

Because the FS was produced by Stoller under contract with Cyprus Amax, it appears premature to state that the alternative is preferred by "the respondents". At the least, the FS would need to include documentation from all respondents agreeing to the preferred alternative. This matter as stated in the FS is confusing anyway, because at no time is a preferred alternative stated. A preference for capping is stated, but not a preference for one of the alternatives. Clarify this discussion in the FS.

Response:

The text has been revised per informal discussions regarding this comment. At the time of this revision, respondents had agreed that a capping alternative was preferred. However, the nature of the cap technology would be identified in the Decision Document (DD) and the specific technology would be selected in the Remedial Design stage using criteria defined in the DD.

Comment:

Part 4, second sentence typo: "The maximum cost for capping ...for source removal, $9.6 million" (addition of a comma after "removal").

Response:

Cyprus Amax agrees to the requested revision.

Pecos Mine Operable Unit

Responsible Parties

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Cyprus Amax Minerals Company
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Title

Feasibility Study

Date Mailed to NMED: September 11, 1997

Executive Summary

This document presents the Feasibility Study (FS) for the Pecos Mine Operable Unit (OU), Upper Pecos Site, San Miguel County, New Mexico. The FS is part of the Remedial Investigation/Feasibility Study (RI/FS) being conducted pursuant to the Administrative Order on Consent (AOC) signed by Amax Resource Conservation Company (now Cyprus Amax) and the State of New Mexico. The RI/FS is being performed by The S.M. Stoller Corporation (Stoller) on behalf of Cyprus Amax Minerals Company and the State of New Mexico, who are the responsible parties for cleanup of the site.

Site Description

The Pecos (Tererro) Mine is an inactive and decommissioned zinc-lead mine located along State Highway 63 at the confluence of the Pecos River and Willow Creek. The Pecos Mine OU includes the mine and associated waste rock dumps, a wetland area of 5 to 10 acres, and affected portions of Willow Creek and the Pecos River. The main waste rock dump covers 9.8 acres and lies approximately 500 feet east of the Pecos River and is separated from the river by State Highway 63. A smaller disjunct dump south of the main dump and west of State Highway 63 extends to within approximately 100 feet of the river. Willow Creek flows east to west and passes through the northern portion of the dumps. The Pecos River flows north to south west of the mine.

The waste rock dumps contain approximately 217,000 cubic yards of material. The dumps overlie colluvial deposits of sandy clay and clay that range in thickness from 0 to about 20 feet. The colluvium overlies Paleozoic sandstones and limestones, which in turn overlie Precambrian schists, amphibolites, and metavolcanics. Alluvial deposits are present along Willow Creek and the Pecos River.

Groundwater flows through four lithologically distinct flow systems: bedrock aquifer, alluvial aquifer, a shallow flow system including interflow and saturated flow in the colluvium, and the waste rock dump. Water in the bedrock aquifer flows east to west toward the river. The potentiometric surface of bedrock groundwater remains well below the bottom of the waste rock dump. Bedrock groundwater discharges in the wetland area where the potentiometric surface converges with the ground surface. Water in the alluvial system receives water from precipitation, Willow Creek, and potentially from the colluvium. The shallow flow system includes intermittent interflow in colluvium uphill from the dump, and saturated flow in deeper deposits beneath and downgradient from the dump. The waste rock dump receives water primarily from infiltration of precipitation and snowmelt. Water percolating through the dump may be discharged at seeps along the dump toe, or may enter the colluvium. Colluvial groundwater discharges at seeps in the wetland, or enters the alluvial deposits.

The waste rock dump is the primary source of contamination at the site. Metals in waste rock are transported in solid form from the dump by erosion and bulk transfer. Dissolved metals are transported by metal-bearing acid leachate that results from the weathering of metal sulfides and water percolating through the dump. The acid leachate is discharged at seeps along the toe of the dump, or enters the shallow flow system beneath the dump and is discharged at seeps along the eastern edge of the wetland. Colluvial water that does not discharge at seeps flows into alluvial materials. Metals are also transported in dissolved form when encrusted salts on the dump surface dissolve in precipitation or snowmelt runoff, and are carried downgradient to surface water.

Seeps entering Willow Creek and the wetland are of two distinct water quality types. Seeps along Willow Creek and the northernmost seeps in the wetland characteristically contain elevated iron and manganese concentrations that exceed state groundwater quality standards, and major ion chemistry that resembles bedrock and alluvial groundwater. Seeps entering the midsection of the wetland have elevated iron and manganese, but also have concentrations of cadmium, lead, zinc, and other metals that exceed state groundwater and/or surface water standards. Major ion chemistry varies, but more closely resembles water from the waste rock dump. Flow from the latter seeps appears to be directed along a pre-existing drainage that is now covered by waste rock.

Deep bedrock groundwater also contains elevated concentrations of several metals. However, only barium, iron, and manganese are present at concentrations that exceed state groundwater quality standards.

Seep water and subsurface discharge of groundwater have affected water quality in Willow Creek, the wetland, and the Pecos River. Measurement of metal concentrations, especially cadmium and zinc, exceed state standards for protection of aquatic life. Exceedence of standards for zinc and cadmium in the Pecos River is event-related corresponding to times of high runoff from snowmelt or rainstorms.

The Health and Environmental Risk Assessment (HERA) was conducted to evaluate risk to human and ecological receptors at the mine site under current (non-remediated) conditions. Results of the human health risk assessment (HHRA) indicate that recreational use of the site under current conditions will not result in exposures that exceed limits established by the Environmental Protection Agency (EPA). The site is currently managed as a recreational area by New Mexico Department of Game and Fish (NMGF).

The HHRA also evaluated risks for potential future residential use of the site, including use of the bedrock or shallow aquifer for a domestic water supply, and a higher frequency of exposure to site soils than in the recreational scenario. Residential risks, as indicated by hazard quotients (HQs) that exceeded 1.0, were associated with exposure to barium in deep bedrock groundwater, and manganese in shallow groundwater. Lead exceeded the EPA threshold for acceptable exposure in resident children when the shallow groundwater was assumed to be the domestic water supply. However, lead concentrations in the well used for the analysis were not greater than background concentrations and did not exceed state water quality standards.

Ecological risks to biota included exposure of soil invertebrates and plants to waste rock, upland soils adjacent to the dump, and wetland soils. Vegetation in discrete areas of approximately 1.5 acres of upland soils adjacent to the main dump, and 0.25 acres in the wetland exhibits visible signs of phytotoxicity due to acidifying effects of leachate and the associated increase in metal bioavailability in soils. Other areas with similarly elevated metal concentrations, but higher pH, did not exhibit toxic effects.

Wildlife exposure estimates were conducted using data on metal concentrations in soils, vegetation, and invertebrates. Elevated metals concentrations in the wetland contribute to a slight to moderate risk of toxicity for species such as beaver and small omnivorous birds and mammals that feed exclusively in the wetland. Upland soils adjacent to the dump were also associated with slight to moderate risk. However, exposure estimates were conservative and tend to overestimate the intake and risk associated with metals in these areas.

For aquatic biota, risks were due primarily to dissolved zinc concentrations in surface waters. Zinc, and less frequently, cadmium concentration exceeded EPA Ambient Water Quality Criteria (AWQC) in the Pecos River during periods of high runoff from the mine. AWQC were also exceeded in the wetland and Willow Creek.

Development of Alternatives

The purpose of the FS was to develop remedial action objectives (RAOs) for addressing contaminated media, identify activities and technologies that could potentially satisfy the RAOs, and develop alternatives for remediation of the site. Alternatives were evaluated using criteria developed by EPA for use in feasibility studies.

Five alternatives were evaluated in the FS:

Alternative 1—No Action
Alternative 2—Non-Compacted Clay Soil Cap
Alternative 3—Compacted Clay Cap
Alternative 4—Geomembrane Cap
Alternative 5—Source Removal

As required by EPA, the No Action alternative was included in the analysis to provide a baseline against which to compare other alternatives. Except where specified, the following discussion refers only to alternatives other than No Action.

Each of the alternatives includes removal of waste rock from the Willow Creek channel, and reclamation of the creek channel and riparian habitat along the creek. Each of the alternatives also assume that NMGF will continue to manage the site as a recreation area and implement institutional controls that prohibit residential development of the site.

Alternatives 2, 3, and 4 include capping the waste rock dump and affected soils at the mine site to minimize percolation of water and transport of metals in surface runoff. The caps also prevent contact of human and ecological receptors with waste rock material or affected soils. All three alternatives are based on a common plan for consolidating waste rock and affected soils. Each of these alternatives includes a diversion ditch and french drain constructed immediately uphill from the capped dump to prevent surface run-on and shallow interflow from upgradient areas from entering the dump. Water intercepted by the diversion system is diverted to Willow Creek.

Alternatives 2, 3, and 4 differ in the technology and materials used in the cap and the treatment of affected soils. Alternative 2 includes a non-compacted clay soil cap which will reduce percolation of water through the waste rock dump by approximately 91 percent. The compacted clay cap in Alternative 3 and the geomembrane cap in Alternative 4 reduce percolation by more than 99 percent. The surface of all three cap types is vegetated with non-woody plant species. Modeling indicates that water quality in the Pecos River would be protected by Alternatives 3 and 4 under any conditions. Alternative 2 would also protect the Pecos River, except under extreme high runoff conditions.

Under Alternative 2, soils beneath excavated waste rock would be treated with crushed limestone to increase pH and decrease metal bioavailability, and thereby alleviate potential ecotoxicity. Under Alternatives 3 and 4, all affected soils would be excavated and capped along with the waste rock. Excavated areas would be filled with clean material and revegetated.

Capping the waste rock dump is expected to affect the quality and flow of seep water entering the wetland. However, residual water in the dump may continue to discharge from the dump and seeps until water has drained adequately. Therefore, a phased approach has been proposed for evaluating the need for treating seep water to protect surface water quality. If seep flow or water quality does not improve adequately, installation of a seep treatment system will be considered. A passive treatment system employing an anoxic limestone drain and sulfate-reducing bacteria (SRB) was proposed. The size and configuration of the treatment system would depend on the quantity and quality of seep water after initial remediation of waste rock and soils.

Shallow and deep bedrock groundwater would also be monitored to determine effects of capping the waste rock. If groundwater quality does not improve adequately, Cyprus Amax and the State of New Mexico may apply for a variance from groundwater quality standards under the rules of the New Mexico Water Quality Control Commission. Alternatively, treatment of groundwater may be considered.

Under Alternative 5, all waste rock, affected soils, and colluvium would be excavated from the mine site and hauled by truck to the El Molino OU. The El Molino OU is approximately 20 miles south of the Pecos Mine, and includes the mill site and tailing impoundments in Alamitos Canyon near the Village of Pecos. Materials hauled from the mine site would be deposited on the tailing impoundments and capped along with the tailing as part of the remediation for the El Molino OU. The volume of affected soils is uncertain because the depth of contaminated material beneath the dump is not known for all areas. Excavated soil and colluvium would be replaced with clean fill, and revegetated to approximate the original habitat that existed before the waste rock was placed.

Removal of the waste rock and affected soils in Alternative 5 would eventually eliminate transport of leachate from mine waste. As with capping alternatives, residual water, natural bedrock, and contaminated soils that cannot be removed may temporarily result in mobilization of metals in shallow groundwater, and subsequent discharge in seep water.

Therefore, the need for seep water treatment will be assessed when the effects of waste rock remediation have been established. As with capping alternatives, Alternative 5 may not adequately improve groundwater, and the phased approach to assessing groundwater actions was also proposed in Alternative 5.

Analysis of Alternatives

Based on results of the HERA, all of the alternatives adequately protect human health if the current recreational land use continues. Continued recreational use would be assured through institutional controls implemented by NMGF.

Alternatives 3, 4, and 5 provide approximately equal protection of ecological health. Alternative 2 offers slightly less protection because soils will be amended to increase pH, instead of being removed. In addition, the non-compacted soil cap included in Alternative 2 will allow more water to infiltrate into the dump, thus increasing the potential for leachate production and the possible effects on surface water in the wetland. If installation of the seep water treatment system is assumed, Alternative 2 results in the same protection of surface water quality as the other alternatives. Residual ecological risk also results from elevated metals in wetland soils that are not excavated. However, the benefits of reducing the minimal risk associated with exposure of wildlife to metals does not appear to justify the extensive environmental damage that would result from excavation in the wetland.

With the exception of No Action, all of the alternatives have the potential to meet RAOs and applicable or relevant and appropriate requirements (ARARs). RAOs for soils and waste rock will be accomplished when the excavation and/or cap installation is complete. Construction associated with capping alternatives is expected to require one to two years. Excavation and construction associated with Alternative 5 is expected to require three to 5.5 years.

Compliance with RAOs and ARARs for surface water and groundwater may not occur immediately upon completion of construction. Effects of waste rock remediation on groundwater and surface water quality will probably be apparent within one year after construction. Installation of a seep water and/or groundwater treatment system would ensure immediate compliance with ARARs. However, the short-term effects and costs of these systems are not justified if remediation of the source material is effective within a relatively short period of time (two to three years).

Short-term impacts of remediation on the local community differs significantly between capping waste material at the mine site (Alternatives 2, 3, and 4), and transporting it to the El Molino OU to be capped along with the tailing (Alternative 5). The primary effects are the safety risks and economic impact of increased truck traffic in the Village of Pecos, on State Highway 63, and county roads. Alternative 5 requires five to ten times the volume of traffic that is required by other alternatives. The route along which material would be hauled to the El Molino OU passes through the village. If ten trucks make five 40-mile round trips per day, hauling material to the mill site would result in 50 to 100 trips through the village each workday for the duration of the project. The risk of vehicle accidents and other impacts are proportional to the volume of traffic for each alternative.

Alternative 5 will also affect the design and schedule for remediation at the El Molino OU. The added volume of materials from the mine site will significantly affect the design of the cap and the diversion channel at El Molino. If Alternative 5 is implemented, the cap at El Molino could not be completed until after all material has been moved from the mine. Cap construction would then require one to two years to complete.

Costs differ significantly between capping the waste rock at the mine (Alternatives 2, 3, and 4) and moving the waste rock and capping at El Molino (Alternative 5). Cost estimates for Alternatives 2, 3, and 4 range from $3.4 million to $3.7 million. Costs for Alternative 5 range from $10 million to $16 million, depending on the amount of affected soils to be moved. Indirect costs associated with maintenance of county and state roads are also lower for Alternatives 2, 3, and 4, because transportation requirements are less for capping the waste rock in-place. Long-term operation and maintenance (O&M) of Alternatives 2, 3, 4, and 5 are similar: totals of $300,000 to $400,000 over 20 years. The O&M costs associated with Alternative 5 may be less because it could be combined with that of the El Molino site.

The respondents prefer an alternative involving consolidation and capping of waste rock material at the mine site. The overall effectiveness of Alternatives 3, 4, and 5 in meeting the remediation objectives is approximately equal. Alternative 5 has the advantage of permanently removing the source material from the mine site. However, the removed material must also be managed at El Molino using similar technology as employed in other capping alternatives. Transporting material from the mine site to El Molino involves considerably greater impact to the local community than capping the material in-place at the mine site. In addition, the uncertainties associated with excavating, hauling, and capping material as described in Alternative 5 are greater than associated with other alternatives. Earthen caps such as those proposed in Alternatives 2, 3, and 4 are proven technologies that are considered permanent remedies for disposal and management of waste material. Therefore, the higher community impacts, safety risks, and costs associated with Alternative 5 do not appear to be justified.

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U.S. List of Acronyms and Abbreviations

ABC	Adrian Brown Consultants, Inc.
AGP	acid-generating potential
ALD	anoxic limestone drain
AMCO	American Metal Company of New Mexico
ANP	acid-neutralizing potential
AOC	Administrative Order on Consent
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
bgs	below ground surface
BOD	biochemical oxygen demand
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	Contaminant of Cocern
cfs	cubic feet per second
COE	U.S. Army Corps of Engineers
cps	centimeters per second
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FS	feasibility study
ft^2	square feet
g/d	grams per day
HDPE	high density polyethylene
HELP	Hydrologic Evaluation of Landfill Performance Model
HERA	Health and Environmental Risk Assessment
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
IRA	interim remedial action
LOAEL	lowest-observed-adverse-effects level
MCL	maximum contaminant level
MDL	method detection limit

mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NCP	National Contingency Plan
NMED	New Mexico Environment Department
NMGF	New Mexico Department of Game and Fish
NMSHTD	New Mexico State Highway and Transportation Department
NOAEL	no-observed-adverse-effects level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRDA	Natural Resource Damage Assessment
O&M	operation and maintenance
OU	Operable Unit
PGM	plant growth medium
PM_{10}	particulate matter < 10 micrometers in diameter
PVC	polyvinyl chloride
RAO	remedial action objective
RI	remedial investigation
SRB	sulfate-reducing bacteria
SPLP	synthetic precipitation leaching procedure
TDS	total dissolved solids
TKN	Total Kjeldahl Nitrogen
TOC	total organic carbon
TSP	total suspended particulates
TSS	total suspended solids
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
UBK	Uptake Biokinetic Model
WQCC	Water Quality Control Commission
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter

1. Introduction

1.1 Purpose and Organization of Report

This document presents the results of the Feasibility Study (FS) for the Pecos Mine Operable Unit (OU) of the Upper Pecos Site, San Miguel County, New Mexico. The FS is part of the Remedial Investigation/Feasibility Study (RI/FS) being conducted pursuant to the Administrative Order on Consent (AOC) signed by Amax Resource Conservation Company (now Cyprus Amax) and the State of New Mexico on December 2, 1992. The RI/FS is being performed by The S.M. Stoller Corporation (Stoller) on behalf of Cyprus Amax Minerals Company and the State of New Mexico, which are the responsible parties for cleanup of the site. Contents of the document are as follows:

- Section 1—Brief overview of site history and summary of findings of the Remedial Investigation Report and Health and Environmental Risk Assessments.

  (Detailed site description, site history, and results of the RI are contained in the RI report [Stoller 1996]. The Pecos Mine Human Health Risk Assessment [HHRA] [NMED 1997] describes human health risks at the site. The Ecological Risk Assessment [ERA] describes risks to ecological receptors [Hagler Bailly 1997].)

- Section 2—Identification and Screening of Technologies
- Section 3—Development and Screening of Alternatives
- Section 4—Detailed Analysis of Alternatives

1.2 Site Description

The Pecos Mine, also known as the Tererro Mine, is an inactive and decommissioned zinc-lead mine located approximately 15 miles north of the village of Pecos in northwestern San Miguel County, New Mexico (Figure 1-1). The mine is situated along State Highway 63 at the confluence of the Pecos River and Willow Creek.

The Pecos Mine OU includes the mine, approximately 12.3 acres of associated waste rock dumps, a wetland area of 5 to 10 acres, and affected portions of Willow Creek and the Pecos River adjacent to and below the Pecos Mine (Figure 1-2).

The main waste rock dump covers 9.8 acres and lies approximately 500 feet east of the Pecos River and is separated from the river by State Highway 63 (Figure 1-2). A smaller disjunct dump south of the main dump and west of State Highway 63 extends to within approximately 100 feet of the river. The disjunct dump and waste rock materials deposited north of Willow Creek cover an additional 2.5 acres.

1.2.1 Site Geology

The Pecos Mine OU is located in an area consisting of Quaternary sediments unconformably overlying Paleozoic sedimentary rocks or Precambrian basement rocks. The Precambrian basement rock consists of various metavolcanics and schists, amphibolites, and basic metadiabases of the greenstone sequence. Paleozoic units of limestone up to 100 feet thick and sandstone up to 80 feet thick were found overlying Precambrian basement rock. The sandstone unit interfingers with the overlying dolomites and limestones. In some areas, the limestone is absent and surficial deposits lie directly on sandstones. Representative geologic cross sections are presented in Appendix A.

Surficial materials include gravel-rich alluvial deposits along the Willow Creek and Pecos River drainages and along some ephemeral drainages. The thickness of the Willow Creek alluvium adjacent to the dump is variable but averages 10 to 15 feet. Colluvial deposits are present on most hillslopes in the areas of the waste rock dumps. The colluvium consists of minor amounts of gravel mixed with clay, silts, and sands. The thickness of the colluvium varies from very thin or absent up to about 45 feet.

1.2.2 Waste Rock Dumps

The thickness of the main dump ranges from 10 feet on the eastern edge to 55 feet on the western edge of the northern sections. The waste rock dump is generally underlain by colluvial deposits of variable thickness up to about 25 feet. In some locations, colluvium is absent and waste rock directly overlies the limestone or sandstone bedrock.

The total volume of waste rock is estimated at approximately 217,000 cubic yards with 190,000 cubic yards in the main dump, 6,700 in the disjunct dump, and 20,300 yards in the areas north of Willow Creek. Volume estimates are based on borehole logs and a modeled topography of the natural ground surface (Stoller 1996).

1.2.3 Hydrogeology

Hydrogeological features at the mine site include a bedrock aquifer and a shallow flow system that includes areas of saturated and unsaturated flow. The shallow flow system includes components in the natural alluvium and colluvium and the waste rock dump.

1.2.3.1 Bedrock Aquifer

Groundwater in the bedrock aquifer flows through Precambrian metamorphic and Paleozoic sedimentary rocks and generally westward from the highlands east of the mine toward the Pecos River (Figure 1-3). The Paleozoic and Precambrian units are hydraulically connected in the mine area.

Bedrock groundwater flow is gravity-driven and discharges to the alluvial deposits in the wetland along Willow Creek and the Pecos River west of the dump, where the potentiometric surface converges with the ground surface (Figure 1-3). The potentiometric surface is nearly 200 feet below ground surface (bgs) east of the dump and remains more than 35 feet below the base of the main dump. The potentiometric surface is more shallow along Willow Creek where bedrock groundwater mixes with alluvial groundwater. Seasonal variation in the elevation of the potentiometric surface is minimal and causes no variation in flow direction.

1.2.3.2 Shallow Flow Systems

Three separate shallow flow systems have been identified at the site: (1) alluvial materials along Willow Creek, (2) colluvial materials on the slopes adjacent to and underlying the waste rock dump, and (3) the main waste rock dump.

<u>Alluvial Flow System</u>

The alluvial flow system consists of alluvium associated with Willow Creek and the Pecos River. In general, groundwater movement within the Pecos River alluvium reflects the direction of surface water flow and moves from north to south.

In the Willow Creek drainage, upslope (east) of the waste rock dump (near wells P-3 and P-3S) (Figure 1-4), groundwater flow in alluvium is distinct from flows in the bedrock aquifer. Adjacent to and downslope of the dump, water levels in the alluvial deposits and in the bedrock aquifer are not distinct (Figure 1-5). Immediately downslope of the dump and farther west, water levels indicate that the bedrock aquifer has a slight upward-directed vertical hydraulic gradient. The vertical gradient may result in groundwater discharge from the bedrock aquifer to the alluvial flow system downslope of the dump.

Alluvial deposits adjacent to and downslope of the waste rock dump receive recharge from infiltrating precipitation, from Willow Creek, and potentially from the bedrock aquifer. Although the bedrock and alluvial flow systems appear interconnected in these areas, the alluvial groundwater does not flow into the bedrock aquifer. During periods of rapid infiltration into the alluvial deposits, such as during snowmelt or precipitation, groundwater may discharge from the alluvial deposits into Willow Creek.

Colluvial Flow System

Groundwater flows through colluvial materials as shallow interflow and as saturated flow in deeper deposits. Groundwater levels vary widely in colluvial deposits, especially in the forested watershed upslope of the main dump. In some areas upslope of the dump, colluvial deposits are always dry; whereas in other areas upslope of the dump, colluvial deposits hold water only during the spring. Water is present more frequently in colluvial deposits beneath and downslope of the dump.

Measurements of saturated hydraulic conductivity of colluvial materials range from 1.5×10^{-8} to 6.9×10^{-8} centimeters per second (cps), indicating very slow rates of groundwater flow through colluvial deposits. However, preferential pathways, such as root channels, desiccation cracks, and animal burrows may control the rate of groundwater flow through colluvium in upgradient areas.

Discharge from the colluvial flow system occurs primarily as discrete and diffuse seeps along the toe of the waste rock dump, along the road cut west of the dump, and along the foot of the hillslope west of the dump at the edge of the wetlands. Colluvial groundwater that does not discharge to seeps and springs may flow laterally and enter the alluvial flow system. In general, colluvial groundwater can be considered as topographically elevated above alluvial groundwater along the Pecos River valley.

Waste Rock Dump Flow System

Vadose zone investigations indicate that the primary source of water in the waste rock dump is infiltration of rainfall and snowmelt. Runoff from upgradient areas is intercepted by the diversion ditch, and occasional shallow subsurface flows from upgradient areas are negligible compared to water infiltrating from the surface.

The hydraulic conductivity of waste rock is greater than that of colluvial materials (1.1×10^{-5} to 8.4×10^{-3} cps). Therefore, water percolating down through the dump and reaching the less permeable colluvium probably flows laterally along the pre-existing topographic surface and is discharged in seeps at the toe of the dump. The locations of discharge points appear to be a function of the topography of the original ground surface. Seeps are abundant where pre-existing drainages beneath the middle of the dump exit at the toe of the dump (ESNDT area, Figure 1-6). Remnants of a collapsed wooden drainage tunnel can be observed at the toe of the dump in this area.

Seep flow varies seasonally with higher flows in the spring and during late summer monsoons. The number of discrete seeps and the area of diffuse seepage from downgradient colluvium also increases in response to storms, indicating that seepage probably originates as precipitation that infiltrates and percolates through the dump.

1.2.4 Surface Water Hydrology

The primary surface water features at the Pecos Mine OU are the Pecos River and Willow Creek (Figure 1-2). The Pecos River flows in a southerly direction west of the mine site. Willow Creek flows generally westward through the northern portion of the site and converges with the Pecos River west of the mine area. A wetland of 5 to 10 acres has formed in the floodplain at the confluence of Willow Creek and the Pecos River west of the main waste rock dump (Figure 1-2). The wetland also receives flow from bedrock and shallow groundwater seeps at the toe of the slope along the eastern edge of the wetland.

At the northern end of the waste rock dump, Willow Creek flows over a substrate that includes waste rock for approximately 500 feet. Willow Creek discharges into the Pecos River after passing through the wetland area on the Pecos River floodplain. Surface water is distributed throughout the wetlands in a complex of small channels that converge into four main channels prior to the confluence with Pecos River.

Seasonal flow patterns of Willow Creek and the Pecos River are similar. Most runoff occurred from March through August, followed by a period of low flow. Willow Creek discharge ranged from approximately 1 cfs at low flow to 5 to 20 cfs at high flow. During the RI field investigation in 1995, flows in the Pecos River near the mine site ranged from about 35 cfs in late fall/early winter to 617 cfs at high flow in June. The majority of runoff in the upper Pecos River watershed occurred from April through August.

In 1992, a diversion ditch was constructed along the uphill (east) edge of the waste rock dump to prevent surface and shallow subsurface flow from upgradient areas. The ditch was designed to accommodate flows from a 10-year, 10-minute storm event. Water intercepted in the northern section of the ditch flows north toward Willow Creek and ultimately discharges to the creek approximately 50 yards upstream of the waste rock dump. Water intercepted in the southern section of the ditch flows south and discharges to a roadside ditch along State Highway 63.

1.3 Site History

The Pecos Mine extracted a polymetallic zinc-lead ore with smaller amounts of copper, gold, and silver. The initial mineral discovery was made in 1882, and the site was mined until 1939. The underground mine workings followed several irregular, disconnected lenses of sulfide ore to levels more than 1,800 feet below the ground surface. Two shafts, the main shaft and the Evangeline shaft, provided access to the mine workings. The mine workings are currently flooded.

In 1925, the American Metal Company (AMCO Ltd, later AMAX, now Cyprus Amax) and the Pecos Corporation formed the American Metal Company of New Mexico (AMCO) to develop the property. In 1939, ownership of the mine passed to Pecos Estates, Inc. The stock of Pecos Estates was sold to the State of New Mexico in 1950. The mine site property and surrounding areas are currently owned by the State of New Mexico and managed by the New Mexico Game and Fish Department (NMGF). Current land use is primarily recreational. No residences are located on the property owned by the State of New Mexico.

On December 2, 1992, New Mexico Environment Department (NMED) entered into an AOC with three respondents: Amax Resource Conservation Company, the NMGF, and the New Mexico State Highway and Transportation Department (NMSHTD). The consent order requires the respondents to perform site investigations and remedial actions at five operable units within the Upper Pecos Site. The mine site was included in the AOC as part of the Pecos Mine OU. With the signing of the AOC, NMED became the regulatory agency responsible for oversight of remedial actions at each of the operable units. Cyprus Amax and the State of New Mexico were responsible for conducting an RI/FS at the Pecos Mine. NMED would provide oversight of the investigations and conduct the Health and Environmental Risk Assessment (HERA) based on data collected during the RI.

1.4 Nature and Extent of Contamination

1.4.1 Waste Rock

Waste rock mineralogy is dominated by silicate gangue minerals (quartz, chlorite, biotite, actinolite, sericite, and tourmaline) (Sugden 1977). The three main sulfide minerals in the ores, in order of decreasing abundance, are pyrite (FeS_2), sphalerite (ZnS_2), and galena (PbS_2) (Bemis 1932).

Analysis of waste rock samples indicates that waste rock is heterogeneous with respect to metal content and potential to generate acid. Trace metals associated with the waste rock are arsenic, cadmium, copper, lead, mercury, nickel, silver, and zinc. Of these, copper, lead, and zinc are present in the highest proportions. Comparison of acid generating potential (AGP) and acid neutralization potential (ANP) indicated that waste rock had the potential to generate acid under appropriate conditions.

Waste rock at the site is concentrated in the dumps described previously. In addition, bulk transport of material from the dumps has resulted in deposition of waste rock in areas outside the dumps, causing elevated metal concentrations in soils and sediments in some downgradient areas.

1.4.2 Soils and Geologic Materials

Upland soils/surficial materials at the mine site were sampled from shallow (0 to 6 and 0 to 3 inch) and deeper (12 to 18 inch) depth intervals. The metals that exceeded background concentrations in the highest proportion of samples were cadmium, lead, and zinc. The distribution of zinc in soils is typical of these three metals and is presented in Figure 1-7. In general, soils adjacent to the waste rock dump had the highest metal concentrations, with concentrations decreasing with distance from the dump. Samples collected along Willow Creek had the highest concentrations of metals in surficial materials because they contained waste rock. The distribution of elevated metal concentrations was more extensive for shallow samples than for deeper samples.

Phytotoxic effects were visible in two areas of the site: the upland barren zone and the area of wetland soil/sediments around seep WSBDT (Figure 1-7). Soils of the upland barren zone contained higher metal concentrations, lower pH, and lower alkalinity than soils in adjacent areas with no visible phytotoxicity. Soil/sediment samples collected near seep WSBDT also contained elevated metal and sulfate concentrations, acidic pH, and depressed alkalinity.

1.4.3 Groundwater

Ten wells were used to monitor water quality of the bedrock aquifer in the vicinity of the mine (Figure 1-8).

Three wells are screened within the Precambrian strata upgradient of the mine site and were used to characterize background groundwater quality (P-3, P-4, and P-10). Two wells are screened in the flooded underground mine workings (P-1 and P-2), one well is screened within Paleozoic sandstone beneath the dump (P-8PL), and two wells are screened in the Precambrian bedrock downgradient of the dump (P-5, P-7).

Seven wells and seven piezometers were used to monitor the water quality of the shallow flow system (Figure 1-8). One well screened in the Willow Creek alluvium upgradient of the mine site (P-3S) was used to characterize background water quality. Two wells monitor the quality of Willow Creek alluvium (P-2S, P-7S), and two monitor the colluvium. Two wells are screened in waste rock material and are typically dry (P-8WR, P-9WR).

1.4.3.1 Bedrock Aquifer

Concentrations of aluminum, barium, iron, and manganese exceeded federal drinking water standards for total (unfiltered) concentration or state groundwater quality standards for dissolved (filtered) concentration in at least one sample from bedrock wells upgradient of the dump.

Concentrations of 12 metals in wells beneath or downgradient of the dump were elevated compared to upgradient conditions. However, only barium, cadmium, iron, and manganese concentrations exceeded state or federal water quality standards in any well. The highest median concentrations of dissolved analytes were in wells P-1 and P-2, which are screened within the underground mine workings, and in well P-7 at the base of the waste rock dump. Concentrations of iron and manganese exceeded state standards in these wells. Well P-7 also consistently contained dissolved barium concentrations that exceeded state standards and cadmium concentrations that exceeded the state standard on one occasion. These wells are screened at depths of 90 to 110 feet bgs and represent water quality in deep bedrock groundwater.

The highest number of total analytes with elevated concentrations compared to background occurred at P-8PL with median concentration of total aluminum, total iron, and total manganese exceeding secondary drinking water standards. Alkalinity, bicarbonate, and total dissolved solids were elevated, and pH was depressed compared to upgradient wells.

1.4.3.2 Shallow Flow System

The median concentrations of dissolved iron, manganese, and cadmium exceeded water-quality standards at upgradient monitoring well P-3S. Metal concentrations in downgradient shallow wells were elevated compared to upgradient conditions. The highest concentrations occurred in well P-8WR, which was screened in waste rock in the center of the dump. Concentrations of 11 metals exceeded state or federal water quality standards in at least one sample from P-8WR. Metal concentrations were lower in shallow wells screened in alluvium (P2S) or colluvium (P7S and P-12) with six metals exceeding federal standards for total concentrations and three metals (iron, lead, and manganese) exceeding state standards for dissolved concentrations. Well P-12 represents colluvium beneath the waste rock dump. However, data from this well are limited because it was dry for several months after completion.

1.4.3.3 Seeps

Water quality of seeps emanating from the toe of the dump, including ESNDT and associated seeps (Figure 1-6), are similar to samples collected from water in the waste rock dump. Concentrations of several metals and water quality parameters exceeded state surface and groundwater quality standards.

WSBDT and associated seeps at the toe of the slope below ESNDT (Figure 1-6) typically contained metal and sulfate concentrations that were lower than seeps emanating directly from the dump. However, concentrations of several metals in these seeps typically exceeded state groundwater and surface water standards. Overall water quality of seeps in this area indicates mixing of water from the dump, colluvial groundwater, and possibly bedrock groundwater, which may intermittently contribute to seep flow.

Seeps along Willow Creek upstream of State Highway 63, spring ESS, and seeps WMS and GSBD in the wetland areas (Figure 1-6) typically contained iron and manganese concentrations that exceed state groundwater or surface water standards, but no other constituents exceeded standards. Major ion chemistry of these seeps was similar to shallow alluvial and deep groundwater.

1.4.4 Surface Water

1.4.4.1 Willow Creek

Willow Creek water quality is affected by runoff and seep flow as it flows along the northern edge of the waste rock dump and by inflow of groundwater seeps and runoff in the wetland. Concentrations of eight metals exceeded water quality standards in stream segments downstream of the mine: aluminum, cadmium, copper, iron (MCL), lead, manganese, mercury, and zinc. Cadmium and zinc were the primary metals associated with mine waste and exceedence of aquatic life standards (dissolved) in Willow Creek. Cobalt, copper, and lead also exceeded aquatic life standards but with lower frequency. Metal concentrations (total) exceeding primary drinking water standards included the above metals, except cobalt. The concentrations and frequency of exceedence of standards were higher in Willow Creek downstream of the seep area in the wetland (site BDT) than in the segment upstream of the wetland but downstream of the dump (site WCD).

At sites upgradient of the mine, concentrations of six metals exceeded standards but with lower frequency and at lower concentrations than in downgradient areas. Aluminum exceeded aquatic life standards with approximately equal frequency and magnitude as in upgradient areas. Iron and manganese concentrations exceeded secondary drinking water standards upstream and downstream of the mine but at higher concentration and with higher frequency at downstream sites.

1.4.4.2 Pecos River

Pecos River water quality is affected by inflow of water from the Willow Creek wetland. Concentrations of 18 metals were elevated over upgradient conditions at sites within 1 mile downstream of the mine site (PE-UN). Aquatic life standards (dissolved) were exceeded for four metals: aluminum, cadmium, copper, and zinc. Drinking water standards were exceeded for aluminum, cadmium, iron, selenium, and zinc. At upgradient sites, aluminum exceeded aquatic life standards, and aluminum, barium, iron, and selenium concentrations exceeded drinking water standards. Concentrations decreased with distance downstream. The number of metals with concentrations elevated over upgradient conditions decreased to five within 1.5 miles downstream of the site (PTS), and only three metals (aluminum [total]; cadmium and zinc [dissolved]) exceeded water quality standards.

1.4.5 Air

Concentrations of airborne particulates were determined from filter samples collected daily for a 28-day period in May and June 1995. Air monitoring was conducted at one location on top of the waste rock dump. Concentrations do not exceed the National Primary Standard for airborne lead.

1.5 Transport of Contaminants

Current transport of waste rock or metals associated with mine waste is primarily due to the following factors:

- Erosion by surface runoff from the waste rock dump and affected upland soils
- Dissolution of metals from waste rock by acid leachate and subsequent transport in groundwater and surface water

Erosion and surface runoff is currently a source of transport at the mine site. Much of the dump surface is encrusted and resistant to erosion. However, erosional transport is important for areas of the dump surface that may be disturbed and for downgradient soils that have been affected by previous erosion and leachate flow. In addition, surface materials on the dump contain precipitates formed when infiltrating precipitation caused dissolution of metals and other materials from waste rock, then evaporated from the surface, leaving metal salt precipitates behind. The precipitates accumulate during relatively dry periods of the year then are re-dissolved by rains and snowmelt and carried downgradient in runoff.

Oxidation of the sulfides in waste rock results in the formation of sulfuric acid and generation of acidic aqueous leachate, or acid rock drainage. Metals in the waste rock matrix can be solubilized by the acidic leachate and transported in surface and subsurface flows to downgradient areas. The metals can be precipitated and deposited in soils and sediments or remain in solution and transported further downgradient in groundwater or surface water. In addition to transport of metals, oxidation of sulfides and transport of acid leachate also result in acidification of soils and water.

1.6 Health and Environmental Risk Assessment

The HERA was conducted pursuant to the AOC to provide information on risks to human health and the environment resulting from exposure to heavy metals in mine waste and leachate. The HERA has two components:

1. Human Health Risk Assessment, Pecos Mine Operable Unit, Upper Pecos Site (HHRA) (NMED 1997)

2. Upper Pecos Site Ecological Risk Assessment (ERA) (Hagler Bailly 1997).

The HERA was conducted by NMED or its subcontractors. The results of both risk assessments are summarized in the following subsections.

1.6.1 Human Health Risk Assessment

The purpose of the HHRA was to characterize existing and potential risk to human health from exposure to current conditions at the mine site. The HHRA was conducted in accordance with methods identified in the Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (EPA 1989a). The HHRA evaluated risk in areas of the site with the greatest likelihood for human exposure. For example, residential exposures were calculated for only those areas where a residence could reasonably be established. Because this was a baseline risk assessment, exposure estimates assumed that no remediation occurred at the site.

Contaminants of concern (COCs) are the chemicals that were evaluated for potential risk in the HHRA. COCs were determined based on results of the RI and best professional judgment of the risk assessors. COCs evaluated in the HHRA were:

- Shallow groundwater: manganese
- Deep groundwater: barium and manganese
- Waste rock: arsenic, barium, cadmium, chromium, copper, lead, molybdenum, nickel, selenium, silver, and zinc
- Soil: arsenic, barium, cadmium, chromium, copper, lead, molybdenum, nickel, selenium, silver, and zinc
- Surface water: aluminum and iron
- Air: none

1.6.1.1 *Exposure Assessment*

The HHRA estimated exposure for current and potential future land use. Chemical intakes were calculated using data on COC concentrations from the RI and standard intake parameters identified in Environmental Protection Agency (EPA) guidance (EPA 1989a). Current land use was assumed to be recreational. Two recreational scenarios were evaluated: vacation and nearby. Vacation use was assumed to be one annual 30-day visit to the site for 10 years. Risk was calculated for children and adults. Nearby recreational use was used to estimate exposures to local residents that may visit the site more frequently. Children were assumed to spend 182 days/year for 10 years in the vicinity, with 50 percent of exposure derived from contaminated areas. Adults were assumed to spend 100 days per year for 30 years in the vicinity, with 80 percent of exposure from contaminated areas. Exposure pathways included incidental ingestion of waste rock and ingestion of surface water as drinking water.

Potential future land use assumed residential use of an area west of the waste rock dump and State Highway 63, with domestic water supply obtained from the shallow and deep aquifers at the site. Risk was calculated for a person spending 30 years, from childhood to adulthood, at the site. Exposure calculations included different intake parameters for different life stages: child age 0 to 6 years, youth age 7 to 17 years, and adults. Age-specific body weights and soil and water ingestion rates were used to calculate intake over the time intervals. Intakes were then combined to estimate an average daily intake for the 30-year period. Exposure frequency was assumed to be 350 days per year.

Exposure point concentrations were estimated from the 95 percent upper confidence limit on the mean for each COC in each medium.

Risk from lead exposure was not evaluated for adults or youths because EPA has not published standard toxicity factors for this metal. Instead, lead exposure and risk were evaluated for resident children using the EPA Lead Uptake/Biokinetic (UBK) model. This approach is taken because the most important toxic effects of lead exposure are developmental and affect primarily children aged 0 to 6 years.

1.6.1.2 *Risk Characterization*

Noncarcinogenic risk was characterized using the Hazard Quotient (HQ)/Hazard Index (HI) method (EPA 1989a). The HQ is the quotient of the estimated site exposure divided by the EPA toxicity factor. An HQ greater than 1.0 indicates exposures exceed the EPA benchmark value. The HI is the sum of HQ values for multiple chemicals and is generally used to assess cumulative risk from several contaminants.

For recreational scenarios, no chemicals were associated with HQ or HI values greater than 1.0. This result indicates that risk from individual COCs and cumulative risk from combined COCs were within acceptable limits as defined by EPA.

For the residential scenario, the HQ for barium in deep groundwater (1.3) and manganese in shallow groundwater (1.2) exceeded the threshold value of 1.0. No other individual chemicals or pathways were associated with HQ values exceeding 1.0. The HI value for soil and water pathways combined was 2.5 when the deep groundwater is used as the domestic water supply and 2.2 when the shallow groundwater was used.

Arsenic was the only COC for which published carcinogenicity slope factors were available. Carcinogenic risk estimates for arsenic ingestion under the residential scenario was 8.7×10^{-3}. This value exceeds the EPA threshold range of 1×10^{-6} to 1×10^{-4}. However, cancer risk from background (natural) levels of arsenic in soils was 6.25×10^{-3}, which is similar to the site value and also exceeds EPA's benchmark range. Therefore, cancer risk due specifically to arsenic in site soils was not appreciably greater than natural conditions in the forested areas around the mine site.

As noted above, risk from lead exposure was evaluated using the UBK model, which estimates risk for children. Results of the UBK model are probabilistic and expressed as the chance that a child's blood lead concentration will exceed 10 micrograms/deciliter (µg/dl) if exposed to site conditions. EPA's benchmark for unacceptable lead risk is a greater than 5 percent chance that child blood lead levels will be equal to or exceed 10 µg/dl. Results of the HHRA indicate that current conditions at the site exceed the acceptable risk range.

The HHRA cites the shallow groundwater as a major contributor to lead risk at the site. However, lead concentration in the monitoring well used for exposure estimate did not exceed background concentrations. The HHRA also indicates that if groundwater from the deep aquifer were used as the domestic water supply, the average soil lead concentration would have to be 840 mg/kg or less for the site to be within the acceptable risk range.

1.6.2 Ecological Risk Assessment

The ERA was conducted for the Upper Pecos site, which comprises the five operable units identified in the AOC. However, sampling and analysis used in the ERA was conducted primarily for the Pecos Mine OU, with the results extrapolated to other operable units (Hagler Bailly 1997). The approach used in the Upper Pecos ERA followed EPA (draft) guidance for conducting ecological risk assessments at Superfund sites (EPA 1994a). Details of the analysis methods and results can be found in the final ERA document (Hagler Bailly 1997).

The ERA evaluated ecotoxicological risks from exposure of aquatic and terrestrial receptors to site-related metal and metalloids in abiotic and biotic media at the Pecos Mine OU. COCs at the site were identified based on data collected from the Pecos Mine OU during the RI (Stoller 1996) and previous investigations and preliminary risk calculations (Hagler Bailly 1995a). The COCs evaluated in the ERA were arsenic, cadmium, copper, lead, selenium, and zinc (Hagler Bailly 1997).

1.6.2.1 Approach

The exposure pathways evaluated for the aquatic ecosystem were exposure of aquatic biota to contaminated surface water and sediments, and exposure of piscivorous and benthivorous biota to metals in the aquatic chains. The following assessment endpoints (EPA 1994a) were identified for evaluated risk from these pathways (Hagler Bailly 1995b, 1997):

- submergent aquatic vegetation communities (periphyton)
- benthic macroinvertebrate communities
- brown trout populations
- benthivorous birds
- piscivorous birds and mammals

Exposure pathways evaluated for the terrestrial ecosystem were (1) exposure of terrestrial vegetation, soil invertebrates, and grazing and burrowing mammals to metals in soils; (2) exposure of terrestrial biota to contaminated groundwater seeps; and (3) exposure of terrestrial herbivores to metals in vegetation, insectivores to metals in soil invertebrates, and carnivores to metals in potential prey species. Assessment endpoints for the terrestrial risk assessment were (Hagler Bailly 1995b, 1997):

- upland vegetation communities
- wetland vegetation communities
- terrestrial invertebrate communities
- terrestrial herbivore populations
- terrestrial insectivore populations

- terrestrial carnivore populations

1.6.2.2 *Risk Characterization*

Aquatic Ecosystem

The ERA evaluated dissolved concentrations of arsenic, cadmium, copper, lead, selenium, and zinc in the Pecos River by comparing them to federal Ambient Water Quality Criteria (AWQC). Concentrations of cadmium, copper, and lead infrequently exceeded AWQC in the Pecos River upstream of the mine. Concentrations of cadmium and selenium infrequently exceeded AWQC or state standards downstream of the mine.

Zinc concentrations downstream of the mine exceeded AWQC more frequently than other metals and to a greater degree. Exceedence of the zinc AWQC coincided with periods of runoff from snowmelt or rainfall events in spring and fall. During runoff events, zinc concentrations exceeded AWQC for a distance of 1 to 1.5 miles downstream of the mine.

Data on fish and aquatic macroinvertebrate communities indicated an effect of the mine on aquatic biota in the Pecos River just below the mine site. Mayfly (Ephemeroptera) density (number individuals/m^2) and the number of mayfly species were lower at the site just (PR3) downstream of the mine than at the site just upstream (PR2). Brown trout populations and total biomass were also lower at PR3 than at PR2. The effect on trout populations may also be correlated with episodic runoff events that may lead to increased zinc concentrations.

The effect on the brown trout populations may be a combination of mortality and behavioral avoidance of high zinc concentrations by trout in the stream reach below the mine. Data indicate that brown trout populations at PR3 recover over time; on at least one occasion when visibly discolored water was emanating from Willow Creek, trout were observed concentrating in the Pecos River just upstream of its confluence with Willow Creek.

Risk from transfer of metal contaminants through food chain interactions appears to be negligible. Concentrations of metals in aquatic invertebrates did not exceed threshold concentrations for toxicity to fish (trout), birds (American dippers), or mammals (raccoons) that may feed on them. Metal concentrations in fish tissues also did not exceed threshold toxic concentrations for piscivorous raptors (bald eagle) or mammals (otters).

In summary, the source of risk to the aquatic ecosystem in the Pecos River appears to be episodic release of metals, primarily dissolved zinc, during episodes of runoff due to snowmelt or rainfall events. The duration of runoff episodes ranges from a few hours to a few days and probably occurs in spring and during the late summer/fall monsoon period. Zinc concentrations in the Pecos River between episodes do not generally exceed AWQC.

Terrestrial Ecosystem

Risk to organisms exposed directly to waste rock and potentially contaminated soils were evaluated using soil toxicity tests. Potential risks to wildlife feeding in the Pecos Mine area were evaluated using concentrations of metals in soil, vegetation, and invertebrates samples collected from the site.

Organisms Exposed Directly to Soil

Soil toxicity tests were conducted using a representative plant species (yarrow) and earthworms. Yarrow was the most sensitive of three species tested in preliminary phytotoxicity trials (Hagler Bailly 1997). Risk evaluation was based on two types of tests: (1) using a series of background soil/waste rock mixtures with varying proportions of waste rock and (2) soils collected from specific sites in the wetland and upland areas of the site. Results of the mixture series tests were used to estimate the threshold level of waste rock content in soils that may result in toxicity to soil organisms. The approximate concentration of metal in mixtures associated with toxicity was then calculated. Soils collected from the wetland and upland areas were also tested to help determine whether site conditions not represented in the soil mixtures (e.g., pH and organic matter content) altered toxic characteristics as predicted from tests based on soil mixture.

The LC50 and LC20 (the concentration resulting in 50 percent and 20 percent germination failure, respectively) for waste rock content correspond to 21 and 14 percent, respectively. The no-observed-adverse effects level (NOAEC) and lowest-observed-adverse effects level (LOAEC) were based on root and shoot growth. The NOAEC was 12 percent waste rock, and the LOAEC was 18 percent waste rock. The toxicological endpoints were also calculated for metal concentrations in waste rock mixtures and soil sampling locations with concentrations of one or more metals that exceed toxicological thresholds identified.

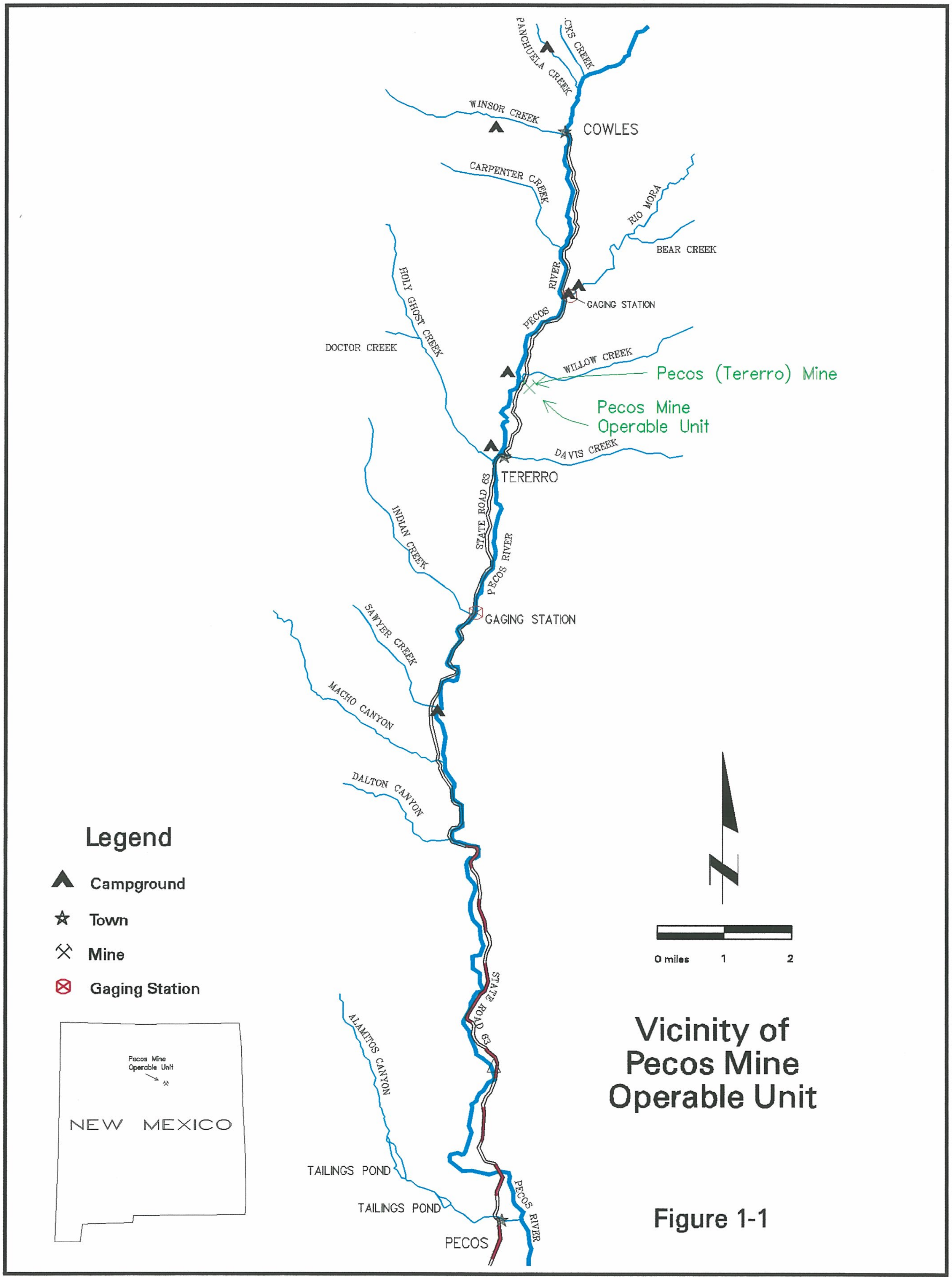
Toxicity test results from site-specific wetland and upland soil samples were not consistent with results of tests conducted with soil mixtures. In soils with metal concentrations much higher than the LC50 but approximately neutral pH, toxicity was absent or much reduced. Germination failure was 100 percent in two samples, one upland sample and one wetland sample, both with pH 4.6 or less. The pH of the remaining eight samples ranged from 6.9 to 7.8. Two samples had reduced germination rate, but no effect on growth parameters; one sample reduced growth but had no effect on germination rate; the remaining samples did not affect test endpoints.

These results indicate that pH was a controlling factor in soil toxicity, probably due to increased solubility and bioavailability of metals with decreasing pH (Hagler Bailly 1997). Soils with neutral pH are relatively non-toxic even with substantially elevated metal concentrations. Raising the pH of affected soils will alleviate but not eliminate risk from elevated metal concentrations (Hagler Bailly 1997).

Wildlife Exposure and Risk Estimates

Analysis of biological tissues indicated that metal concentrations in biota at the mine site were elevated compared to similar samples from unaffected areas. Evaluation of resulting wildlife exposure to metals in food items indicated that wide ranging species such as deer, fox, and hawks are not at risk. Species with smaller home ranges such as songbirds and small mammals were evaluated at each individual sampling site. Results indicated 2 (of 18) sites with at least one metal exceeding toxicity thresholds for voles, 5 for shrews, and 6 for robins. The degree of risk of toxic effect increases with the magnitude of the exposure and the number of metals for which toxic thresholds are exceeded. The degree of risk associated with the exposures was low to moderate, except for exposure of shrews to lead, which was associated with a higher level of risk at individual sites.

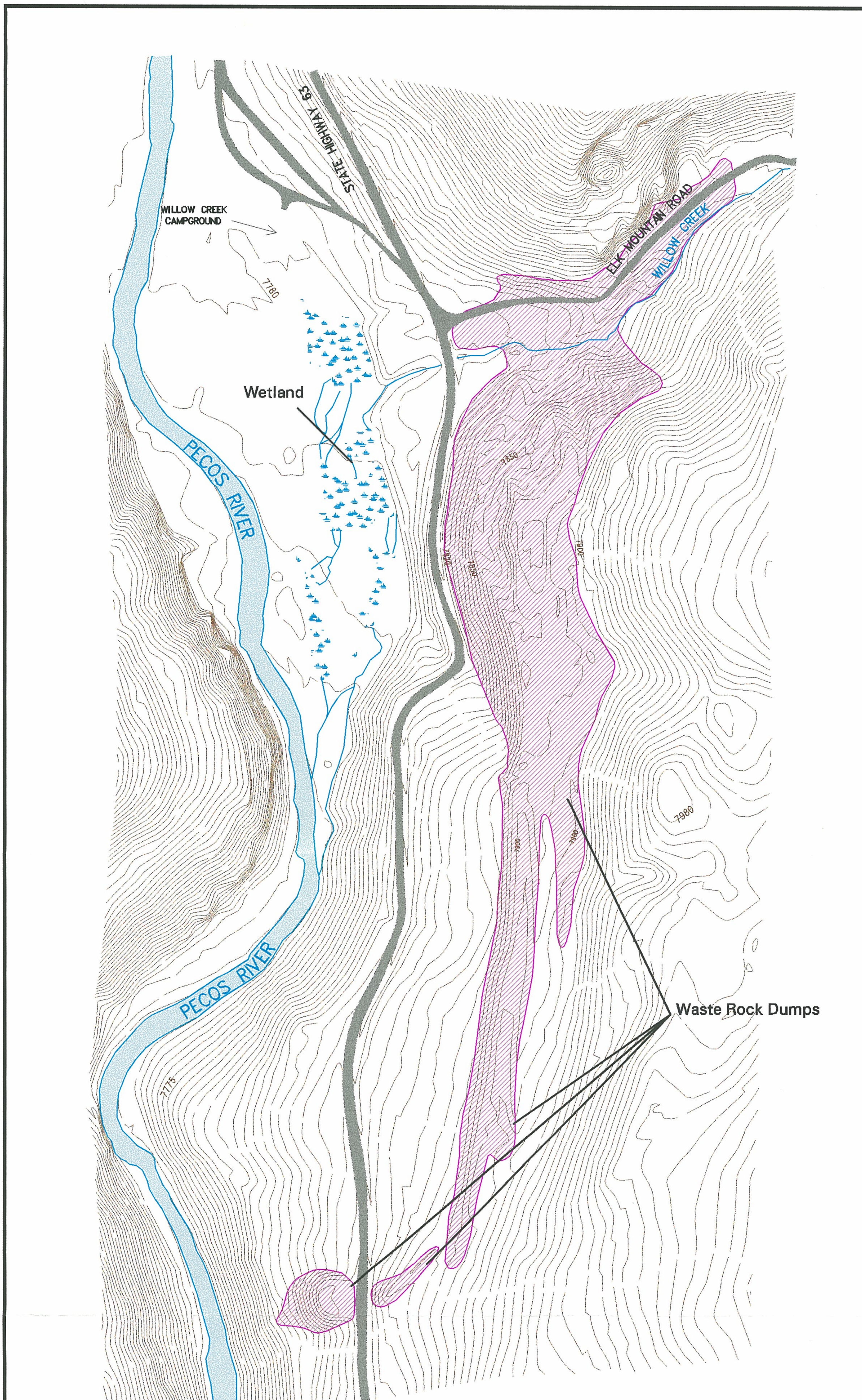
SECTION 1 FIGURES



Vicinity of Pecos Mine Operable Unit

Figure 1-1

05/20/97 TERERRO2.MAP



Explanation

Waste Rock Boundary

North

Stoller established 1959

0 Feet 250 500

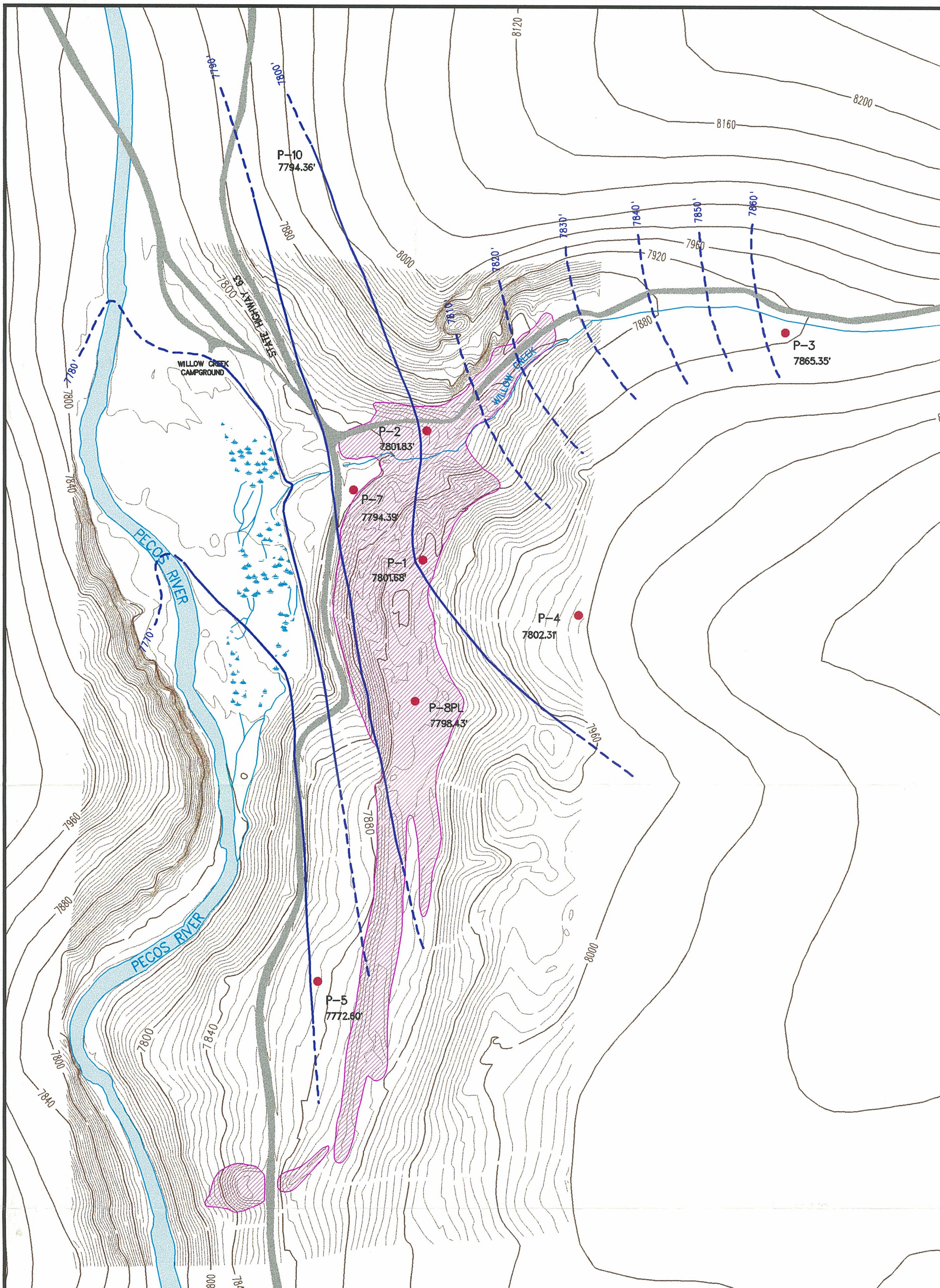
Contour Interval 5 Feet

Pecos Mine Operable Unit

Pecos Mine and Vicinity

Figure 1-2

20-MAY-1997 /export/home/data3/pecos/update/vicin.cml



Explanation

Monitoring Well (with water elevation)

Lines of Equal Potentiometric Elevation (dashed where inferred)

Waste Rock Dump

North

Stoller established 1959

0 Feet 300 600

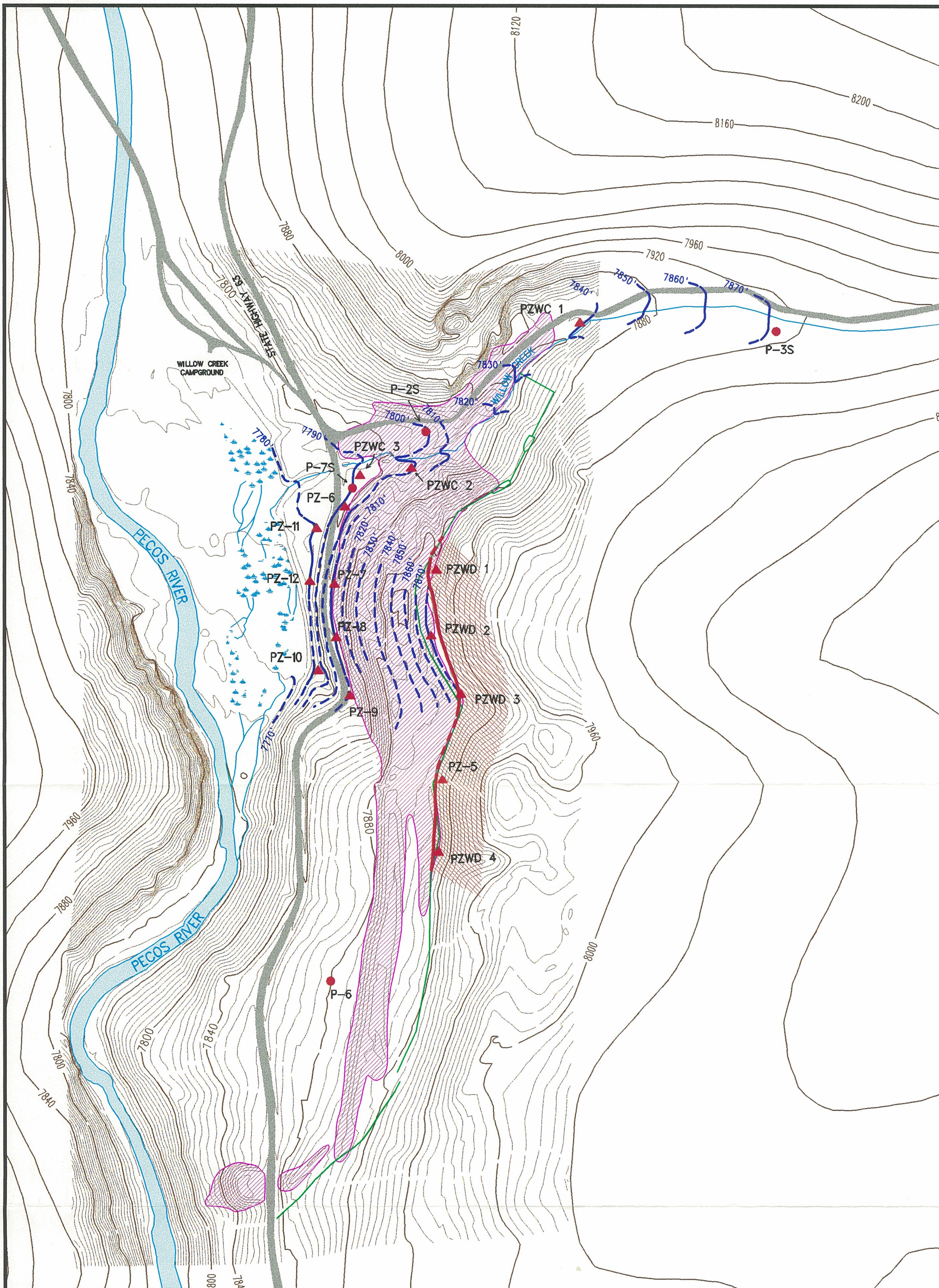
Operable Unit topography from aerial photography performed in 1992; contour interval 5 feet. Surrounding topography from USGS DEM; contour interval 40 feet.

Pecos Mine Operable Unit

Bedrock Aquifer Potentiometric Surface Elevation April 1995

Figure 1-3

05/20/97 BEDPOTEN-495.GRA POTEN95.AML



Explanation

- Monitoring Well
- Piezometer
- Water-Level Elevation (dashed where inferred)
- Uphill Diversion Ditch
- Unsaturated
- Waste Rock Dump

North

Stoller established 1959

0 Feet 300 600

Operable Unit topography from aerial photography performed in 1992; contour interval 5 feet. Surrounding topography from USGS DEM; contour interval 40 feet.

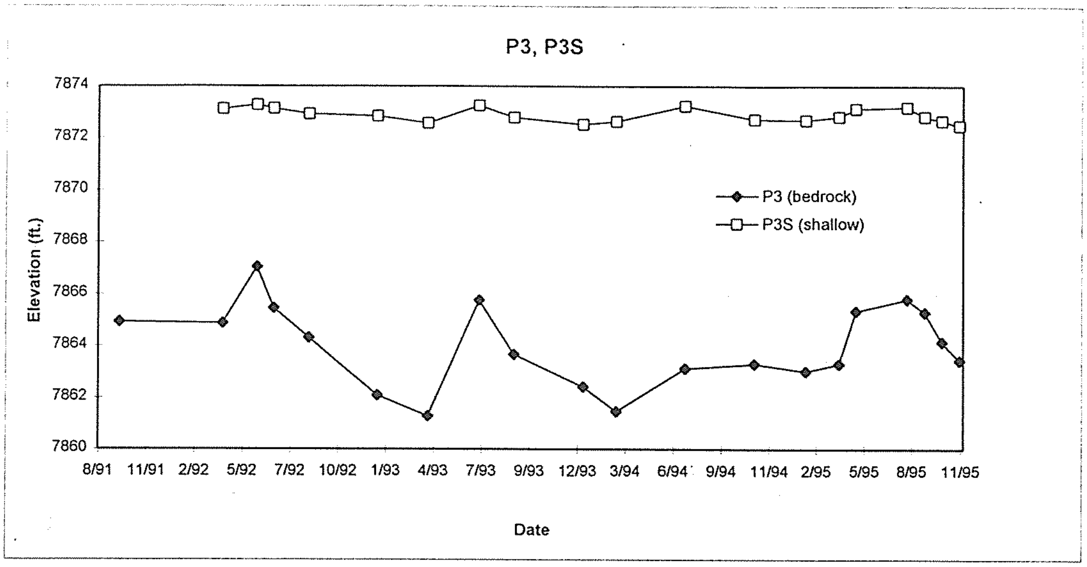
Pecos Mine Operable Unit

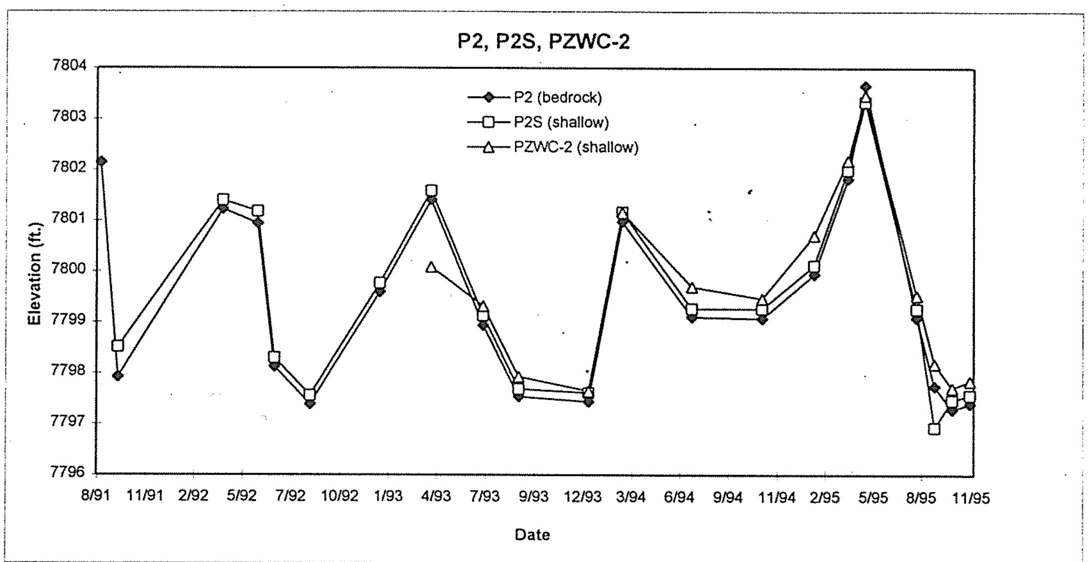
Shallow Groundwater Flow Systems: Water-Level Elevations August 1995

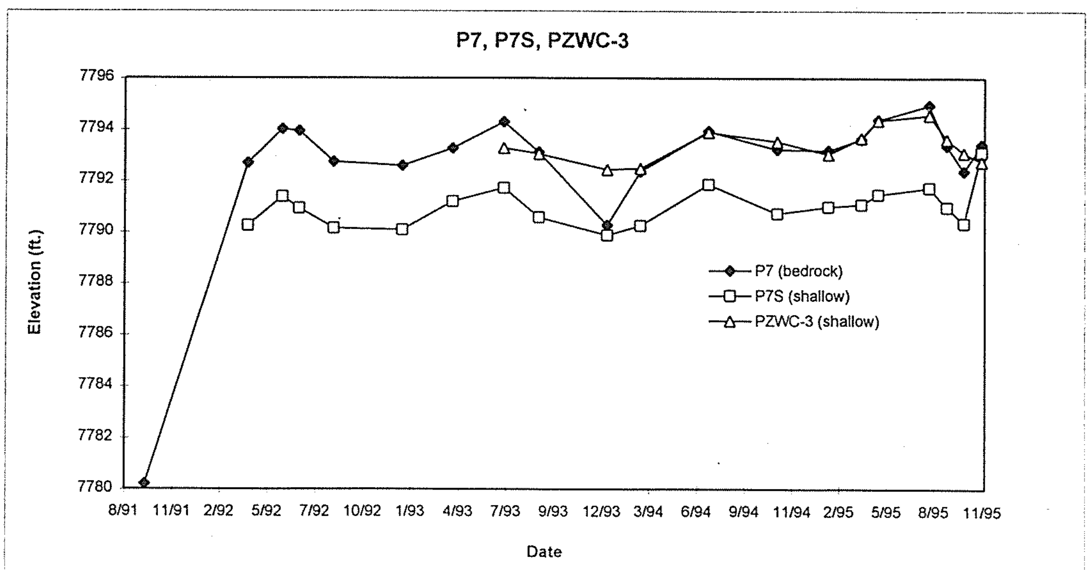
Figure 1-4

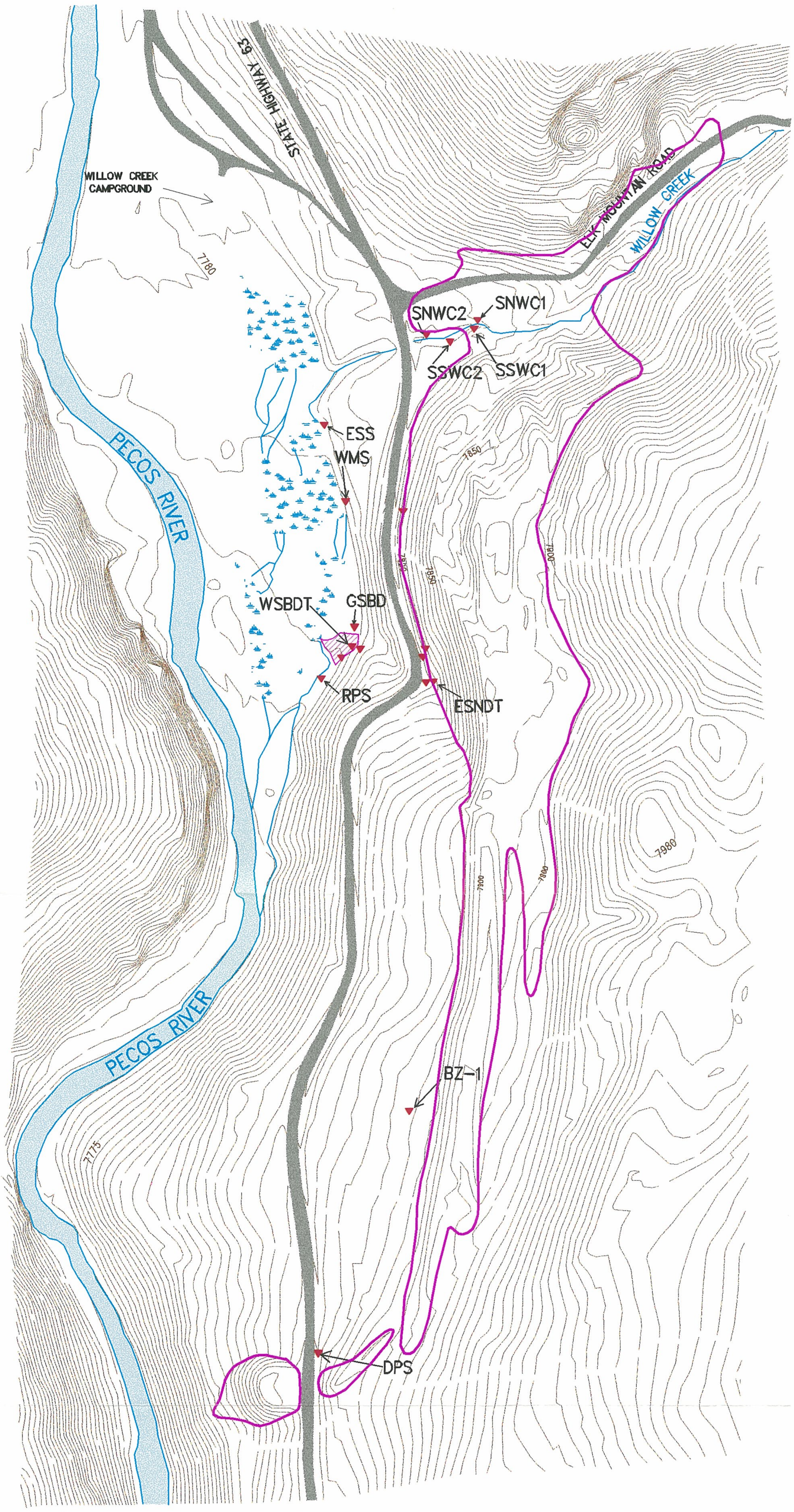
05/20/97 ALUVPOTEN-895.GRA POTEN95.AML

Figure 1-5
Water Levels in Paired Deep and Shallow Wells Along Willow Creek









Explanation

- Seep and Spring Sampling Sites
- Waste Rock Boundary
- Barren Seep Area

North

Stoller established 1959

0 Feet 250 500

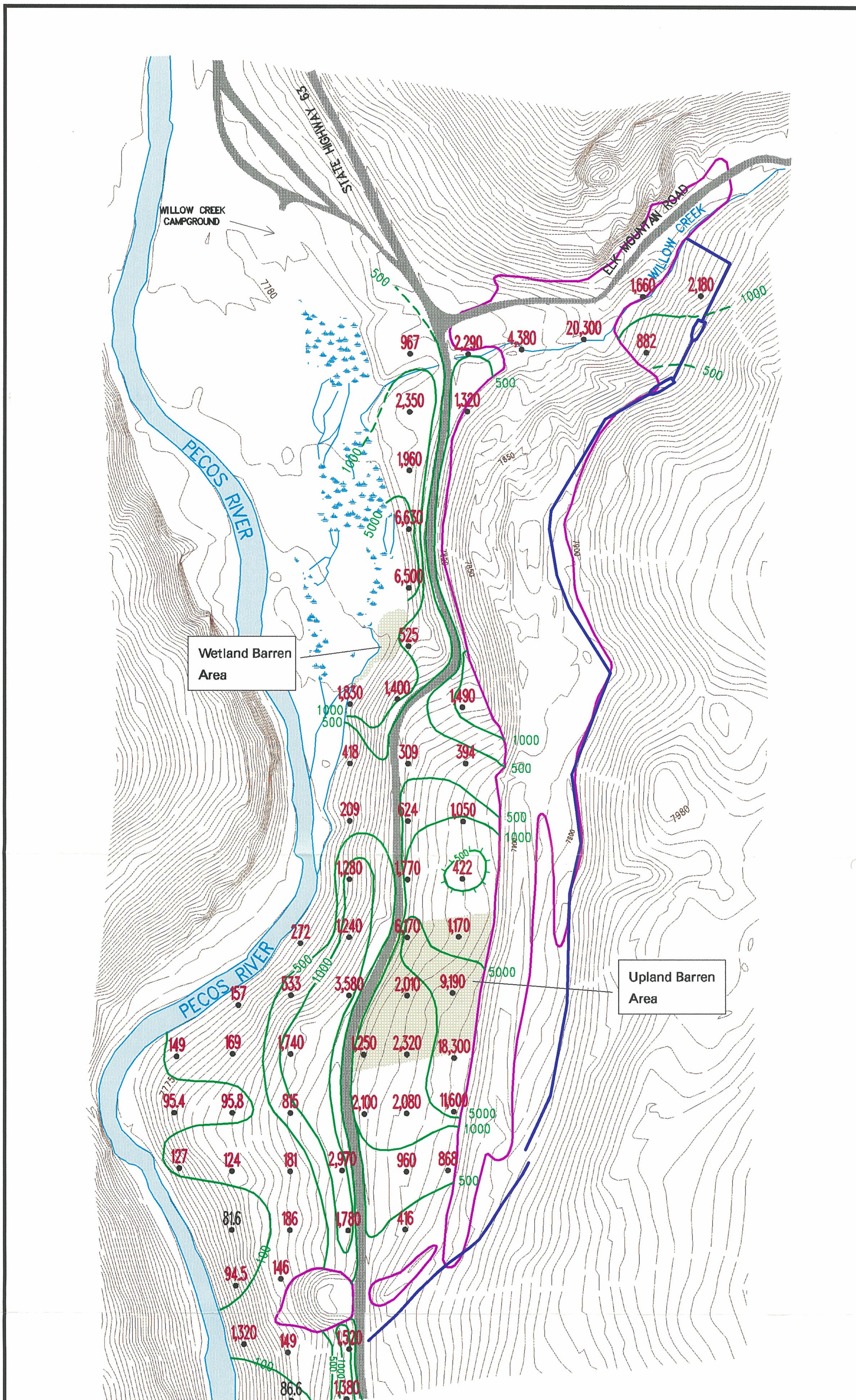
Contour Interval 5 Feet

Pecos Mine Operable Unit

Seep Characterization Sampling Locations

Figure 1-6

05/20/97 SEEP_CHARMAP



Explanation

- • Soil Sampling Location
- Waste Rock Boundary
- Diversion Ditch
- Isoconcentration Contour (dashed where inferred)

North

0 Feet 250 500

Contour Interval 5 Feet

Stoller established 1959

Pecos Mine Operable Unit

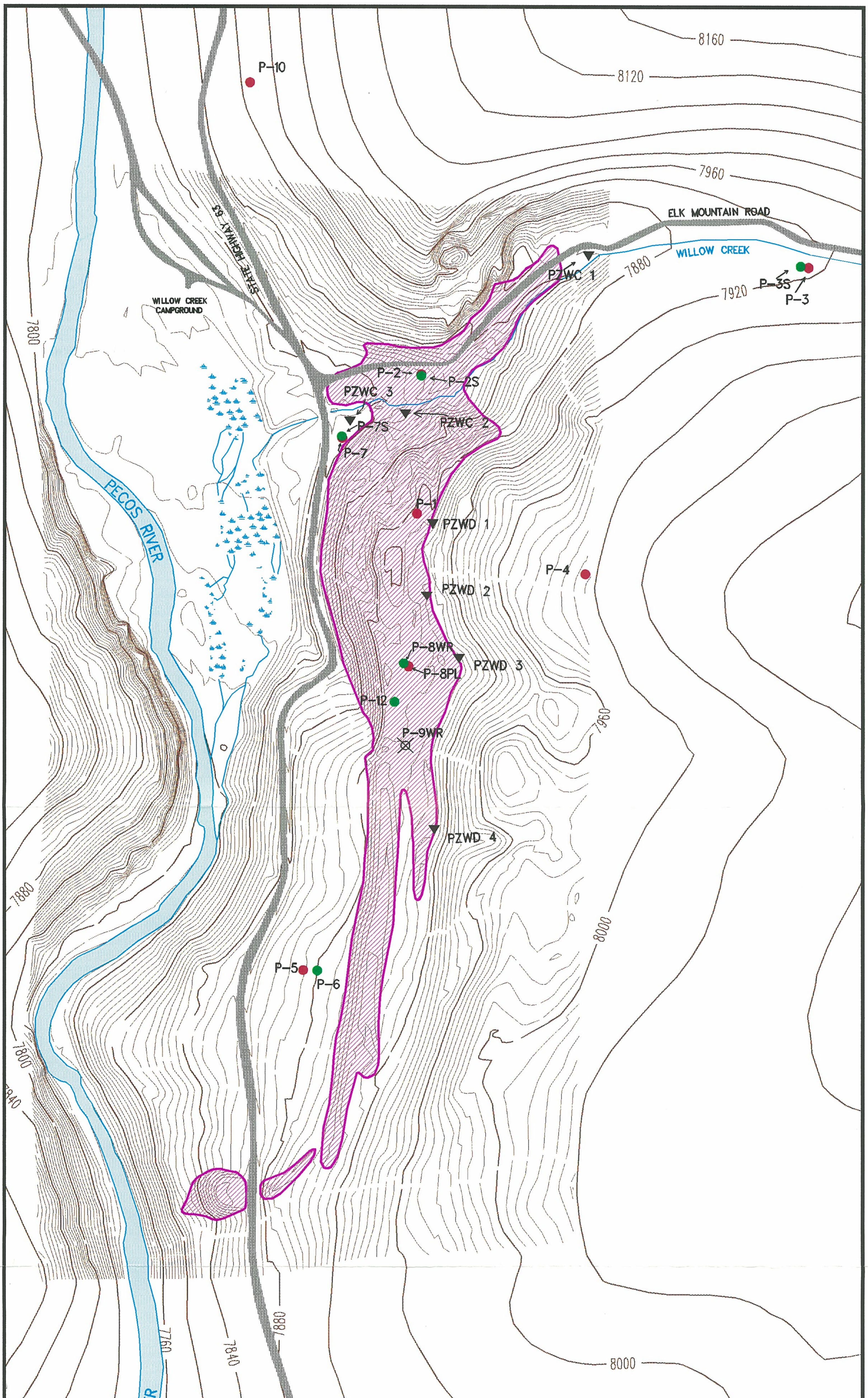
Zinc Concentrations in Soil (0 to 6 inch depth)

Background UTL = 93.0 mg/kg

(UTL exceedance noted in red)

Figure 1-7

05/21/97 SSZIN_0_6.GRA - SSPOST.AML



Explanation

- ▼ Piezometers
- Bedrock Monitoring Wells
- Shallow Monitoring Wells
- Abandoned Well
- Waste Rock Dump

North

0 Feet 300 600

Operable Unit topography from aerial photography performed in 1992; contour interval 5 feet.
Surrounding topography from USGS DEM; contour interval 40 feet.

Stoller established 1959

Pecos Mine Operable Unit

Groundwater Monitoring Wells and Piezometers

Figure 1-8

05/20/97 MON_PEZ.MAP

2. Identification and Screening of Technologies

2.1 Remedial Action Objectives

Remedial action objectives (RAOs) are medium-specific or operable unit-specific goals for protecting human health or the environment from contamination at a site (EPA 1988). Preliminary RAOs were developed in the RI report for the Pecos Mine Operable Unit. However, the preliminary RAOs did not include objectives based on the site-specific risk assessments because the HERA had not been completed, and exposure pathways, contaminated media, and exposure points representing unacceptable levels of risk had not been identified.

Final RAOs were developed based on results of the RI and HERA and indicate the contaminants, media, and specific areas of the Pecos Mine Operable Unit where risk thresholds were exceeded.

2.1.1 Waste Rock

Data from the RI indicate that waste rock is the ultimate source of metals transported by erosion and leachate generated in the waste rock dump. Evidence of solid material transport includes elevated metals in sediments of Willow Creek and soils in the wetland and adjacent to the main waste rock dump.

RI data show that acid leachate generated in the dump affects shallow groundwater quality and can also affect surface water quality in Willow Creek through discharge of contaminated groundwater at seeps. Results of the vadose zone investigation indicate that the primary source of water for acid leachate generation is infiltration of precipitation and snowmelt into the dump. Therefore, remediation that affects infiltration into the waste rock dump will also affect shallow groundwater and surface water quality.

Pathways potentially associated with unacceptable levels of exposure include incidental ingestion of waste rock material under residential (human) land-use scenarios and potential ecotoxicity to vegetation and soil invertebrates through direct contact. No unacceptable exposures were observed for recreational use of the site.

RAOs for waste rock are to:

1. *Prevent exposure of human receptors to metals in waste rock at levels that exceed RACCs.*
2. *Minimize generation of acid leachate from percolation of water through the waste rock dump.*
3. *Prevent migration of contaminants to surface water or groundwater at levels that would exceed RACCs.*
4. *Minimize erosional transport of waste rock particulates to downgradient soils and surface water drainages.*

2.1.2 Affected Soils

Soils in some areas of the Pecos Mine OU have been affected by transport of metals in waste rock material or leachate. Soils represent potential exposure to humans and ecological receptors in restricted areas, and may act as a secondary source of contamination.

As with waste rock, exposure pathways potentially associated with unacceptable levels of exposure include incidental ingestion of waste rock and soils by humans and potential ecotoxicity to vegetation and soil invertebrates through direct contact. No unacceptable exposure in the soil pathway was observed for recreational or residential use of the site.

RAOs directly involving soils are to:

1. *Prevent exposure of human receptors to metals in soils that exceed RACCs.*
2. *Prevent toxic exposure of ecological receptors to site contaminants that could result in significant effects on local plant and/or soil fauna communities.*
3. *Minimize transport of waste rock contaminated soils to downgradient areas and waterways that would result in exceedence of RACCs.*
4. *Revegetate areas in which vegetation has been impacted due to toxic effects of waste rock or leachate in soils.*

2.1.3 Groundwater

Data from the RI indicate that groundwater in the shallow flow system has been affected by transport of metals and sulfates from the waste rock dump to the alluvial groundwater north of the dump and to unsaturated and saturated flows within the colluvial flow path. Water from the shallow flow systems discharges at seeps along the toe of the hillslope in the wetland. Therefore, transport of metals into the shallow flow system can also affect surface water quality.

Deep bedrock groundwater has been minimally affected but contains manganese, iron and, in some cases, barium concentrations that exceed state groundwater quality standards.

Results of the HERA indicated that persons using the site on a recreational basis would not experience unacceptable risk levels. Current land use of the site is recreational. Barium and manganese were present at concentrations that exceed acceptable exposure levels if groundwater at the site was used as the water supply for a residence. Groundwater at the site or in nearby downgradient areas is not currently used for residential or commercial water supplies.

RAOs for protection of groundwater are to:

1. *Restore groundwater quality to conform with RACCs.*
2. *Reduce transport of contaminants from groundwater to surface water to levels that conform with RACCs.*

2.1.4 Surface Water

RI data show that water quality in Willow Creek and the Pecos River has been affected by the mine site. Data also show that most (>90 percent) of the zinc loading in the Pecos River immediately downstream of the mine site is contributed from Willow Creek and that most of the zinc loading in Willow Creek occurs in the wetland area. The most important sources of dissolved metal loading to Willow Creek are the southernmost seeps along the eastern edge of the wetland, and overland transport of metals dissolved from encrusted materials on the dump surface. Exceedence of water quality standards in the Pecos River is episodic and correlated with large snowmelt and rainfall events. As a result, important objectives in protection of water quality in Willow Creek and the Pecos River is attenuation of metal loading to colluvial groundwater that emanates from the seep area, and preventing runoff from waste rock.

The ultimate source of metals and depressed pH in seep water is percolation and leaching of water through the waste rock dump. Therefore, actions that reduce infiltration and percolation through the waste rock dump will also affect seep water quality and metal loading to Willow Creek and the Pecos River. These actions will also prevent contact of precipitation with waste rock and the generation of contaminated runoff from the dump surface.

The HHRA found no unacceptable exposures associated with surface water at the site. Results of the ERA indicate that metal concentrations exceed AWQC and state standards in Willow Creek, the wetland and, less frequently, the Pecos River .

The RAO for seep water and surface water is to:

1. *Reduce site-related loading of metals to surface water to levels that will allow conformance with RACCs.*

2.1.5 Wetland Soils

The RI data indicate that wetland soils contained elevated concentrations of metals. However, results of toxicity testing performed for the ERA indicate that soils of most areas were generally not toxic. Field observations also indicate relatively healthy vegetation growth, except around WSBDT and associated seeps where vegetation was absent or exhibited signs of toxicity. Laboratory toxicity tests supported the field observations indicating phytotoxicity in this area. Samples collected from this area contained the highest metal concentrations and lowest pH of sediment sampling sites. Metal precipitates in the soils around WSBDT may also be a source for dissolution and transport of metals to the Pecos River.

The RAOs for wetland soil refers to an area around seep WSBDT, is to:

1. *Prevent release of contaminants that would result in release of contaminants to wetland soils at levels that would result in exceedence of RACCs.*

2. *Prevent movement of contaminated soils that would result in exceedence of RACCs in surface water.*

2.1.6 Willow Creek Bed Material

Surface water data from Willow Creek indicate that metal concentrations increase as the creek flows by the northern extent of the main waste rock dump. The creek bed in this reach contains waste rock, and iron staining is apparent on the south bank indicating some seepage and precipitation of iron oxyhydroxides. Concentrations of cadmium, chromium, copper, and mercury exceed health-based water quality standards in at least one sample. These data suggest that waste rock material in the creek bed and subsurface seepage from the waste rock dump may contribute to metal loads in Willow Creek. In addition, the riparian area along this stream reach shows signs of physical disturbance.

Remediation of the waste rock dump will attentuate shallow subsurface seepage into Willow Creek. Therefore, the RAOs relating specifically to waste rock in the stream channel are to:

1. *Minimize contact of stream water with waste rock to prevent metal concentrations in surface water from exceeding RACCs.*
2. *Reclaim riparian area along the stream reach.*

2.1.7 Air

Baseline air monitoring during the RI indicated no impacts of the mine site on air quality. However, particulate material may be suspended during earthmoving and construction activities. Therefore, an RAO was included to account for potential short-term effects of remediation activities on air quality. The RAO for air quality is to:

1. *Prevent concentrations of airborne particles (PM_{10}) from exceeding health-based standards for non-worker (i.e., offsite) exposures during earthmoving or construction activities associated with remediation at the Pecos Mine.*

2.2 General Response Actions

The initial step in selecting remediation alternatives for the Pecos Mine site was identification of appropriate response actions and technologies by which remediation can be accomplished. General response actions are broad categories of activities that have the potential to satisfy the RAOs (EPA 1988). General response actions and technologies for implementing them were identified for the waste rock dumps, groundwater, Willow Creek adjacent to the main dump, seep water, and wetland soils. The types of response actions considered for the Pecos Mine OU include:

- no action
- institutional controls
- containment
- removal

- treatment

The quantity and composition of media to be addressed in the remediation are summarized in Table 2-1. Volume estimates are based on measurements and analyses conducted for the RI (Stoller 1996).

2.3 Identification and Screening of Technology Types and Process Options

Technologies available for implementing general response actions are presented in Tables 2-2 through 2-7. Process options, or specific approaches to implementing each technology, are also identified in the tables (EPA 1988). Technologies were screened using a qualitative approach to identify technologies that are practical for use at the Pecos Mine site. Technologies were evaluated based on effectiveness, implementability, and cost (EPA 1988). The screening resulted in identification of technologies and process options that are most appropriate for the Pecos Mine OU. The technologies remaining after the screening were used to develop remedial alternatives (Section 3). The technologies selected for inclusion in the remedial alternatives are described in the following sections.

Evaluation of the effects of no remedial action at the site is required by EPA under the 1990 revisions to the National Contingency Plan. Therefore, the "no action" option is included in Tables 2-2 through 2-7.

2.3.1 Waste Rock Dumps

Four response actions were considered for addressing RAOs at the waste rock dumps: institutional controls, containment, and removal (Table 2-2).

2.3.1.1 Institutional Controls

Risk from exposure to contaminants at the mine site could be reduced through limiting access to the waste rock dumps. Restricting access for humans could be accomplished through imposing conditions on the deed that would restrict land use in order to minimize human contact with waste rock. For example, residential land use of the site could be prohibited. This approach could be coupled with erection of physical barriers such as fences and warning signs.

Institutional controls would not prevent infiltration of water into the dump or the transport of contaminants from the waste rock dump to downgradient areas. They also would not prevent contact of ecological receptors with the waste rock dump.

2.3.1.2 *Containment*

Containment options considered for the waste rock dumps include technologies that prevent water from precipitation, surface run-on, or subsurface flow from entering the waste rock pile in quantities that could result in acid leachate generation and subsequent discharge to surface water or groundwater. Containment technologies considered for the waste rock dump included capping the dump with combinations of earthen and synthetic materials to prevent infiltration and intercteption of flow from upgradient areas by an interceptor system. Other technologies such as *in-situ* vitrification and direct revegetation are either not feasible for this site or have a low chance of satisfying the RAOs.

Three cap configurations for the dump top were selected to represent a range of performance characteristics and construction material requirements. Performance was evaluated based on the capacity of the design to reduce percolation of water through the waste rock and into underlying colluvium. The Hydrological Evaluation of Landfill Performance (HELP) model (EPA 1994b) was used to evaluate the relative performance of the cap designs. The HELP model was developed for use in assessing cap and liner designs for landfills, and is commonly used in assessing performance of caps and liners in the mining industry (Hutchison and Dille 1993). Specific cap configurations are proposed in Section 3, and results of HELP model runs are included in detailed analysis of the individual alternatives (Section 4.2).

RI results show that water is present intermittently in some areas of the shallow subsurface upgradient of the dump, and the stormwater and snowmelt can run onto the dump during wet periods. Therefore, for alternatives in which waste rock remains onsite, drainage structures will be constructed upgradient of the dump to intercept intermittent flow before it reaches waste rock and divert it to Willow Creek. This activity was not included in alternatives that include removal of waste rock.

2.3.1.3 *Treatment*

Technologies available for treatment of waste rock include extraction of metals from the rock matrix followed by sale or disposal of metals and disposal of the waste materials (e.g., tailing). Technologies available include conventional milling and metals extraction, or as yet untested technologies that utilize other mechanisms of metal extractions. Any treatment technology considered would also require treatment to reduce the acid-generating potential of the rock.

Conventional milling and process of the waste rock was not considered feasible because the overall grade of the ore was too low for economical recovery of metals. In addition, the tailing material generated would have high sulfate content and require additional treatment to reduce acid-generating potential. Mill facilities are not available nearby. Therefore, the waste rock material would have to be transported greatly increasing the impact of transporting materials and increasing costs to levels inconsistent with other alternatives that are as effective in accomplishing RAOs.

Unconventional treatment technologies were also considered. A technology involving crushing of waste rock to fine particles, followed by physical separation was considered. However, this technology has not been tested at the scale needed at the Pecos Mine site. The chemical composition and physical attributes of the waste material generated is also unknown. Therefore, the issues associated with waste disposal aspects cannot be readily predicted. Further consideration of waste rock treatment technologies is not justified based on the uncertainties associated with effectiveness and cost.

2.3.1.4 Removal

One removal option was considered: excavation and transport of waste rock and contaminated soils to the tailing ponds at the El Molino Operable Unit. Waste rock would be placed on the mill tailing deposits and covered with the containment cap already planned for the mill site. This option would require redesign of the cap and surface water diversions planned for El Molino to accommodate the added volume of material and the difference in physical characteristics of the waste rock.

2.3.2 Affected Soils

RI data indicate that soils at the site have been affected by transport of metals in waste rock and leachate, with subsequent deposition in areas downgradient of the dump. The following remediation technologies were considered.

2.3.2.1 Institutional Controls

Application of institutional controls to restrict access to soils at the site is similar to that discussed for waste rock.

2.3.2.2 Containment

Containment options considered for soils include excavation and capping along with waste rock, either at the mine site or at the mill site, depending on the remediation alternatives selected for waste rock.

2.3.2.3 *Treatment*

Data from the RI and ERA indicate that the toxicity of soils is highly dependent on pH. Soils with elevated metals and low pH were toxic to yarrow and earthworms (Hagler Bailly 1997), but soils with similar metal concentrations and near-neutral pH showed little or no toxicity. Therefore, *in-situ* adjustment of soil pH can be effective in reducing toxicity and protecting ecological receptors exposed to contaminated soils. Adjustment of soil pH can be accomplished by incorporating agricultural lime or crushed limestone to affected soils.

Alternatively, soils that show significant toxicity in laboratory tests or contain elevated metal concentrations and are associated with unacceptable risk can be excavated and disposed, either onsite or offsite, with waste rock. The depth and areal extent of excavations will vary with location dependent upon the lateral and vertical extent of contamination.

Alternative methods of treatment include solidification and stabilization. Solidification technologies include nitrification (in situ or ex situ) and incorporating soils into solid matrices such as concrete to prevent leaching of metals. These approaches were not considered in the alternatives because of (1) high cost and low implementability for the Pecos Mine site and (2) they do not represent a significant advantage over containment or treatments that neutralize pH and immobilize metals.

2.3.3 Groundwater

RAOs for groundwater address restoration of water quality. RI results indicate that water in the shallow flow system downgradient of the dump, including alluvial, colluvial, and unsaturated flow is affected by leachate from the waste rock dump. An overall objective of the waste rock dump remediation is to minimize generation of acid leachate from the waste rock dumps by minimizing the amount of water entering the waste rock dump from external sources, including infiltration of precipitation and intermittent flow in the shallow subsurface from areas upgradient of the dump (Section 2.3.1.2).

Results of the RI indicate that bedrock groundwater does not contact waste rock in the dump and thus does not contribute to generation of acid leachate. Deep bedrock groundwater (~100 feet bgs) contains concentrations of barium (one well), manganese, and iron that exceed state standards.

Response actions considered for groundwater included institutional controls and treatment (Table 2-4). Containment and diversion of shallow subsurface flow from areas upgradient were included in the discussion of remedial technologies for waste rock (Section 2.3.1.2).

2.3.3.1 Institutional Controls

Results of the HERA showed that human health risks were acceptable under the current land use, which is recreational. Deed restrictions limiting site use to recreational can be effectively imlemented by NMGF. This use restriction would ensure that groundwater use at the site does not include domestic water supplies. The use restriction can be permanent or implemented on an interim basis until RAOs and applicable or relevant and appropriate requirements (ARARs) are satisfied.

The effects of waste rock remediation on groundwater quality will be assessed by monitoring bedrock and colluvial groundwater in new monitoring wells to be located downgradient of the current dump location. These data can be used to evaluate whether further actions are needed to protect surface water.

2.3.3.2 Treatment

Remediation of the waste rock dump will affect groundwater quality. However, the time required for groundwater quality to improve is uncertain. Potential treatment of groundwater to meet state water quality standards was also considered in remedial alternatives. Treatment includes interception and diversion of shallow groundwater and seep water with subsequent treatment as described in the next section.

2.3.4 Seep Water

Seeps emanating from the foot of the waste rock pile and at the eastern edge of the wetland contain elevated metal concentrations and are acidic. Containment and removal options proposed for remediation of the waste rock dump are expected to attenuate leachate generation. However, seeps along the wetland originate, in part, from colluvial material beneath the dump which may continue to produce contaminated water for a period of time after remediation. Institutional controls and treatment were the response actions considered for seep water (Table 2-5).

2.3.4.1 Institutional Controls

Institutional control technologies for seeps included access restrictions and monitoring. These technologies are not mutually exclusive and some combination could be used in conjunction with actions elsewhere at the site.

Access restrictions, including physical barriers (e.g., fencing), deed restrictions, and warning signs could reduce exposure of human receptors but would be less effective in reducing exposure to ecological receptors and would not prevent further release of contaminants to Willow Creek and the Pecos River.

As noted for Willow Creek, the effects of waste rock remediation could be assessed by monitoring seep flow and water quality. For example, attenuation of water flow through the dump will reduce seep flow, reduce contaminant input to seeps, or both. These data could be used to assess the type of remedy, if any, needed for the seeps after remediation of other areas of the site.

2.3.4.2 *Treatment*

Treatment technologies identified for seep water included (1) collection, transport, and treatment at an offsite facility; (2) construction of a conventional onsite treatment facility; and (3) construction of a passive treatment system employing sulfate-reducing bacteria (SRB), anoxic limestone drains (ALD), or engineered wetlands. Treatment technologies can be categorized into those that are active treatment systems that require continuous operation and maintenance (O&M) throughout period of use, and those that are passive treatment systems with minimal O&M costs.

Reverse osmosis, precipitation/coagulation, and ion exchange are examples of active treatment systems. Each of these technologies involve selective removal of metals from water using chemical and physical separation techniques. The methods require that artificial containers, mixing devices, and pumps be installed to collect and treat water and store waste. Waste consists of concentrated slurries or solids that require regular disposal at approved facilities. Precipitation/coagulation also involves addition of chemicals to water to adjust pH and provide substrates that encourage precipitation and coagulants to allow settling of colloidal metal salts such as zinc sulfates. Each of the active treatment technologies also requires installation of onsite facilities, including tanks for storage of chemicals, precipitates or slurries, overflow holding areas, and buildings to house service personnel and equipment. Each also requires electrical power at the site to drive mixers, pumps, and/or measurement instruments involved in proper operation of the systems.

SRB and wetland treatment systems are passive treatment technologies. Although these systems are not maintenance-free, they do require much lower O&M effort, no electrical or power to onsite storage facilities, and can be constructed to blend aesthetically with a natural wetland setting. SRB and constructed wetlands are commonly used in treating metal-contaminated water at mineral and coal mine sites (Hedin *et al.* 1994).

Selection of a seep treatment technology for consideration in remedial alternatives was based on the overall effectiveness of the technology in meeting treatment requirements and minimizing O&M efforts required to keep the system operational. Minimizing O&M requirements is important because of the relative remoteness of the site. In addition, the wetland portion of the site is in the floodplain of the Pecos River, which is designated as recreational under the Wild and Scenic Rivers Act and is an area of heavy recreational use. Therefore, it is desirable that seep water collection and treatment systems be as inconspicuous as possible to be less susceptible to vandalism. In addition, containers with potentially hazardous materials such as strong base solutions and the sludge generated by coagulation/precipitation treatment should not be placed in a floodplain where they could be washed into waterways during floods. The SRB and wetland technologies best fit these preliminary criteria.

Results of water and soil/sediment sampling indicate that the existing wetland is effective in attenuating transport of particulate and dissolved metals and neutralizing acidic pH of leachate entering the wetland from the dump. Natural and engineered wetlands have been used successfully to treat acid leachate and runoff from mine waste at other sites in the western United States (Moshiri 1993). Use of wetland treatment could also be used in conjunction with other treatment options for final stages of treatment.

Any treatment options could require bench- or pilot-scale tests to develop appropriate configuration and sizing parameters.

2.3.5 Willow Creek Stream Bed

Waste rock material was identified in the Willow Creek stream bed and surface materials adjacent to the dump and along Elk Mountain Road north of the dump. Concentrations of some contaminants in Willow Creek surface water exceeded water quality standards downstream of the mine. Potential sources of elevated metal concentrations include contact with waste rock in the stream bed and seepage of water percolating through waste rock. General response actions considered for this area included institutional controls, containment, and removal (Table 2-6). Containment and removal actions are discussed together because both require excavation in the stream bed.

2.3.5.1 *Institutional Controls*

Institutional controls include monitoring stream water quality and actions that reduce the potential for receptor contact with stream water. Monitoring could be used to assess the effects of waste rock remediation on water and sediment quality in Willow Creek and to determine whether further remediation of stream bed materials was warranted.

2.3.5.2 *Containment/Removal*

Two options for preventing contact of stream water with waste rock in bed materials were considered: (1) installing a culvert or other artificial conveyance to contain Willow Creek through the area of concern and (2) excavation of waste rock from the stream bed. Waste rock removed from the stream could be disposed of along with affected soils and waste rock from the dump. These options would be effective in preventing contact of stream water with waste rock in the stream bed.

Installation of a culvert through the area of concern would prevent contact of stream water with waste rock and seep water. However, this approach would result in the loss of potential riparian habitat along the stream. Reconstruction of the stream channel would include reclamation to mitigate habitat loss. Options involving reclamation of the stream channel and riparian zone will be considered in the remedial alternatives.

2.3.6 Wetland Soils

Results from the RI and ERA indicate that sediment metal concentrations are elevated in some areas of the wetland. Results of the ERA combined with field observations of existing vegetation growth indicate that much of the wetland is capable of supporting relatively normal vegetation growth (Hagler Bailly 1997). Toxic conditions are limited to the area around WW07 and the stream braids downgradient. Based on these results and informal communication with NMED risk managers, the disturbance associated with extensive sediment remediation in the wetland may outweigh benefits. Therefore, it is proposed that remediation in the wetland be restricted to soils in the vicinity of WW07 and segments of downgradient stream braids.

The possible response actions considered appropriate for wetland soils were institutional controls, removal, and containment (Table 2-7).

2.3.6.1 *Institutional Controls*

Access restrictions were the only institutional controls considered for wetland soils. Access restriction options include land and deed use restrictions, signage, and physical barriers. As noted in previous sections, access restriction may reduce exposure to human receptors but will not reduce exposure to ecological receptors or release and transport of contaminants from the site. As with other sections of the site, institutional controls could be implemented in conjunction with other remedial strategies.

2.3.6.2 *Removal*

Removal of contaminated soils from the wetland would be the most effective means of preventing exposure of human and ecological receptors to sediment contaminants. Excavated soils can be disposed along with waste rock and contaminated soils. However, excavation of soils would be the most destructive to the wetland habitat.

Excavation of soils can be restricted to small areas. Therefore, this option can be selectively applied in the wetland area. This approach could preserve much of the wetland function, reduce rehabilitation costs, and reduce potential erosion problems associated with removal of otherwise stable soils.

Criteria for removal of soils in the WW07 area will be based on visual examination of current and past years' vegetation growth in the area. Soils will be excavated from areas in which vegetation is lacking or appears to be adversely affected by sediment quality. Fine soils consisting of silts, clays, and organic material will be excavated from the surface. Cobbles, gravels, or other coarse materials beneath the fine soils will be left in place. These materials do not tend to bind large amount of metals and therefore do not represent a significant reservoir for contaminants. Excavated soils will be disposed of with waste rock and affected soils. Excavated material will be replaced with clean fill and the wetland area reclaimed.

2.3.6.3 *Containment*

Options considered for containment of contaminated soils included stabilization of soils and construction of a lined channel in the wetland to convey Willow Creek and prevent contact of stream water with soils.

Stabilization of soils through direct revegetation would reduce erosion of soils during flood events and would reduce but not prevent contact of human and ecological receptors with soils. Based on results of toxicity tests conducted for the ERA, soils around WW07 could support vegetation if amended to increase pH and total organic carbon. However, unlike other areas of the wetland where metals may be associated with waste rock particles transported by erosion, metals in soils of this area were deposited as they precipitated from seep water. Metals in precipitates and adsorbed forms may be more readily solubilized and released to surface water than those in waste rock. Therefore, stabilization with vegetation may not adequately attenuate risk to surface water quality.

Channelization of Willow Creek through the wetland would prevent contact of stream water with contaminated soils and reduce erosion of the soils. However, this approach would prevent inundation of some parts of the wetland, possibly resulting in permanent loss of the wetland habitat. This approach would also not prevent human or ecological receptors from contacting soils, nor eliminate soils as a potential secondary source of contamination.

SECTION 2 TABLES

Table 2-1
Approximate Volumes of Media Addressed in Pecos Mine Feasibility Study

Medium	Location in Pecos Mine Site	Volume/Flow		Mass		Comment
Waste Rock	Main Waste Rock Dump	189,800	CY	341,640	T	Assume waste rock density is 1.8 T/CY
	Disjunct Dump	6,700	CY	12,060	T	
	North of Willow Creek	20,300	CY	36,540	T	
	Total	216,800		390,240		
Affected Soils/ Sediments	Beneath Dump (13 ac)	41,947	CY	58,726	T	Estimated volumes to be removed to attenuate surface exposures. Assumes soil density is 1.4 T/CY; includes soils to 2 feet depth below dumps, 3 feet in upland barren area, and 3 feet in wetland barren area; 1 foot in "other"
	Upland Barren Area (1.5 ac)	7,260	CY	10,164	T	
	Wetland Barren Area (0.2 ac)	3,630	CY	5,082	T	
	Other Affected Soils (~1 ac)	1,613	CY	2,258	T	
	Total	54,450		76,230		
	Colluvial Material Beneath Dump and Downgradient to State Road 63					
	maximum estimate	372,054	CY	520,876	T	Estimated volumes to be removed to attenuate generation of acid leachate. Maximum assumes average colluvium depth of 5 feet at east edge of dump, 28 feet at State Road 63. Minimum is 50 percent of maximum.
	minimum estimate	186,027	CY	260,438	T	
	Willow Creek Bed Material	440	CY	792	T	400 yards long, 10 yards wide section of Willow Creek channel N. of dump to 1 foot depth
Seep Water	ESNDT and associated seeps	5 gpm (max)		na		5 gpm flow assumption used for treatment design; measured flows at seep 0.2 gpm during wet periods (Oct. 1996)
Groundwater	Alluvial	20-2,500	CF/Day	na		Flow rate estimates from Table 5-3 and 5-5 of the RI. Area of affected groundwater includes
	Bedrock	90-6,500	CF/Day	na		

CF = cubic feet; CY = cubic yards; T = tons; gpm = gallons per minute

Table 2-2
Screening of Remedial Technologies:
Waste Rock Dumps

Response Action	Technology	Process Options	Effect.	Imp.	Cost	Comments
No Action	N/A	N/A	L	L	L	Existing pathways for exposure and release will not be attenuated; implementabiliy low because of low public acceptance
Institutional Controls	Access restrictions	Land use and deed restrictions	L	H	L	Would not prevent transport of contaminants from waste rock dump
		Physical Barriers to access (e.g., fences)	M	H	L	Effective for humans but not ecological receptors
		Signage	M	H	L	Warning signs and barriers can be used in conjunction with other technologies
Containment	Cap	Non-compacted clay layer, direct revegetation of clay layer	H	H	M	Reduces percolation through untreated waste rock by > 90%
		Compacted clay layer, lateral drainage layer, vegetated topsoil surface	H	H	M	Reduces percolation through untreated waste rock by 99%
		Compacted clay layer with 40 mil geomembrane, lateral drainage layer	H	H	M	Reduces percolation through untreated waste rock > 99%
	Stabilization	Direct revegetation	L	L	L	May not provide adequate protection against infiltration and percolation
Removal	Excavate waste rock dumps	Transport waste rock from main waste rock dump, place on El Molino Mill tailing piles, cap with tailing remediation	H	M	H	Removes primary source; removal of underlying surface may be required
Treatment	Extract metals, oxidize sulfides	Reprocess waste rock to extract metals	M	L	H	Traditional methods not economical; tailing disposal necessary after milling; new technologies untested

Effect = Effectiveness; Imp. = Implementability
H = high; M = moderate; L = low

Table 2-3
Screening of Remedial Technologies:
Affected Soils

Response Action	Technology	Process Options	Effect.	Imp.	Cost	Comments
No Action	N/A	N/A	L	L	L	Existing pathways for exposure and release will not be attenuated
Institutional Controls	Access restrictions	Land use and deed restrictions	L	L	L	Exposure to ecological receptors would not be attenuated
		Physical Barriers to access (i.e., fences)	L	H	L	Effective for humans but not ecological receptors
		Signage	L	H	L	Warning signs and barriers can be used in conjunction with other technologies
Removal	Excavation	Excavate and dispose at appropriate landfill or capped along with waste rock	M	L	H	Fill and reclamation of excavated areas would be needed
Containment	Stabilization	Direct revegetation	M	H	L	Soil treatment needed to allow plant growth
	Capping	Clay soil cover to prevent contact from receptors, reduce infiltration, reduce erosional transport	H	H	H	Higher O&M costs than other technologies
Treatment	Extract metals	Plant sediments with metal-absorbing vegetation	M	H	L	Could result in exposure to terrestrial herbivores; Could be used in conjunction with other technology
	Neutralize pH, immobilize metals	Addition of agricultural lime or crushed limestone	H	H	L	ERA showed increased pH reduced phytotoxicity. Limestone available on site.
	Solidification	in-situ vitrification, mix with stabilizing agents (e.g., concrete)	H	L	H	May require removal and disposal at other site or through capping. Therefore, may not offer adavantage over capping.

Effect = Effectiveness; Imp. = Implementability
H = high; M = moderate; L = low

Table 2-4
Screening of Remedial Technologies:
Groundwater

Response Action	Technology	Process Options	Effect.	Imp.	Cost	Comments
No Action	N/A	N/A	L	L	L	Existing pathways for exposure and release will not be attenuated
Institutional Controls	Access restrictions	Land use and deed restrictions	L	L	L	Exposure to ecological receptors would not be attenuated
		Physical Barriers to access (i.e., fences)	L	H	L	Effective for humans but not ecological receptors
		Signage	L	H	L	Warning signs and barriers can be used in conjunction with other technologies
Containment	Surface and subsurface interception	Interceptor ditch	H	H	L	Intercept surface and subsurface flow from slopes upgradient of dump
Treatment	Neutralize pH and remove metals	SRB treatment (see Seep water Table 2-5)	M	H	L	Collect shallow groundwater at seeps and divert to treatment system
		Precipitation/coagulation, offsite disposal	H	M	H	High capital and high O&M costs

Effect = Effectiveness; Imp. = Implementability
H = high; M = moderate; L = low

Table 2-5
Screening of Remedial Technologies:
Seep Water

Response Action	Technology	Process Options	Effect.	Imp.	Cost	Comments
No Action	N/A	N/A	L	L	L	Existing pathways for exposure and release will not be attenuated
Institutional Controls	Monitoring	Monitor water quality in Willow Creek	L	H	L	Will be required
	Access restrictions	Physical Barriers to access (i.e., fences)	L	H	L	Effective for humans but not ecological receptors
		Signage	L	H	L	Warning signs and barriers can be used in conjunction with other technologies
Treatment	Onsite Treatment	Sulfate-reducing bacteria treatment (SRB)/ wetland polishing cell	H	M	M	Permits required for dredge/fill in wetland, and release of water from any facility; intermittent O&M
		Ion exchange, offsite disposal	H	M	H	High capital and high O&M costs
		Reverse osmosis, offsite disposal	H	M	H	High capital and high O&M costs
		Precipitation/coagulation, offsite disposal	H	M	H	High capital and high O&M costs
	Offsite Treatment	Collection, transport to POTW	H	M	H	High O&M costs; permit restrictions

Effect = Effectiveness; Imp. = Implementability
H = high; M = moderate; L = low

Table 2-6
Screening of Remedial Technologies:
Willow Creek Bed Adjacent to Waste Rock Dump

Response Action	Technology	Process Options	Effect.	Imp.	Cost	Comments
No Action	N/A	N/A	L	L	L	Existing pathways for exposure and release will not be attenuated
Institutional Controls	Monitoring	Monitor water quality in Willow Creek	L	H	L	Will be required
	Access restrictions	Physical Barriers to access (i.e., fences)	L	H	L	Effective for humans but not ecological receptors; release not attenuated
		Signage	L	H	L	Warning signs and barriers can be used in conjunction with other technologies
Removal	Excavation	Remove waste rock from stream channel and restore channel	H	H	M	Quality of Willow Creek water also depends on reducing runoff from road upstream and dump
Containment	Line channel	Channel creek through culvert, discharge to wetland	H	M	M	Installation of culvert results in lost habitat
Treatment (of water)	Onsite Treatment	Sulfate-reducing bacteria (SRB)	H	M	H	Permits required for construction in wetland and discharge of effluent; large area of existing wetland required for treatment cells
		Ion exchange	H	M	H	high capital, O&M costs
		Precipitation/coagulation	H	M	H	high capital, O&M costs
	Wetland	Modify existing wetland	H	M	H	Permits required for construction, installation, and release of water

Effect = Effectiveness; Imp. = Implementability
H = high; M = moderate; L = low

Table 2-7
Screening of Remedial Technologies:
Wetland Barren Area Sediments

Response Action	Technology	Process Options	Effect.	Imp.	Cost	Comments
No Action	N/A	N/A	L	L	L	Existing pathways for exposure and release will not be attenuated
Institutional Controls	Access restrictions	Land use and deed restrictions	L	L	L	Exposure to ecological receptors would not be attenuated
		Physical Barriers to access (i.e., fences)	L	H	L	Effective for humans but not ecological receptors
		Signage	L	H	L	Warning signs and barriers can be used in conjunction with other technologies
Removal	Excavation	Excavate sediments and dispose at appropriate landfill or capped with wasterock	M	L	H	Removal of sediments would severely damage wetland; restoration of wetland would be required
Containment	Stabilization	Direct revegetation	M	H	L	Soil treatment needed to allow plant growth
	Channelize creek	Channelize Willow Creek through area to prevent contact with sediments	H	H	H	May not eliminate diffuse subsurface flow into Willow Creek or Pecos River
Treatment	Extract metals	Plant sediments with metal-absorbing vegetation	M	H	L	Could be used in conjunction with other technology

Effect = Effectiveness; Imp. = Implementability
H = high; M = moderate; L = low

3. Development and Screening of Alternatives

Remedial alternatives are combinations of specific technologies and activities assembled to address RAOs. One purpose of the FS is to develop and present a range of alternatives for addressing contamination at a given site. Alternatives were developed from the range of technologies and process options described in Section 2. The selected remedy for the site may be a specific alternative or a new combination of technologies extracted from multiple alternatives. For some environmental media or activities, a single technology was selected for inclusion in one or more of the alternatives. Section 3.1 provides details of aspects that are common to more than one alternative. Remedial alternatives are described in Section 3.2.

3.1 Technologies Common to Multiple Alternatives

3.1.1 Regrading Plan for Capping Waste Rock at the Pecos Mine OU

Treatment of the waste rock dumps is the core consideration upon which the remedial alternatives were developed. Three of the final alternatives described in Section 3.2 include containment of waste rock by capping in place. Under capping alternatives, the dump will be reconfigured to consolidate waste rock from the area north of Willow Creek and the disjunct dump west of Highway 63 into the area of the main dump. Consolidation of the waste rock will reduce the total surface area available for infiltration and percolation of precipitation falling on the dump and reduces the area for which cap treatment is required.

In order to determine the feasibility of consolidating waste rock into a single repository, a conceptual regrading plan was developed based on placing all waste rock in an area centered on the main body of the current dump (Figure 3-1). The regrading plan included removal of waste rock from the drainage that currently passes beneath the midsection of the dump (Figure 3-1). The total area of the dump under this configuration is approximately 6.9 acres which represents a 47 percent decrease from the current configuration.

The topography of the regraded dump includes a relatively flat top of approximately 2.7 acres that slopes gently (2 percent grade) to the east, away from the sideslopes of the dump (Figure 3-2). This approach reduces the potential for erosion of the sideslopes by diverting runoff from the top of the dump to the eastern edge. Runoff from the top will be collected in surface and subsurface collection systems and channeled to Willow Creek. (See Section 3.1.4.2 for description of drainage structures.) Under this configuration, the sideslopes of the dump would be graded to a pitch of approximately 2 horizontal: 1 vertical. The area of the sideslopes is approximately 4.2 acres. This regrading plan requires movement of about 90,000 cubic yards of waste rock.

The conceptual regrading design was intended to demonstrate the feasibility of consolidating waste rock at the mine site. The specific acreage and configuration of the regraded dump may be altered in the final design to accommodate results of design-phase investigations. The configuration of the dump may be altered to reduce the steepness of slopes, the depth (height) of the dump, or to ensure that no portion of the cap or dump will be in the 100-year floodplain of the Willow Creek.

An example alternative configuration is shown in Figure 3-3. In this configuration, the waste rock would be distributed over a larger area by dividing the dump into two sections with a portion of waste rock placed in the area along the southern end of the current dump. The dump was divided into two segments to open the drainage that currently passes under the midsection of the dump (Figure 3-3). In addition, the shallow groundwater intercept system along the western edge of the dump (Ditch #1 in Figure 3-1) would be extended to prevent subsurface flow into the dump. The existing intercept system extends into this area of the site and can be modified to accommodate the new design discussed in Section 3.1.3. In addition to the advantages noted above, this configuration would require excavation of less colluvium from beneath the southern end of the current dump.

The conceptual design presented in Figure 3-1 and Figure 3-2 indicates that consolidation of the waste rock at the mine site is feasible. The final design of the dump will be conducted during remedial design activities which follow completion of the Decision Document by NMED, if a capping alternative is selected. The final design will more completely address aspects of the dump configuration such as slope stability, structural geology of underlying rock units, and design of drainage structures.

3.1.2 Soil Remediation Approach

Soils affected by leachate or other contaminant transport mechanism will be remediated by one of two approaches: (1) amendment to reduce toxicity and mobility of metals or (2) excavation and onsite or offsite disposal. The method of remediation for particular areas varies among the alternatives. Areas to be remediated were identified using quantitative and qualitative methods. Quantitative approaches were used to identify areas with metal concentrations greater than background and areas in which ecological or human health risk was identified. Qualitative methods included identification of areas with visible effects such as dead or stressed vegetation or visible deposition of metal precipitates.

Qualitative identification of remediated areas is justified for the mine site because results of the ERA indicate that soil toxicity in samples collected from the site was due to interaction between soil pH and metals concentrations. Areas with near-neutral pH showed no toxicity to earthworms and yarrow, while areas with similar metal concentrations but low pH (4.5) showed toxicity. A similar result was observed for wetland soils. Also, it was not possible to establish concentration-based remediation criteria because laboratory toxicity studies did not include independent manipulation of pH and individual metal concentrations.

Treatment of soils will be conducted by application of crushed limestone to add alkalinity, increase pH, and buffer additional acid production. The rate of application will be calculated using methods that ensure adequate neutralization of existing acid conditions as well as acids produced by further weathering of sulfides in soils (Sorenson *et al.* 1980). Limestone will be incorporated in the uppermost 6 inches of soil.

Revegetation will be conducted after soil has been amended. Areas will be re-seeded with grasses and forbs that are native to the spruce-fir forests typical of the area. Where appropriate, trees and shrubs will also be planted.

3.1.3 Shallow Flow Upgradient of the Dump

Results of the RI indicate that percolation of water through waste rock has affected the shallow flow system downgradient of the dump. Therefore, an overall objective of the Pecos Mine remediation is to protect groundwater from further contamination by attenuating percolation of water through waste rock. The approach to reducing infiltration of precipitation into waste rock will be addressed separately for each alternative and is described in later sections. For all capping alternatives, potential run-on and shallow subsurface flow into the dump from upgradient areas will be addressed using an interceptor ditch system installed just upgradient from the dump. A single design will be used for all onsite capping alternatives.

The interceptor ditch design includes two ditches (Figure 3-3). Ditch #1 will be located upslope of the regraded and capped waste rock dump (Figure 3-1). Ditch #1 will include a rip-rap lined channel to intercept surface flow from the natural slope east of the dump and from the top of the dump. The eastern edge of Ditch #1 will be contiguous with lining material of the cap. Ditch #1 also includes a French drain system keyed to bedrock to intercept subsurface flows. Ditch #2 will be constructed in the natural drainage along the southeast edge of the dump and connect to the southernmost portion of the existing diversion channel (Figure 3-1). Ditch #2 will be a rip-rap lined channel (Figure 3-3). Both ditches include drop structures constructed of wire blanket and rock-filled gabions.

3.1.4 Groundwater

Deep (bedrock) and shallow (alluvium/colluvium/waste rock) groundwater flow systems were evaluated in the RI and HERA. Shallow groundwater near the midsection of the dump site (well P-WR) contains elevated metals, sulfate, and depressed pH and is similar to seep water collected from the toe of the dump and at WSBDT in the wetland area. Results of the RI indicate that water in this part of the shallow flow system is dominated by flow from the waste rock dump which discharges to the surface in seeps along the dump toe and in the wetland area. Therefore, flow in this system is addressed by actions described for seepwater in Section 3.1.5. This approach is consistent with the New Mexico WQCC regulations regarding protection of surface water from contamination by groundwater (WQCC Regulations Part 2, Subpart IV).

The HHRA evaluated risk to human health and included groundwater in the shallow and deep flow systems in the northern sections of the site. Results showed that human health risks under current (non-remediated) conditions and two recreational land-use scenarios were within acceptable limits. One of the scenarios ("nearby recreational use") included assumptions more stringent than normally used to assess chemical exposures under a recreational land use. The Pecos Mine site and adjacent areas are owned by NMGF. The current and most probable future use of the site is recreational. Therefore, human health is adequately protected under current land use.

The HHRA also evaluated risks based on a future residential scenario in which groundwater from the site is used as a domestic water supply and consumed on a daily basis during the resident's lifetime. The primary risk to human health under the potential residential scenario was due to barium concentrations in the deep aquifer, and manganese and lead in the shallow flow system. Barium concentrations exceeded health-based state water quality standards for domestic water supplies in the bedrock well used in the HHRA. Manganese exceeded a secondary (aesthetic) standard in the shallow well. Lead did not exceed the state groundwater standard. *(Note: Iron concentrations also exceeded the secondary (aesthetic)standard but was not associated with human health risk.)*

Decisions regarding remediation of groundwater may be, in part, dependent upon land use assumptions for the site. Concentrations of some constituents exceed state groundwater quality standards. However, the HHRA showed no risk under the current, and most probable future land use. Actions included in the alternatives for groundwater are discussed below.

3.1.4.1 Potential Groundwater Actions

The purpose of remediation at the waste rock dump and installation of the diversion ditches is, in part, to restore and protect groundwater quality downgradient of the dump. After the initial remediation activities, bedrock and shallow groundwater will be monitored at NMED-approved locations and other locations selected by Cyprus Amax to assess performance of the remediation. If groundwater quality is adequate to satisfy compliance criteria for eight consecutive quarters, then no further action is required. If remediation of the waste rock dump does not adequately improve groundwater quality, further action may be required. Potential further actions include:

- monitoring for a longer time period to determine effects of remediation
- further investigation to determine sources
- installation of a treatment system to collect and treat groundwater
- if treatment proves ineffective, initiation of procedures for "determination of infeasibility" as defined in the AOC and New Mexico Water Quality Control Commission (WQCC) regulations (WQCC Regulations Part 2, Subpart IV, Section 4103(E)(1), may be implemented to obtain variance from standards

A determination of infeasibility cannot be invoked unless the concentration of a chemical in groundwater is 200 percent or less of the applicable state standard. If concentrations are greater than 200 percent of the standard, application for temporary (up to 5 years) variance from groundwater standards can be made pursuant to WQCC Regulation Part 2, Subpart I, Section 1210A.

WQCC regulations also allow application for permanent alternative abatement standards under Section 4103F. Application for alternative abatement standards is based, in part, on demonstrating the condition "will not result in a present or future hazard to public health or undue damage to property." Application for alternative abatement standards does not require prior attempts to treat groundwater. Information contained in the HERA and information gathered during the RI can be used to assess potential health effects.

The exact nature of further action may include one or more of the above actions. Decisions regarding further action will be taken after remediation criteria have been established by NMED in the Decision Document, and monitoring data have been used to establish a trend in groundwater quality. Potential groundwater treatment technologies are discussed below.

3.1.4.2 *Potential Groundwater Treatment Technologies*

RI results showed that shallow and deep groundwater flow at the north end of the dump (wells P-7s and P7) contained iron and manganese at concentrations that exceed state groundwater quality standards. Barium exceeded the state standard in the bedrock aquifer only (well P7). Concentrations (median) in deep groundwater were less than in shallow water:

Well	Barium	Iron	Manganese
P7 (110 ft)	2.6 mg/L	1.9 mg/L	0.77 mg/L
P7s (15 ft)	not exceed std	12 mg/L	3.45 mg/L
State Standard	1 mg/L	1 mg/L	0.2 mg/L

Iron and manganese standards are not health-based. Rather, they are based on aesthetic parameters (e.g., staining of laundry) or engineering concerns (e.g., scaling of pipes). The barium standard is health-based.

The most commonly used treatment for iron in water supplies is oxidization and precipitation (Linsley 1992). Aeration followed by sedimentation and sand filtration are generally incorporated in such a treatment systems. Chlorine may be used as a polishing oxidant for maximum efficiency of removal (Tchobanoglous and Schroeder 1987). Other less commonly used methods for iron removal include ion exchange on zeolites or cation exchange resins.

Manganese is often found in association with iron in groundwater and, like iron, in a water with neutral pH is symptomatic of a reducing groundwater chemistry environment. When exposed to air, dissolved manganese oxidizes and forms a black precipitate that causes stains. The treatment of water to remove manganese is similar that used for iron (Linsley 1992).

Barium is not commonly encountered in potential water sources because of the ubiquitous presence of sulfate ions. Barium sulfate has a solubility product of 1.07×10^{-10} (Lide 1992) which would theoretically result in barium concentrations below the state water quality standard with sulfate concentrations as low as a few parts per million. Water from well P7 has a low sulfate content (0.38 mg/L) which is nearly 100 times lower than the background median concentration (well P3, 33.5 mg/L). Barium was not detected in groundwater or surface elsewhere at the site. Therefore, barium concentrations in well P7 may be higher than elsewhere on the site because water in other formations contains sufficient sulfate to cause precipitation. Water associated with the waste rock contamination has very high sulfate concentrations (> 2,000 mg/L). Therefore, it is unclear whether the barium in water from well P7 is a result of mine site contamination. The barium could result from naturally occurring barite deposits that are commonly found with rocks rich in lead and zinc minerals. Before treatment of groundwater for barium removal is required, further characterization of the barium source is necessary.

Treatment of water to reduce barium is normally conducted using cation exchange resins and resin stripping with brine solutions (Driscoll 1986). However, barium may be co-precipitated with manganese and iron with the addition of sulfate concentrations typical of background groundwater quality at the Pecos site.

3.1.5 Seep Water

Seep water emanating from the hillslope near WSBDT (Figure 1-6) is characterized by elevated concentrations of metals and sulfides and depressed pH and alkalinity. RI data indicate that elevated concentrations are due to percolation of water through waste rock materials, with transport of the resulting leachate to the seep area through shallow subsurface and surface flow paths. Seep water flow into Willow Creek affects water quality in portions of the wetland downstream from the seeps and in the Pecos River.

Remediation of the waste rock dump is expected to significantly affect seep water quality and/or flow because generation of leachate by contact of water with waste rock will be attenuated. Improved seep water quality and/or reduced flow will reduce the amount of metals and sulfate loading to Willow Creek and the Pecos River. If loading is sufficiently reduced, then no further action may be needed to protect surface water quality.

If loading is not sufficiently reduced, collection and treatment of seep water may be required. Seep water quality and flow are key factors in determining the characteristics of potential treatment systems. Therefore, the need for seep water treatment and the size and configuration of the treatment system will be evaluated after the effects of waste rock remediation have been established through monitoring seep flow and water quality.

Monitoring will be conducted on a quarterly basis, with specific event-related sampling conducted once during spring and fall after construction is complete. Seep water quality will be reviewed one year after remediation of waste rock has been completed. If monitoring data do not indicate a significant trend of improving water quality or decreasing discharge, a seep water collection and treatment system may be considered. The system will be based on the SRB treatment technology described in the following sections.

3.1.5.1 Potential System Configuration

If the need for a seep treatment system is indicated, a bioremediation system based on SRB treatment technology is proposed. The primary components of the proposed system are (listed from upstream to downstream):

- seep water intercept system and primary precipitation basin
- anoxic limestone drain (ALD)
- anaerobic media containing sulfate-reducing bacteria (SRB)
- aerobic limestone polishing cell
- wetland polishing cell

3.1.5.2 Seep Water Intercept System.

The seep water intercept system will be constructed to intercept flow from the seep areas along the eastern edge of Willow Creek. Depending on need, the following seep sampling locations could be included (Figure 1-6): ESS, WSM, GSBD, WSBDT, and RPS. Seeps at ESS and WSM do not contain metal concentrations that exceed primary (health-based) surface water or drinking water standards. However, samples contain elevated iron concentrations that exceed secondary (aesthetic) standards and result in deposition of iron oxyhydroxides in adjacent areas (Stoller 1996). Other seeps contain metal and sulfate concentrations that exceed state groundwater and surface water quality standards and have acidic pH (Stoller 1996).

The intercept system will be composed of a French drain and lined channels and will discharge to a primary precipitation basin. The precipitation basin is necessary to allow formation and settling of precipitates that form when seep water is exposed to air and when water from ESS and WMS is mixed with the more acidic and higher metal content water from the WSBDT area. Precipitation will result in significant removal of metals from the water, especially iron and aluminum. Zinc, cadmium, and copper may also coprecipitate with the iron and aluminum oxyhydroxides.

Removal of metals from the seep water through precipitation and settling decreases the potential for clogging in the limestone drain and will reduce the metal loading to the SRB and subsequent cells. This step will increase the time period over which the treatment media can be used without replacement, thus reducing the long-term O&M costs.

Sediment from the primary precipitation basin will be removed for disposal as necessary. Sediment will be analyzed to determine the proper method of disposal.

3.1.5.3 Anoxic Limestone Drain

The ALD will receive decant water from the primary settling basin. The purpose of the limestone drain is to increase the alkalinity and pH of seep water. Contact with the limestone will result in precipitation of gypsum, aluminum oxyhydroxides, and minor quantities of other metals. Effluent of the limestone drain will flow into a second precipitation and settling basin to help remove precipitates from water before it enters anaerobic cells.

The ALD will be contained in a lined channel, 6 feet deep, 10 feet wide, and 75 feet long and constructed along the toe of the hillslope downstream (south) of sampling location RPS. The channel liner would be composed of a compacted clay base overlain by a 30-mil HDPE membrane. The channel would be filled with high-quality limestone with $CaCO_3$ content > 90 percent by weight. The surface of the drain would be covered with HDPE membrane and 6 to 8 inches of soil.

3.1.5.4 Anaerobic Compost Cells

The anaerobic compost cells provide the substrate and appropriate conditions for growth of SRB. The compost media are a mixture of organic materials including alfalfa, sawdust, and manure, with limestone added to help buffer acidity and add alkalinity. Preliminary design of the system for the Pecos Mine includes two cells in series, each 35 feet long, 35 feet wide, and 6 feet deep. Cells will be lined and covered as described for the limestone drain. Anaerobic cells will also be covered with an HDPE membrane and crushed limestone to inhibit vegetation growth. This measure will be taken to prevent accumulation of metals from enriched organic media in vegetation on which wildlife might feed.

3.1.5.5 Limestone Polishing Cell

The anaerobic cells will drain to a second limestone cell to aid in removal of sulfides that did not precipitate with metals in the previous steps. The drain will consist of shallow channel lined with crushed limestone and include baffles created with limestone berms that force the water to flow in a sinuous pattern. This channel will also aid increasing dissolved oxygen concentrations and decreasing biochemical oxygen demand (BOD).

3.1.5.6 Wetland Polishing Cell

The final stage of the treatment system will be a wetland cell constructed with native materials and planted with native wetland vegetation. The wetland cell will serve to help remove excess particulates and further reduce BOD. The cell will include drop structures to further increase oxygen content prior to discharge to Willow Creek.

3.1.6 Seep Area Soils

Results from the RI and ERA indicate that metal concentrations are elevated in soils throughout the wetland. However, soil phytotoxicity and earthworm toxicity tests indicated mortality only in soils from the seep WSBDT area, where signs of toxicity are visible in the native vegetation (Hagler Bailly 1997). Seed germination and seedling growth was inhibited in samples from three other sites. However, growth of vegetation around these sites appeared normal when compared to other sites in the wetland area showing no toxicity in tests. Therefore, wetland soil remediation will be limited to the WSBDT seep area.

Criteria for deciding whether or not wetland soils should be removed will be based on visual examination of current and past years' vegetation growth in the area. Soils will be excavated from areas in which vegetation is lacking or appears to be adversely affected by soil quality. Fine materials consisting of silts, clays, and organic material will be excavated from the surface. The cobbles, gravels, or other coarse materials beneath will be left in place. These materials do not tend to bind large amount of metals and therefore do not represent a significant reservoir for contaminants. Excavation of 0.25 to 0.75 acres is anticipated. Excavated material will be disposed of along with waste rock and other affected soils.

It is anticipated that if a seep treatment system is needed, some components will be installed in the areas from which contaminated soils have been excavated. Shortly after removal has been conducted, the excavated material will be replaced with clean fill and the wetland area reclaimed.

3.1.7 Stream Channel and Willow Creek Riparian Reclamation

Waste rock material will be removed from the stream channel and stream banks of Willow Creek along the northern edge of the existing waste rock dump. The stream channel morphology, gradient, and bank vegetation will be reclaimed to approximate characteristics of Willow Creek upstream of the Pecos Mine OU, or similar first-order streams in the area. Reclaimed stream banks will be stabilized using a combination of permanent structures such as boulders and rock gabions and temporary structures such as biodegradable matting and live cribwalls formed with willow and alder cuttings from nearby areas. Where necessary, live cribwalls will be backfilled using layers of appropriate fill materials and live cuttings from willow and alders in the area.

3.1.8 Reclamation

The alternatives vary in the amount of area to be revegetated and restrictions on the types of revegetation techniques that are compatible with the overall remedy. For example, cover and capping options require that woody species or phreatopytes be prevented from growing on the cap surface. Deep roots of such plants can penetrate cap layers increasing the overall permeability of the cap. To the extent practicable, reclamation and revegetation plans will be designed to meet requirements of the Natural Resource Damage Assessment (NRDA) for mitigating injury to natural resources.

Final reclamation and revegetation plans will be prepared as part of the Remedial Design. General approach to reclamation and revegetation is discussed below.

1. Amendment of acid soils with limestone to increase pH and buffering capacity of soils

Reclamation of acidic soils will include application of limestone to add alkalinity, increase pH, and buffer additional acid production. Data from the ERA indicate that adjustment of soil pH in areas such as the Barren Zone is adequate to mitigate toxicity from heavy metals. The rate of lime application will be calculated using methods that ensure adequate neutralization of existing acid conditions and acids produced by further weathering of sulfides in soils (Sorenson *et al.* 1980). Crushed limestone stockpiled at the Pecos Mine will be used. Soils will be amended to approximate pH of background soils (6.0). Limestone will be incorporated into the uppermost 6 inches of soil.

2. Replacement of topsoil removed as a result of contaminated soils excavation

If the selected remedy includes excavation and disposal of existing topsoil materials, clean topsoil will be transported to the site from offsite sources. To help ensure compatibility, replacement topsoil will be obtained from sites as close to the Pecos Mine OU as possible.

To discourage growth of non-native species (i.e., weeds), reclaimed soils will not be fertilized. Fertilizer may be added to fill material brought to the site from outside sources if soil tests indicate nutrient concentration below background levels.

3. Upland Revegetation

Upland areas to be reclaimed at the Pecos Mine OU will be revegetated with plant species typical of similar communities in the immediate vicinity. Existing information on vegetation communities at the site will be used to determine the mix of species used. Appropriate seed mixes will be obtained from commercial vendors. Tree and shrub species will be planted where appropriate and consistent with objectives of the selected site remedy. Coniferous trees will be obtained from local sources, including the U.S. Forest Service and/or commercial vendors.

4. Wetland Reclamation

Materials excavated from the wetland will be replaced with clean fill from nearby sources or from commercial vendors. Total area to be excavated is approximately 0.25 to 0.75 acres. Revegetation will be accomplished by transplanting wild specimens from adjacent sections of the wetland and obtaining cultured specimens from commercial sources. Surveys of the native vegetation species present in the wetland will be used to develop a final reclamation plan.

3.2 Development of Alternatives

Remedial alternatives included in the detailed analysis were developed based on the RAOs, requirements of the AOC, EPA guidance (EPA 1988), and information presented in previous sections.

Five alternatives were developed for inclusion in the detailed analysis (Section 4):

1. No Action
2. Clay Soil Cover
3. Compacted Clay Cap
4. Geomembrane Cap
5. Source Removal

The activities or technologies included in the alternatives are summarized in Table 3-1. Detailed descriptions of the alternatives are presented in the following sections. In some cases, the proposed remedial action for a given medium is the same for two or more alternatives. Where this occurs, text describing the remedial action is presented the first time it is discussed and not repeated for subsequent alternatives in which it appears.

3.2.1 Alternative 1—No Action

Under the No Action alternative, no remedial actions will be implemented beyond the current facilities or activities that are currently in place or being conducted. EPA, through the 1990 revisions to the National Contingency Plan (NCP), requires that the No Action alternative be examined in detail during evaluation of remedial alternatives. The No Action alternative is presented as a baseline to which other remedial alternatives are compared. Current conditions at the Pecos Mine OU include.

- access restrictions (fences) and warning signs
- a diversion ditch constructed upslope of the waste rock dump to divert run-on and shallow subsurface flow
- quarterly groundwater, surface water, and seep water monitoring

3.2.2 Alternative 2—Containment: Non-Compacted Clay Soil Cap

3.2.2.1 Waste Rock

Alternative 2 includes the common regrading plan for the waste rock and soils described in Section 3.1.1. The top 2.7 acres of the regraded waste rock dump are covered with a clay soil cover with two layers, listed from uppermost to lowermost (Figure 3-4):

Layer 1: 24 inches of non-compacted clay soil, directly vegetated with grasses and forbs

Layer 2: 2 inches of crushed limestone incorporated into the surface of the regraded waste rock dump

The clay soil and the vegetation in Layer 1 prevent erosional transport of the waste rock and direct contact of human and ecological receptors with waste rock in the dump. Vegetation also maximizes evapotranspiration of water that infiltrates into the surface of the dump.

The purpose of the crushed limestone is to add alkalinity to water that percolates through the upper layer, thus reducing the potential for net acid generation and mobilization of metals as water flows through the dump. The amount of limestone was not derived using formal chemical balance calculations. Limestone available at the site will be used.

As with other cap alternatives, the dump sideslopes will be covered with a 48-inch low permeability compacted clay layer overlain by 18 inches of vegetated plant growth medium (PGM) (Figure 3-5).

3.2.2.2 *Affected Soils*

Remediation of soils in areas from which waste rock is removed will be conducted by application of crushed limestone to add alkalinity, increase pH, and buffer additional acid production (Figure 3-6). The rate of limestone application will be calculated using methods that ensure adequate neutralization of existing acid conditions as well as acids produced by further weathering of sulfides in soils (Sorenson *et al.* 1980). Limestone will be incorporated in the uppermost six inches of soil.

Revegetation will be conducted when soil has been amended. Areas will be re-seeded with grasses and forbs native to the spruce-fir forests typical of the area.

Preliminary evaluation of clay soils in the upland barren area (Figure 3-6) indicates that soils from this area are suitable for construction of the cap. If soils from this area are used for the cap, the upper 2 to 3 feet of material with elevated metal concentrations will be placed beneath the cap. Clay soils underlying contaminated material will be used in cap construction. Obtaining cap material from this location has the advantage of minimizing disturbance of another borrow area either onsite or offsite. The excavated material will be replaced with clean fill and revegetated.

3.2.2.3 Groundwater

Intermittent subsurface flows in the unsaturated materials upgradient of the dump will be intercepted and diverted away from the waste rock. Conceptual design of the diversion system is shown in Figure 3-3.

Groundwater quality in the deep bedrock aquifer will be monitored at two of the existing background monitoring wells (P-3 and P-4) and at an NMED-approved location downgradient of the dump. Groundwater quality in the shallow flow system will be monitored at an existing background location (P-3s) and an NMED-approved location downgradient of the dump. Alternative 2 also assumes use of the property will remain recreational through institutional controls implemented by NMGF. This approach could be taken by retaining ownership and prohibiting residential use of the site.

3.2.2.4 Seep Water

The effect of waste rock remediation on contaminant loading to surface water will be assessed by monitoring seep water quality and flow and surface water quality in Willow Creek. Monitoring will be conducted on a quarterly basis, with specific event-related sampling conducted once during spring and fall. Seep water quality will be reviewed one year after remediation of waste rock has been completed. If monitoring data do not indicate a trend of improving water quality, a seep water collection and treatment system may be considered. The system will be based on the SRB treatment technology described in Section 3.1.4. The specific configuration and sizing will be based on seep water flows and quality at the time the need for the system is identified.

3.2.2.5 Willow Creek Stream Channel

Waste rock in the Willow Creek stream channel and in the stream banks along the northern edge of the waste rock dump (Figure 3-7) will be removed, placed on the regraded waste rock dump, and capped along with the dump. The stream channel morphology, gradient, and bank vegetation will be reclaimed to approximate characteristics of Willow Creek upstream of the Pecos Mine OU, or similar first-order streams in the area. Stream and riparian reclamation are further described in Section 3.1.6.

3.2.2.6 Seep Area Soils

Fine soils around seep WSBDT will be excavated as described in Section 3.1.5 (Figure 3-6), placed on the regraded waste rock dump, and capped. Excavated materials will be replaced with clean fill and the area revegetated as described in Section 3.1.8.

3.2.3 Alternative 3—Containment: Compacted Clay Cap

3.2.3.1 Waste Rock

Alternative 3 includes the common regrading plan for the waste rock and soils described in Section 3.1.1. A compacted clay cap will be applied to the top of the dump. The cap design includes three layers (Figure 3-8):

Layer 1: 18 inches of PGM, directly vegetated with grasses and forbs

Layer 2: 2-inch lateral drainage layer composed of 0.25 inch rock (D50)

Layer 3: 18 inches of compacted clay, installed in 6-inch lifts

The plant growth medium has the same purposes as described for Alternative 2. A thinner layer of plant growth medium is justified by the presence of the drainage layer and lower permeability layers below it.

The compacted clay layer will have extremely low permeability to water (10^{-8} centimeters per second [cps]) and thus provides a barrier to downward vertical movement of water that is not eliminated by evapotranspiration or runoff. The lateral drainage layer provides a conduit for removal of water that accumulates on top of the clay layer. Drainage of this water helps reduce the vertical hydraulic head on the clay layer, further reducing the potential for passage of water through to waste rock.

As with other onsite cap alternatives, the dump sideslopes would be covered with a 48-inch low permeability compacted clay layer (Figure 3-5).

3.2.3.2 Affected Soils

Selected areas of affected soils, sediments, and other geologic materials located outside the regraded dump will be excavated, removed to the main dump, and capped along with waste rock. Approximate areas to be excavated are shown in Figure 3-9. Initial estimates for removing soils from these areas were based on excavating soils to 2 feet in depth in the waste rock areas, and 3 feet in the upland barren area. As described in Section 3.1.2, soil remediation areas were identified qualitatively based on results of the HHRA and ERA and the appearance of adverse affects to vegetation.

3.2.3.3 *Groundwater*

Interflow in unsaturated materials upslope of the dump will be intercepted by the diversion/drainage structure as described for Alternative 2. The effect of waste rock remediation on groundwater would be monitored in bedrock and shallow monitoring wells installed downgradient of the dump.

3.2.3.4 *Seep Water*

Remediation of seep water will be evaluated as described previously for Alternative 2 and in Section 3.1.5.

3.2.3.5 *Willow Creek Bed Material*

Remediation and reclamation of the Willow Creek stream channel and riparian zone will be conducted as described for Alternative 2.

3.2.3.6 *Seep Area Soils*

Excavation and disposal of soils around WSBDT and associated seeps will be conducted as described for Alternative 2.

3.2.4 Alternative 4—Geomembrane Cap

3.2.4.1 *Waste Rock*

Alternative 4 includes the common regrading plan for the waste rock and soils described in Section 3.1.1. A geomembrane cap will be applied to the top of the dump. The geomembrane cap include four layers (Figure 3-10):

Layer 1: 18 inches of PGM, directly vegetated with grasses and forbs

Layer 2: 0.2-inch geonet drainage layer enclosed in geotextile

Layer 3: 30-mil polyvinyl chloride (PVC) geomembrane

Layer 4: 12 inches of compacted clay

The plant growth medium has the same purposes as described for other cap alternatives.

The geonet drainage layer will be installed over the geomembrane liner to remove water that accumulates over the liner. Preliminary surveys indicate that the availability of appropriate rock materials from local sources may be limited. Use of the geonet drainage layer will reduce the resources required to bring drainage materials to the site. The geonet drainage layer will be enclosed in a geotextile to help prevent clogging of the geonet by fine materials from washing in from the PGM.

Layer 3 is a 30-mil PVC geomembrane with very low permeability to water (10^{-13} cps). The compacted clay layer provides a smooth surface on which to place the geomembrane, reducing the potential for punctures. The clay layer also provides a further barrier to vertical migration of water in the event of a leak in the geomembrane.

As with other containment alternatives, the dump sideslopes will be covered with a 48-inch low permeability compacted clay layer (Figure 3-5).

3.2.4.2 Affected Soils

Selected areas of affected soils, sediments, and other geologic materials located outside the regraded dump will be remediated as described for Alternative 3.

3.2.4.3 Groundwater

Groundwater interception and monitoring will be conducted as described for Alternative 3.

3.2.4.4 Seep Water

Remediation of seep water will be evaluated as described previously for Alternative 2 and in Section 3.1.4.

3.2.4.5 Willow Creek Bed Material

Remediation and reclamation of the Willow Creek stream channel and riparian zone will be conducted as described for Alternative 2.

3.2.4.6 Seep Area Soils

Excavation and disposal of soils around seep WSBDT and associated seeps will be conducted as described for Alternative 2.

3.2.5 Alternative 5—Source Removal

3.2.5.1 Waste Rock and Affected Soils

As noted in Section 1.4, waste rock at the Pecos Mine is the ultimate source of contaminants at the site. Metals solubilized from waste rock by acid leachate have been transported from the dump to downgradient areas. Waste rock has also been transported by erosion of the dump. Soils and sediments that have been affected can act as secondary sources of contaminants for further transport of metals. Waste rock and affected soils/sediments are also important exposure points for human and ecological receptors.

Under Alternative 5, waste rock and secondarily contaminated soils and colluvium at the Pecos Mine site will be excavated and transported to the El Molino OU and deposited on the existing tailing ponds. Affected soils and geological materials beneath the existing waste rock dumps and in downgradient areas could serve as continuing sources of contamination as water infiltrates and percolates through subsurface materials (Figure 3-11). Therefore, contaminated materials will be excavated and disposed of along with waste rock.

The depth to which underlying materials will be removed is uncertain because the vertical distribution of contaminants is not known for all areas of the mine site. Therefore, a range of estimates for volume of material to be removed has been provided (Table 2-1). The maximum volume assumes that all soil and colluvial materials beneath the existing dump and downgradient to State Highway 63 will be removed. The depth of material was estimated from borehole logs and was assumed to be 5 feet at the eastern edge of the dump and 28 feet at the State Highway 63. The minimum volume estimate was assumed to be 50 percent of the maximum.

The actual extent to which colluvial materials are excavated will be determined by Cyprus Amax and NMED personnel based on visual inspection and, when necessary, analysis of samples. The primary objective of colluvium removal is protection of groundwater and surface water from metals and sulfates in leachate. Therefore, analysis of colluvium samples will be based on Synthetic Precipitation Leaching Procedure (SPLP) (EPA Method 1312). SPLP simulates the leaching process associated with wetting of soils. The resulting liquid is analyzed for metal concentrations and used to predict the effect of percolation on groundwater and surface water quality.

The materials from the mine site would be capped along with the tailing material using technology appropriate for the El Molino site. The cap technology currently planned for the El Molino site includes a PVC geomembrane barrier and geonet drainage layer. However, a cap technology that includes a capillary barrier instead of the geomembrane and geonet may be used. The geomembrane cap is similar to that described for the mine site in Alternative 4, except that the El Molino cap does not include a clay layer that underlies the geomembrane. The surface of the regraded tailing is smooth enough to prevent puncture of the PVC. If a geomembrane cap is applied to waste rock moved to the El Molino site, a layer of clay or other material would be needed to create a smooth surface on which to place the geomembrane. A capillary break cap would not require a smooth bedding layer.

Based on estimates of the volume of waste rock and soils to be transported to the El Molino OU, the amount of material to be added to the tailing pond deposits and capped is 250 to 350 acre-feet. This amount of material will significantly affect the design and configuration of the cap containment system at the El Molino OU. The potential depth of the waste rock and soil dump will vary depending on the area over which it is deposited and the topographic surface needed to maintain required drainage characteristics. If spread flat over 10 to 35 acres, the new deposit would be approximately 7 to 25 feet in depth.

Excavated areas at the mine site will be filled with clean fill material and graded to approximate the original, pre-mining topography of the site. The areas will be reclaimed according to methods described in Section 3.1.5.

3.2.5.2 Groundwater

Because the source materials will have been removed, a groundwater intercept system will not be needed to divert water upslope of the dump. The effect of waste rock remediation on groundwater beneath and downgradient of the dump would be monitored as described for other alternatives.

3.2.5.3 Seep Water

Remediation of seep water will be evaluated as described previously for Alternative 2 and in Section 3.1.4.

3.2.5.4 Willow Creek Bed Material

Remediation and reclamation of the Willow Creek stream channel and riparian zone will be conducted as described for Alternative 2.

3.2.5.5 Seep Area Soils

Excavation and disposal of soils around WSBDT and associated seeps will be conducted as described for Alternative 2.

SECTION 3 TABLES

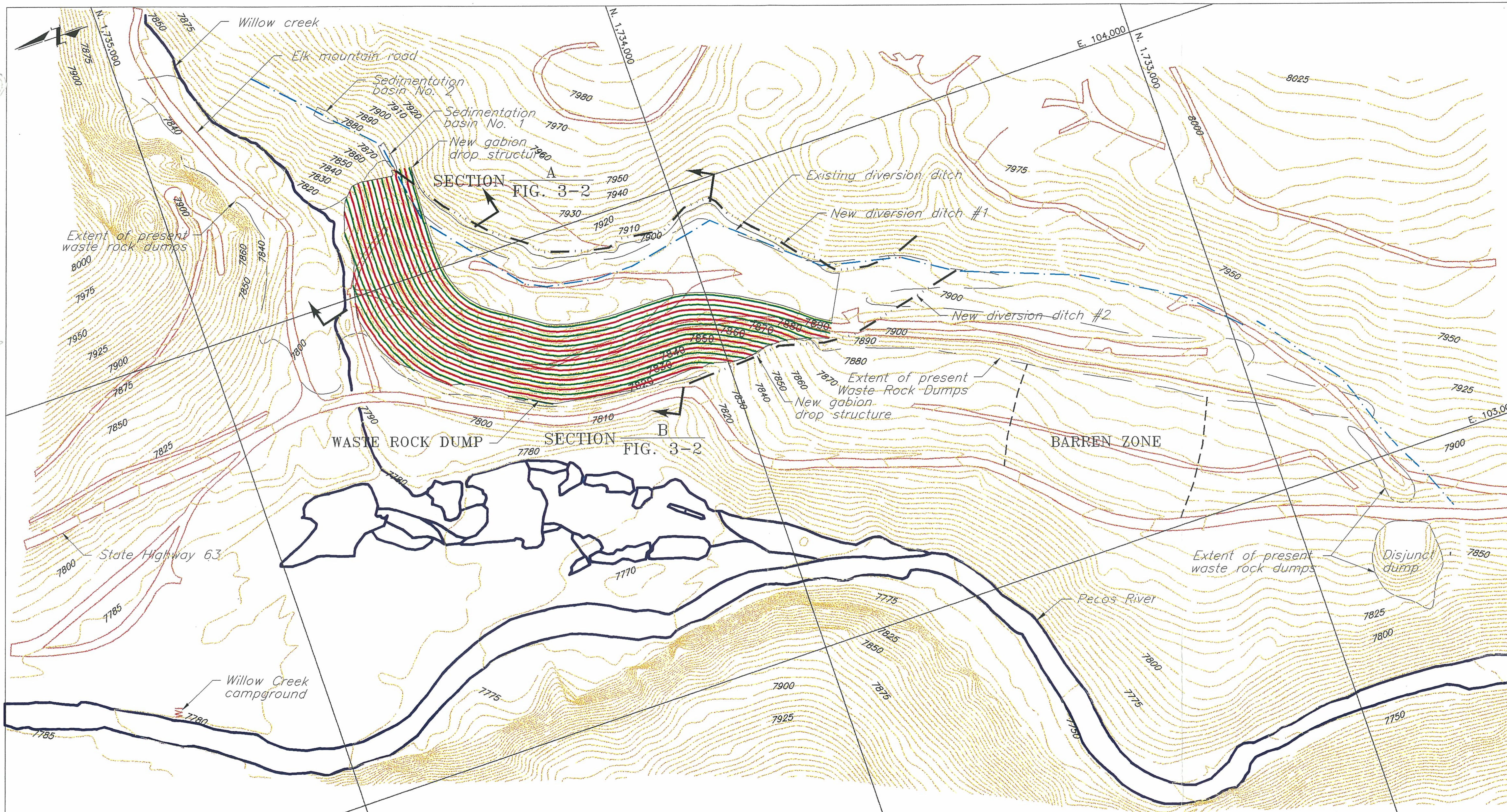
Table 3-1
Remedial Alternatives for Pecos Mine Operable Unit

Medium	General Response Actions: Technology Type	Area or Volume	Alternatives: 1 No Action	2 Soil Cap	3 Compacted Clay Cap	4 Geo-membrane Cap	5 Remove to Mill Site
Waste Rock	Access restrictions, warning signs	13 acres	X[1]				
	Excavate, offsite disposal	216k CY					X
	Onsite regrading and consolidation of waste rock	90k CY		X	X	X	
	Top: Vegetated clay soil cover Sideslopes: compacted clay, vegetated	7 acres		X			
	Top: compacted clay cap, rock drainage layer, veg. soil surface Sideslopes: compacted clay, vegetated	7 acres total			X		
	Top: clay soil bedding, geomembrane, geonet drainage layer, veg. soil surface Sideslopes: compacted clay, vegetated	7 acres total				X	
Affected Soils	Access restrictions, warning signs	5 acres	X[1]				
	Amendment to increase pH			X			
	Excavate, offsite disposal	180 to 370k CY					X
	Excavate, onsite disposal	9.3k CY			X	X	
Ground-water	Upslope interception, diversion		X[1]	X	X	X	
	Site use restrictions			X	X	X	X
Seep water	Warning signs		X[1]				
	Onsite treatment - SRB/wetland (optional)[2]			X[2]	X[2]	X[2]	X[2]
Willow Creek bed material	Excavate, offsite disposal	440 CY					X
	Excavate, onsite disposal	440 CY		X	X	X	
	Line and reclaim channel	200 yds length		X	X	X	X
Seep Area Sediments	Access restrictions		X[1]				
	Excavation, offsite disposal	2.1k CY					X
	Excavation, onsite disposal	2.1k CY		X	X	X	
Monitoring	Groundwater		X[1]	X	X	X	X
	Seep water		X[1]	X	X	X	X
	Surface water		X[1]	X	X	X	X
	Air (during construction)			X	X	X	X

[1] Warning signs, monitoring, upslope diversion are currently in place

[2] Seep treatment requirements will be evaluated after effects of waste rock remediation have been established.

SECTION 3 FIGURES



Reference:
–Topographic mapping provided by The S.M. Stoller Corp.
Filename: "Pecos.zip" Dated: 10/03/96.

LEGEND:

7850 (yellow dotted line)	Existing ground surface contour and el, ft.
7850 (red line)	Waste rock dump regraded contour and el., ft.
(outlined shape)	Water

PLAN

200 0 200 FEET

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Stoller Environmental Services

Pecos Mine Operable Unit Feasibility Study

Drawing By: Knight Piesold LLC
Date: 01/27/97
KP ACAD file name: 1492F05B

Plan View Of Regraded Pecos Waste Rock Dump
Figure 3-1

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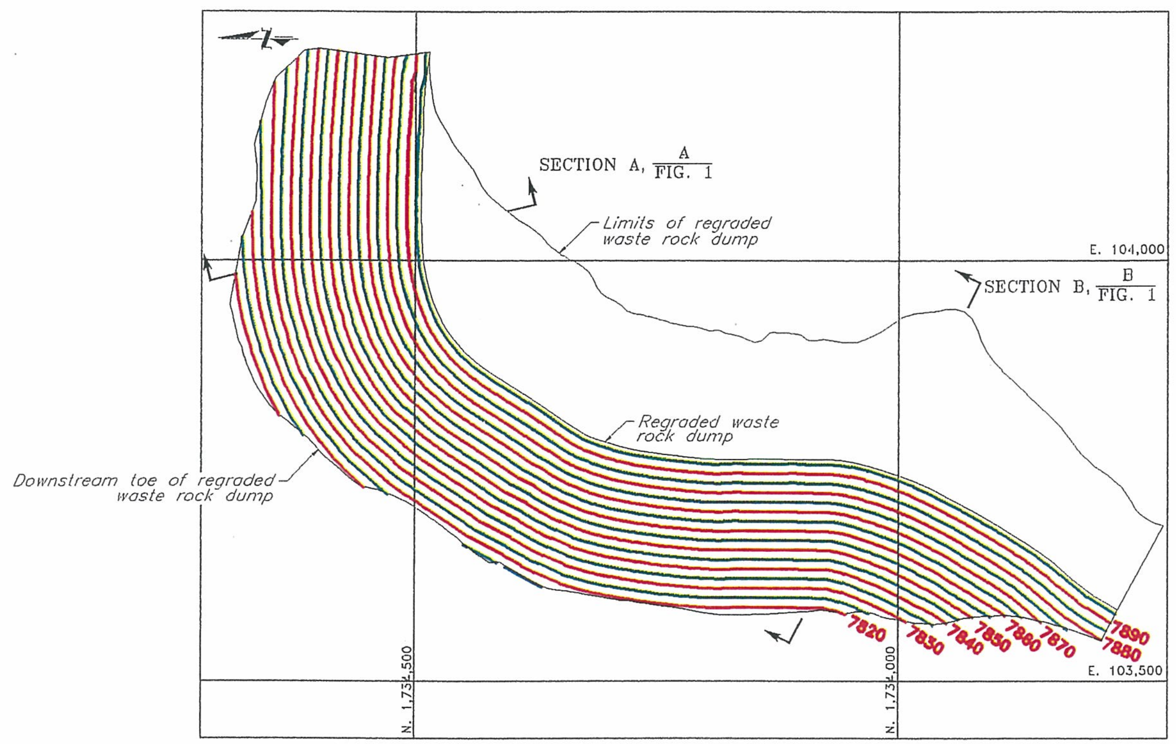
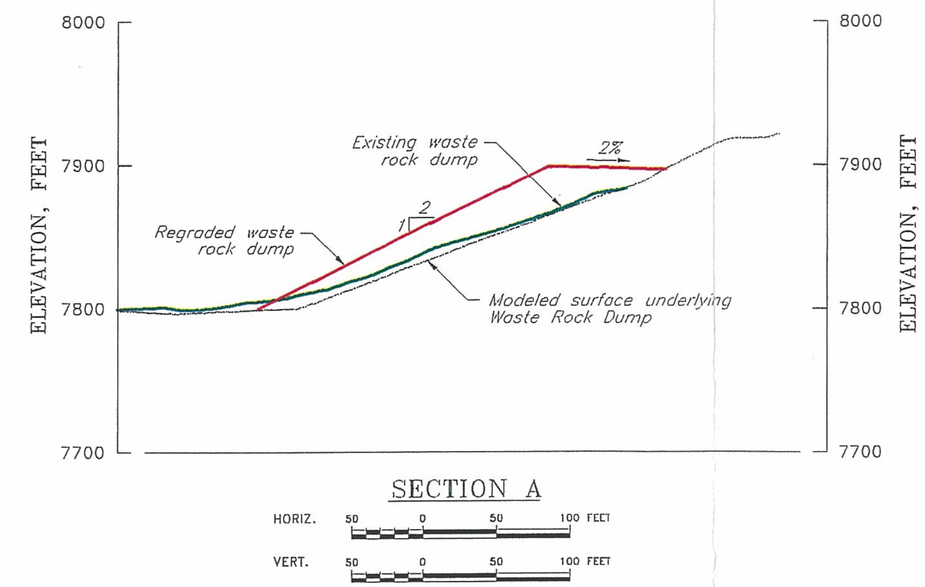


Reference:
–Topgraphic mapping provided by The S.M. Stoller Corp. Acad file "Pecos.zip" Dated: 10/03/96.

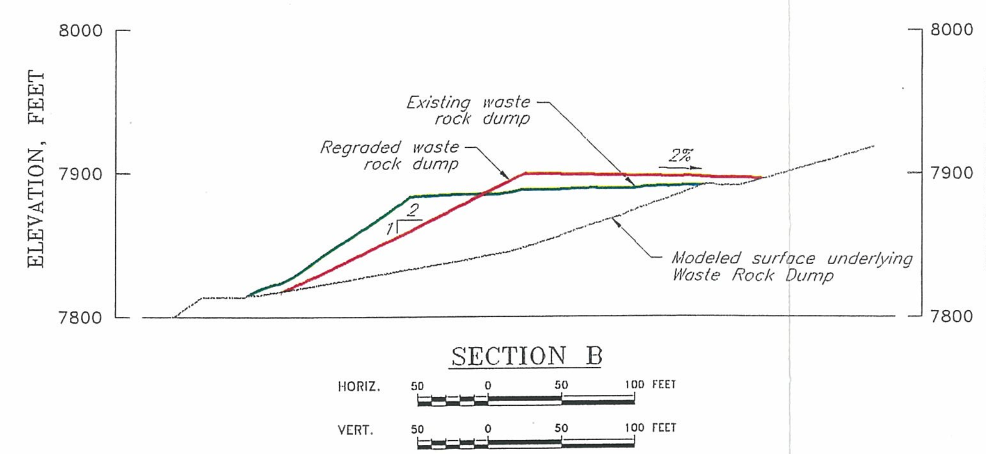
PLAN

LEGEND:

Waste rock dump regraded contours and el., ft.

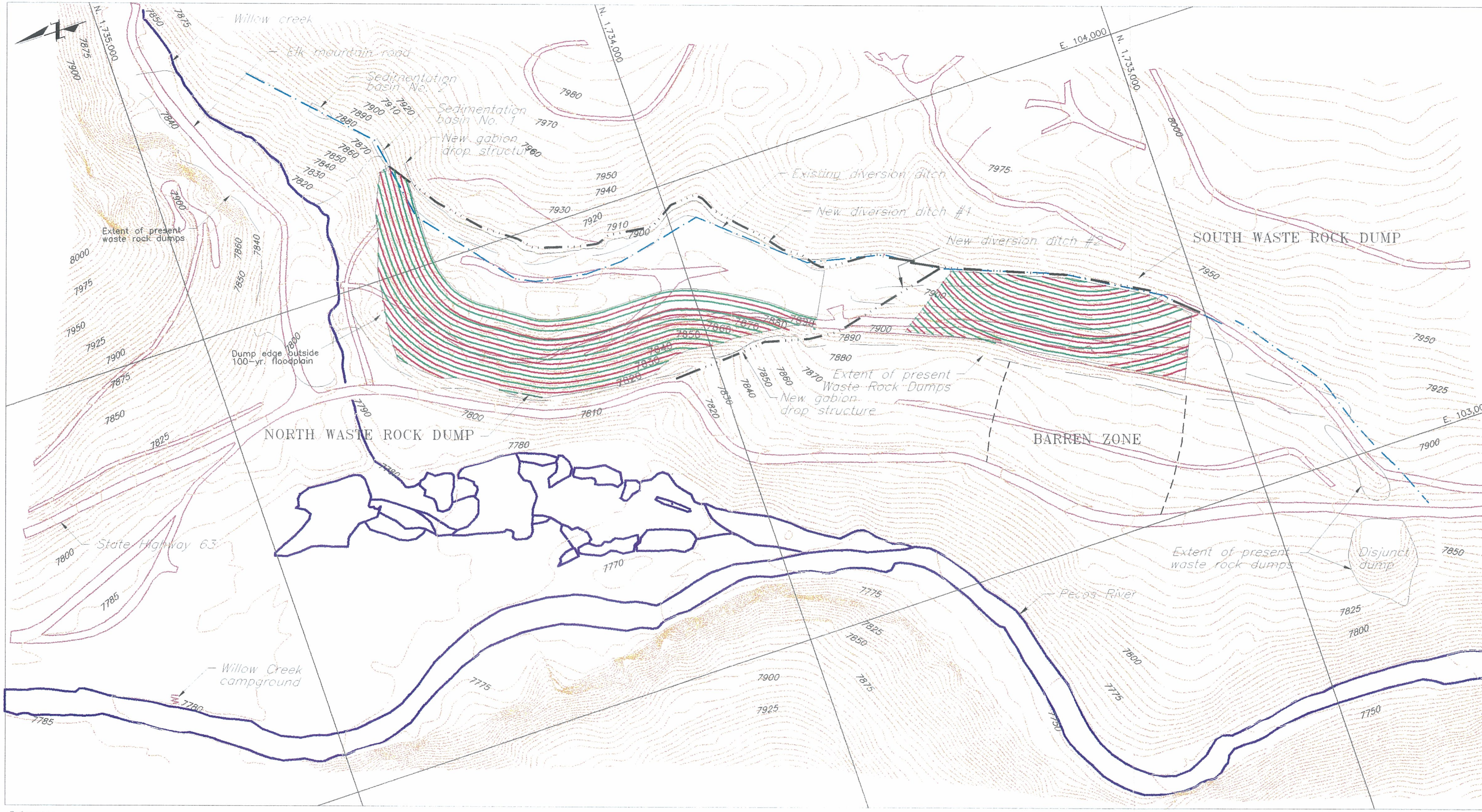


SECTION A



SECTION B

Stoller Environmental Services	Pecos Mine Operable Unit Feasibility Study
Drawing By: Knight Piesold LLC Date: 01/27/97 KP ACAD file name: 1492F06B	Regraded Waste Rock Dump And Sections Figure 3–2



Reference:
–Topographic mapping provided by
The S.M. Stoller Corp.
Filename: "Pecos.zip" Dated: 10/03/96.

LEGEND:

7850 Existing ground surface contour and el., ft.

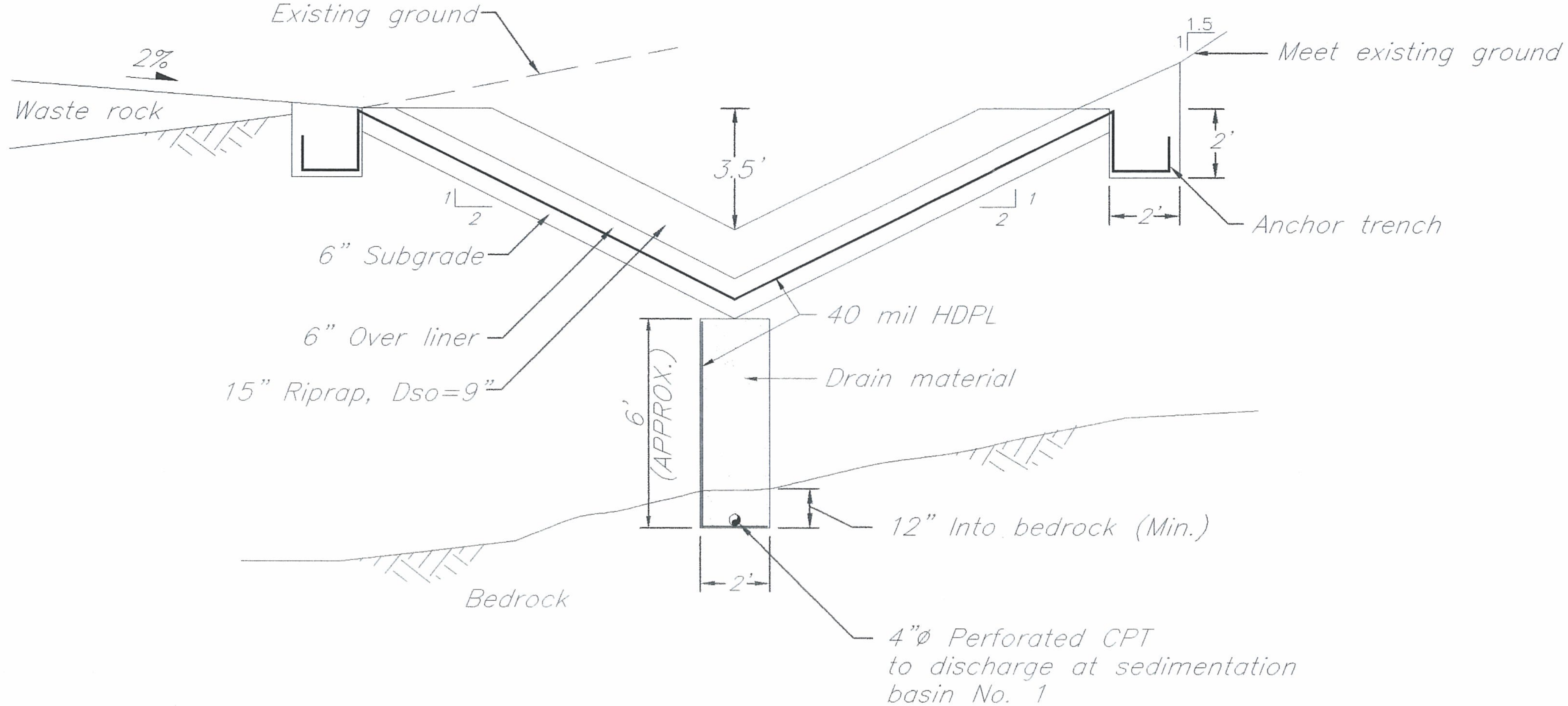
7850 Waste rock dump regraded contour and el., ft.

Water

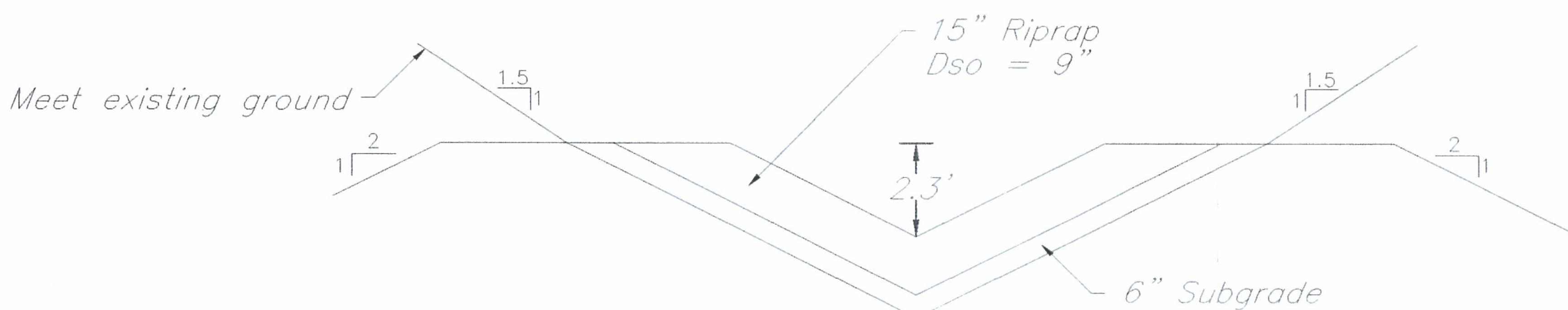
PLAN

200 0 200 FEET

Stoller Environmental Services	Pecos Mine Operable Unit Feasibility Study
Drawing By: Knight Piesold LLC Date: 01/27/97 KP ACAD file name: 1492F05B	Plan View Of Regraded Pecos Waste Rock Dumps (two dumps) Figure 3-3

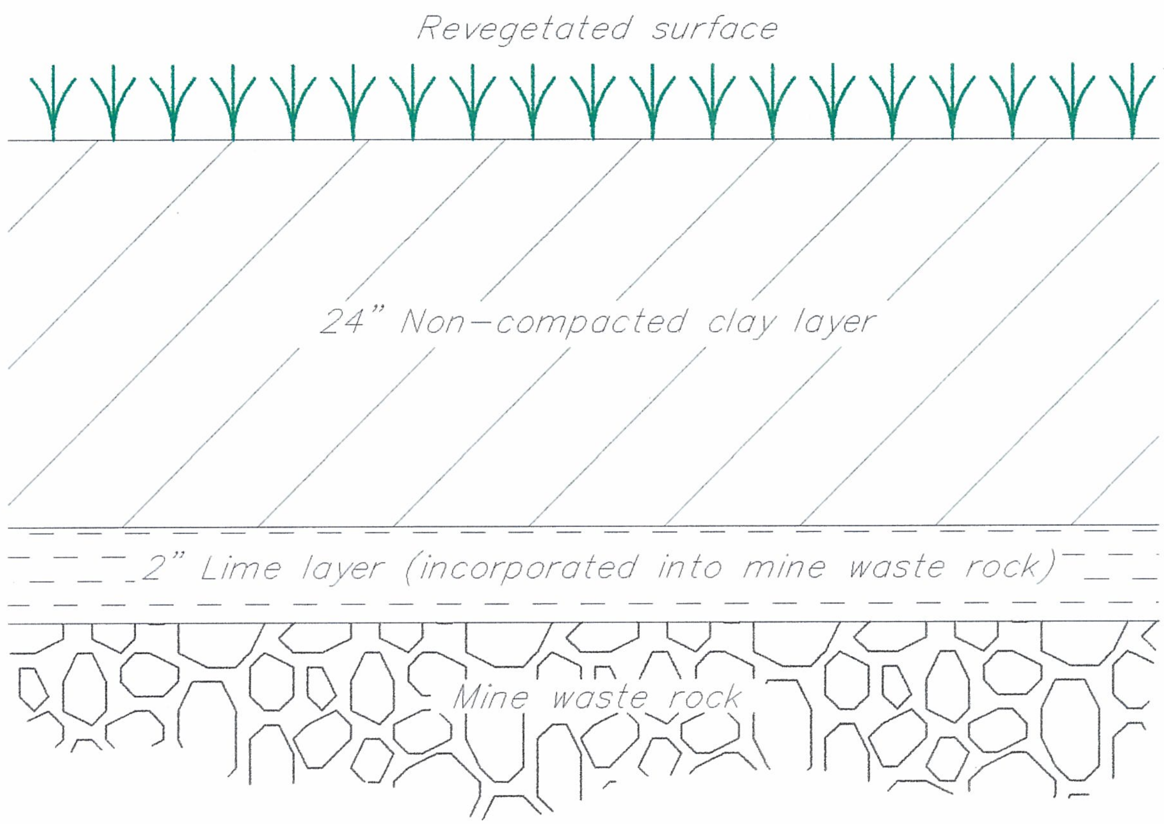


DITCH No. 1
TYPICAL SECTION
NTS



DITCH No. 2
TYPICAL SECTION
NTS

Stoller Environmental Services	Pecos Mine Operable Unit Feasibility Study
Drawing By: Knight Piesold LLC Date: 01/27/97 Rev. 5/14/97 KP ACAD file name: 1492D01A	Water Diversion Structure Sections Figure 3-4



Not to scale

Stoller Environmental Services

Pecos Mine Operable Unit Feasibility Study

Drawing By: Knight Piesold LLC
Date: 01/27/97
KP ACAD file name: 1492F01B

Alternative 2
Cover Design For Dump Surface
Figure 3–5

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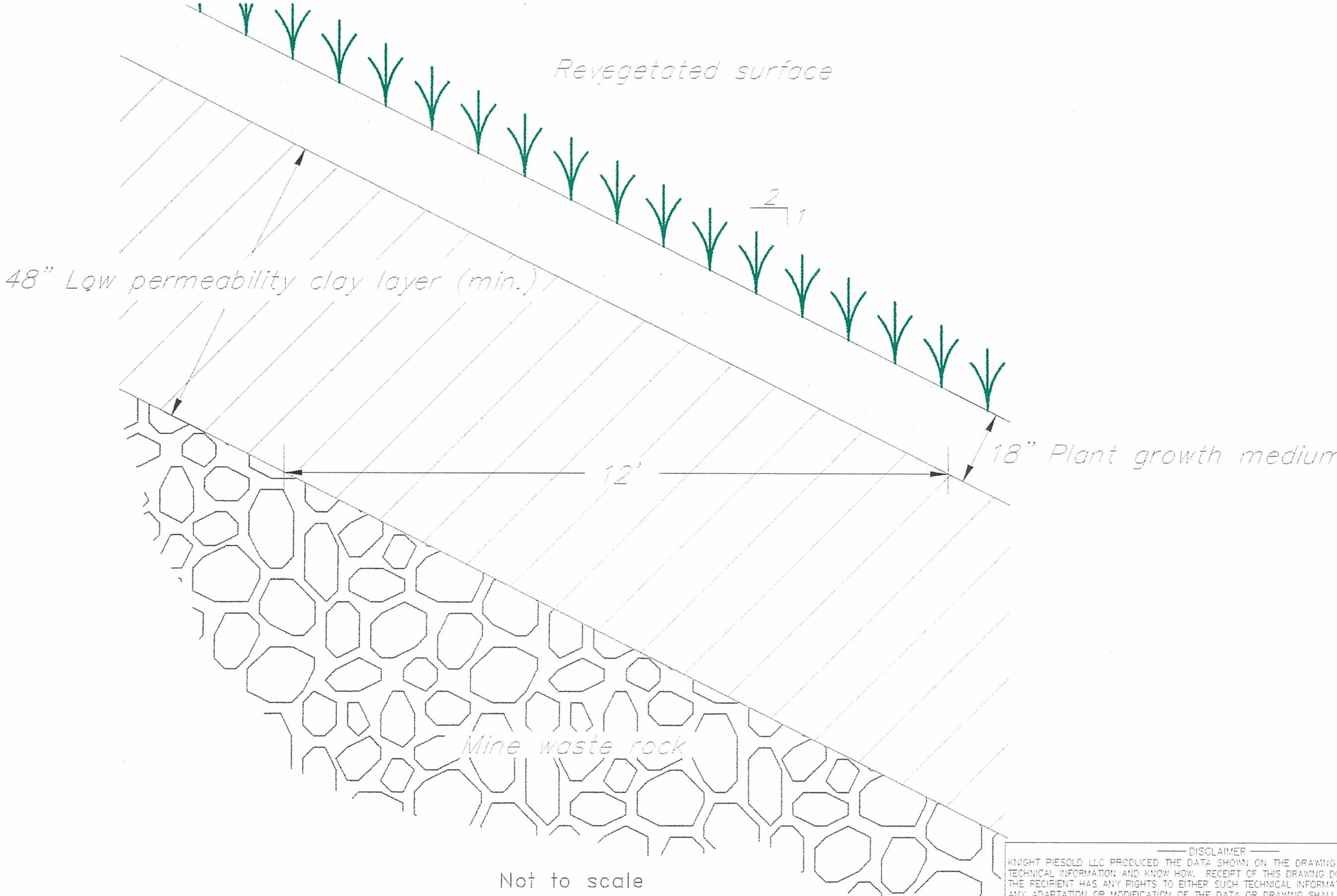
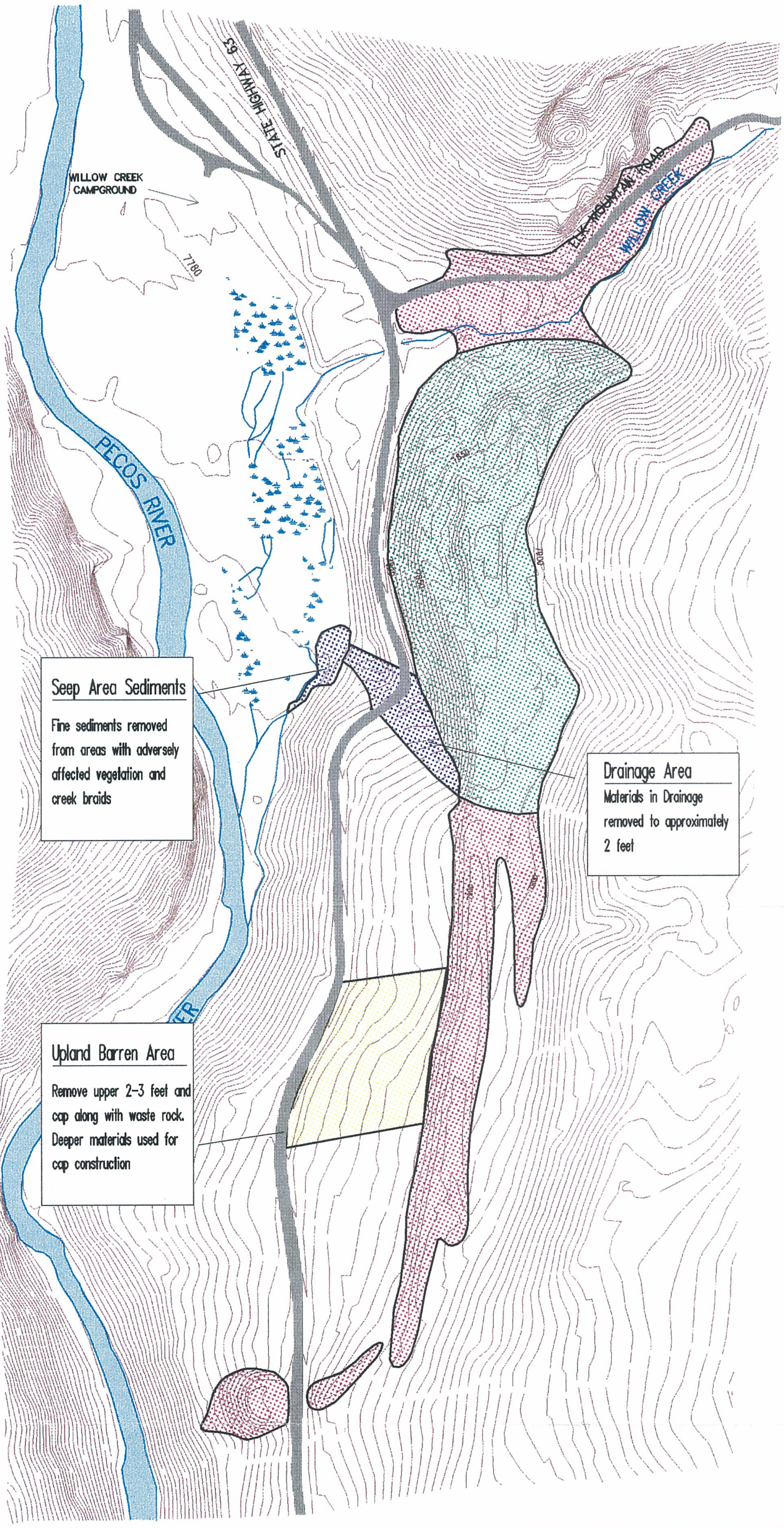


Stoller Environmental Services	Pecos Mine Operable Unit Feasibility Study
Drawing By: Knight Piesold LLC Date: 01/27/97; rev. 4/11/97 KP ACAD file name: 1492F04B	Cover Design For Dump Slopes Figure 3-6



Explanation

Approximate Area of Regraded Waste Rock Dump

Waste Rock Boundary (Pre-remediation)

Areas of Soil Amendment

North

Stoller
established 1959

0 Feet 250 500

Contour Interval 5 Feet

Pecos Mine Operable Unit

Approximate Areas of Soil and Sediment Amendment and Excavation for Alternative 2

Figure 3-7

02-SEP-1997 /export/home/data3/pecos/update/sspost5.aml

Explanation

—— Waste Rock Boundary (Pre-remediation)

North

Stoller established 1959

0 Feet 250 500

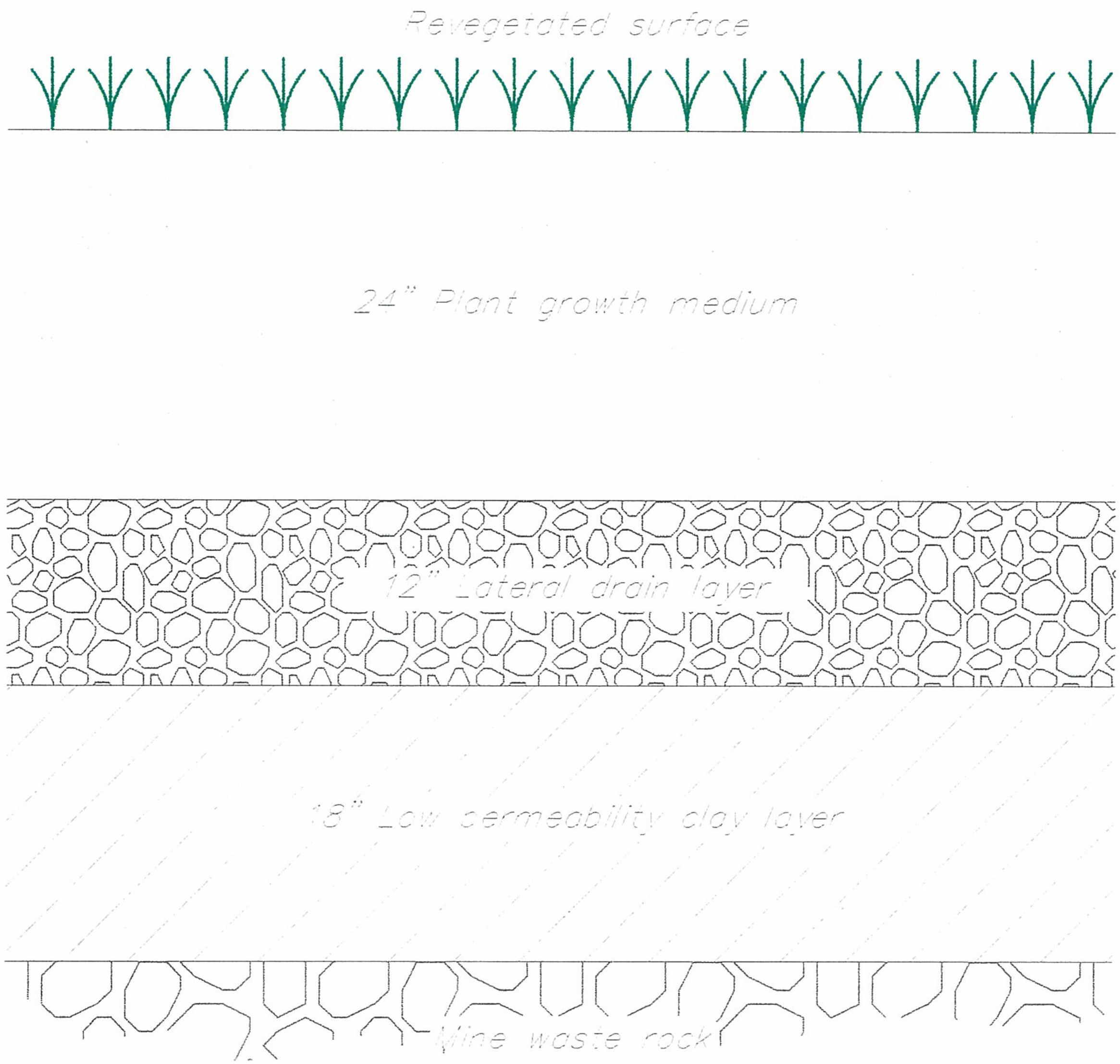
Contour Interval 5 Feet

Pecos Mine Operable Unit

Approximate Segment of Willow Creek to be Restored

Figure 3-8

02-SEP-1997 /export/export/home/data5/pecos/update/sspost3.aml



Not to scale

Stoller Environmental Services	Pecos Mine Operable Unit Feasibility Study
Drawing By: Knight Piesold LLC Date: 01/27/97 Rev. 5/14/97 KP ACAD file name: 1492F02B	Alternative 3 Cover Design For Dump Surface Figure 3-9

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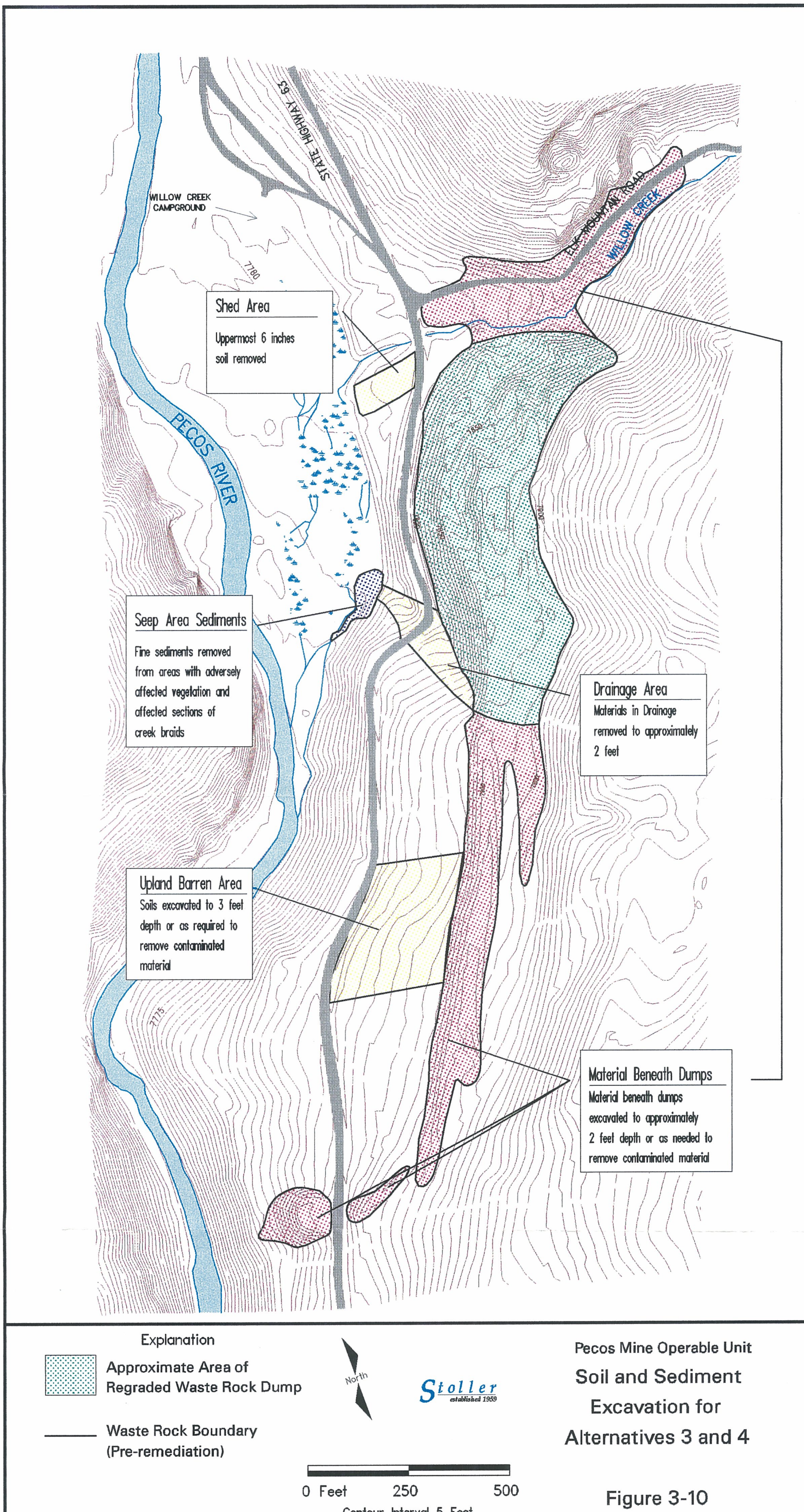
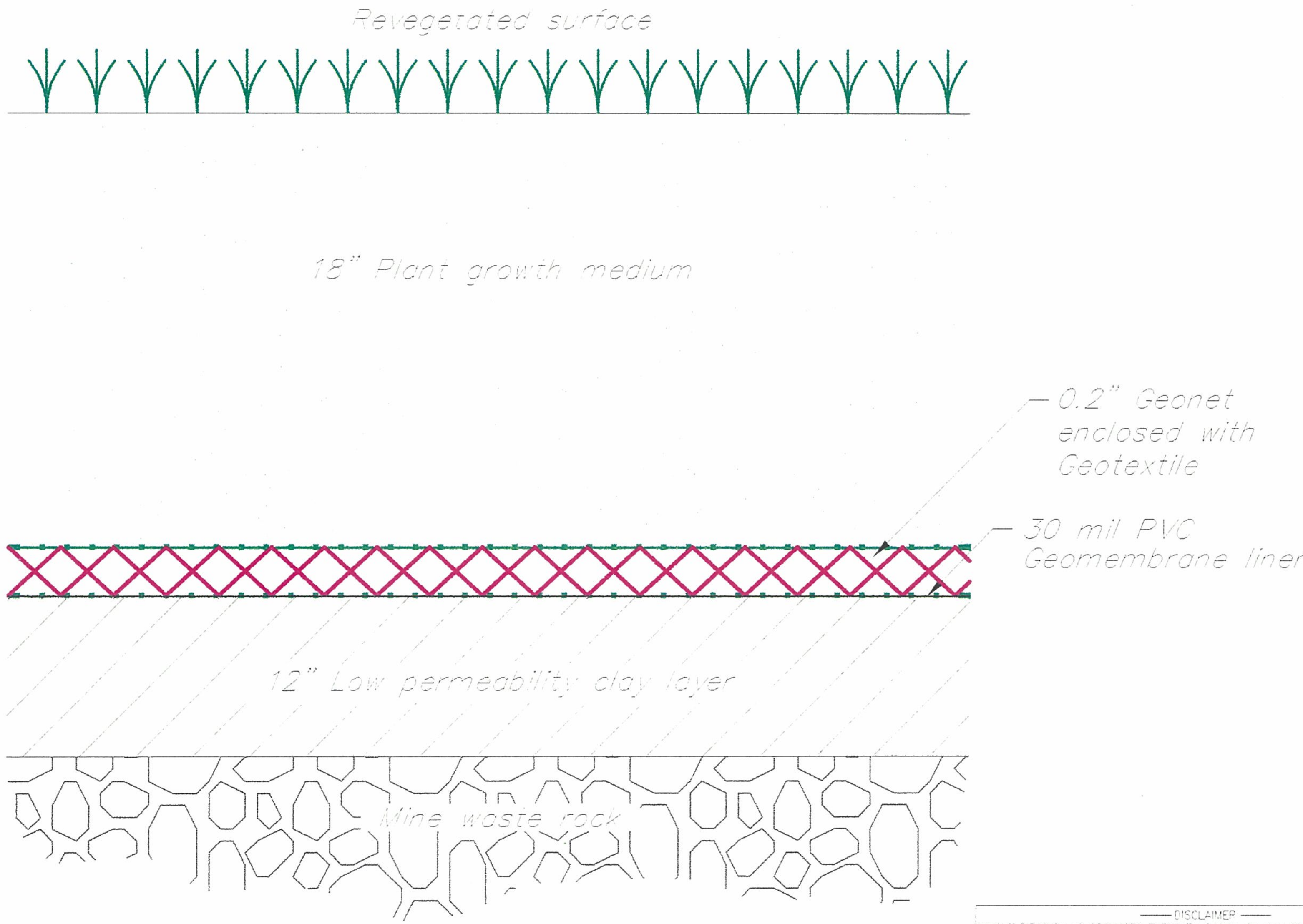


Pecos Mine Operable Unit

Soil and Sediment Excavation for Alternatives 3 and 4

Figure 3-10

02-SEP-1997 /export/export/home/dallas3/pecos/update/sspost.aml



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Not to scale

Stoller Environmental Services	Pecos Mine Operable Unit Feasibility Study
Drawing By: Knight Piesold LLC Date: 01/27/97 Rev. 05/14/97 KP ACAD file name: 1492F08A	Alternative 4 Cover Design For Dump Surface Figure 3-11

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4. Detailed Analysis of Alternatives

4.1 Approach

Section 4 presents information needed by decision makers at the State of New Mexico and Cyprus Amax to compare alternatives and select a site remedy. As required in the AOC, the detailed analysis for the Pecos Mine OU was implemented according to EPA guidance for evaluating alternatives at Superfund sites (EPA 1988).

EPA (1988) developed nine evaluation criteria on which detailed analysis of alternatives should be based in order to meet requirements of the NCP and CERCLA. The nine criteria are:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness and performance
4. Reduction of toxicity, mobility, and volume of contamination
5. Short-term effectiveness
6. Implementability
7. Cost
8. State/support agency acceptance
9. Community acceptance

The detailed analysis presented in this document addresses criteria 1 through 7. Criteria 8 and 9 will be addressed after agency and public review of the Feasibility Study Report. Adherence to these criteria is addressed in the Decision Document.

EPA categorizes the nine criteria as follows (EPA 1988):

Threshold Criteria:

1. Overall protection of human health and the environment. against this criterion describes how the alternative achieves an protection of human health and the environment.

2. *Compliance with applicable or relevant and appropriate requirements (ARARs).* Evaluation for this criterion describes how the alternative ensures compliance with ARARs or justifies required waivers.

Balancing Criteria:

3. Long-term effectiveness and permanence. The assessment of alternatives against this criterion evaluates the long-term effectiveness in maintaining protection of human health and the environment after response objectives have been met. This criterion is often referred to as "residual risk."

4. Reduction of toxicity, mobility, and volume of contamination. Evaluation for this criterion includes anticipated performance of the specific remediation technologies employed in an alternative.

5. Short-term effectiveness. This criterion is intended for evaluation of effectiveness in protecting human health and the environment during construction and implementation of remedies described by an alternative.

6. Implementability. Assessment based on this criterion is intended for evaluation of the technical and administrative feasibility, including the availability of goods and services.

7. Cost. This criterion is intended for evaluation of capital and O&M costs of an alternative.

Modifying Criteria:

8. State/support agency acceptance. This assessment reflects the regulatory agency preferences among or concerns about alternatives.

9. Community acceptance. This assessment reflects the public preferences among or concerns about alternatives.

   [NOTE: Modifying criteria will be addressed after initial review by NMED and appropriate public reviewers.]

Information to support evaluation of each alternative against threshold and balancing criteria is presented below. The presentation of information was based on guidance in EPA (1988).

4.2 Individual Analysis of Alternatives

Individual analyses of the alternatives that were described in Section 3 are presented below. According to EPA guidance, the analysis is presented in a narrative format. However, quantitative information is presented where necessary. Discussion of criteria and analyses for alternatives involving active remediation is most detailed for Alternative 2. For several criteria, evaluation is similar or identical for two or more of the alternatives. In these cases, discussion emphasizes differences in alternatives, and cites earlier discussions for similar evaluations.

4.2.1 Alternative 1—No Action

4.2.1.1 Threshold Criteria

Overall Protection of Human Health and the Environment

The No Action alternative does not reduce exposure of human or ecological receptors to site contaminants. Results of the HHRA indicated that risks to humans were acceptable under recreational land-use scenarios. The NMGF currently owns the mine site and adjacent properties, and the current use of the site is recreational. The HHRA determined that potential future residents of the site may be exposed to unacceptable levels of risk if the bedrock or shallow aquifers were used for drinking water.

Compliance with ARARs

Release of waste rock and leachate from the site would not be attenuated. Therefore, exceedence of New Mexico state water quality standards would continue at the current frequency and magnitude. As a result, this alternative does not comply with ARARs.

4.2.1.2 Balancing Criteria

Long-term effectiveness and permanence

The No Action alternative does not increase protectiveness of human health or the environment over the long term.

Reduction of toxicity, mobility, and volume of contamination

The No Action alternative does not reduce toxicity, mobility, or volume of current contamination at the site.

Short-term effectiveness

Short-term effects on existing site conditions do not differ from long-term effects of the No Action alternative.

Implementability

The technical implementability of the No Action alternative is high. However, it would require the State of New Mexico to permit ongoing release of waste rock and leachate from the site. The state is unlikely to permit ongoing releases from the site.

Cost

Costs associated with the No Action alternative are minimal.

4.2.2 Alternative 2—Non-Compacted Clay Soil Cap

The remediation activities proposed for Alternative 2 are described in Section 3.2.2. and summarized in Table 3-1. Activities include consolidation and regrading of the waste rock and excavation of soils from the seep WSBDT area in the wetland. Excavated materials will be covered with a vegetated 24-inch non-compacted clay soil cap. Surface and subsurface diversion systems will be installed upgradient of the dump. Acidic soils beneath excavated waste rock will be amended to increase pH and decrease bioavailability of metals. The need for a seep water collection and treatment system will be evaluated after the effects of the soil cover on seep water quality and discharge have been established.

4.2.2.1 Threshold Criteria

Overall protection of human health and the environment

Human Health:

As with all cap options (i.e., Alternatives 3 and 4), Alternative 2 eliminates the potential for incidental ingestion of waste rock by covering the dump with a vegetated soil barrier that will prevent contact with the waste rock. Revegetation of affected soils to prevent erosion and replace wildlife habitat will also reduce potential for incidental ingestion of soils by humans.

RI data indicate that water percolating through the waste rock dump contributes to shallow groundwater in the area assessed for residential risk. The dump cover proposed in Alternative 2 will reduce infiltration and percolation of water into the waste rock dump by more than 91 percent (Figure 4-1) and reduce loading of manganese to shallow groundwater.

The HHRA evaluated risk to human health and included groundwater in the shallow and deep flow systems in the northern sections of the site. Results showed that human health risks under current (non-remediated) conditions and two recreational land-use scenarios were within acceptable limits. One of the scenarios ("nearby recreational use") included assumptions that are more stringent than normally used to assess chemical exposures under a recreational land use. The Pecos Mine site and adjacent areas are owned by NMGF. The current and most probable future use of the site is recreational. Therefore, human health is adequately protected under current land use.

The HHRA also evaluated risks based on a future residential scenario in which groundwater from the site is used as a domestic water supply and consumed on a daily basis during the resident's lifetime. The primary risk to human health under the potential residential scenario was due to barium concentrations in the deep aquifer, and manganese and lead in the shallow flow system. Barium concentrations exceeded health-based state water quality standards for domestic water supplies in the bedrock well used in the HHRA. Manganese exceeded a secondary (aesthetic) standard in the shallow well. Lead did not exceed the state groundwater standard.

It is anticipated that remediation of the waste rock dump will result in restoration of groundwater quality to state standards over the long term. Actions that guarantee continued recreational use of the site would afford another layer of protection. NMGF currently does not allow residential use of lands that it controls. Therefore, an action that prohibits sale or transfer of the property would help guarantee that use of the site remains recreational. Such actions include deed restrictions imposed by NMGF which prohibit residential use of the site.

Shallow and bedrock groundwater will be monitored after installation of the cap on the waste rock dump. If adequate improvement in groundwater quality is not observed, further action may be necessary to ensure that groundwater quality at the site meets RACCs. Potential actions are described in Section 3.1.4.

Ecological Health:

The ERA determined that unacceptable ecological risks at the Pecos Mine site were due to:

- contact of vegetation or soil invertebrates with waste rock or contaminated soils adjacent to the waste rock dump

- zinc and cadmium concentrations in the Pecos River that exceed federal AWQC
- metal concentrations in Willow Creek and the wetland area that exceed AWQC
- ingestion of woody plants by beaver feeding exclusively in the wetland area

The soil cover included in Alternative 2 will attenuate contact of plants and soil invertebrates with waste rock. Potentially toxic conditions in soils beneath excavated waste rock will be alleviated by amendment of soils to increase pH. RI data indicate that neutralization of pH in acidic soils of the upland barren area eliminates toxicity to test species (yarrow and earthworms), probably by decreasing the bioavailability of metals in soils.

Soils in the area of WSBDT and associated seeps will be excavated and replaced with clean fill to eliminate the potential toxicity of soils contaminated by leachate.

Results of HELP model runs were used to evaluate the potential for the soil cover to reduce metal loading to colluvial groundwater and surface water. Data from the RI and ERA were used to estimate the daily zinc loading from Willow Creek that results in exceedence of the water quality standard in the Pecos River (25,000 grams per day [g/d]). Data from the first 2 weeks of April 1995 were used to estimate critical loading. During this time period, zinc concentration in the Pecos River exceeded state standards, flows in the Pecos River (~ 105 cfs) and Willow Creek (~ 3 cfs) were near annual minimums, and seep flows were elevated. Thus, the critical loading was estimated for times of lower flow when dilution of water from Willow Creek by flow in the Pecos River were near the minimum. Critical loading for periods of higher flow would be higher due to greater dilution. This is a conservative comparison that assumes that all zinc entering the colluvium is transferred to the Pecos River. RI data indicate that this is not the case but are not adequate to predict the proportion of zinc or other metals that is removed from water in the subsurface and wetland. The loading criterion was then compared to the estimated daily loading of zinc to colluvial water under each of the capping alternatives (Figure 4-1).

HELP model results indicate that the soil cover has the potential to reduce zinc loading in the shallow flow system to levels that will not result in exceedence of water quality standards in the Pecos River, except during periods of extreme high precipitation and infiltration into the dump (Figure 4-1). The extreme event depicted in Figure 4-1 is based on the peak daily percolation rate through waste rock that was observed in the HELP model simulations for Alternative 2 (Appendix B).

To evaluate potential seasonal fluctuations in zinc loading, a similar comparison was made using the 10-year average percolation rate (in inches of water) for each month (Figure 4-2). Results for Alternative 2 indicate no individual months for which the average loading exceeds the criterion. Under current conditions (i.e., no cap), results indicate monthly average loading could exceed the criterion for eight months (April - November).

Similar analyses for Willow Creek could not be performed because of the difficulty in measuring flow and calculating loading for the diffuse flow system in the wetland. However, since percolation through the waste rock dump is reduced by over 91 percent, the resulting reduction in seep flow and/or metal loading to the shallow flow system may result in adequate protection of surface water quality in the affected stream braids in the wetland.

Water quality and seep discharge will be monitored to determine the effect of the soil cover. If adequate improvement of seep water quality and/or flow is observed, no further action will be required. If adequate attenuation of metal transport has not been achieved, an SRB treatment system may be installed to collect and treat seep water before it is discharged to Willow Creek or the Pecos River.

Compliance with ARARs

An evaluation of the potential chemical-, location-, and action-specific ARARs for the Pecos Mine OU is presented in Appendix N of the RI Report (Stoller 1996). The relationship between activities and potential results of Alternative 2 and compliance with ARARs is discussed below.

Chemical-Specific ARARs:

The primary chemical-specific ARARs associated with the site are state standards for surface water and groundwater quality.

HELP model analyses indicate that the cap proposed under Alternative 2 will adequately protect surface water quality in the Pecos River except during periods of extreme high infiltration. The reduced metal loading also will improve surface water quality in Willow Creek adjacent to the seeps.

Water quality of seeps may not meet state standards, because residual water in the dump will continue to percolate until the moisture content of the dump reaches the effective field capacity of waste rock. Therefore, the proposed remediation includes a phased approach with respect to seep water and groundwater quality. The effects of the soil cover on groundwater and surface water quality will be monitored at NMED-approved compliance points. If water quality does not improve adequately to satisfy criteria, further steps will be taken to help ensure compliance with remediation criteria. For seep water, further action includes installation the collection and treatment system described in Section 3.1.5. Possible further actions for groundwater are described in Section 3.1.4.

Chemical-specific ARARs are also available for air quality at the site. The site is in compliance with air quality ARARs with no remediation. Appropriate measures such as dust suppression and air monitoring will be taken to ensure compliance with air quality regulations during construction of the cap.

Location-specific ARARs:

Potential location specific ARARs for the site include the following.

- Archaeological, Historical, and Cultural Resources

In 1992, the New Mexico State Historic Preservation Officer documented that the mine structure lacks sufficient integrity to be considered eligible for the National Register of Historic Places (36 CFR 800.4) (letter from T. Merlan to B. Montoya, October 27, 1992). The New Mexico State Cultural Properties Protection Act (NMSA 1978, 18-6-1 *et seq.*) and the New Mexico Prehistoric and Historic Sites Preservation Act (NMSA 1989, 18-8-1 *et seq.*) may become applicable if an artifact related to mining or prior occupation by Native Americans is discovered by workers during remediation.

- Wetlands

The wetland area associated with lower Willow Creek was delineated according to U.S. Army Corps of Engineers (COE) procedures. The wetlands meet the criteria for a jurisdictional wetland, and a permit pursuant to Section 404 of the Clean Water Act would be required prior to any dredge or fill operations conducted during remediation. The COE considered wetlands at the El Molino OU of the Pecos Site to be covered by the "Nationwide Permit 38" associated with Section 404 Permit process. This action has not formally been taken for the Pecos Mine OU. Therefore, application for a 404 permit may be necessary before performing remediation in the wetland.

- Rivers and Floodplains

As noted above, the 404 Permit process would apply to the Pecos River and Willow Creek stream channels. In addition, the Wild and Scenic Rivers Act (16 USC 1271 *et seq.*) and corresponding designation the Pecos River adjacent to the mine site requires water quality be maintained to federal AWQC or approved state standards. The New Mexico Water quality standards have been approved by EPA, and compliance with state water quality standards is a requirement identified in the AOC.

As discussed previously, the soil cover proposed in Alternative 2 would greatly reduce release of metals to Willow Creek and the Pecos River. If the soil cover alone does not adequately protect water quality, an SRB treatment system may be installed to collect and treat seep water.

- Plant and Animal Resources

A state permit pursuant to the Protection of Native New Mexico Plants Act (NMSA 1978, 76-8-1 *et seq.*) will be required for actions that require removal of native plants within 400 feet of the roadway. Alternative 2 includes potential for removal of plants during excavation within 400 feet of State Highway 63.

Action-Specific ARARs:

- Surface Water

If a system is installed to collect and treat seep water or groundwater, a federal NPDES permit may be required pursuant to 40 CFR 125. If an NPDES permit is not required, state standards for discharge to surface waters would apply (WQCC 82-1, 1-100 et seq.).

- Plant and Animal Resources

No Threatened or Endangered species have been identified at the site. Therefore, no special action is required to mitigate impacts. To ensure compliance with the Migratory Bird Treaty Act (16 USC 703-711), activities that involve removal of trees, shrubs, or wetland vegetation will be avoided during nesting season. If such action is necessary during nesting season, appropriate surveys will be conducted to determine whether native migratory birds are present and/or nesting in the area to be affected. If such species are present, appropriate actions will be taken to mitigate adverse effects.

Federal permits such as the NPDES or 404 permits may necessitate consultation between the responsible agency (i.e., EPA or COE) and the USFWS pursuant to the Fish and Wildlife Conservation Act and the Fish and Wildlife Coordination Act.

4.2.2.2 *Balancing Criteria*

Long-term effectiveness and permanence

According to EPA (1988), this criterion is included to evaluate the magnitude of residual risks and the adequacy and reliability of controls associated with long-term performance of the alternative.

Magnitude of Residual Risk:

Results of the HHRA indicated that under recreational exposure scenarios, current conditions (non-remediated) at the site do not represent unacceptable risk to human health. Since the site is part of a state recreation area, human health risk under the current land use is acceptable. Remediation activities associated with Alternative 2 will further reduce risk. As noted previously, an added layer of protection can be afforded through actions that will prevent residential use of the site in the future.

Residual ecological risks result primarily from elevated metal concentration in soils in the wetland. Soils in the barren areas will be removed or amended to increase pH and decrease bioavailability of metals. However, the amendment does not reduce the concentration of metals in soils. Therefore, changes in soil conditions such as decreased buffering capacity, input of sulfidic materials, or input of acid leachate could acidify soils and increase bioavailability of metals. Remediation of the waste rock and other site controls are adequate to neutralize current acidic condition and prevent further acidification. However, some risk from elevated metal concentrations remains.

Results of the ERA indicated that exposure of beavers or similar species to cadmium and zinc in wetland vegetation exceeded conservative ecotoxicological benchmarks. The corresponding risk was categorized as slight to moderate. However, phytotoxicity tests and field observations of vegetation growth in the wetland indicate relatively healthy conditions, except around seep WSBDT. Remediation of the wetland to reduce exposures to beaver would require extensive excavation. Based on the potential damage to the wetland that would result from extensive excavation and the conservatism associated with the risk estimates for beaver, excavation in the wetland will be restricted to the WSBDT seep area.

Adequacy and Reliability of Controls:

The use of covers and caps is a common practice in mine site closure and solid waste disposal. Caps are generally considered permanent remedies and require low maintenance. Consolidation and covering the waste rock results in highly reliable control for reducing contact of human and ecological receptors to waste rock.

HELP modeling indicates that the soil cover included in Alternative 2 will reduce percolation by more than 91 percent. The HELP model is conservative and tends to overestimate percolation rates. Therefore, this performance estimate appears to be a reliable indicator that percolation rates will be reduced by at least 91 percent.

Long-term management and maintenance requirements associated with the soil cover include:

- periodic (every 3 to 6 months) inspections of soil cover for vegetation growth and integrity of dump surface
- replanting areas of dump with inadequate vegetation coverage
- removing deep-rooted plant species
- repairing and replacing eroded or otherwise damaged areas of the dump surface
- monitoring seep water quality and discharge
- monitoring surface water quality

If a seep treatment system is installed, monitoring and management would include:

- periodic inspection of the system components for damage from erosion or animals
- repair or replace system components as needed
- monitoring chemistry of water within system and at discharge to confirm proper function and compliance with remediation criteria

No difficulties in performance of monitoring and maintenance activities are expected.

If sections of the dump cover were to need replacement, the increased exposure to infiltrating water would be minimal with respect to the overall dump surface. Based on HELP model results, average percolation rates under Alternative 2 could be increased up to five fold before water quality standards are exceeded in the Pecos River. Effects on Willow Creek could occur at lower percolation rates. If a seep water collection and treatment is installed, excess flows would be treated before entering Willow Creek.

Temporary inactivation of a seep treatment system for repairs may result in discharge of untreated water if performed at a time when seeps are running. Temporary discharge will probably have minimal effects on the Pecos River. RI data indicate event-related exceedence of water quality standards occur under current conditions. Seep water flow and/or quality is expected to improve as a result of the soil cover on the dump. Temporary discharge of seep water under these conditions is likely to have far less impact than current releases. Current releases do not satisfy state water quality standards. However, based on current aquatic community health, the releases also do not result in extreme and irreversible effects on aquatic fauna.

Reduction of toxicity, mobility, and volume of contamination

Toxicity:

Toxicity of some environmental media at the site will be reduced as a result of Alternative 2. Bioavailability of metals in acid soils will be greatly reduced by amendment to increase pH. Results of the ERA show that increase of pH eliminated phytotoxicity of soil samples from the upland barren area. This approach may also reduce propensity of metals to accumulate in vegetation at the site. Toxicity of surface waters and colluvial groundwater will be reduced by preventing generation of acid leachate that transport metals to Willow Creek and the Pecos River. If water quality does not improve adequately, subsequent action will be taken to comply with ARARs. Toxicity of waste rock will not be reduced, but the potential for contact with waste rock will be greatly reduced.

Mobility:

Mobility of contaminants will be greatly reduced as a result of Alternative 2. The soil cover will prevent erosional transport of waste rock and greatly attenuate, if not eliminate, generation of acid leachate. Excavation of contaminated soils from the seep area of the wetland will prevent further transport of solid and dissolved metals in surface water. Transport by seep water will also be attenuated by preventing release of contaminants to upgradient groundwater.

Volume:

The total area occupied by waste rock will be reduced by 47 percent. The volume of waste rock and contaminated soils remaining at the site will be unaffected because all materials will be consolidated under the soil cover. The volume of acid leachate generated by percolation will be greatly reduced, if not eliminated. As a result, the volume of contaminated surface water will also be reduced.

Short-term effectiveness

Risks to the Community:

Risks to the local community are associated with transportation of materials to the site, and possible generation of fugitive dust during construction.

Approximately 243,000 truck miles would be required to transport the required materials to Pecos Mine site. Risks of accident, injury, and fatality corresponding to the estimated transportation needs risks are summarized in Table 4-1. Flow of local vehicle traffic, including residents and recreationists using roads along the haul route, may also be affected during operations.

Regrading the waste rock dump and construction of the soil cover may result in fugitive dust emissions. One residence is located approximately 0.6 miles northwest of the mine. No other residences are within one mile of the site. With this exception, risk to the general public will be restricted to recreationists in the area. Appropriate site controls and state requirements for dust control will be implemented during construction.

Transportation of construction materials will also affect road surface of State Highway 63 and other roads along the haul route. Currently, no weight limits for roads or bridges exist for roads along the haul route. However, State Highway 63 is a relatively light-duty road that could be damaged by heavy truck traffic.

Risks to Workers:

No unusual hazards are present at the site. Waste rock contains potentially toxic metals but generally not at concentrations that are acutely toxic. Given the length of time required for construction of Alternative 2, chronic exposure to workers could result. However, standard construction safety practices and requirements of OHSA standard 1910.120 for protection of workers at hazardous waste sites will be implemented during construction. Other risks to workers include risk of vehicle accident and injury during transport of construction materials to the mine site from borrow areas.

Environmental Impacts:

Potential environmental impacts that may occur during initial stages of excavation and construction associated with Alternative 2 include:

- potential temporary increase in sediment loading to Willow Creek
- temporary disruption of Willow Creek habitat as the channel is remediated
- physical disruption from noise and movement during construction activities
- excavation of approximately 0.25 acres of wetland

Sediment loading will be minimized by appropriate grading of surfaces to encourage sediment deposition upgradient of the creek and installation of silt fencing. Excavation of contaminated soils in the wetland will be accompanied by installation of temporary berms and silt fencing to prevent downstream transport of material that is resuspended during excavation. Excavated areas of the wetland will be reclaimed using clean fill and native wetland vegetation.

A temporary diversion of Willow Creek will be necessary while the stream channel is remediated. This action will temporarily disrupt stream habitat along approximately 600 feet of channel adjacent to the north end of the waste rock dump.

The time required to complete the initial stages of excavation and construction for Alternative 2 is approximately one to two years.

Impacts that may occur after initial stages are complete but before Alternative 2 is fully implemented include:

- release of leachate to surface waters until effects of cap are realized and/or installation of a seep water treatment system is complete
- loss of habitat during time required for revegetated areas to develop

As noted previously, surface water will be monitored to assess the effect of remediation at the waste rock dump on discharge of metals into Willow Creek. Current discharges are expected to continue until remediation at the dump is complete. Remediation at the dump is expected to affect seep water quality and/or flow. Measurable improvement of water quality is expected to occur within one year after the dump remediation is complete. If adequate improvement in water quality has not occurred in a reasonable amount of time, installation of a water treatment system may be required. Decisions on the period of monitoring and installation of seep treatment system will be made by NMED.

Time required to achieve substantial vegetation growth in meadow and wetland areas is one to three years. Areas planted with trees require longer periods to develop. Maturation of plant communities requires much longer periods of time.

Time Until RAOs are Achieved:

RAOs regarding soil and waste rock remediation will be achieved when excavation and cap construction are complete. Waste rock consolidation and cap construction are expected to require one to two years. HELP model results indicate that attenuation of infiltration and percolation into waste rock will be achieved within the first year and that evapotranspiration from vegetative cover on the cap is adequate. Adequate vegetative cover is expected within one to three years after completion of cap construction.

Protection of surface water will be achieved when seep water quality is adequately improved by the cap or installation of a treatment system, if necessary, is completed. The effects of the soil cover on seep water flow and/or quality is expected within one to three years.

<u>Implementability</u>

Technical Feasibility:

All technologies included in Alternative 2 are commonly used in traditional construction or mine remediation. Regrading the waste rock dump to the proposed configuration identified can be accomplished using well-known technologies, equipment, and procedures. Construction of the soil cap is also based on well-known and tested technologies.

The passive SRB technology proposed for potential seep water treatment is known to be effective at increasing pH and removing metals from water. SRB systems have been installed and function effectively at mine sites throughout the country. The specific size and configuration of the system will be determined after the effect of the waste rock dump remediation has been established.

Administrative Feasibility:

State and government agencies involved in the Pecos Mine OU include NMED, NMGF, NMHTD, and EPA Region VI. The USFS was not a party to the AOC and has deeded its original holdings at the site to NMGF. NMGF, the current owner of the site, and NMED have exhibited a high degree of cooperation in implementing the initial stages of the RI/FS. According the Las Vegas district office of NMHTD, currently no weight limits or permits are required for truck traffic on State Highway 63. Involvement by the COE may be required if permits for wetland dredging are necessary. The NPDES for New Mexico is administered by EPA, but discharge permits for seeps or treatment systems would also be needed from NMED. A stormwater discharge plan and permit will also be required for the site.

Availability of Services and Materials:

Initial volume estimates indicate that materials to construct the soil cover are available from sources at the mine site. Clay materials for construction of the sideslopes of the dump may require a higher sand content than is typical of clays available at the site. Materials from the site may be amended for use in cap construction, or, if necessary, materials will be obtained from offsite borrow areas or commercial vendors. Cost estimates assume material will be obtained from an offsite source. Rock appropriate for rip-rap lining of the diversion ditches is also not available onsite but generally available from sources in the region.

<u>Cost</u>

Costs associated with Alternative 2 are summarized in Table 4-2. Assumptions used in estimating costs for excavation, material handling, and transportation are summarized in Table 4-3. Accuracy of cost estimates is within the -30 to +50 percent range suggested by EPA (EPA 1988).

Potential costs associated with the SRB seep treatment system or potential groundwater treatment are not included in Table 4-2. These items will be installed if needed. Costs for design and installation of the SRB seep treatment system are estimated at $100,000, including a 25 percent contingency. Costs for groundwater treatment systems vary with the type of action and the extent of additional investigation that may be needed. These costs are common to all alternatives except No Action.

In addition to costs directly associated with activities at the Pecos Mine site, indirect costs will be incurred for maintenance of State Highway 63. Transport of fill and construction materials to the site will result in a greater volume of heavy truck traffic than currently occurs. Costs estimates for maintenance under these conditions were obtained from the NMHTD. Costs estimates ranged from \$0.014 to \$0.028 per truck-mile and were based on truck traffic on secondary roads. The mid-point of this range (\$0.021 per truck-mile) was used to estimate road maintenance costs for all alternatives. Cost estimates are included in Table 4-1.

4.2.3 Alternative 3—Compacted Clay Cap

The remediation activities included in Alternative 3 are discussed in Section 3.2.3. The remediation proposed for Alternative 3 is similar to that of Alternative 2, except that the cap design includes a low permeability layer of compacted clay with an overlying drainage layer (Table 3-1, Figure 3-7), and all affected soils in the upland areas will be excavated and capped along with the waste rock.

Decreased percolation and leachate generation are expected to result in improved seep water quality and decreased seep discharge. Either effect will decrease impacts to surface water quality in Willow Creek. If water quality does not improve adequately, these effects will also decrease the size and/or complexity of a seep treatment system.

4.2.3.1 Threshold Criteria

Overall protection of human health and the environment

Human Health:

Alternative 3 provides greater protection for human health than described for Alternative 2. Human health risks from groundwater may be lower for Alternative 3 than Alternative 2 because the greater impermeability of the cap will provide greater protection of groundwater quality.

Ecological Health:

Protection of ecological health under Alternative 3 is greater than that under Alternative 2 because more of the affected soils in the upland barren area will be removed and greater protection of surface water quality by the lower permeability of the compacted clay cap (Figure 4-1).

As for Alternative 2, results of HELP model runs were used to evaluate the potential for the compacted clay cap to reduce loading to surface water. Results indicate that the compacted clay cap will reduce percolation through waste rock by more than 99 percent. As a result, Alternative 3 has the potential to reduce zinc loading in the shallow flow system to levels that will not result in exceedence of water quality standards in the Pecos River, even during the most extreme high flow event predicted by the HELP model (Figure 4-1). As with Alternative 2, results also indicate no individual months for which the average loading exceeds the criterion (Figure 4-2). These data indicate that the compacted clay cap will adequately protect surface water quality in the Pecos River.

Water quality in Willow Creek will also improve as a result of attenuated metal transport in seep water. However, quantitative estimates of improvement in this area were not conducted because flow data from the wetland were not available. Unless flumes are constructed at the inlet and outlet of a wetland, measurement of the diffuse surface and subsurface flow typical of the wetlands is difficult and associated with low accuracy.

As with other alternatives, water quality and seep discharge will be monitored to determine the effect of the compacted clay cap. If adequate improvement of seep water quality and/or flow is observed, no further action will be required. If adequate attenuation of metal transport has not been achieved, an SRB treatment system will be installed to collect and treat seep water before it is discharged to Willow Creek or the Pecos River.

Compliance with ARARs

Chemical-Specific ARARs:

As noted for Alternative 2, the effect of the compacted clay cap on groundwater and surface water quality will be monitored at NMED-approved compliance points. If water quality does not improve adequately to satisfy criteria, further steps will be taken to help ensure compliance with remediation criteria.

Location-specific ARARs:

Compliance with potential location-specific ARARs is the same as discussed for Alternative 2.

Action-Specific ARARs:

- Surface water

Compliance with action-specific ARARs for surface water is the same as discussed for Alternative 2.

- Plant and Animal Resources

Compliance with action-specific ARARs for plant and animal resources is the same as discussed for Alternative 2.

4.2.3.2 Balancing Criteria

Long-term effectiveness and permanence

Magnitude of Residual Risk:

As noted for Alternative 2, human health risk under recreational land use and current (non-remediated) conditions is acceptable. The magnitude of residual human health risk after implementation of Alternative 3 will be less than that associated with Alternative 2 due to removal of contaminated soils and greater protection of groundwater. Additional protection could be afforded if NMGF took action to prohibit sale or transfer of the property that would result in residential use of the site.

Residual ecological risks from Alternative 3 are similar to those discussed for Alternative 2. However, residual risks in soils of the upland barren area will be eliminated by excavation of contaminated material and replacement with clean fill. In addition, the lower permeability of the compacted clay cap will result in greater protection for surface water quality.

Adequacy and Reliability of Controls:

The use of covers and caps is a common practice in mine site closure and solid waste disposal. Consolidation and covering the waste rock results in highly reliable control for reducing contact of human and ecological receptors to waste rock.

HELP modeling indicates that the compacted clay cap included in Alternative 3 will reduce percolation by more than 99 percent. This performance estimate appears to be reliable since the HELP model results are conservative estimates (i.e., overestimates) of percolation rates.

Long-term management and maintenance requirements associated with the clay cap and seep water treatment system are the same as described for Alternative 2.

If sections of the cap were to need replacement, the increased exposure to infiltrating water would be minimal with respect to the overall dump surface. Based on HELP model results, average percolation rates with the compacted clay cap could be increased almost 70 fold before the zinc water quality standard is exceeded in the Pecos River. Effects on Willow Creek could occur at lower percolation rates. If a seep water collection and treatment is installed, excess flows would be treated before entering Willow Creek.

The effects of temporary inactivation of a seep treatment system for repairs is the same as discussed for Alternative 2.

Reduction of toxicity, mobility, and volume of contamination

Toxicity:

Toxicity of some environmental media at the site will be reduced as a result of Alternative 3. Removal and replacement of contaminated soils in the upland barren area will eliminate toxicity. Toxicity of surface waters and groundwater will be reduced by preventing generation of acid leachate that transport metals to Willow Creek and the Pecos River. If water quality does not improve adequately, subsequent action will be taken to comply with ARARs. As with Alternative 2, toxicity of waste rock will not be reduced, but the potential for contact with waste rock will be greatly reduced.

Mobility:

The reduction in mobility of contaminants under Alternative 3 will be similar to that under Alternative 2. Potential mobility of metals in waste rock and affected soils will be reduced more than under Alternative 2 because of the lower potential for water to enter the waste rock material. Potential mobility of metals from soils in the upland barren area is also further reduced by their removal and placement under the cap.

Volume:

As with Alternative 2, the total area occupied by waste rock will be reduced by 47 percent. However, the volume of waste rock and contaminated soils remaining at the site will be unaffected because all materials will be consolidated under the compacted clay cap. The volume of acid leachate generated by percolation will be greatly reduced if not eliminated. As a result, the volume of contaminated surface water will also be reduced.

Short-term effectiveness

Risks to the Community:

As for Alternative 2, risks to the local community are associated with transportation of materials to the site and possible generation of fugitive dust during construction. Alternative 3 requires a similar volume of truck traffic to transport the materials to the Pecos Mine site (Table 4-1). Corresponding accident, injury, and fatality risks; as well as road maintenance costs area also similar to Alternative 2 (Table 4-1). Transportation of some materials to the site may require truck traffic through the village of Pecos. Flow of local vehicle traffic, including residents and recreationists using roads along the haul route, may be affected during operations. Risks associated with fugitive dust emissions will be similar to risks described for Alternative 2.

Risks to Workers:

Risks to workers under Alternative 3 are the same as described for Alternative 2.

Environmental Impacts:

Potential environmental impacts associated with Alternative 3 include those identified for Alternative 2. The impacts and possible mitigation measures are discussed under Alternative 2.

In addition, the more extensive excavation of soils in the upland barren area will result in more extensive impacts to the local vegetation. However, this area will ultimately be improved as excavated soils will be replaced with clean materials and the site revegetated with native species.

The time required to complete initial stages of Alternative 3 remediation is one to two years.

Time Until RAOs are Achieved:

RAOs regarding soil and waste rock remediation will be achieved when excavation and cover construction are complete, approximately two years. The low permeability of the clay cap will significantly reduce infiltration and percolation within the first year after cap construction.

Implementability

Technical Feasibility:

As with Alternative 2, technologies and methods required to implement Alternative 3 are commonly used in traditional construction or mine remediation. Regrading the waste rock dump to the specifications identified can be accomplished using well-known technologies, equipment, and procedures. Construction of the compacted clay cap is also based on well-known and tested technologies.

The passive SRB technology proposed for seep water treatment in all active alternatives is known to be effective at increasing pH and removing metals from water. The specific size and configuration of the system will be determined after the effect of the waste rock dump remediation has been established.

Administrative Feasibility:

Administrative feasibility for implementing Alternative 3 is approximately the same as for Alternative 2.

Availability of Services and Materials:

Initial volume estimates indicate that clay materials available at the site are adequate for construction of the clay barrier. Topsoil for plant growth medium is available from a source within 5 miles of the mine site. Clay materials for construction the sideslopes may be obtained from onsite sources or, if necessary, offsite borrow areas or commercial vendors. Rock appropriate for rip-rap lining of the diversion ditches is not available onsite but generally available from sources in the region.

Cost

Costs associated with Alternative 3 are summarized in Table 4-4. Other direct and indirect costs associated with Alternative 3 are similar to those described for Alternative 2 and shown in Table 4-1.

4.2.4 Alternative 4—Geomembrane Cap

The remediation activities included in Alternative 4 are discussed in Section 3.2.4. Alternative 4 includes a low permeability cap consisting of a 30-mil PVC liner that overlies a compacted clay layer and a geonet drainage layer that overlies the geomembrane. The function of the compacted clay is to provide a smooth surface over which to lay the geomembrane. The permeability of the geomembrane cap is approximately five orders of magnitude lower than the compacted clay cap in Alternative 3. The percolation of water through the waste rock will be decreased by more than 99.9 percent from that estimated for the uncovered dump (Table 4-1).

Decreased percolation and leachate generation are expected to result in improved seep water quality and/or decreased seep discharge. Either effect will decrease impacts to surface water quality in Willow Creek. If water quality does not improve adequately, these effects will also decrease the size and/or complexity of a seep treatment system.

4.2.4.1 Threshold Criteria

Overall protection of human health and the environment

Human Health:

Alternative 4 provides greater protection for human health than described for Alternatives 2 and 3 because the greater impermeability of the cap will provide greater protection of groundwater quality. See discussion in Section 4.2.2.1 for summary of residual risks.

Ecological Health:

Protection of ecological health under Alternative 4 is similar to that for Alternative 3. Greater protection of surface water quality is implied by the lower permeability of the geomembrane cap.

As for Alternatives 2 and 3, results of HELP model runs were used to evaluate the potential for the geomembrane cap to reduce loading to surface water. Results indicate that zinc concentrations in the Pecos River will not exceed water quality standards. As noted previously, similar data are not available for Willow Creek. However, the extremely low permeability of the geomembrane cap will result in greater potential for protection of surface water in Willow Creek and the associated wetland.

As with other alternatives, water quality and seep discharge will be monitored to determine the effect of the geomembrane cap. If adequate improvement of seep water quality and/or flow is observed, no further action will be required. If adequate attenuation of metal transport has not been achieved, an SRB treatment system will be installed to collect and treat seep water before it is discharged to Willow Creek or the Pecos River.

<u>Compliance with ARARs</u>

Chemical-Specific ARARs:

As noted for Alternative 2, the effect of the geomembrane cap on groundwater and surface water quality will be monitored at NMED-approved compliance points. If water quality does not improve adequately to satisfy RAOs, further steps may be taken to help ensure compliance with remediation criteria.

Location-specific ARARs:

Compliance with potential location-specific ARARs is the same as discussed for Alternative 2.

Action-Specific ARARs:

- Surface water

Compliance with action-specific ARARs for surface water is the same as discussed for Alternative 2.

- Plant and Animal Resources

Compliance with action-specific ARARs for plant and animal resources is the same as discussed for Alternative 2.

4.2.4.2 Balancing Criteria

<u>Long-term effectiveness and permanence</u>

Magnitude of Residual Risk:

Residual human health and ecological risks associated with Alternative 4 are the same as discussed for Alternative 3.

As noted for Alternative 2, human health risk under recreational land use and current (non-remediated) conditions is acceptable. The magnitude of residual human health risk after implementation of Alternative 4 will be less than that associated with Alternative 2 or Alternative 3 due to the greater protection of groundwater. Additional protection could be afforded if NMGF took action to prohibit sale or transfer of the property that would result in residential use of the site.

Adequacy and Reliability of Controls:

The use of covers and caps is a common practice in mine site closure and solid waste disposal. Consolidation and covering the waste rock results in highly reliable control for reducing contact of human and ecological receptors to waste rock.

HELP modeling indicates that the geomembrane cap included in Alternative 4 will reduce percolation by more than 99.9 percent. This performance estimate appears to be reliable since the HELP model results in conservative estimates (i.e., overestimates) of percolation rates.

Long-term management and maintenance requirements associated with the clay cap and seep water treatment system are the same as described for Alternative 2. No difficulties in performance of these activities are expected. However, repair of the geomembrane cap would require a greater effort than for the soil cover or compacted clay cap.

If sections of the cap were to need replacement, average percolation rates with the geomembrane cap could be increased by over 100 fold before the zinc water quality standard is exceeded in the Pecos River. Effects on Willow Creek could occur at lower percolation rates.

Temporary inactivation of a seep treatment system for repairs would have the same effects as described for Alternative 2.

<u>Reduction of toxicity, mobility, and volume of contamination</u>

Toxicity:

Toxicity of some environmental media at the site will be reduced as a result of Alternative 4. Removal and replacement of contaminated soils in the upland barren area will eliminate toxicity. Toxicity of surface waters and groundwater will be reduced by preventing generation of acid leachate that transport metals to Willow Creek and the Pecos River. If water quality does not improve adequately, subsequent action will be taken to comply with ARARs. As with Alternatives 2 and 3, toxicity of waste rock will not be reduced, but the potential for contact with waste rock will be greatly reduced.

Mobility:

The reduction in mobility of contaminants under Alternative 4 will be similar to that under Alternative 3. The lower permeability of the geomembrane cap further reduces the potential mobility of metals from waste rock and other capped materials.

Volume:

As with Alternatives 2 and 3, the total area occupied by waste rock will be reduced by 47 percent. However, the volume of waste rock and contaminated soils remaining at the site will be unaffected because all materials will be consolidated under the soil cover. The volume of acid leachate generated by percolation will be greatly reduced if not eliminated. As a result, the volume of contaminated surface water will also be reduced.

<u>Short-term effectiveness</u>

Risks to the Community:

Risks to the local community are associated with transportation of materials to the site and possible generation of fugitive dust during construction.

Approximately 236,000 truck miles would be required to transport the required materials to Pecos Mine site. This amount is lower than for Alternative 3 because less material is required to construct the cap. Risks of accident, injury, and fatality corresponding to the estimated transportation needs are summarized in Table 4-1. Flow of local vehicle traffic, including residents and recreationists using roads along the haul route, may be affected during operations.

Risks associated with fugitive dust emissions will be similar to risks described for Alternative 2.

Transportation of mine waste and construction materials associated with Alternative 2 will also affect the surface of State Highway 63 and other roads along the haul route. Effects will be slightly less than for Alternative 3 due to the lower haul requirements.

Risks to Workers:

Risks to workers under Alternative 4 are the same as described for Alternative 2.

Environmental Impacts:

Potential environmental impacts associated with Alternative 4 are the same as those discussed for Alternative 3. The time to complete initial stages of Alternative 4 is one to two years.

Time Until RAOs are Achieved:

Time until RAOs are achieved is the same as for Alternative 3. A shorter time to compliance with surface water quality standards may be expected based on lower permeability of the cap.

Implementability

Technical Feasibility:

Technical feasibility of implementing Alternative 4 is generally the same as other capping alternatives. Installation of the geomembrane adds complexity to the construction because of the specialized equipment and work crews needed. However, the technology for geomembrane installation is common and no difficulty is anticipated.

Administrative Feasibility:

Administrative feasibility for implementing Alternative 4 is high. A similar cap design was approved for use at the El Molino OU. Therefore, the use of this technology is familiar to regulators at state and federal level.

Availability of Services and Materials:

Availability of earthen construction materials for Alternative 4 is the same as described for Alternative 3. The geomembrane material, geotextile encasing material, and the geonet drainage layer are readily available from vendors. Rock appropriate for rip-rap lining of the diversion ditches is also not available onsite but generally available from sources in the region.

Cost

Costs associated with Alternative 4 are summarized in Table 4-5.

4.2.5 Alternative 5—Source Removal

Remediation activities associated with Alternative 5 are described in Section 3.2.5. Alternative 5 includes removal of source materials, including waste rock, contaminated soil, and contaminated colluvial material from the site. Source materials would be transported by truck to the El Molino OU, placed on the tailing deposits, and capped along with the tailing.

Excavated areas at the Pecos Mine OU will be filled with clean materials, regraded to approximate the original site contours, and revegetated using native species.

4.2.5.1 Threshold Criteria

Overall protection of human health and the environment

Human Health:

Alternative 5 provides similar protection as described for Alternatives 3 and 4. As noted previously, the site is owned by NMGF, and the current land use is recreational. The HHRA showed that human health risks under two recreational land use scenarios were within acceptable limits. Therefore, Alternative 5 adequately protects human health if the site use remains recreational.

Removal of the source materials will attenuate potential exposure to waste rock and affected soils. Source removal will also eliminate transport of manganese and other metals to shallow groundwater. As with capping alternatives, monitoring will be conducted to determine effects of waste rock remediation on groundwater quality. If groundwater quality does not improve adequately, further actions described in Section 3.1.4 may be taken.

Ecological Health:

Potential contact of soil invertebrates and plants with contaminated soils and waste rock in upland areas will be eliminated as a result of Alternative 5. Risk from contaminated soils in the wetland will be the same as for Alternatives 3 and 4.

Unlike capping alternatives, activities associated with Alternative 5 are not intended to attenuate infiltration and percolation through the area currently occupied by the dump. Instead, the primary source of acid leachate generation in the shallow flowpath will have been removed, and water quality in shallow groundwater and unsaturated flows will probably improve. However, it may not be practical or possible to remove all potentially contaminated materials in the flow path between the dump area and the seep discharge area. As with capping alternatives, residual contamination in soils and colluvium and naturally mineralized rock in the ground may continue to contribute metals or acidity to shallow flows and result in seep water that does not meet RAOs immediately.

As with other alternatives, water quality and seep discharge will be monitored to determine the effect of remediation. If adequate improvement of seep water quality and/or flow is observed, no further action will be required. If adequate attenuation of metal transport has not been achieved, an SRB treatment system will be installed to collect and treat seep water before it is discharged to Willow Creek or the Pecos River.

<u>Compliance with ARARs</u>

Chemical-Specific ARARs:

As noted for other alternatives, the effect of source removal on groundwater and surface water quality will be monitored at NMED-approved compliance points. If water quality does not improve adequately to satisfy criteria, further steps will be taken to help ensure compliance with remediation criteria.

Location-specific ARARs:

Compliance with potential location-specific ARARs is the same as discussed for Alternative 2.

Action-Specific ARARs:

- Surface Water

Compliance with action-specific ARARs for surface water is the same as discussed for Alternative 2.

- Plant and Animal Resources

Compliance with action-specific ARARs for plant and animal resources is the same as discussed for Alternative 2.

4.2.5.2 *Balancing Criteria*

Long-term effectiveness and permanence

Magnitude of Residual Risk:

As with other alternatives, results of the HHRA indicated that under recreational exposure scenarios, current conditions (non-remediated) at the site represent no unacceptable risk to human health. The site is part of a state recreation area, and the current and most probable future use is recreational. As with other alternatives, the added layer of protection could be afforded if NMGF were to prohibit sale or transfer of the property that could result in residential use of groundwater.

Residual ecological risks from Alternative 5 are similar to those discussed for Alternative 4. When Alternative 5 is fully implemented, sources of unacceptable risk due to metals exposure will be mitigated.

Adequacy and Reliability of Controls:

Removal of contaminant source materials from the site is an effective control for exposure of human and ecological receptors to waste rock and affected soils, and transport of metals in waste rock or leachate. Should a seep water treatment system be needed, the SRB treatment system will be adequate to increase pH and remove metals from seep water.

Alternative 5 includes removal of a greater volume of soils and colluvial materials from the dump area than other alternatives. Clean fill material will be placed in the excavated areas, graded to approximate the topographic surface of the original landscape, and revegetated to approximate native plant communities. The reclaimed area will require inspection and maintenance to ensure that regraded areas are stable and retain adequate slope characteristics and that revegetation is successful.

Waste rock and soils removed from the mine site will be capped along with tailing material at the El Molino OU. As noted previously, the use of covers and caps is a common practice in mine site closure and solid waste disposal. As with the cap alternatives, long-term management and maintenance requirements associated with the cap at the El Molino OU will include periodic inspection, repair of reclaimed areas that become eroded or fail to support adequate vegetative cover, and monitoring of surface water and groundwater quality. Efforts required for cap inspection and maintenance at the El Molino OU will be increased by addition of this material to the tailing deposit. Additional surface water and groundwater points may also be required in areas where waste rock is deposited.

Installation of a seep treatment system would require inspection and maintenance as described for other alternatives. Performance of monitoring and maintenance activities can be performed year round at the site. No difficulties in performance of these activities are expected.

Reduction of toxicity, mobility, and volume of contamination

Toxicity:

Removal of waste rock and affected soils from the site will not reduce the inherent toxicity of these materials. However removal will eliminate potential toxicity for human and ecological receptors in the mine area. Toxicity of surface water and groundwater will be reduced by preventing generation of acid leachate that transport metals to Willow Creek and the Pecos River. If water quality does not improve adequately, subsequent action may be taken to comply with ARARs.

Mobility:

Activities associated with Alternative 5 will reduce contaminant mobility at the mine site to a greater extent than under capping alternatives because contaminant source materials will have been removed. However, waste rock has a higher acid generation potential than tailing material the mill site. Therefore, the potential mobility of metals in materials at the El Molino site will increase as a result of the presence of waste rock and the associated potential for acid leachate generation. The increased potential mobility will be mitigated by capping of the waste rock combined with the lower amount of precipitation that occurs at the El Molino OU.

Volume:

The volume of waste rock and affected soils at the mine site will be reduced greatly under Alternative 5. However, the volume of mine waste and affected soils at the El Molino OU will be increased as a result of Alternative 5. The volume of acid leachate generated by percolation will be greatly reduced if not eliminated. As a result, the volume of contaminated surface water will also be reduced.

Short-term effectiveness

Risks to the Community:

Risks to the local community are associated with transportation of materials to and from the site and generation of fugitive dust during excavation and construction.

Traffic volume associated with Alternative 5 is greater than for other alternatives. Approximately 1.1 to 1.9 million truck-miles would be required to transport excavated materials from the mine site to the El Molino OU. An additional 460,000 to 1.1 million truck-miles will be required to transport clean fill materials to the mine site for site reclamation. Risks of accident, injury, and fatality corresponding to the estimated transportation needs are summarized in Table 4-1. Flow of local vehicle traffic, including residents and recreationists using roads along the haul route, may be affected during operations. Potential fugitive dust emissions will affect persons at the mine site as described for Alternative 2.

Residents of the village of Pecos will be affected by truck traffic to a greater extent than other alternatives. The route along which waste material will be hauled passes directly through the village within one block of the community school. Assuming a fleet of ten 20-ton trucks making five round trips per day, transport of materials from the mine to the El Molino OU would result in approximately 100 truck trips through town each day, and require 3 to 5.5 years to complete. In addition, implementation of Alternative 5 will delay installation of the final cap at the El Molino OU, increasing the length of exposure from wind-blown materials from the tailing ponds to town residents.

Transportation of mine waste and construction materials will also affect the surface of State Highway 63 and other roads along the haul route. Currently, no weight limits for roads or bridges exist for roads along the haul route. However, State Highway 63 is a relatively light-duty road that could be damaged by heavy truck traffic.

Risks to Workers:

Risks to workers are similar for Alternative 5 as were described for other alternatives. However, transportation risks will be greater given the longer time period required to implement Alternative 5 and the larger volume of traffic generated. In addition, risk of vehicle accidents is greater for loaded trucks hauling downhill, than uphill.

Environmental Impacts:

The types of potential short-term environmental impacts associated with Alternative 5 is the same as those identified for other alternatives. Potential erosion and sedimentation from excavated areas, physical disruption due to noise and activity of remediation actions, and temporary diversion of Willow Creek will continue until initial phases of construction are complete. However, interim actions such as silt fences and control of runoff will be in place to minimize effects during construction. For Alternative 5, this period is expected to last for up to 5.5 years.

Time Until RAOs are Achieved:

Time until RAOs are achieved for soils and waste rock is longer than that for capping alternatives because of the time required to excavate and move materials to the El Molino OU. Excavation and construction for Alternative 5 are expected to require 3 to 5.5 years. However, seep water quality may begin to improve as waste rock is removed. After all waste rock and contaminated material is removed, seep quality may improve quickly. Another two to three years will be required to construct the cap for the tailing and waste rock at the El Molino OU. The time required for water quality improvement at the seeps is uncertain.

Implementability

Technical Feasibility:

The excavation and transportation technologies required to implement Alternative 5 are commonly used in traditional construction or mine remediation. Current information is not adequate to determine the exact volume of affected soils and colluvium beneath the dump that is contaminated and will be removed. Volume estimates in Table 2-1 reflect the uncertainty associated with the extent of contamination in soils and colluvium. The time required to transport material from the Pecos Mine to the El Molino OU is also uncertain. With optimal weather and other operating conditions, excavation and transport is expected to require 3 to 5.5 years, depending on the final volume of material to be moved (Table 4-1). However, multiple delays due to adverse weather conditions or equipment malfunction can be expected in a project of this length.

Adequate space and capacity for deposition of mine waste and affected soils is available at the El Molino OU. Standard capping technologies are currently proposed for the mill tailing at the El Molino OU. As noted for other alternatives, capping mine waste to prevent exposure and infiltration of water is commonly used in mine remediation.

Capping mine waste at the El Molino OU appears to be adequate to meet RAOs. However, the potential impacts on the El Molino remediation may be significant. Approximately 250 to 350 acre-feet of material will be moved to the El Molino OU under Alternative 5. This volume will significantly affect the final topography of the deposits at El Molino. In addition, engineered structures such as the walls of the drainage channels and the tailing dams were designed for the existing amount of material at the site. The effects of adding material from the mine site on stability of these structures is currently unknown.

The passive SRB technology proposed for seep water treatment in all active alternatives is known to be effective at increasing pH and removing metals from water. The specific size and configuration of the system will be determined after the effect of the waste rock dump remediation has been established.

No future remedial actions are expected for the site after Alternative 5 is fully implemented.

Administrative Feasibility:

Potential interagency coordination that may be required for Alternative 5 is similar to that of other alternatives. Permits associated with action- and location-specific ARARs are as described for Alternative 2. In addition, more extensive coordination with the NMHTD, San Miguel County, and the village of Pecos may be required due to the heavy use of State Highway 63 and county roads used to access the El Molino OU.

Availability of Services and Materials:

Availability of services for excavation and construction at the mine site and the El Molino OU is adequate. A large volume of clean fill and topsoil will be required to reclaim the excavated portion of the mine site. Availability of this volume from local sources is questionable. Construction material may be available from regional sources. However, the cost of materials increases with the distance from which they are transported.

Cost

Costs associated with Alternative 5 are summarized in Table 4-6. Other direct and indirect costs associated with Alternative 5 are similar to those described for Alternative 2 and summarized in Table 4-1. However, the extreme amount of truck traffic associated with Alternative 5 may necessitate a greater measure of road maintenance, including complete resurfacing of State Highway 63 between the village of Pecos and the Pecos Mine OU. Costs for resurfacing State Highway 63 between Pecos and Tererro were estimated by NMHTD at $1.3 million.

4.3 Comparative Analysis

The comparative analysis evaluates the relative performance of the alternatives with respect to the nine evaluation criteria described in Section 4.1. The discussion in this section focuses on the differences between alternatives to facilitate comparisons.

4.3.1 Threshold Criteria

4.3.1.1 Overall protection of human health and the environment

Human Health

Based on results of the HHRA, all of the alternatives are protective of human health under recreational-use scenarios. The site is owned by the NMGF, and the current use of adjacent areas is recreational. All of the alternatives assume institutional controls will be implemented by NMGF to maintain recreational use of the site.

Each of the alternatives reduces the potential for exposure of humans to site contaminants. Alternatives 2, 3, 4, and 5 eliminate exposure to waste rock either by covering the dump or removing waste rock from the site. Under Alternative 2, acidic soils beneath excavated portions of the dump would be amended to increase pH but will not be removed or covered. Therefore, the potential for incidental ingestion of metals from affected soils will remain. Alternatives 3, 4, and 5 include removal of affected soils from these areas, thus eliminating this potential exposure pathway.

Potential exposure to surface water and groundwater will be addressed through actions described in Sections 3.1.4 and 3.1.5.

Ecological Health

Under current conditions, ecological risk at the site is associated with exposure of terrestrial receptors to waste rock, soils adjacent to the dump, and soils in the wetland. For aquatic organisms, zinc and cadmium concentrations in the Pecos River exceeded AWQC during times of heavy rainfall and/or snowmelt. Zinc, cadmium, and other metals also exceeded AWQC in the wetland, especially downstream of WSBDT and associated seeps.

Exposure to waste rock will be eliminated under all of the alternatives except No Action. Soils in the upland barren area and other soils adjacent to the waste rock dump will be excavated under Alternatives 3, 4, and 5.

Under Alternative 2, soils beneath excavated waste rock will be amended to increase pH and decrease bioavailability and toxicity of metals. Results of the ERA indicate that neutralization of pH was adequate to eliminate toxicity of contaminated upland soils to toxicity test organisms. Risk from exposure to affected upland soils is eliminated under Alternatives 3, 4, and 5, because the soils will be removed.

Remediation of wetland soils is the same for all active alternatives. Soils in the WSBDT area will be removed and capped along with waste rock. Soils outside this area will not be removed in order to avoid unnecessary disruption of the wetland. The potential ecotoxicity of the wetland under current conditions does not justify the extensive impacts associated with excavating the wetland to remediate all soils with elevated metal concentrations.

HELP modeling indicates that Alternatives 3 and 4 will virtually eliminate percolation through the waste rock dump and thus prevent loading of metals to shallow groundwater and subsequently to surface water. Alternative 2 does not attenuate percolation to the extent that was predicted for Alternatives 3 and 4, but modeling indicates that loading of zinc to shallow groundwater and surface water would be reduced by approximately 90 percent (Figure 4-1). Source removal in Alternative 5 will eventually eliminate the loading of metals from mine waste to groundwater. However, metals may temporarily continue to leach from contaminated material that cannot be removed and discharged with seep water.

Water quality in the Willow Creek channel downstream of the WSBDT seep area may receive metal loading from residual seep water until the full effect of waste rock remediation is realized. Under any of the proposed alternatives, seep water quality and flow will be monitored to determine effects of remediation at the waste rock dump. If insufficient improvement in water quality is observed, installation of an SRB treatment system may be considered. If the treatment system is installed, discharged water would meet ARARs at the discharge point, and surface water quality would be protected.

4.3.1.2 Compliance with ARARs

Chemical-Specific ARARs

- Surface Water

Under existing conditions, water quality standards for zinc and cadmium are exceeded in the Pecos River during wet seasons. The frequency of exceedence in the Willow Creek wetland downstream from the seep area is higher but not well characterized.

Without a seep water treatment system, Alternative 2 would result in occasional exceedence of water quality standards in the Pecos River during times of extreme high infiltration into the dump. Alternatives 3, 4, and 5 would eliminate exceedence of standards in the Pecos River. Exceedence of standards in the Willow Creek wetland would be more frequent as residual contaminated shallow groundwater is discharged. However, if remediation of the waste rock dump does not result in compliance with ARARs, installation of an SRB system to collect and treat seep water may be required. Treatment of seep water will result in compliance with ARARs.

- Groundwater

Potential compliance with groundwater standards is similar for Alternatives 2, 3, 4, and 5. Remediation at the waste rock dump is expected to reduce manganese and iron concentrations in shallow groundwater. As with surface water, if remediation at the waste rock dump does not result in adequate improvement of groundwater quality in any unit, further action will be considered to allow compliance with ARARs.

Location-specific ARARs

All alternatives will comply with location-specific ARARs.

Action-Specific ARARs

All alternatives, except No Action comply with action-specific ARARs.

4.3.2 Balancing Criteria

4.3.2.1 Long-term effectiveness and permanence

Magnitude of Residual Risk

As noted previously, current conditions at the site do not represent unacceptable risk to human health under recreational exposure scenarios. Therefore, human health is adequately protected under all of the alternatives, including No Action.

With the exception of No Action, all of the alternatives attenuate human exposure to waste rock equally. Exposure to affected soils is prevented in Alternatives 3, 4, and 5. In Alternative 2, soils are amended in place. Therefore, exposure through incidental ingestion is not attenuated.

Residual ecological risk is approximately equal for all alternatives except No Action.

Adequacy and Reliability of Controls

Alternatives 2, 3, 4, and 5 include containment of waste rock and affected soils by placing it beneath an earthen cap structure. Alternatives 2, 3, and 4 include capping waste rock at the Pecos Mine OU. Under Alternative 5, waste materials will be transported to the El Molino OU and capped along with tailing. As noted in the individual analyses, the use of caps is common practice in the mining and waste management industries. Caps are generally considered permanent remedies for isolating waste material.

All alternatives include short-term, intermediate, and long-term monitoring of groundwater and surface water. For Alternatives 2, 3, 4, and 5, short-term (one to two years) monitoring will be necessary to determine the need for installation of a seep treatment system to protect surface water. Monitoring for an intermediate period is required to satisfy obligations in the AOC that the selected remedy results in compliance with ARARs and RAOs for eight consecutive quarters. Long-term monitoring will be required to verify performance of the remediation for longer periods and comply with the AOC.

4.3.2.2 Reduction of toxicity, mobility, and volume of contamination

Toxicity

Limestone amendment in Alternative 2 will reduce toxicity of soils beneath excavated waste rock. Toxicity of groundwater and surface water will be reduced under all alternatives except No Action by preventing generation of acid leachate and subsequent transport to downgradient areas.

Toxicity of waste rock will not be reduced by any of the alternatives. However, waste rock will be capped or moved and capped to prevent receptor contact. Toxicity of affected soils will not be reduced in Alternatives 3, 4, and 5, which include excavation and capping of soils with waste rock.

Mobility

The mobility of metals and sulfate in waste rock will be substantially reduced through capping in Alternatives 2, 3, 4, and 5. Mobility of metals in affected soils will also be reduced by capping in Alternatives 3, 4, and 5. In Alternative 2, mobility of metals will be reduced through increasing soil pH in the upland barren area.

The mobility of metals and sulfates in contaminated groundwater will be reduced under capping alternatives because the infiltration and percolation of water through the dump and underlying colluvium will be reduced or eliminated. Percolation of water through the area currently occupied by the dump may not be attenuated under Alternative 5 (Source Removal), but removal of waste rock and contaminated materials will eliminate the source of metals to shallow groundwater.

Volume

Volumes of waste rock and affected soils will not be affected by any alternative. Alternative 5 includes removal of affected materials from the site, but overall volume will not be affected.

Volumes of affected groundwater and surface water will be reduced under all alternatives except No Action, because the generation of acid leachate will be attenuated.

4.3.2.3 *Short-term effectiveness*

Risks to the Community

Risks to the general community from remedial activities are primarily associated with transportation of construction materials and/or mine waste. Effects of transportation include volume of local traffic, additional costs for road maintenance for state and county roads, and potential vehicle accidents and associated injuries and fatalities. Impacts associated with Alternative 5 are approximately 10 times those associated with other alternatives because of the much larger volume of material moved (Table 4-1). Alternatives 2, 3, and 4 have approximately equal impacts.

Exposure of the public to resuspended dust is proportional to the length of time over which excavation activity occurs at the mine site. Because of the larger volume of material to be moved, Alternative 5 will result in the greatest exposure to resuspended dust. However, public exposure will be minimal because recreational use of the area will be reduced during remediation, and the nearest residence is 0.6 miles to the northwest with no other residences closer than 3 miles.

Risks to Workers

The types of risks to workers are similar for all alternatives and include exposure to waste rock on the site and traditional risks associated with excavation and construction and truck traffic on public roadways. Risks associated with Alternative 5 are considerably higher than for other alternatives because of the greater length of time required to complete excavation, the larger volume of truck traffic, and the driving of loaded trucks downhill.

Environmental Impacts

The potential environmental impacts associated with excavation and reclamation at the mine site are described in detail for Alternative 2. Because of the volume of native materials excavation and the length of time required to complete the remediation, Alternative 5 represents the greatest short-term risk to the environment.

Time Until RAOs are Achieved

Alternatives 2, 3, and 4 will require approximately the same amount of time (1 to two years) to complete initial construction activities associated with regrading and capping waste rock, reclaiming the Willow Creek channel, and reclaiming the wetland area. Vegetative cover on the cap surfaces will require 1 to 3 years to establish. The vegetative cover is more important to full function of the soil cap (Alternative 2) than the other caps that include low permeability layers. Therefore, significant reduction in percolation is expected in three to five years for Alternative 2, and two to three years for Alternatives 3 and 4.

Initial excavation activities for Alternative 5 will require 3 to 5.5 years to complete. Revegetation associated with reclamation will require one to three years after initial construction activities are complete and longer periods to establish mature vegetation communities similar to native habitats.

Capping alternatives are expected to affect groundwater and seep water quality within one year of installation. Source removal associated with Alternative 5 could affect water quality in a similar time period but may require longer if all source materials cannot be removed.

For all alternatives, groundwater and seep water quality will be monitored to determine effects of waste rock remediation. If remediation does not result in adequate protection of water quality, installation of a system to intercept and treat shallow groundwater will be considered.

4.3.2.4 Implementability

Technical Feasibility

The technology for excavation and construction are well known and proven for all of the alternatives.

Besides No Action, Alternative 2 is the least complex alternative to implement. Alternatives 3 is somewhat less complex than Alternative 4 because of the use of geomembranes in Alternative 4 that require specialized construction crews and equipment. Alternative 5 is the most complex because it involves complicated logistics of transporting waste rock and construction of additional geomembrane cap structure at El Molino.

If seep water or groundwater treatment systems are necessary, some treatability testing may be required to design systems appropriate for the volume and chemistry of the water present at the time the system is installed.

Administrative Feasibility

The administrative feasibility of the alternatives is approximately equal. Permits required for action- and location-specific ARARs are the same for the alternatives because the activities that are included in them are similar.

Availability of Services and Materials

Materials for cap construction are available locally. Soil for plant growth media is available from a borrow source within six miles of the mine site. Initial investigations indicate that clay material for Alternative 3 (compacted clay cap) and Alternative 4 (geomembrane cap) is available on site. Synthetic geomembrane and drainage materials are readily available from commercial vendors. Materials for construction of the cap at El Molino are also readily available.

4.3.2.5 Cost

Costs for implementing the alternatives are summarized in Tables 4-2 through 4-5. Cost estimates are within the -30 to +50 percent range specified for feasibility studies (EPA 1988). Costs estimates range from approximately $3.4 million for Alternative 2 to $16.5 million for Alternative 5, including a 25 percent contingency. Costs for the seep treatment system included as a contingency item in Tasks 2, 3, and 4 is approximately $125,000. Because it is a contingent cost dependent upon the volume and chemistry of water to be treated, the costs were not included in the overall estimates for alternatives.

Indirect costs to the State of New Mexico for increased road maintenance costs are similar for Alternatives 2, 3, and 4. These costs are much higher for Alternative 5 because of the higher volume of traffic generated by moving the waste rock and affected soils to the El Molino OU.

4.4 Preferred Alternative

This section identifies the alternative preferred by the respondents and provides justification for the selection of the preferred alternative. Selection of a preferred alternative by the respondents is identified as a requirement of the FS report in Section V(B)(7)(a)(6) of the SOW.

As described in the preceding sections, five remediation alternatives were included in the FS. Alternative 1—No Action is not acceptable because release of contaminants will continue at current rates that have been shown to result in environmental effects and exceedence of ARARs. Alternatives 2, 3, and 4 propose covering the waste rock dump at the mine site to prevent infiltration and percolation of precipitation and subsequent generation of acid leachate. The alternatives differ primarily in the type of cover placed on the waste rock. Alternative 5 proposes to remove the primary source material (i.e., waste rock) and secondary source materials (i.e., affected soils, colluvium) from the site. These materials would be transported to the El Molino OU and capped along with tailing material.

Since all "action" alternatives involve capping the waste materials, the comparison largely reduces to whether it is better to cap the materials at the mine site or transport them to the El Molino OU and cap them with the tailing materials. Based on the detailed individual and comparative analyses presented in previous sections, the respondents believe that capping the waste rock and affected materials at the mine site is the best approach for remediating environmental contamination and stresses at the Pecos Mine OU. This assessment is based on the following:

1. The analyses presented in Sections 4.2 and 4.3 indicate that capping and source removal approaches offer equal protection of human health and the environment at the Pecos Mine Site. Both approaches attenuate the primary exposure pathways identified in the HERA and RI.

   Both approaches will also attenuate transport of metals and other materials by groundwater and seep water flow. The time frame required to achieve adequate attenuation is unclear for all alternatives. As a result, a phased approach that includes installation of a seep water interception and treatment system, if necessary, was included in each of the action alternatives.

2. Capping waste at the mine site will result in far less impact to the community of Pecos and residents of the Pecos River canyon. Transportation of mine waste to the mill site requires a large amount of heavy truck traffic to pass through the village of Pecos. Capping materials at the mine site requires a far less amount of materials to be transported through the village.

   Community impacts also include damage to state- and county-maintained roads from heavy truck traffic. Alternative 5 will result in much higher road maintenance and replacement costs because of the larger volume of traffic. The larger volume of truck traffic and loaded trucks traveling downhill increases risks to truck drivers and the public.

3. Alternatives 2, 3, and 4 will require less time to implement than Alternative 5. Alternative 5 requires that materials first be transported to the El Molino OU, then capped. Estimated time to transport haul source materials to the mill site is 3 to 5.5 years. The time required to prepare materials for capping on site is much less. Therefore, the time required to achieve most RAOs is less for capping materials at the mine site.

   Implementation of Alternative 5 also will delay completion of the remediation at the El Molino OU.

4. Costs for source removal exceed those for capping in place by a large margin. The maximum cost for capping, $3.7 million is substantially less than the minimum estimate for source removal, $9.6 million. Cost estimates for source removal exceed those of the most expensive capping alternative even when the -30 to +50 percent range of accuracy is

considered. Capping costs including a +50 percent margin of error, \$5.5 million, are less than the minimum source removal costs, including a -30 percent margin of error, \$6.7 million. Since the level of environmental protection provided by the two approaches is similar, capping at the mine site is more cost effective.

Of the capping options, Alternatives 3 and 4 offer the greater protection of the environment. Alternatives 2, 3, and 4 differ primarily in the type of cap applied to the relatively flat 2.7 acres on top of the regraded waste rock dump. The caps for Alternatives 3 and 4 include low permeability barriers: compacted clay for Alternative 3 and geomembrane/compacted clay for Alternative 4. HELP modeling indicates that the low permeability layers decrease percolation through the waste rock into the underlying colluvium by more than 99 percent. The soil cap in Alternative 2 does not include a low permeability layer, but HELP modeling shows that percolation is reduced by more than 90 percent.

The decrease in percolation through waste rock materials will result in decreased flow and improved groundwater quality beneath the dump and in downgradient areas. The improved groundwater quality and the elimination of surface runoff from the uncovered waste rock will reduce metal loading to Willow Creek and the Pecos River. The caps in Alternatives 3 and 4 have greater potential to reduce seep flow and protect surface water. However, all three capping alternatives include potential installation of an SRB seep water treatment system if metals loading to surface water does not decrease adequately.

In summary, all three on-site capping alternatives have the potential to meet RAOs. Alternatives 3 and 4 have the greatest potential to meet RAOs for groundwater and for surface water without the aid of the SRB treatment system. However, if a seep water treatment system is stipulated in the Decision Document, Alternative 2 will offer equal protection for surface water quality.

SECTION 4 TABLES

Table 4-1
Local Impact from Materials Hauling for Pecos Mine Operable Unit Remedial Alternatives

	Alternatives					
	No Action	Soil Cap	Compacted Clay Cap	Geomembrane Cap	Remove Waste Rock and Colluvium	
	1	2	3	4	5	
Haul to Pecos Mine Site (CY)					minimum	maximum
PGM		9,400	7,045	7,045		
Drainage Layer			4,300			
Sideslopes		32,500	32,500	32,500		
Fill for Reclamation		36,000	36,000	36,000	150,000	350,000
Materials for Diversion Ditch		1,200	1,200	1,200		
Total volume moved (CY)		79,100	81,045	76,745	150,000	350,000
Haul from Mine to Mill Site (CY)						
Affected Soil					150,000	400,000
Sediments					2,100	2,100
Waste Rock					217,000	217,000
Total volume moved (CY)					369,100.00	619,100.00
Totals						
Total Volume moved (CY)	0	79,100	81,045	76,745	519,100	969,100
Round Trips required @ 13 CY/trip	0	6,085	6,234	5,903	39,931	74,546
Total miles @ 40 miles/RT	0	243,385	249,369	236,138	1,597,231	2,981,846
Total Truck Days @ 5 trips/day	0	1,217	1,247	1,181	7,986	14,909
Road Maintenance Costs @ $0.021 per truck-mile	$0	$5,111	$5,237	$4,959	$33,542	$62,619
Associated Transportation Risks						
Accidents (@ 2.5×10^{-6}/mile)	0	1	1	1	4	7
Injuries (@ 6.36×10^{-7}/mile)	0	0	0	0	1	2
Fatalities (@ 1.06×10^{-7}/mile)	0	0	0	0	0	0

Table 4-2
Pecos Mine Operable Unit Feasibility Study
Preliminary Cost Estimate

Alternative 2 -- Soil Cap

Activity/Medium	Action	Cost	Comment
Site Management	Office trailer	$ 5,520	Include rental, utilities, hookup charge; 8 months
	Move power line	$ 10,000	6 poles moved
	Abandon wells	$ 5,000	5 wells @ $1,000
	Close adit	$ 7,000	
	Site prep	$ 100,000	Roads, wetland access, silt fencing, signs, etc
	Misc. permits	$ 10,000	Wetland, construction, discharge, etc.
	Mobilization/demobilization	$ 4,000	
Affected Soils	Amendment	$ 5,000	Use agricultural lime stored on site
Willow Creek	Excavate[1]/Line/Reclaim	$ 244,000	Lump sum; includes haulage, reclamation
Wetland Sediments	Excavate[1]	$ 65,000	$15k for excavation material, $50k for water diversion, treatment, discharge
Verification Sampling	Sampling/Analysis	$ 5,000	50 samples @ $100
Waste Rock	Soil cap	$ 1,745,055	Lump sum; includes consolidation and regrading waste rock dumps, design, QC, surveying, const. mgmt, and 30 % contingency
Groundwater	Upslope diversion	$ 169,000	Lump sum; includes mob/demob and 30 % contingency
Reclamation	Fill for reclamation	$ 403,293	36,300 CY @ $11.11 (1.5 ac to 15 ft depth)
	Reclamation outside cap	$ 7,650	4.25 acres @ $1,800
	Wetland reclamation	$ 1,500	1 acre @$1,500
	Mitigate forest	$ 6,825	13 acres @ $525
	Reclaim borrow area	$ 7,200	4 acres @ $1,800
Road maintenance	State/County roads	$ 5,100	Pavement patching
Confirmation Sampling	Event-related surface water monitoring	$ 10,000	Includes event-related monitoring for one spring and one fall period
	Soil/sediment sampling	$ 2,000	20 samples @ $100
Groundwater Monitor Wells	Install new monitoring wells (2)	$ 15,000	3 wells @ $5,000
	Groundwater and surface water	$ 48,000	1 year interim monitoring and minimum 2 years (8 quarters) monitoring required for compliance @ $16,000 per year.
	Air	$ 16,000	6 months @ $2,500 plus $1,000 mob/demob
	Subtotal	$ 2,897,143	
	Project Management	$ 289,714	10 % of subtotal
	Subtotal Cost	$ 3,186,857	
	Plus Contingency (25%)	$ 244,522	Includes all items except cap, diversion, seep treatment
	TOTAL COST	$3,431,379	

[1] Excavated soils, sediments, and waste rock capped along with waste rock

Operation & Maintenance	Item	Total Costs	Comment
	Inspections	$ 2,400	3 @ $800
	Surveying	$ 1,200	1 @ $1,200
	Soil Replacement (1 percent of cap at 6 inches)	$ 532	Approximately 56 CY
	Revegetation (10 percent of cap)	$ 375	0.75 acres @ $500
	Quarterly groundwater and surface water monitoring	$ 16,000	Includes quarterly monitoring
	Subtotal	$ 20,507	
	Contingency (15%)	$ 3,076	
	Total Annual Costs	$ 23,583	
	Present value of O&M costs for 20 years (@ 3%/yr discount rate)	$ 350,856	

Table 4-3
Assumptions for Estimating Material Excavation and Transport Costs

Excavation and Material Handling Costs *(Alternatives 2, 3, and 4)*			
Activity	**Unit Cost**	**Unit**	**Comment**
Excavation	$2.33	CY	
Haul/place	$0.79	CY	material excavated and placed on site
Smooth Grade	$0.69	CY	
Compact	$0.31	CY	
	$4.12	CY	

Offsite Transportation of Waste Rock and Soils *(Alternative 5)*		
Haul Assumptions:	$50/hr for truck and driver	
	five 40-mile round trips per 10-hour workday	
	18 T hauled per round trip	
Haul Cost Per Ton		
Cost	$500.00	per day
Tons Hauled	90	T/day
Cost/T	$5.56	$/T

Total Costs Per Cubic Yard

Waste Rock			Soil		
Excavation	$2.33	CY	Excavation	$2.33	CY
Haul/place[1]	$10.00	CY	Haul/place[1]	$7.78	CY
Smooth Grade	$0.69	CY	Smooth Grade	$0.69	CY
Compact	$0.31	CY	Compact	$0.31	CY
Total	$13.33	CY	Total	$11.11	CY

[1] Waste rock density is 1.8 T/CY; soil density is 1.4 T/CY

Table 4-4
Pecos Mine Operable Unit Feasibility Study
Preliminary Cost Estimate of Remedial Alternatives

Alternative 3 -- Compacted Clay Cap

Activity/Medium	Action		Cost	Comment
Site Management	Office trailer	$	5,520	Include rental, utilities, hookup charge; 8 months
	Move power line	$	10,000	6 poles moved
	Abandon wells	$	5,000	5 wells @ $1,000
	Close adit	$	7,000	
	Site prep	$	100,000	Roads, wetland access, silt fencing, signs, etc
	Misc. permits	$	10,000	Wetland, construction, discharge, etc.
	Mobilization/demobilization	$	4,000	
Affected Soils	Excavate[1]	$	46,680	11,330 CY @ $4.12
Willow Creek	Excavate[1]/Line/Reclaim	$	244,000	Lump sum; includes haulage, reclamation
Wetland Sediments	Excavate[1]	$	65,000	$15k for excavation material, $50k for water diversion, treatment, discharge
Verification Sampling	Sampling/Analysis	$	5,000	50 samples @ $100
Waste Rock	Compacted Clay Cap	$	1,967,703	Lump sum; includes consolidation and regrading waste rock dumps, design, QC, surveying, const. mgmt, and 30 % contingency
Groundwater	Upslope Diversion	$	169,000	Lump sum; includes mob/demob and 30 % contingency
Reclamation	Fill for reclamation	$	403,293	36,300 CY @ $11.11 (1.5 ac to 15 ft depth)
	Reclamation outside cap	$	7,650	4.25 acres @ $1,800
	Wetland reclamation	$	1,500	1 acre @$1,500
	Mitigate forest	$	6,825	13 acres @ $525
	Reclaim borrow area	$	7,200	4 acres @ $1,800
Road maintenance	State/County roads	$	5,200	Pavement patching
Confirmation Sampling	Event-related surface water monitoring	$	10,000	Includes event-related monitoring for one spring and one fall period
	Soil/sediment sampling	$	2,000	20 samples @ $100
Groundwater Monitor Wells	Install new monitoring wells (2)	$	10,000	2 wells @ $5,000
	Groundwater and surface water	$	48,000	1 year interim monitoring and minimum 2 years (8 quarters) monitoring required for compliance @ $16,000 per year.
	Air	$	16,000	6 months @ $2,500 plus $1,000 mob/demob
	Subtotal	$	3,156,571	
	Project Management	$	315,657	10 % of subtotal
	Subtotal Cost	$	3,472,228	
	Plus Contingency (25%)	$	253,717	Includes all items except cap, diversion, seep treatment
	TOTAL COST	**$**	**3,725,945**	

[1] Excavated soils, sediments, and waste rock capped along with waste rock

Operation & Maintenance	Item		Total Costs	Comment
	Inspections	$	2,400	3 @ $800
	Surveying	$	1,200	1 @ $1,200
	Soil Replacement (1 percent of cap at 6 inches)	$	532	Approximately 56 CY
	Clay Cap Repair	$	5,000	
	Revegetation (10 percent of cap)	$	375	0.75 acres @ $500
	Quarterly groundwater and surface water monitoring	$	16,000	Includes quarterly monitoring
	Subtotal	$	25,507	
	Contingency (15%)	$	3,826	
	Total Annual Costs	$	29,333	
	Present value of O&M costs for 20 years (@ 3%/yr discount rate)	$	436,402	

Table 4-5
Pecos Mine Operable Unit Feasibility Study
Preliminary Cost Estimate of Remedial Alternatives

Alternative 4 -- Compacted Clay/Geomembrane Cap

Activity/Medium	Action		Cost	Comment
Site Management	Office trailer	$	5,520	Include rental, utilities, hookup charge; 8 months
	Move power line	$	10,000	6 poles moved
	Abandon wells	$	5,000	5 wells @ $1,000
	Close adit	$	7,000	
	Site prep	$	100,000	Roads, wetland access, silt fencing, signs, etc
	Misc. permits	$	10,000	Wetland, construction, discharge, etc.
	Mobilization/demobilization	$	4,000	
Affected Soils	Excavate[1]	$	46,680	11,330 CY @ $4.12
Willow Creek	Excavate[1]/Line/Reclaim	$	244,000	Lump sum; includes haulage, reclamation
Wetland Sediments	Excavate[1]	$	95,000	$40k for excavating and hauling material, $50k for water diversion, treatment, discharge
Verification Sampling	Sampling/Analysis	$	5,000	50 samples @ $100
Waste Rock	Compacted Clay/Geomembrane	$	1,897,507	Lump sum; includes consolidation and regrading waste rock dumps, design, QC, surveying, const. mgmt, and 30 % contingency
Groundwater	Upslope Diversion	$	169,000	Lump sum; includes mob/demob and 30 % contingency
Reclamation	Fill for reclamation	$	403,293	36,300 CY @ $11.11 (1.5 ac to 15 ft depth)
	Reclamation outside cap	$	7,650	4.25 acres @ $1,800
	Wetland reclamation	$	1,500	1 acre @$1,500
	Mitigate forest	$	6,825	13 acres @ $525
	Reclaim borrow area	$	7,200	4 acres @ $1,800
Road maintenance	State/County roads	$	5,000	Pavement patching
Confirmation Sampling	Event-related surface water monitoring	$	10,000	Includes event-related monitoring for one spring and one fall period
	Soil/sediment sampling	$	2,000	20 samples @ $100
Compliance Monitoring	Install new monitoring wells (2)	$	10,000	2 wells @ $5,000
	Groundwater and surface water	$	48,000	1 year interim monitoring and minimum 2 years (8 quarters) monitoring required for compliance @ $16,000 per year.
	Air	$	16,000	6 months @ $2,500 plus $1,000 mob/demob
	Subtotal	$	3,116,175	
	Project Management	$	311,617	10 % of subtotal
	Subtotal Cost	$	3,427,792	
	Plus Contingency (25%)	$	261,167	Includes all items except cap, diversion, seep treatment
	Total Cost	**$**	**3,688,959**	

[1] Excavated soils, sediments, and waste rock capped along with waste rock

Operation & Maintenance	Item		Total Costs	Comment
	Inspections	$	2,400	3 @ $800
	Surveying	$	1,200	1 @ $1,200
	Soil Replacement (1 percent of cap at 6 inches)	$	532	Approximately 56 CY
	Cap Repair	$	7,000	
	Revegetation (10 percent of cap)	$	375	0.75 acres @ $500
	Quarterly groundwater and surface water monitoring	$	16,000	Includes quarterly monitoring
	Subtotal	$	27,507	
	Contingency (15%)	$	4,126	
	Total Annual Costs	$	31,633	
	Present value of O&M costs for 20 years (@ 3%/yr discount rate)	$	470,620	

Table 4-6
Pecos Mine Operable Unit Feasibility Study
Preliminary Cost Estimate of Remedial Alternatives

Alternative 5 -- Source Removal

Activity/Medium	Action	Cost	Comment
Site Management	Office trailer	$ 22,800	Include rental, utilities, hookup charge; 60 months
	Move power line	$ 10,000	6 poles moved
	Abandon wells	$ 5,000	5 wells @ $1,000
	Close adit	$ 7,000	
	Site prep	$ 200,000	Roads, wetland access, silt fencing, signs, etc
	Misc. permits	$ 10,000	Wetland, construction, discharge, etc.
	Mobilization/demobilization	$ 4,000	
Affected Soils	Excavate/haul/place/grade*	$ 4,133,520	372,054 CY @ $11.11
Wetland Sediments	Excavate/haul/place/grade*	$ 23,331	2,100 CY @ $11.11
Waste Rock	Excavate/haul/place/grade*	$ 2,892,610	217,000 CY @ $13.33
Willow Creek	Excavate[1]/Line/Reclaim	$ 244,000	Lump sum; includes haulage, reclamation
Design Modification for Alamitos Cap	Lump sum	$ 35,000	lump sum
Added cost of materials and labor for El Molino cap	Lump sum	$ 200,000	lump sum
Reclamation	Fill for Reclamation	$ 3,888,500	350,000 CY @ $11.11
	Reclamation at mine site	$ 36,800	16 acres @ $2,300
	Reclaim Borrow Area	$ 7,200	4 acres @ $1,800
	Wetland reclamation	$ 1,500	1 acre @$1,500
Road maintenance	State/County roads	$ 63,000	Pavement patching
Confirmation Sampling	Event-related surface water monitoring	$ 10,000	Includes event-related monitoring for one spring and one fall period
	Soil/sediment sampling	$ 5,000	50 samples @ $100
Compliance Monitoring	Install new monitoring wells (2)	$ 10,000	2 wells @ $5,000
	Groundwater and surface water	$ 48,000	1 year interim monitoring and minimum 2 years (8 quarters) monitoring required for compliance @ $16,000 per year.
	Air	$ 151,000	60 months @ $2,500 plus $1,000 mob/demob
	Subtotal	$ 12,008,261	
	Project Management	$ 1,200,826	10 % of subtotal
	Total	$ 13,209,087	
	Plus Contingency (25%)	$ 3,302,272	
	Grand Total	$ 16,511,359	

*Excavated waste rock, soils, and sediments will be placed at tailing ponds and capped along with tailing

Sensitivity analysis for volume of colluvium removed

Variation from Original Estimate	Removal costs	Corresponding Total Cost*
Costs associated with 25 percent less colluvium removed	$ 3,100,140	$13,105,096
50 percent less	$ 2,066,760	$9,996,565

* Includes proportionately reduced fill material costs

Operation & Maintenance	Item	Total Costs	Comment
	*El Molino Cap**		
	Inspections	$ 1,200	3 @ $400
	Surveying	$ 1,200	1 @ $1,200
	Soil Replacement (1 percent of cap at 6 inches)	$ 532	Approximately 56 CY
	Monitoring	$ 3,000	Additional monitoring for waste rock section of capped areas
	Pecos Mine Site		
	Quarterly groundwater and surface water monitoring	$ 16,000	Includes quarterly monitoring
	Subtotal	$ 21,932	
	Contingency (15%)	$ 3,290	
	Total Annual Costs	$ 25,222	
	Present value of O&M costs for 20 years (@ 3%/yr discount rate)	$ 375,237	

* Costs are in addition to maintenance and monitoring for El Molino OU

SECTION 4 FIGURES

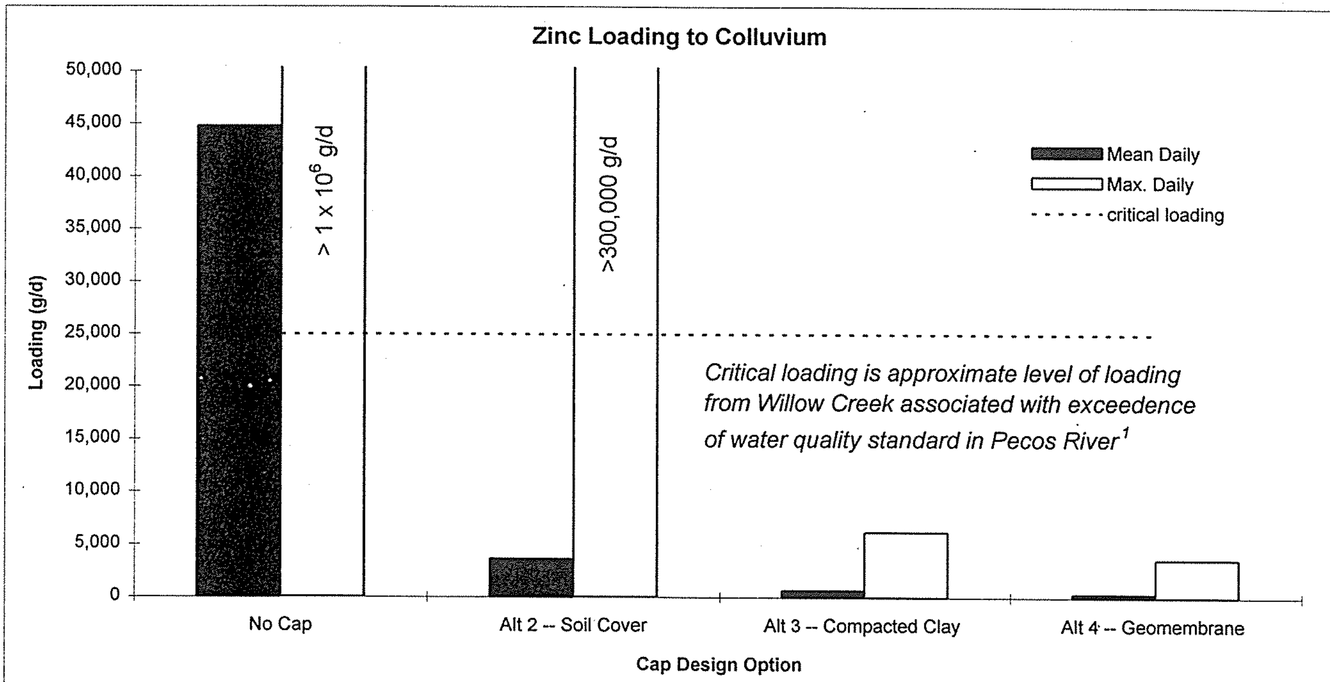
Figure 4-1
Comparative Performance of Conceptual Cap Designs
Pecos Mine Operable Unit Feasibility Study

Estimated Performance of Conceptual Cap Designs[1]

Conceptual Design Type	Mean percolation rate through waste rock (gpm) Top	Sideslopes	Total	% change	Daily Zn Loading to Colluvium[2] (g/d) Mean Daily	Max. Daily
No Cap	2.61	4.08	6.69	--	44,796	1,640,523
Alt 2 -- Soil Cover	0.49	0.05	0.54	-92%	3,616	362,018
Alt 3 -- Compacted Clay	0.05	0.05	0.1	-99%	670	6,210
Alt 4 -- Geomembrane	0	0.05	0.05	-99%	335	3,610

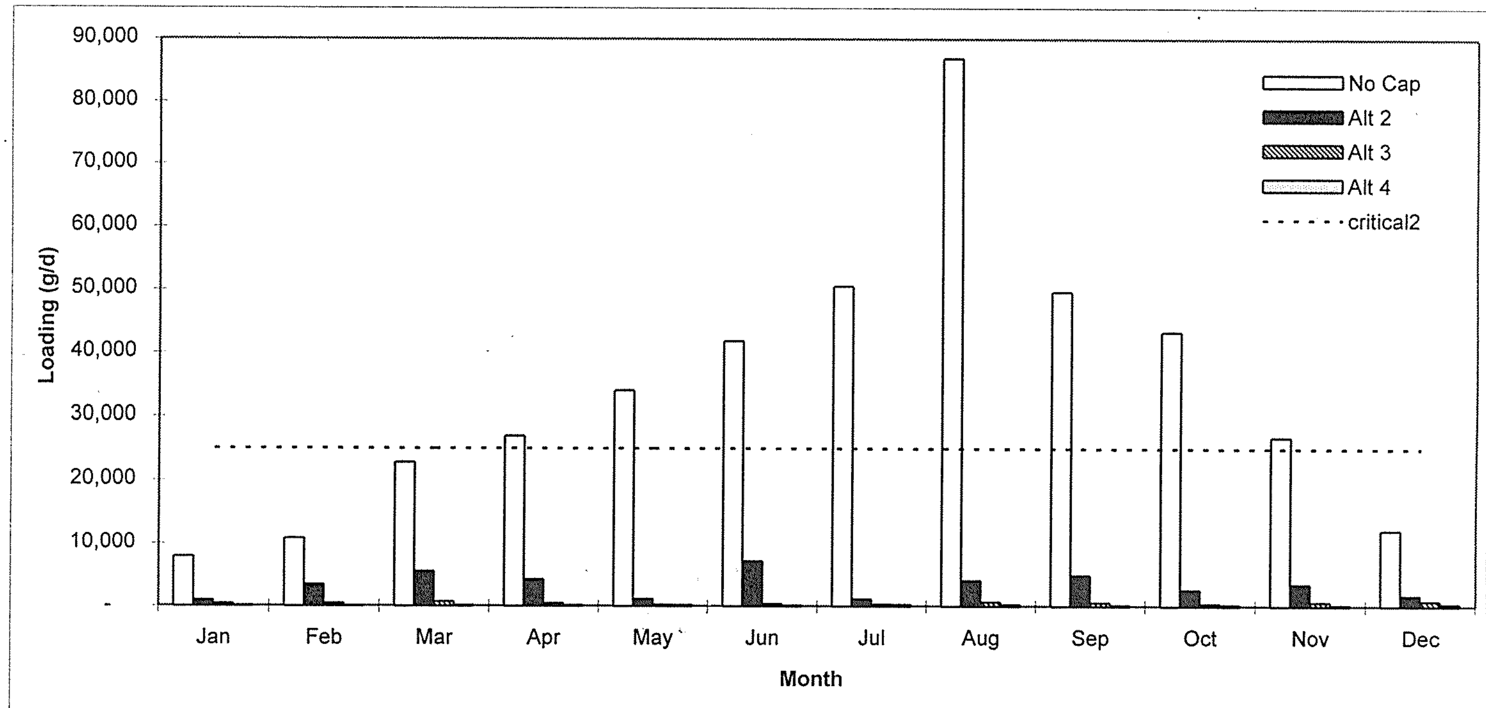
[1] Percolation estimates based on HELP model runs; gpm = gallons per minute, g/d = grams per day

[2] Assume zinc concentration of 1,200 mg/L (seep water)



[1] Obtained by comparing event-specific loading data and zinc concentrations in Pecos River. Estimation of a similar factor for Willow Creek was not possible.

Figure 4-2
Zinc Loading to Colluvium from Waste Rock Dump[1]



[1] Calculated from 10-year average total percolation for each month. Results from HELP model runs. Loading calculation assumes 1.2 g/l zinc concentration in leachate.

[2] Critical loading is that associated with exceedence of water quality standard for zinc in Pecos River (~25,000 g/d)

5/22/97 CAPPERF.XLS monthly

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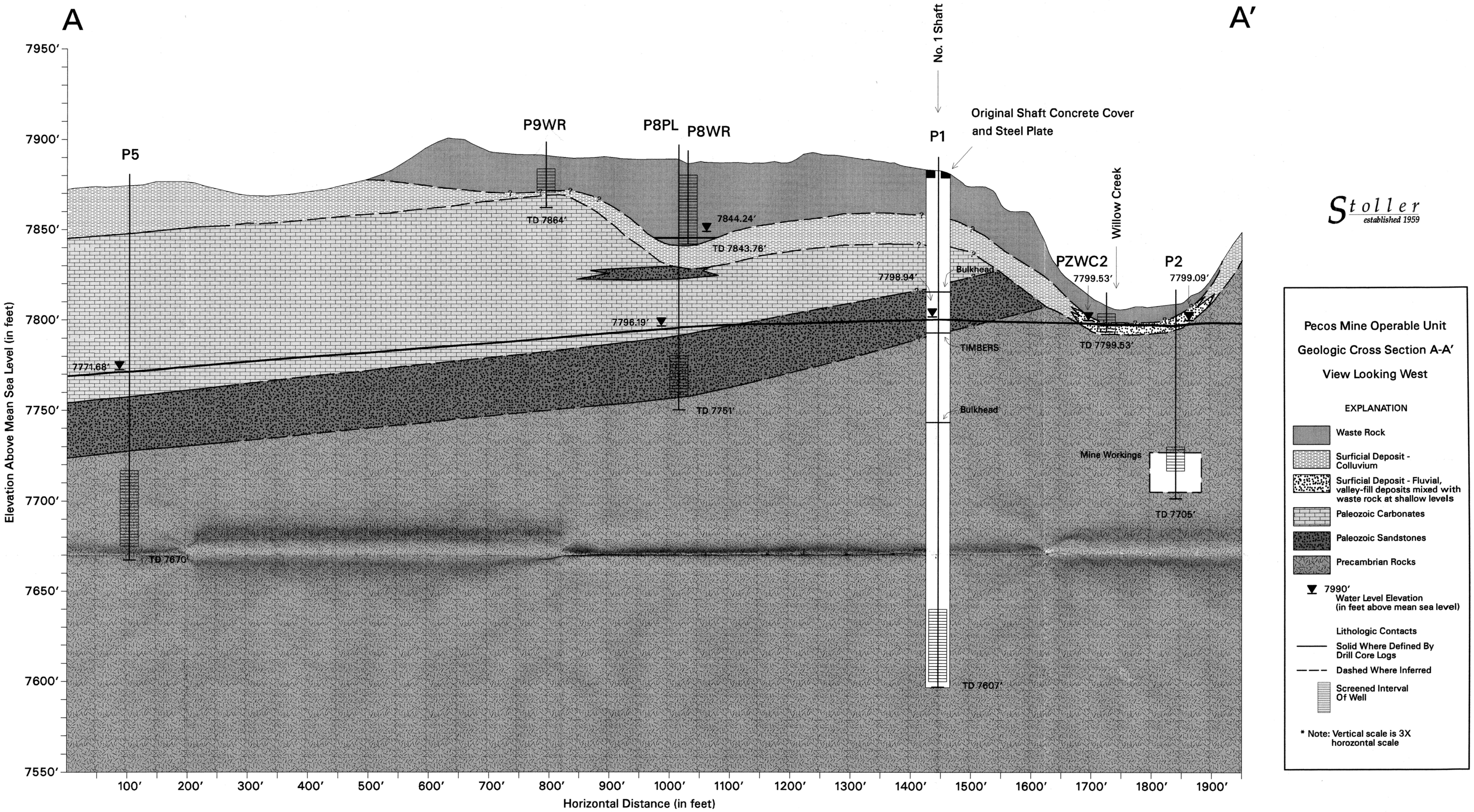
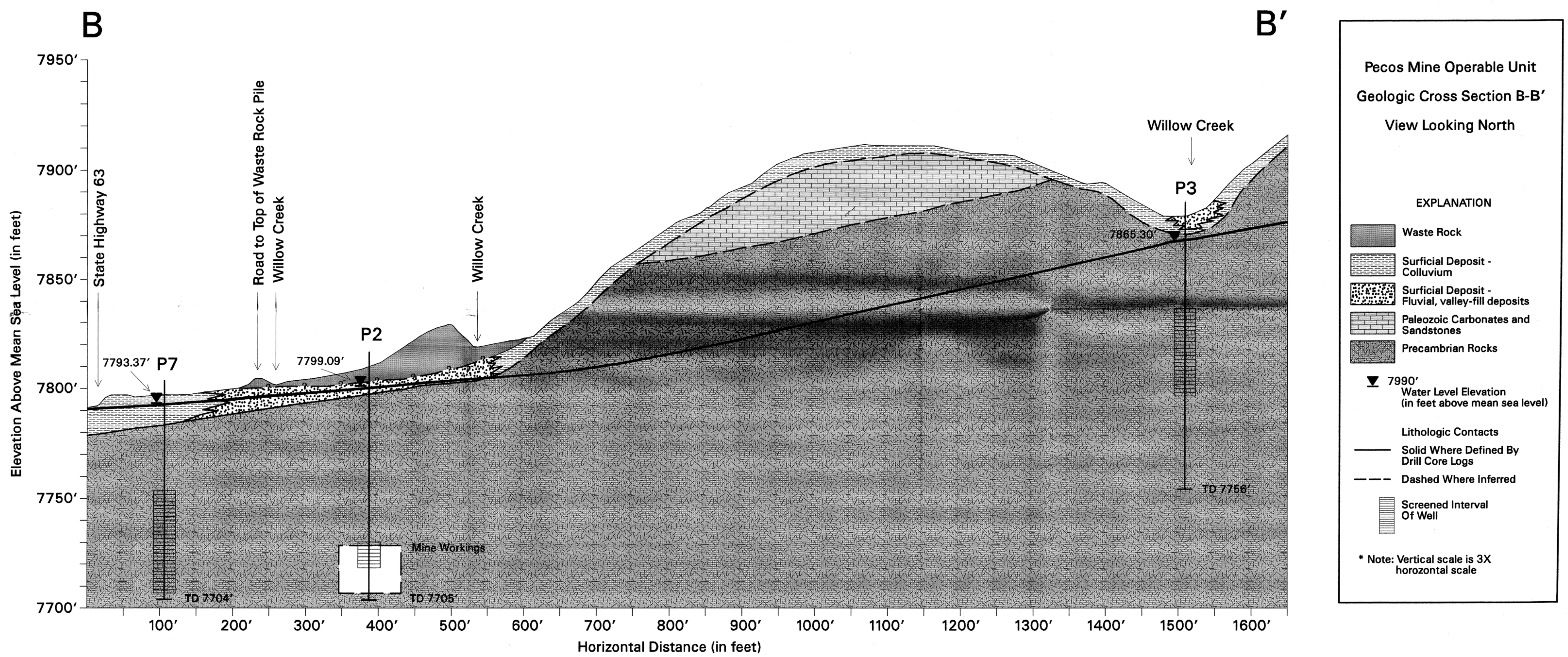
APPENDIX A:

GEOLOGIC CROSS SECTION OF PECOS MINE SITE



A
A′
No. 1 Shaft
Original Shaft Concrete Cover and Steel Plate
P5
P9WR
P8PL
P8WR
P1
PZWC2
Willow Creek
P2
TD 7864′
7844.24′
TD 7843.76′
7798.94′
Bulkhead
7799.53′
7799.09′
7796.19′
7771.68′
TIMBERS
TD 7799.53′
TD 7751′
Bulkhead
Mine Workings
TD 7705′
TD 7670′
TD 7607′
Elevation Above Mean Sea Level (in feet)
7950′
7900′
7850′
7800′
7750′
7700′
7650′
7600′
7550′
100′ 200′ 300′ 400′ 500′ 600′ 700′ 800′ 900′ 1000′ 1100′ 1200′ 1300′ 1400′ 1500′ 1600′ 1700′ 1800′ 1900′
Horizontal Distance (in feet)
Stoller
established 1959
Pecos Mine Operable Unit
Geologic Cross Section A-A′
View Looking West
EXPLANATION
Waste Rock
Surficial Deposit - Colluvium
Surficial Deposit - Fluvial, valley-fill deposits mixed with waste rock at shallow levels
Paleozoic Carbonates
Paleozoic Sandstones
Precambrian Rocks
7990′
Water Level Elevation (in feet above mean sea level)
Lithologic Contacts
Solid Where Defined By Drill Core Logs
Dashed Where Inferred
Screened Interval Of Well
* Note: Vertical scale is 3X horozontal scale



B
B′
State Highway 63
Road to Top of Waste Rock Pile
Willow Creek
Willow Creek
Willow Creek
P7
P2
P3
7793.37′
7799.09′
7865.30′
Mine Workings
TD 7704′
TD 7705′
TD 7756′
Elevation Above Mean Sea Level (in feet)
7950′
7900′
7850′
7800′
7750′
7700′
100′ 200′ 300′ 400′ 500′ 600′ 700′ 800′ 900′ 1000′ 1100′ 1200′ 1300′ 1400′ 1500′ 1600′
Horizontal Distance (in feet)
Pecos Mine Operable Unit
Geologic Cross Section B-B′
View Looking North
EXPLANATION
Waste Rock
Surficial Deposit - Colluvium
Surficial Deposit - Fluvial, valley-fill deposits
Paleozoic Carbonates and Sandstones
Precambrian Rocks
7990′
Water Level Elevation (in feet above mean sea level)
Lithologic Contacts
Solid Where Defined By Drill Core Logs
Dashed Where Inferred
Screened Interval Of Well
* Note: Vertical scale is 3X horozontal scale

APPENDIX B:

RESULTS OF HELP MODEL ANALYSIS

ALTERNATIVE 2:

SOIL CAP

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**          HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                   **
**            HELP MODEL VERSION 3.06    (17 AUGUST 1996)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\bobr\1492b\BASE.D4
TEMPERATURE DATA FILE:       C:\bobr\1492b\BASE.D7
SOLAR RADIATION DATA FILE:   C:\bobr\1492b\BASE.D13
EVAPOTRANSPIRATION DATA:     C:\bobr\1492b\BASE.D11
SOIL AND DESIGN DATA FILE:   C:\bobr\1492b\1BASE1.D10
OUTPUT DATA FILE:            C:\bobr\1492b\1BASE1.OUT

TIME:  12:33     DATE:  12/ 3/1996

******************************************************************************

     TITLE:  PECOS MINE - OPTION 1 BASE CASE

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  11
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.4640 VOL/VOL
          FIELD CAPACITY               =      0.3100 VOL/VOL
          WILTING POINT                =      0.1870 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3100 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.639999998000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                   LAYER  2
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =    360.00   INCHES
          POROSITY                     =      0.3210 VOL/VOL
          FIELD CAPACITY               =      0.0510 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0470 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.240000011000E-02 CM/SEC
```

1BASE1

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.48	208186.344	100.00
RUNOFF	0.386	3745.291	1.80
EVAPOTRANSPIRATION	18.848	182680.156	87.75
PERC./LEAKAGE THROUGH LAYER 2	2.003547	19418.578	9.33
CHANGE IN WATER STORAGE	0.242	2342.277	1.13
SOIL WATER AT START OF YEAR	24.360	236099.453	
SOIL WATER AT END OF YEAR	24.602	238441.734	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.042	0.00

****

****

ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.74	307627.312	100.00
RUNOFF	1.236	11981.543	3.89
EVAPOTRANSPIRATION	26.188	253820.281	82.51
PERC./LEAKAGE THROUGH LAYER 2	4.580630	44395.930	14.43
CHANGE IN WATER STORAGE	-0.265	-2570.407	-0.84
SOIL WATER AT START OF YEAR	24.602	238441.734	
SOIL WATER AT END OF YEAR	24.191	234459.922	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.146	1411.412	0.46
ANNUAL WATER BUDGET BALANCE	0.0000	-0.055	0.00

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IBASE1

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.94	270797.281	100.00
RUNOFF	2.741	26562.947	9.81
EVAPOTRANSPIRATION	20.415	197866.234	73.07
PERC./LEAKAGE THROUGH LAYER 2	6.436530	62383.496	23.04
CHANGE IN WATER STORAGE	-1.652	-16015.447	-5.91
SOIL WATER AT START OF YEAR	24.191	234459.922	
SOIL WATER AT END OF YEAR	22.684	219855.875	
SNOW WATER AT START OF YEAR	0.146	1411.412	0.52
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.042	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.95	241817.953	100.00
RUNOFF	1.534	14863.015	6.15
EVAPOTRANSPIRATION	19.663	190571.437	78.81
PERC./LEAKAGE THROUGH LAYER 2	2.835129	27478.350	11.36
CHANGE IN WATER STORAGE	0.919	8905.124	3.68
SOIL WATER AT START OF YEAR	22.684	219855.875	
SOIL WATER AT END OF YEAR	23.603	228761.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.016	0.00

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|BASE|

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.10	262655.906	100.00
RUNOFF	1.744	16902.182	6.44
EVAPOTRANSPIRATION	20.722	200838.687	76.46
PERC./LEAKAGE THROUGH LAYER 2	2.877424	27888.285	10.62
CHANGE IN WATER STORAGE	1.757	17026.676	6.48
SOIL WATER AT START OF YEAR	23.603	228761.000	
SOIL WATER AT END OF YEAR	24.790	240263.359	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.570	5524.313	2.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.092	0.00

****

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.49	169514.797	100.00
RUNOFF	0.041	399.000	0.24
EVAPOTRANSPIRATION	15.418	149435.609	88.15
PERC./LEAKAGE THROUGH LAYER 2	3.152027	30549.764	18.02
CHANGE IN WATER STORAGE	-1.121	-10869.529	-6.41
SOIL WATER AT START OF YEAR	24.790	240263.359	
SOIL WATER AT END OF YEAR	24.017	232775.750	
SNOW WATER AT START OF YEAR	0.570	5524.313	3.26
SNOW WATER AT END OF YEAR	0.221	2142.403	1.26
ANNUAL WATER BUDGET BALANCE	0.0000	-0.044	0.00

****

IBASE1

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.15	204987.922	100.00
RUNOFF	2.023	19610.502	9.57
EVAPOTRANSPIRATION	16.996	164729.141	80.36
PERC./LEAKAGE THROUGH LAYER 2	1.721774	16687.604	8.14
CHANGE IN WATER STORAGE	0.409	3960.673	1.93
SOIL WATER AT START OF YEAR	24.017	232775.750	
SOIL WATER AT END OF YEAR	24.647	238878.828	
SNOW WATER AT START OF YEAR	0.221	2142.403	1.05
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.001	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.85	279617.125	100.00
RUNOFF	0.372	3610.018	1.29
EVAPOTRANSPIRATION	23.346	226272.812	80.92
PERC./LEAKAGE THROUGH LAYER 2	4.706206	45613.020	16.31
CHANGE IN WATER STORAGE	0.425	4121.206	1.47
SOIL WATER AT START OF YEAR	24.647	238878.828	
SOIL WATER AT END OF YEAR	24.743	239810.078	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.329	3189.944	1.14
ANNUAL WATER BUDGET BALANCE	0.0000	0.060	0.00

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1BASE1

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.73	210609.391	100.00
RUNOFF	1.457	14125.859	6.71
EVAPOTRANSPIRATION	19.284	186905.922	88.75
PERC./LEAKAGE THROUGH LAYER 2	3.747426	36320.430	17.25
CHANGE IN WATER STORAGE	-2.759	-26742.867	-12.70
SOIL WATER AT START OF YEAR	24.743	239810.078	
SOIL WATER AT END OF YEAR	22.109	214281.156	
SNOW WATER AT START OF YEAR	0.329	3189.944	1.51
SNOW WATER AT END OF YEAR	0.204	1976.003	0.94
ANNUAL WATER BUDGET BALANCE	0.0000	0.044	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.40	226795.156	100.00
RUNOFF	0.786	7613.513	3.36
EVAPOTRANSPIRATION	18.084	175273.687	77.28
PERC./LEAKAGE THROUGH LAYER 2	3.460050	33535.148	14.79
CHANGE IN WATER STORAGE	1.070	10372.792	4.57
SOIL WATER AT START OF YEAR	22.109	214281.156	
SOIL WATER AT END OF YEAR	23.039	223296.484	
SNOW WATER AT START OF YEAR	0.204	1976.003	0.87
SNOW WATER AT END OF YEAR	0.344	3333.474	1.47
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

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(BASE)

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.93	1.34	1.35	2.03	2.31
	3.52	4.95	2.44	2.33	1.60	1.00
STD. DEVIATIONS	1.08	0.98	1.24	1.31	1.13	2.08
	2.41	1.82	1.55	1.70	1.48	0.57
RUNOFF						
TOTALS	0.164	0.146	0.383	0.010	0.028	0.102
	0.197	0.092	0.041	0.029	0.010	0.029
STD. DEVIATIONS	0.329	0.281	0.567	0.018	0.045	0.180
	0.461	0.184	0.075	0.060	0.024	0.085
EVAPOTRANSPIRATION						
TOTALS	0.482	0.795	1.045	1.403	1.737	3.005
	2.625	3.060	2.982	1.602	0.694	0.465
STD. DEVIATIONS	0.114	0.305	0.505	0.730	0.979	1.548
	1.122	0.818	0.909	0.784	0.160	0.099
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0798	0.3137	0.4919	0.3752	0.0900	0.6479
	0.0793	0.3949	0.4356	0.2227	0.3017	0.1193
STD. DEVIATIONS	0.1168	0.4059	0.5557	0.4940	0.0936	1.0933
	0.1496	0.5856	0.4805	0.2303	0.4298	0.1990

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	24.58	(4.326)	238260.9	100.00
RUNOFF	1.232	(0.8418)	11941.39	5.012
EVAPOTRANSPIRATION	19.897	(3.0861)	192839.42	80.936
PERCOLATION/LEAKAGE THROUGH LAYER 2	3.55207	(1.39975)	34427.059	14.44931
CHANGE IN WATER STORAGE	-0.098	(1.3767)	-946.95	-0.397

1BASE

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	4.54	44002.137
RUNOFF	1.421	13769.5459
PERCOLATION/LEAKAGE THROUGH LAYER 2	1.090984	10573.92970
SNOW WATER	2.60	25202.5117

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3750
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1870

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	6.1190	0.2550
2	16.9200	0.0470
SNOW WATER	0.344	

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GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 150. FEET.

SCS RUNOFF CURVE NUMBER	=	80.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	2.670	ACRES
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.440	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.136	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	4.488	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	24.360	INCHES
TOTAL INITIAL WATER	=	24.360	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM ALBUQUERQUE NEW MEXICO

STATION LATITUDE	=	35.35 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	120
END OF GROWING SEASON (JULIAN DATE)	=	300
EVAPORATIVE ZONE DEPTH	=	24.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	1.50 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	50.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.15	1.25	1.63	1.47	1.73	1.96
4.27	4.16	2.22	1.38	1.09	1.04

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.30	30.90	34.90	41.40	48.80	57.10
60.90	59.00	53.90	45.90	36.80	30.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO AND STATION LATITUDE = 35.35 DEGREES

ALTERNATIVE 3:

COMPACTED CLAY CAP

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**              HELP MODEL VERSION 3.06   (17 AUGUST 1996)                  **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**              USAE WATERWAYS EXPERIMENT STATION                           **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:    C:\bobr\1492b\HELP\BASE.D4
TEMPERATURE DATA FILE:      C:\bobr\1492b\HELP\BASE.D7
SOLAR RADIATION DATA FILE:  C:\bobr\1492b\HELP\BASE.D13
EVAPOTRANSPIRATION DATA:    C:\bobr\1492b\HELP\BASE.D11
SOIL AND DESIGN DATA FILE:  C:\bobr\1492b\HELP\2ABASE1.D10
OUTPUT DATA FILE:           C:\bobr\1492b\HELP\2aBASE1.OUT

TIME:  15: 9     DATE:   1/21/1997

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     TITLE:  PECOS MINE - OPTION 2A BASE CASE

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
            WERE SPECIFIED BY THE USER.

                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   9
          THICKNESS                  =    18.00   INCHES
          POROSITY                   =     0.5010 VOL/VOL
          FIELD CAPACITY             =     0.2840 VOL/VOL
          WILTING POINT              =     0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.1350 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.190000006000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                                  LAYER  2
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER  20
          THICKNESS                  =     0.20   INCHES
          POROSITY                   =     0.8500 VOL/VOL
          FIELD CAPACITY             =     0.0100 VOL/VOL
          WILTING POINT              =     0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.0320 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =   10.0000000000      CM/SEC
          SLOPE                      =     2.00   PERCENT
          DRAINAGE LENGTH            =   150.0    FEET
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LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00 INCHES
POROSITY	=	0.4270 VOL/VOL
FIELD CAPACITY	=	0.4180 VOL/VOL
WILTING POINT	=	0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.200000002000E-06 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	360.00 INCHES
POROSITY	=	0.3210 VOL/VOL
FIELD CAPACITY	=	0.0510 VOL/VOL
WILTING POINT	=	0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0470 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.240000011000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 150. FEET.

SCS RUNOFF CURVE NUMBER	=	80.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	2.670	ACRES
EVAPORATIVE ZONE DEPTH	=	18.2	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.436	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.188	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.431	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	27.042	INCHES
TOTAL INITIAL WATER	=	27.042	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ALBUQUERQUE NEW MEXICO

STATION LATITUDE	=	35.35 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	120
END OF GROWING SEASON (JULIAN DATE)	=	300
EVAPORATIVE ZONE DEPTH	=	18.2 INCHES
AVERAGE ANNUAL WIND SPEED	=	1.50 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	50.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.15	1.25	1.63	1.47	1.73	1.96
4.27	4.16	2.22	1.38	1.09	1.04

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.30	30.90	34.90	41.40	48.80	57.10
60.90	59.00	53.90	45.90	36.80	30.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO
AND STATION LATITUDE = 35.35 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.48	208186.344	100.00
RUNOFF	0.362	3505.203	1.68
EVAPOTRANSPIRATION	16.072	155769.469	74.82
DRAINAGE COLLECTED FROM LAYER 2	2.2371	21681.953	10.41
PERC./LEAKAGE THROUGH LAYER 3	0.202979	1967.291	0.94
AVG. HEAD ON TOP OF LAYER 3	0.0124		
PERC./LEAKAGE THROUGH LAYER 4	0.202979	1967.290	0.94
CHANGE IN WATER STORAGE	2.606	25262.410	12.13
SOIL WATER AT START OF YEAR	27.042	262096.812	
SOIL WATER AT END OF YEAR	29.649	287359.219	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.027	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.74	307627.312	100.00
RUNOFF	1.095	10612.470	3.45
EVAPOTRANSPIRATION	26.491	256752.797	83.46
DRAINAGE COLLECTED FROM LAYER 2	4.0079	38844.551	12.63
PERC./LEAKAGE THROUGH LAYER 3	0.473985	4593.912	1.49
AVG. HEAD ON TOP OF LAYER 3	0.0220		
PERC./LEAKAGE THROUGH LAYER 4	0.473985	4593.912	1.49
CHANGE IN WATER STORAGE	-0.328	-3176.515	-1.03
SOIL WATER AT START OF YEAR	29.649	287359.219	
SOIL WATER AT END OF YEAR	29.175	282771.281	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.146	1411.412	0.46
ANNUAL WATER BUDGET BALANCE	0.0000	0.087	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.94	270797.281	100.00
RUNOFF	2.565	24857.109	9.18
EVAPOTRANSPIRATION	20.403	197751.562	73.03
DRAINAGE COLLECTED FROM LAYER 2	5.7218	55456.332	20.48
PERC./LEAKAGE THROUGH LAYER 3	0.401984	3896.071	1.44
AVG. HEAD ON TOP OF LAYER 3	0.0327		
PERC./LEAKAGE THROUGH LAYER 4	0.401984	3896.071	1.44
CHANGE IN WATER STORAGE	-1.152	-11163.833	-4.12
SOIL WATER AT START OF YEAR	29.175	282771.281	
SOIL WATER AT END OF YEAR	28.169	273018.875	
SNOW WATER AT START OF YEAR	0.146	1411.412	0.52
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.027	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.95	241817.953	100.00
RUNOFF	1.549	15014.061	6.21
EVAPOTRANSPIRATION	19.360	187636.891	77.59
DRAINAGE COLLECTED FROM LAYER 2	2.7725	26871.580	11.11
PERC./LEAKAGE THROUGH LAYER 3	0.197927	1918.332	0.79
AVG. HEAD ON TOP OF LAYER 3	0.0150		
PERC./LEAKAGE THROUGH LAYER 4	0.197927	1918.332	0.79
CHANGE IN WATER STORAGE	1.071	10377.052	4.29
SOIL WATER AT START OF YEAR	28.169	273018.875	
SOIL WATER AT END OF YEAR	29.240	283395.906	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.037	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.10	262655.906	100.00
RUNOFF	1.753	16991.865	6.47
EVAPOTRANSPIRATION	20.963	203172.250	77.35
DRAINAGE COLLECTED FROM LAYER 2	2.6295	25485.215	9.70
PERC./LEAKAGE THROUGH LAYER 3	0.382584	3708.040	1.41
AVG. HEAD ON TOP OF LAYER 3	0.0144		
PERC./LEAKAGE THROUGH LAYER 4	0.382584	3708.040	1.41
CHANGE IN WATER STORAGE	1.372	13298.469	5.06
SOIL WATER AT START OF YEAR	29.240	283395.906	
SOIL WATER AT END OF YEAR	30.042	291170.062	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.570	5524.313	2.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.076	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.49	169514.797	100.00
RUNOFF	0.037	362.940	0.21
EVAPOTRANSPIRATION	15.429	149536.562	88.21
DRAINAGE COLLECTED FROM LAYER 2	2.4956	24187.855	14.27
PERC./LEAKAGE THROUGH LAYER 3	0.408387	3958.131	2.33
AVG. HEAD ON TOP OF LAYER 3	0.0138		
PERC./LEAKAGE THROUGH LAYER 4	0.408387	3958.131	2.33
CHANGE IN WATER STORAGE	-0.880	-8530.690	-5.03
SOIL WATER AT START OF YEAR	30.042	291170.062	
SOIL WATER AT END OF YEAR	29.511	286021.281	
SNOW WATER AT START OF YEAR	0.570	5524.313	3.26
SNOW WATER AT END OF YEAR	0.221	2142.403	1.26
ANNUAL WATER BUDGET BALANCE	0.0000	0.001	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.15	204987.922	100.00
RUNOFF	1.922	18624.365	9.09
EVAPOTRANSPIRATION	17.440	169032.922	82.46
DRAINAGE COLLECTED FROM LAYER 2	1.5770	15284.526	7.46
PERC./LEAKAGE THROUGH LAYER 3	0.263030	2549.318	1.24
AVG. HEAD ON TOP OF LAYER 3	0.0089		
PERC./LEAKAGE THROUGH LAYER 4	0.263030	2549.318	1.24
CHANGE IN WATER STORAGE	-0.052	-503.249	-0.25
SOIL WATER AT START OF YEAR	29.511	286021.281	
SOIL WATER AT END OF YEAR	29.680	287660.437	
SNOW WATER AT START OF YEAR	0.221	2142.403	1.05
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.042	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.85	279617.125	100.00
RUNOFF	0.361	3495.633	1.25
EVAPOTRANSPIRATION	23.501	227775.109	81.46
DRAINAGE COLLECTED FROM LAYER 2	3.9998	38766.937	13.86
PERC./LEAKAGE THROUGH LAYER 3	0.534989	5185.168	1.85
AVG. HEAD ON TOP OF LAYER 3	0.0220		
PERC./LEAKAGE THROUGH LAYER 4	0.534989	5185.168	1.85
CHANGE IN WATER STORAGE	0.453	4394.302	1.57
SOIL WATER AT START OF YEAR	29.680	287660.437	
SOIL WATER AT END OF YEAR	29.804	288864.812	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.329	3189.944	1.14
ANNUAL WATER BUDGET BALANCE	0.0000	-0.040	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.73	210609.391	100.00
RUNOFF	1.355	13131.521	6.24
EVAPOTRANSPIRATION	18.932	183491.844	87.12
DRAINAGE COLLECTED FROM LAYER 2	3.3486	32454.982	15.41
PERC./LEAKAGE THROUGH LAYER 3	0.306390	2969.562	1.41
AVG. HEAD ON TOP OF LAYER 3	0.0183		
PERC./LEAKAGE THROUGH LAYER 4	0.306390	2969.562	1.41
CHANGE IN WATER STORAGE	-2.212	-21438.562	-10.18
SOIL WATER AT START OF YEAR	29.804	288864.812	
SOIL WATER AT END OF YEAR	27.717	268640.187	
SNOW WATER AT START OF YEAR	0.329	3189.944	1.51
SNOW WATER AT END OF YEAR	0.204	1976.003	0.94
ANNUAL WATER BUDGET BALANCE	0.0000	0.036	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.40	226795.156	100.00
RUNOFF	0.749	7263.904	3.20
EVAPOTRANSPIRATION	18.363	177971.891	78.47
DRAINAGE COLLECTED FROM LAYER 2	3.1426	30457.928	13.43
PERC./LEAKAGE THROUGH LAYER 3	0.326051	3160.115	1.39
AVG. HEAD ON TOP OF LAYER 3	0.0171		
PERC./LEAKAGE THROUGH LAYER 4	0.326051	3160.115	1.39
CHANGE IN WATER STORAGE	0.819	7941.392	3.50
SOIL WATER AT START OF YEAR	27.717	268640.187	
SOIL WATER AT END OF YEAR	28.397	275224.094	
SNOW WATER AT START OF YEAR	0.204	1976.003	0.87
SNOW WATER AT END OF YEAR	0.344	3333.474	1.47
ANNUAL WATER BUDGET BALANCE	0.0000	-0.064	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.93	1.34	1.35	2.03	2.31
	3.52	4.95	2.44	2.33	1.60	1.00
STD. DEVIATIONS	1.08	0.98	1.24	1.31	1.13	2.08
	2.41	1.82	1.55	1.70	1.48	0.57
RUNOFF						
TOTALS	0.149	0.141	0.373	0.010	0.025	0.095
	0.193	0.084	0.039	0.032	0.009	0.027
STD. DEVIATIONS	0.310	0.271	0.560	0.018	0.037	0.169
	0.467	0.168	0.073	0.066	0.019	0.078
EVAPOTRANSPIRATION						
TOTALS	0.445	0.708	1.182	1.402	1.820	2.680
	2.595	3.089	2.913	1.646	0.731	0.482
STD. DEVIATIONS	0.187	0.323	0.451	0.795	0.929	1.746
	1.053	0.827	0.906	0.769	0.176	0.122
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.1131	0.2452	0.4523	0.2504	0.0292	0.4742
	0.1593	0.4512	0.3917	0.2091	0.2968	0.1207
STD. DEVIATIONS	0.1844	0.3950	0.6401	0.4670	0.0752	1.0482
	0.4293	0.5938	0.6522	0.3681	0.5525	0.2356
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0298	0.0367	0.0511	0.0273	0.0072	0.0221
	0.0057	0.0344	0.0387	0.0161	0.0395	0.0410
STD. DEVIATIONS	0.0433	0.0421	0.0613	0.0368	0.0178	0.0354
	0.0125	0.0478	0.0429	0.0296	0.0670	0.0560
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0298	0.0367	0.0511	0.0273	0.0072	0.0221
	0.0057	0.0344	0.0387	0.0161	0.0395	0.0410
STD. DEVIATIONS	0.0433	0.0421	0.0613	0.0368	0.0178	0.0354
	0.0125	0.0478	0.0429	0.0296	0.0670	0.0560

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0073	0.0176	0.0293	0.0167	0.0019	0.0322
	0.0103	0.0292	0.0262	0.0135	0.0199	0.0078
STD. DEVIATIONS	0.0119	0.0283	0.0414	0.0312	0.0049	0.0717
	0.0278	0.0384	0.0436	0.0238	0.0370	0.0153

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	24.58	(4.326)	238260.9	100.00
RUNOFF	1.175	(0.8029)	11385.91	4.779
EVAPOTRANSPIRATION	19.695	(3.3609)	190889.12	80.118
LATERAL DRAINAGE COLLECTED FROM LAYER 2	3.19324	(1.16631)	30949.189	12.98962
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.34983	(0.11133)	3390.594	1.42306
AVERAGE HEAD ON TOP OF LAYER 3	0.018	(0.007)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.34983	(0.11133)	3390.594	1.42306
CHANGE IN WATER STORAGE	0.170	(1.3951)	1646.08	0.691

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	4.54	44002.137
RUNOFF	1.457	14124.5732
DRAINAGE COLLECTED FROM LAYER 2	0.94360	9145.45703
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.007579	73.45432
AVERAGE HEAD ON TOP OF LAYER 3	2.052	
MAXIMUM HEAD ON TOP OF LAYER 3	3.143	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	25.4 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.007579	73.45432
SNOW WATER	2.60	25202.5117

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3823
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1336

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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2ABASE1

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	3.7391	0.2077
2	0.0517	0.2586
3	7.6860	0.4270
4	16.9200	0.0470
SNOW WATER	0.344	

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Alternative 4:

Geomembrane Cap

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.06   (17 AUGUST 1996)                 **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:    C:\bobr\1492b\HELP\BASE.D4
TEMPERATURE DATA FILE:      C:\bobr\1492b\HELP\BASE.D7
SOLAR RADIATION DATA FILE:  C:\bobr\1492b\HELP\BASE.D13
EVAPOTRANSPIRATION DATA:    C:\bobr\1492b\HELP\BASE.D11
SOIL AND DESIGN DATA FILE:  C:\bobr\1492b\HELP\3ABASE1.D10
OUTPUT DATA FILE:           C:\bobr\1492b\HELP\3ABASE1.OUT

TIME:  15:20     DATE:   1/21/1997

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     TITLE:  PECOS MINE - OPTION 3A BASE CASE

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.

                                   LAYER  1
                                   --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   9
           THICKNESS                  =       18.00    INCHES
           POROSITY                   =        0.5010 VOL/VOL
           FIELD CAPACITY             =        0.2840 VOL/VOL
           WILTING POINT              =        0.1350 VOL/VOL
           INITIAL SOIL WATER CONTENT =        0.1350 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =    0.190000006000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                                   LAYER  2
                                   --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                       MATERIAL TEXTURE NUMBER  20
           THICKNESS                  =        0.20    INCHES
           POROSITY                   =        0.8500 VOL/VOL
           FIELD CAPACITY             =        0.0100 VOL/VOL
           WILTING POINT              =        0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT =        0.0320 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =    10.0000000000        CM/SEC
           SLOPE                      =        2.00    PERCENT
           DRAINAGE LENGTH            =      150.0     FEET
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3HBASE1

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 37

THICKNESS	=	0.03	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999999000E-10	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.200000002000E-06	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	360.00	INCHES
POROSITY	=	0.3210	VOL/VOL
FIELD CAPACITY	=	0.0510	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0470	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.240000011000E-02	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 150. FEET.

SCS RUNOFF CURVE NUMBER	=	80.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	2.670	ACRES
EVAPORATIVE ZONE DEPTH	=	18.2	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.436	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.188	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.431	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	24.480	INCHES
TOTAL INITIAL WATER	=	24.480	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ALBUQUERQUE NEW MEXICO

STATION LATITUDE	=	35.35 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	120
END OF GROWING SEASON (JULIAN DATE)	=	300
EVAPORATIVE ZONE DEPTH	=	18.2 INCHES
AVERAGE ANNUAL WIND SPEED	=	1.50 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	50.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.15	1.25	1.63	1.47	1.73	1.96
4.27	4.16	2.22	1.38	1.09	1.04

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.30	30.90	34.90	41.40	48.80	57.10
60.90	59.00	53.90	45.90	36.80	30.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO
AND STATION LATITUDE = 35.35 DEGREES

SHBASE1

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.48	208186.344	100.00
RUNOFF	0.362	3507.652	1.68
EVAPOTRANSPIRATION	16.056	155615.875	74.75
DRAINAGE COLLECTED FROM LAYER 2	2.4521	23766.027	11.42
PERC./LEAKAGE THROUGH LAYER 4	0.000135	1.308	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0136		
PERC./LEAKAGE THROUGH LAYER 5	0.000135	1.308	0.00
CHANGE IN WATER STORAGE	2.610	25295.463	12.15
SOIL WATER AT START OF YEAR	24.480	237266.500	
SOIL WATER AT END OF YEAR	27.090	262561.969	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.74	307627.312	100.00
RUNOFF	1.094	10607.201	3.45
EVAPOTRANSPIRATION	26.492	256758.922	83.46
DRAINAGE COLLECTED FROM LAYER 2	4.4828	43447.555	14.12
PERC./LEAKAGE THROUGH LAYER 4	0.000250	2.426	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0246		
PERC./LEAKAGE THROUGH LAYER 5	0.000250	2.426	0.00
CHANGE IN WATER STORAGE	-0.329	-3188.901	-1.04
SOIL WATER AT START OF YEAR	27.090	262561.969	
SOIL WATER AT END OF YEAR	26.616	257961.641	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.146	1411.412	0.46
ANNUAL WATER BUDGET BALANCE	0.0000	0.088	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.94	270797.281	100.00
RUNOFF	2.566	24866.395	9.18
EVAPOTRANSPIRATION	20.410	197814.766	73.05
DRAINAGE COLLECTED FROM LAYER 2	6.1189	59304.891	21.90
PERC./LEAKAGE THROUGH LAYER 4	0.000323	3.129	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0350		
PERC./LEAKAGE THROUGH LAYER 5	0.000323	3.129	0.00
CHANGE IN WATER STORAGE	-1.155	-11191.913	-4.13
SOIL WATER AT START OF YEAR	26.616	257961.641	
SOIL WATER AT END OF YEAR	25.607	248181.141	
SNOW WATER AT START OF YEAR	0.146	1411.412	0.52
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.95	241817.953	100.00
RUNOFF	1.549	15015.116	6.21
EVAPOTRANSPIRATION	19.365	187690.359	77.62
DRAINAGE COLLECTED FROM LAYER 2	2.9650	28737.281	11.88
PERC./LEAKAGE THROUGH LAYER 4	0.000154	1.490	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0160		
PERC./LEAKAGE THROUGH LAYER 5	0.000154	1.490	0.00
CHANGE IN WATER STORAGE	1.070	10373.669	4.29
SOIL WATER AT START OF YEAR	25.607	248181.141	
SOIL WATER AT END OF YEAR	26.677	258554.812	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.022	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.10	262655.906	100.00
RUNOFF	1.753	16991.490	6.47
EVAPOTRANSPIRATION	20.968	203224.141	77.37
DRAINAGE COLLECTED FROM LAYER 2	3.0020	29095.477	11.08
PERC./LEAKAGE THROUGH LAYER 4	0.000165	1.598	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0164		
PERC./LEAKAGE THROUGH LAYER 5	0.000165	1.598	0.00
CHANGE IN WATER STORAGE	1.377	13343.168	5.08
SOIL WATER AT START OF YEAR	26.677	258554.812	
SOIL WATER AT END OF YEAR	27.484	266373.656	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.570	5524.313	2.10
ANNUAL WATER BUDGET BALANCE	0.0000	0.043	0.00

ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.49	169514.797	100.00
RUNOFF	0.037	362.944	0.21
EVAPOTRANSPIRATION	15.434	149589.828	88.25
DRAINAGE COLLECTED FROM LAYER 2	2.9014	28121.049	16.59
PERC./LEAKAGE THROUGH LAYER 4	0.000171	1.657	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0161		
PERC./LEAKAGE THROUGH LAYER 5	0.000171	1.657	0.00
CHANGE IN WATER STORAGE	-0.883	-8560.601	-5.05
SOIL WATER AT START OF YEAR	27.484	266373.656	
SOIL WATER AT END OF YEAR	26.949	261194.969	
SNOW WATER AT START OF YEAR	0.570	5524.313	3.26
SNOW WATER AT END OF YEAR	0.221	2142.403	1.26
ANNUAL WATER BUDGET BALANCE	0.0000	-0.089	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.15	204987.922	100.00
RUNOFF	1.922	18624.957	9.09
EVAPOTRANSPIRATION	17.443	169062.828	82.47
DRAINAGE COLLECTED FROM LAYER 2	1.8336	17771.746	8.67
PERC./LEAKAGE THROUGH LAYER 4	0.000105	1.017	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0103		
PERC./LEAKAGE THROUGH LAYER 5	0.000105	1.017	0.00
CHANGE IN WATER STORAGE	-0.049	-472.691	-0.23
SOIL WATER AT START OF YEAR	26.949	261194.969	
SOIL WATER AT END OF YEAR	27.122	262864.687	
SNOW WATER AT START OF YEAR	0.221	2142.403	1.05
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.064	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.85	279617.125	100.00
RUNOFF	0.361	3495.471	1.25
EVAPOTRANSPIRATION	23.505	227809.781	81.47
DRAINAGE COLLECTED FROM LAYER 2	4.5344	43948.316	15.72
PERC./LEAKAGE THROUGH LAYER 4	0.000249	2.409	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0249		
PERC./LEAKAGE THROUGH LAYER 5	0.000249	2.409	0.00
CHANGE IN WATER STORAGE	0.450	4361.193	1.56
SOIL WATER AT START OF YEAR	27.122	262864.687	
SOIL WATER AT END OF YEAR	27.242	264035.937	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.329	3189.944	1.14
ANNUAL WATER BUDGET BALANCE	0.0000	-0.053	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.73	210609.391	100.00
RUNOFF	1.355	13132.263	6.24
EVAPOTRANSPIRATION	18.938	183544.578	87.15
DRAINAGE COLLECTED FROM LAYER 2	3.6491	35367.258	16.79
PERC./LEAKAGE THROUGH LAYER 4	0.000207	2.005	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0200		
PERC./LEAKAGE THROUGH LAYER 5	0.000207	2.005	0.00
CHANGE IN WATER STORAGE	-2.212	-21436.842	-10.18
SOIL WATER AT START OF YEAR	27.242	264035.937	
SOIL WATER AT END OF YEAR	25.156	243813.031	
SNOW WATER AT START OF YEAR	0.329	3189.944	1.51
SNOW WATER AT END OF YEAR	0.204	1976.003	0.94
ANNUAL WATER BUDGET BALANCE	0.0000	0.135	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.40	226795.156	100.00
RUNOFF	0.750	7264.337	3.20
EVAPOTRANSPIRATION	18.365	177990.828	78.48
DRAINAGE COLLECTED FROM LAYER 2	3.4622	33555.945	14.80
PERC./LEAKAGE THROUGH LAYER 4	0.000182	1.765	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0189		
PERC./LEAKAGE THROUGH LAYER 5	0.000182	1.765	0.00
CHANGE IN WATER STORAGE	0.824	7982.283	3.52
SOIL WATER AT START OF YEAR	25.156	243813.031	
SOIL WATER AT END OF YEAR	25.839	250437.844	
SNOW WATER AT START OF YEAR	0.204	1976.003	0.87
SNOW WATER AT END OF YEAR	0.344	3333.474	1.47
ANNUAL WATER BUDGET BALANCE	0.0000	-0.004	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.93	1.34	1.35	2.03	2.31
	3.52	4.95	2.44	2.33	1.60	1.00
STD. DEVIATIONS	1.08	0.98	1.24	1.31	1.13	2.08
	2.41	1.82	1.55	1.70	1.48	0.57
RUNOFF						
TOTALS	0.149	0.141	0.373	0.010	0.025	0.095
	0.193	0.084	0.039	0.032	0.009	0.027
STD. DEVIATIONS	0.310	0.271	0.560	0.018	0.037	0.169
	0.467	0.168	0.073	0.066	0.019	0.078
EVAPOTRANSPIRATION						
TOTALS	0.445	0.708	1.182	1.402	1.820	2.683
	2.595	3.087	2.913	1.647	0.732	0.482
STD. DEVIATIONS	0.187	0.323	0.451	0.795	0.928	1.745
	1.054	0.826	0.906	0.768	0.176	0.122
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.1434	0.2816	0.5022	0.2779	0.0361	0.4961
	0.1644	0.4850	0.4319	0.2244	0.3363	0.1611
STD. DEVIATIONS	0.2260	0.4284	0.6945	0.4963	0.0831	1.0783
	0.4397	0.6358	0.6938	0.3872	0.5938	0.2881
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0093	0.0201	0.0325	0.0186	0.0023	0.0337
	0.0106	0.0314	0.0289	0.0145	0.0225	0.0104
STD. DEVIATIONS	0.0146	0.0307	0.0450	0.0332	0.0054	0.0737
	0.0285	0.0412	0.0464	0.0251	0.0397	0.0187

3HBHSE1

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	24.58	(4.326)	238260.9	100.00
RUNOFF	1.175	(0.8030)	11386.78	4.779
EVAPOTRANSPIRATION	19.698	(3.3625)	190910.20	80.127
LATERAL DRAINAGE COLLECTED FROM LAYER 2	3.54016	(1.23241)	34311.555	14.40083
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00019	(0.00006)	1.880	0.00079
AVERAGE HEAD ON TOP OF LAYER 3	0.020	(0.007)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00019	(0.00006)	1.880	0.00079
CHANGE IN WATER STORAGE	0.170	(1.3968)	1650.48	0.693

PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	4.54	44002.137
RUNOFF	1.457	14125.0068
DRAINAGE COLLECTED FROM LAYER 2	0.95017	9209.15918
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000052	0.50113
AVERAGE HEAD ON TOP OF LAYER 3	2.067	
MAXIMUM HEAD ON TOP OF LAYER 3	3.163	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	25.5 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000052	0.50113
SNOW WATER	2.60	25202.5117
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3826	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1336	

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	3.7436	0.2080
2	0.0517	0.2587
3	0.0000	0.0000
4	5.1240	0.4270
5	16.9200	0.0470
SNOW WATER	0.344	

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RESULTS FOR REGRADED, BUT UNCOVERED DUMP:

SURFACE

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.06   (17 AUGUST 1996)                 **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\bobr\1492b\BASE.D4
TEMPERATURE DATA FILE:       C:\bobr\1492b\BASE.D7
SOLAR RADIATION DATA FILE:   C:\bobr\1492b\BASE.D13
EVAPOTRANSPIRATION DATA:     C:\bobr\1492b\BASE.D11
SOIL AND DESIGN DATA FILE:   C:\bobr\1492b\SURFACE.D10
OUTPUT DATA FILE:            C:\bobr\1492b\SURFACE.OUT

TIME:   9:54     DATE:  11/21/1996

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     TITLE:  PECOS MINE - RESLOPED DUMP SURFACE ONLY (2.67 ACRES)

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
            WERE SPECIFIED BY THE USER.

                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   0
           THICKNESS                  =    360.00    INCHES
           POROSITY                   =      0.3210 VOL/VOL
           FIELD CAPACITY             =      0.0510 VOL/VOL
           WILTING POINT              =      0.0470 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0470 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.240000011000E-02 CM/SEC


                    GENERAL DESIGN AND EVAPORATIVE ZONE DATA
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         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
                SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE
                OF  2.% AND A SLOPE LENGTH OF  150. FEET.

        SCS RUNOFF CURVE NUMBER            =     80.90
        FRACTION OF AREA ALLOWING RUNOFF   =    100.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE =      2.670  ACRES
        EVAPORATIVE ZONE DEPTH             =     24.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE  =      1.128  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE =      7.704  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE =      1.128  INCHES
        INITIAL SNOW WATER                 =      0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS   =     16.920  INCHES
        TOTAL INITIAL WATER                =     16.920  INCHES
        TOTAL SUBSURFACE INFLOW            =      0.00   INCHES/YEAR
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EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ALBUQUERQUE NEW MEXICO

STATION LATITUDE	=	35.35 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	120
END OF GROWING SEASON (JULIAN DATE)	=	300
EVAPORATIVE ZONE DEPTH	=	24.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	1.50 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	50.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.15	1.25	1.63	1.47	1.73	1.96
4.27	4.16	2.22	1.38	1.09	1.04

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.30	30.90	34.90	41.40	48.80	57.10
60.90	59.00	53.90	45.90	36.80	30.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO
AND STATION LATITUDE = 35.35 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.48	208186.344	100.00
RUNOFF	0.277	2681.414	1.29
EVAPOTRANSPIRATION	3.603	34920.867	16.77
PERC./LEAKAGE THROUGH LAYER 1	17.498663	169598.797	81.46
CHANGE IN WATER STORAGE	0.102	985.278	0.47
SOIL WATER AT START OF YEAR	16.920	163990.219	
SOIL WATER AT END OF YEAR	17.022	164975.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.018	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.74	307627.312	100.00
RUNOFF	0.853	8265.253	2.69
EVAPOTRANSPIRATION	5.979	57951.832	18.84
PERC./LEAKAGE THROUGH LAYER 1	24.755344	239931.281	77.99
CHANGE IN WATER STORAGE	0.153	1478.906	0.48
SOIL WATER AT START OF YEAR	17.022	164975.500	
SOIL WATER AT END OF YEAR	17.029	165043.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.146	1411.412	0.46
ANNUAL WATER BUDGET BALANCE	0.0000	0.018	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.94	270797.281	100.00
RUNOFF	2.163	20961.285	7.74
EVAPOTRANSPIRATION	4.961	48080.246	17.76
PERC./LEAKAGE THROUGH LAYER 1	20.931442	202869.641	74.92
CHANGE IN WATER STORAGE	-0.115	-1113.821	-0.41
SOIL WATER AT START OF YEAR	17.029	165043.000	
SOIL WATER AT END OF YEAR	17.059	165340.594	
SNOW WATER AT START OF YEAR	0.146	1411.412	0.52
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.074	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.95	241817.953	100.00
RUNOFF	1.427	13827.307	5.72
EVAPOTRANSPIRATION	5.621	54475.527	22.53
PERC./LEAKAGE THROUGH LAYER 1	18.042068	174865.531	72.31
CHANGE IN WATER STORAGE	-0.139	-1350.362	-0.56
SOIL WATER AT START OF YEAR	17.059	165340.594	
SOIL WATER AT END OF YEAR	16.920	163990.219	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.055	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.10	262655.906	100.00
RUNOFF	1.464	14193.343	5.40
EVAPOTRANSPIRATION	4.765	46185.660	17.58
PERC./LEAKAGE THROUGH LAYER 1	20.300322	196752.750	74.91
CHANGE IN WATER STORAGE	0.570	5524.313	2.10
SOIL WATER AT START OF YEAR	16.920	163990.219	
SOIL WATER AT END OF YEAR	16.920	163990.219	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.570	5524.313	2.10
ANNUAL WATER BUDGET BALANCE	0.0000	-0.148	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.49	169514.797	100.00
RUNOFF	0.134	1300.167	0.77
EVAPOTRANSPIRATION	3.430	33245.793	19.61
PERC./LEAKAGE THROUGH LAYER 1	13.585226	131669.375	77.67
CHANGE IN WATER STORAGE	0.340	3299.544	1.95
SOIL WATER AT START OF YEAR	16.920	163990.219	
SOIL WATER AT END OF YEAR	17.609	170671.687	
SNOW WATER AT START OF YEAR	0.570	5524.313	3.26
SNOW WATER AT END OF YEAR	0.221	2142.403	1.26
ANNUAL WATER BUDGET BALANCE	0.0000	-0.083	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.15	204987.922	100.00
RUNOFF	2.069	20048.645	9.78
EVAPOTRANSPIRATION	4.410	42743.098	20.85
PERC./LEAKAGE THROUGH LAYER 1	14.944270	144841.359	70.66
CHANGE IN WATER STORAGE	-0.273	-2645.154	-1.29
SOIL WATER AT START OF YEAR	17.609	170671.687	
SOIL WATER AT END OF YEAR	17.557	170168.922	
SNOW WATER AT START OF YEAR	0.221	2142.403	1.05
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.037	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.85	279617.125	100.00
RUNOFF	0.206	2001.136	0.72
EVAPOTRANSPIRATION	4.328	41948.957	15.00
PERC./LEAKAGE THROUGH LAYER 1	24.500914	237465.312	84.93
CHANGE IN WATER STORAGE	-0.186	-1798.191	-0.64
SOIL WATER AT START OF YEAR	17.557	170168.922	
SOIL WATER AT END OF YEAR	17.043	165180.797	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.329	3189.944	1.14
ANNUAL WATER BUDGET BALANCE	0.0000	-0.092	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.73	210609.391	100.00
RUNOFF	1.462	14173.899	6.73
EVAPOTRANSPIRATION	4.452	43152.395	20.49
PERC./LEAKAGE THROUGH LAYER 1	16.063345	155687.547	73.92
CHANGE IN WATER STORAGE	-0.248	-2404.508	-1.14
SOIL WATER AT START OF YEAR	17.043	165180.797	
SOIL WATER AT END OF YEAR	16.920	163990.219	
SNOW WATER AT START OF YEAR	0.329	3189.944	1.51
SNOW WATER AT END OF YEAR	0.204	1976.003	0.94
ANNUAL WATER BUDGET BALANCE	0.0000	0.055	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.40	226795.156	100.00
RUNOFF	0.646	6264.488	2.76
EVAPOTRANSPIRATION	4.188	40591.250	17.90
PERC./LEAKAGE THROUGH LAYER 1	18.347498	177825.797	78.41
CHANGE IN WATER STORAGE	0.218	2113.613	0.93
SOIL WATER AT START OF YEAR	16.920	163990.219	
SOIL WATER AT END OF YEAR	16.998	164746.375	
SNOW WATER AT START OF YEAR	0.204	1976.003	0.87
SNOW WATER AT END OF YEAR	0.344	3333.474	1.47
ANNUAL WATER BUDGET BALANCE	0.0000	0.018	0.00

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SURFACE

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.93	1.34	1.35	2.03	2.31
	3.52	4.95	2.44	2.33	1.60	1.00
STD. DEVIATIONS	1.08	0.98	1.24	1.31	1.13	2.08
	2.41	1.82	1.55	1.70	1.48	0.57
RUNOFF						
TOTALS	0.137	0.129	0.324	0.013	0.036	0.061
	0.173	0.105	0.031	0.016	0.026	0.020
STD. DEVIATIONS	0.313	0.259	0.483	0.028	0.049	0.106
	0.415	0.216	0.064	0.036	0.054	0.057
EVAPOTRANSPIRATION						
TOTALS	0.229	0.250	0.336	0.191	0.365	0.365
	0.788	0.922	0.337	0.267	0.202	0.321
STD. DEVIATIONS	0.148	0.217	0.188	0.153	0.200	0.331
	0.481	0.410	0.121	0.153	0.174	0.139
PERCOLATION/LEAKAGE THROUGH LAYER 1						
TOTALS	0.3613	0.4942	1.0410	1.2305	1.6097	1.8987
	2.2809	3.9738	2.2488	1.9787	1.2228	0.5566
STD. DEVIATIONS	0.4691	0.6722	0.8175	1.1882	0.9027	1.7078
	1.0482	1.4985	1.3210	1.4189	1.0920	0.4165

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	24.58	(4.326)	238260.9	100.00
RUNOFF	1.070	(0.7532)	10371.69	4.353
EVAPOTRANSPIRATION	4.574	(0.7999)	44329.56	18.605
PERCOLATION/LEAKAGE THROUGH LAYER 1	18.89691	(3.75187)	183150.750	76.86982
CHANGE IN WATER STORAGE	0.042	(0.2803)	408.96	0.172

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	4.54	44002.137
RUNOFF	1.289	12495.5518
PERCOLATION/LEAKAGE THROUGH LAYER 1	1.974095	19133.12500
SNOW WATER	2.60	25202.5117
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.1664
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0470

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	16.9980	0.0472
SNOW WATER	0.344	

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RESULTS FOR REGRADED, BUT UNCOVERED DUMP:

SIDESLOPES

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.06   (17 AUGUST 1996)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\bobr\1492b\BASE.D4
TEMPERATURE DATA FILE:        C:\bobr\1492b\BASE.D7
SOLAR RADIATION DATA FILE:    C:\bobr\1492b\BASE.D13
EVAPOTRANSPIRATION DATA:      C:\bobr\1492b\BASE.D11
SOIL AND DESIGN DATA FILE:    C:\bobr\1492b\SLOPE.D10
OUTPUT DATA FILE:             C:\bobr\1492b\SLOPE.OUT

TIME:   9:57     DATE:  11/21/1996

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     TITLE:  PECOS MINE - DUMP SLOPE ONLY (4.20 ACRES)

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =    360.00   INCHES
          POROSITY                     =      0.3210 VOL/VOL
          FIELD CAPACITY               =      0.0510 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0470 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =   0.240000011000E-02 CM/SEC


                    GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                    ----------------------------------------

       NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
                SPECIFIED CURVE NUMBER OF 80.0, A SURFACE SLOPE
                OF 50.% AND A SLOPE LENGTH OF  170. FEET.

        SCS RUNOFF CURVE NUMBER              =     82.40
        FRACTION OF AREA ALLOWING RUNOFF     =    100.0     PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE   =      4.200   ACRES
        EVAPORATIVE ZONE DEPTH               =     24.0     INCHES
        INITIAL WATER IN EVAPORATIVE ZONE    =      1.128   INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE   =      7.704   INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.128   INCHES
        INITIAL SNOW WATER                   =      0.000   INCHES
        INITIAL WATER IN LAYER MATERIALS     =     16.920   INCHES
        TOTAL INITIAL WATER                  =     16.920   INCHES
        TOTAL SUBSURFACE INFLOW              =      0.00    INCHES/YEAR
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EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ALBUQUERQUE NEW MEXICO

STATION LATITUDE	=	35.35 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	120
END OF GROWING SEASON (JULIAN DATE)	=	300
EVAPORATIVE ZONE DEPTH	=	24.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	1.50 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	50.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.15	1.25	1.63	1.47	1.73	1.96
4.27	4.16	2.22	1.38	1.09	1.04

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
29.30	30.90	34.90	41.40	48.80	57.10
60.90	59.00	53.90	45.90	36.80	30.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ALBUQUERQUE NEW MEXICO
AND STATION LATITUDE = 35.35 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.48	327484.125	100.00
RUNOFF	0.325	4955.211	1.51
EVAPOTRANSPIRATION	3.603	54934.055	16.77
PERC./LEAKAGE THROUGH LAYER 1	17.450211	266045.906	81.24
CHANGE IN WATER STORAGE	0.102	1548.974	0.47
SOIL WATER AT START OF YEAR	16.920	257962.141	
SOIL WATER AT END OF YEAR	17.022	259511.109	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.029	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.74	483908.062	100.00
RUNOFF	1.078	16429.350	3.40
EVAPOTRANSPIRATION	5.943	90610.539	18.72
PERC./LEAKAGE THROUGH LAYER 1	24.566500	374540.844	77.40
CHANGE IN WATER STORAGE	0.153	2327.270	0.48
SOIL WATER AT START OF YEAR	17.022	259511.109	
SOIL WATER AT END OF YEAR	17.029	259618.187	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.146	2220.199	0.46
ANNUAL WATER BUDGET BALANCE	0.0000	0.087	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.94	425973.187	100.00
RUNOFF	2.310	35217.828	8.27
EVAPOTRANSPIRATION	5.302	80840.906	18.98
PERC./LEAKAGE THROUGH LAYER 1	20.442503	311666.375	73.17
CHANGE IN WATER STORAGE	-0.115	-1751.904	-0.41
SOIL WATER AT START OF YEAR	17.029	259618.187	
SOIL WATER AT END OF YEAR	17.059	260086.469	
SNOW WATER AT START OF YEAR	0.146	2220.199	0.52
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.029	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.95	380387.750	100.00
RUNOFF	1.664	25375.498	6.67
EVAPOTRANSPIRATION	5.870	89500.352	23.53
PERC./LEAKAGE THROUGH LAYER 1	17.554522	267636.219	70.36
CHANGE IN WATER STORAGE	-0.139	-2124.340	-0.56
SOIL WATER AT START OF YEAR	17.059	260086.469	
SOIL WATER AT END OF YEAR	16.920	257962.141	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.029	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.10	413166.594	100.00
RUNOFF	1.551	23643.855	5.72
EVAPOTRANSPIRATION	4.757	72529.656	17.55
PERC./LEAKAGE THROUGH LAYER 1	20.221914	308303.281	74.62
CHANGE IN WATER STORAGE	0.570	8689.930	2.10
SOIL WATER AT START OF YEAR	16.920	257962.141	
SOIL WATER AT END OF YEAR	16.920	257962.141	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.570	8689.930	2.10
ANNUAL WATER BUDGET BALANCE	0.0000	-0.145	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.49	266652.469	100.00
RUNOFF	0.175	2670.424	1.00
EVAPOTRANSPIRATION	3.430	52291.418	19.61
PERC./LEAKAGE THROUGH LAYER 1	13.544928	206505.953	77.44
CHANGE IN WATER STORAGE	0.340	5184.710	1.94
SOIL WATER AT START OF YEAR	16.920	257962.141	
SOIL WATER AT END OF YEAR	17.609	268466.719	
SNOW WATER AT START OF YEAR	0.570	8689.930	3.26
SNOW WATER AT END OF YEAR	0.221	3370.072	1.26
ANNUAL WATER BUDGET BALANCE	0.0000	-0.044	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.15	322452.875	100.00
RUNOFF	2.150	32784.687	10.17
EVAPOTRANSPIRATION	4.425	67471.109	20.92
PERC./LEAKAGE THROUGH LAYER 1	14.846202	226345.187	70.19
CHANGE IN WATER STORAGE	-0.272	-4148.063	-1.29
SOIL WATER AT START OF YEAR	17.609	268466.719	
SOIL WATER AT END OF YEAR	17.558	267688.719	
SNOW WATER AT START OF YEAR	0.221	3370.072	1.05
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.044	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.85	439847.125	100.00
RUNOFF	0.296	4505.484	1.02
EVAPOTRANSPIRATION	4.335	66086.141	15.02
PERC./LEAKAGE THROUGH LAYER 1	24.405838	372091.375	84.60
CHANGE IN WATER STORAGE	-0.186	-2835.885	-0.64
SOIL WATER AT START OF YEAR	17.558	267688.719	
SOIL WATER AT END OF YEAR	17.043	259834.937	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.329	5017.889	1.14
ANNUAL WATER BUDGET BALANCE	0.0000	-0.029	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.73	331295.656	100.00
RUNOFF	1.327	20228.152	6.11
EVAPOTRANSPIRATION	4.043	61640.309	18.61
PERC./LEAKAGE THROUGH LAYER 1	16.608255	253209.453	76.43
CHANGE IN WATER STORAGE	-0.248	-3782.372	-1.14
SOIL WATER AT START OF YEAR	17.043	259834.937	
SOIL WATER AT END OF YEAR	16.920	257962.141	
SNOW WATER AT START OF YEAR	0.329	5017.889	1.51
SNOW WATER AT END OF YEAR	0.204	3108.319	0.94
ANNUAL WATER BUDGET BALANCE	0.0000	0.087	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.40	356756.406	100.00
RUNOFF	0.826	12587.833	3.53
EVAPOTRANSPIRATION	3.994	60898.141	17.07
PERC./LEAKAGE THROUGH LAYER 1	18.361910	279945.656	78.47
CHANGE IN WATER STORAGE	0.218	3324.784	0.93
SOIL WATER AT START OF YEAR	16.920	257962.141	
SOIL WATER AT END OF YEAR	16.998	259151.578	
SNOW WATER AT START OF YEAR	0.204	3108.319	0.87
SNOW WATER AT END OF YEAR	0.344	5243.667	1.47
ANNUAL WATER BUDGET BALANCE	0.0000	-0.029	0.00

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	4.54	69216.836
RUNOFF	1.445	22028.4746
PERCOLATION/LEAKAGE THROUGH LAYER 1	1.919220	29260.42970
SNOW WATER	2.60	39644.3984

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.1648
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0470

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	16.9980	0.0472
SNOW WATER	0.344	

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.78	0.93	1.34	1.35	2.03	2.31
	3.52	4.95	2.44	2.33	1.60	1.00
STD. DEVIATIONS	1.08	0.98	1.24	1.31	1.13	2.08
	2.41	1.82	1.55	1.70	1.48	0.57
RUNOFF						
TOTALS	0.137	0.129	0.324	0.018	0.046	0.085
	0.200	0.108	0.043	0.026	0.034	0.020
STD. DEVIATIONS	0.313	0.259	0.483	0.041	0.063	0.144
	0.468	0.173	0.083	0.054	0.072	0.057
EVAPOTRANSPIRATION						
TOTALS	0.229	0.250	0.338	0.189	0.395	0.392
	0.774	0.878	0.336	0.268	0.202	0.321
STD. DEVIATIONS	0.148	0.217	0.188	0.150	0.256	0.346
	0.460	0.339	0.120	0.154	0.174	0.138
PERCOLATION/LEAKAGE THROUGH LAYER 1						
TOTALS	0.3610	0.4944	1.0387	1.2270	1.5000	1.9184
	2.3301	3.9531	2.2382	1.9679	1.2143	0.5572
STD. DEVIATIONS	0.4683	0.6721	0.8160	1.1852	0.7367	1.7719
	1.0822	1.4506	1.3086	1.4047	1.0863	0.4167

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	24.58	(4.326)	374792.4	100.00
RUNOFF	1.170	(0.7652)	17839.83	4.760
EVAPOTRANSPIRATION	4.570	(0.8862)	69680.27	18.592
PERCOLATION/LEAKAGE THROUGH LAYER 1	18.80028	(3.66688)	286629.062	76.47675
CHANGE IN WATER STORAGE	0.042	(0.2802)	643.31	0.172

Appendix A2

PMOU Decision Document

FINAL DECISION DOCUMENT
PECOS MINE OPERABLE UNIT
UPPER PECOS SITE
TERRERO, NEW MEXICO

NEW MEXICO ENVIRONMENT DEPARTMENT
9 APRIL 1998

FINAL DECISION DOCUMENT
PECOS MINE OPERABLE UNIT
UPPER PECOS SITE
TERRERO, NEW MEXICO

9 April 1998

SITE NAME AND LOCATION

Upper Pecos Site
Pecos Mine Operable Unit
Terrero, San Miguel County, New Mexico

STATEMENT OF BASIS AND PURPOSE

The Upper Pecos Site, New Mexico, comprises five operable units: Pecos Mine, El Molino, State Recreation Use Areas, State Highway 63, and Lisboa Springs Fish Hatchery. This Decision Document presents the selected remedial actions for the Pecos Mine Operable Unit, located approximately 1.5 miles north of Terrero, New Mexico. These remedial actions were chosen in accordance with the Consent Order for the site, the New Mexico Environmental Improvement Act, the New Mexico Water Quality Control Commission (NMWQCC) regulations, NMWQCC Water Quality Standards for Interstate and Intrastate Streams in New Mexico, and to the extent practicable, the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Contingency Plan (NCP). This decision is based on the administrative record for the site.

ASSESSMENT OF THE SITE

Actual or threatened releases of contaminants and hazardous substances from this site, if not addressed by implementing the response actions selected in this Decision Document, may present a current or potential threat to public health, welfare, or the environment.

COMMUNITY PARTICIPATION

Community participation in the Pecos Mine Operable Unit has included a series of public information meetings and technical review roundtables held over the past three years. The community relations contractor has conducted interviews with individuals to encourage public opinions.

The draft Decision Document was subjected to a 60-day public comment period. It was presented at both a technical review roundtable and a public information meeting. The draft was reviewed by the New Mexico Environment Department, the Office of the Natural Resources Trustee, and EPA.

DESCRIPTION OF THE SELECTED REMEDY

The major components of the selected remedy are outlined below. A detailed description of the selected remedy and compliance monitoring is provided in the sections "Selected Remedy" and "Remedial Action Cleanup Criteria".

1. Consolidate waste rock and underlying contaminated soils into one to two piles. Piles when completed shall have side slopes of demonstrated stability, but in no instance should overall slope be steeper than 3:1. Surface construction shall minimize erosion. Completed piles shall not encroach upon the Willow Creek 100-year floodplain.
2. Completely remove waste rock, the lime pile, and contaminated soils from the Willow Creek floodplain and from the disjunct pile west of State Highway 63, and place the excavated material on the waste piles prior to capping. Determination of contaminated soils and cleanup criteria shall be field XRF lead concentrations of 1200 mg/kg or higher; XRF values will be subject to laboratory confirmation sampling. Such cleanup criteria are consistent with those previously implemented during remedial activities at the El Molino OU, and with EPA cleanup values for commercial areas (1000-2000 mg/kg). Vehicle access to the upper portion of Willow Creek, either through connecting FR645 or through maintaining access up Willow Creek road, shall not be prohibited. Vehicle travel along Highway 63 shall not be prohibited during remediation. If the FR645 project cannot be enacted, Willow Creek road through the site shall be replaced.
3. Excavate contaminated soils from the barren zone and other upland areas, and place those excavated soils on the waste pile prior to capping. Determination of contaminated soils and cleanup criteria shall be field XRF readings of 1200 mg/kg lead. XRF readings shall be subject to laboratory confirmation sampling.
4. Excavate contaminated sediments from the wetlands in the area of seeps WSBDT and ESS. The extent of contaminated sediments to be removed will be determined in the field, and based on visual inspection by a qualified ecological expert of the extent of

discolored sediment and stressed vegetation caused by the seeps. Removal may include sediment within the channeled sections of the wetland.

5. Construct a cap for the top of the consolidated waste pile that will comprise three layers: A low permeability layer (10^{-8} centimeters per second or less; at least 18 inches of compacted low-permeability clay or a geomembrane fabric) on the waste pile, overlain by a lateral drainage layer (at least a 2-inch of 0.25 inch rock (D50) or a geonet fabric), topped by at least an 18-inch vegetation layer. The cap must decrease infiltration to the pile by greater than 99% compared to current conditions. Other cap materials that meet the performance standards may be proposed in the Remedial Design, subject to NMED approval. Include in the Remedial Design a Construction Quality Assurance Plan for construction of the cap.
6. Construct a cap for the sides of the consolidated waste pile that will comprise two layers: A low permeability clay layer (permeability of 10^{-7} centimeters per second or less) at least 48 inches in perpendicular thickness, overlain by a vegetation layer at least 18 inches in perpendicular thickness. The cap must decrease infiltration to the pile by greater than 99% compared to current conditions. Other cap materials that meet the performance standards may be proposed in the Remedial Design, and are subject to NMED approval. Include in the Remedial Design a Construction Quality Assurance Plan for construction of the cap.
7. Construct a surface/subsurface diversion structure along the entire uphill/upgradient side of the consolidated waste pile, to divert all surface run-on and colluvial subsurface flow from the pile. The subsurface portion of the diversion structure shall be keyed to bedrock. The surface portion of the diversion structure shall be lined with PVC or other impermeable material and keyed to the cap of the consolidated waste pile. Diverted water will emit at Willow Creek or other suitable natural surface drainages. The diversion structure shall be capable of accepting a flow equal to a 100-year maximum precipitation event.
8. Operational safeguards shall be in place during remediation to ensure the health and safety of all workers and visitors at the site.
9. Institutional controls shall be implemented to prohibit use of site ground water as a drinking water source, and to prohibit construction of residences on site. These controls shall remain so long as site conditions warrant.
10. Monitoring of seeps WSBDT and ESS, surface water locations, and ground water monitoring wells will be used to assess the remediation effects on seep volume and quality, surface water quality, and ground water quality. Installation of additional monitoring wells or additional surface sampling points may be required to adequately assess ground water and seep water quality. If within five years the remediation enacted through this Decision Document does not attain, or is shown to be not successfully attaining, RAC for seep water, surface water and ground water, further remedial efforts will be required to address those pathways, as described below in "Contingency Measures".
11. The Willow Creek corridor within the site shall be restored to natural conditions. Restoration shall be deemed effective with the establishment of a viable, self-

sustaining ecological community that is in a natural condition and will naturally proceed without intervention to baseline conditions for Willow Creek. If the restoration does not meet specified compliance standards, further restoration efforts will be required.

12. All areas from which waste rock and contaminated soils have been excavated, including the barren zone and the disjunct pile, will be restored to natural conditions of mountain meadow or appropriate forest habitat. Restoration shall be deemed effective with the establishment of a viable, self-sustaining ecological community that is in a natural condition and will naturally proceed without intervention to baseline conditions for uplands in this area. If the restoration does not meet specified compliance standards, further restoration will be required. Revegetation shall include an attempt to install a community of Holy Ghost Ipomopsis; the success of the Ipomopsis community will not be a RAC.
13. The vegetation layer on the cap of the waste pile shall be revegetated to grassland or meadow habitat appropriate for this area. Revegetation shall be limited to those plants that normally do not root deeper than the vegetation layer.
14. To replace residual injury to natural resources that cannot be restored on site, for example uplands under the consolidated waste pile, Respondents shall participate in the connection of Forest Road 645 and closing of the Willow Creek road between FR645 and State Highway 63. The FR645 project is contingent upon agreement between NMGF and USFS. If the FR645 project cannot be accomplished, Respondents shall participate in the US Park Service's restoration project along Glorieta Creek in the Pecos National Historic Park. Participation in either project may take the form of active operation or financial assistance, but shall not be required to exceed a comparable value of $50,000.
15. Install and maintain measures to protect newly remediated and restored areas for the term of the Consent Order.
16. Develop and implement a compliance monitoring program, subject to NMED approval, for the term of the Consent Order, to assess the effectiveness of the remedy. The program shall include, but not be limited to, assessing residual and potential contamination of soil, assessing ground water and surface water quality, assessing success in meeting performance criteria established for natural resource restoration and replacement, including revegetation on cap areas, and assessing the engineering stability of the cap. After at least eight consecutive quarterly samples from a particular pathway show no contamination, Respondents may propose, subject to NMED approval, that portions of the compliance monitoring program may be amended and/or eliminated if data confirms effective remediation of specific media or pathways. Completion of the compliance monitoring program is subject to the terms and conditions of the Consent Order and Statement of Work (Consent Order Attachment A).
17. Air monitoring will be required during remedial construction to ensure worker and visitor safety.

18. Develop a long-term operation and maintenance plan for NMED approval. The plan shall be implemented upon meeting compliance criteria; implementation shall be the responsibility of NMGF, and shall be subject to review and possibly modification by NMED every five years.

NMED DETERMINATIONS

This Decision Document, and the remedy described herein, are required pursuant to an Administrative Order on Consent (AOC) entered into between NMED and the Respondents on 2 December 1992. The selected remedy is protective of human health and the environment, complies with the AOC, federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. Because the selected remedy will result in hazardous substances remaining on site, although in containment, a review of the effectiveness of the selected remedy will be conducted five years after commencement of the remedial action to ensure that the remedy provides adequate protection of human health and the environment. If the remedy does not fulfill its obligation for protection, NMED will require Respondents to perform such additional work as may be reasonably necessary.

Mark E. Weidler
Secretary
New Mexico Environment Department

4/9/98
Date

FINAL DECISION DOCUMENT
FOR THE
PECOS MINE OPERABLE UNIT
UPPER PECOS SITE
CONCURRENCE DOCUMENTATION

MARCH 1998

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FINAL DECISION DOCUMENT

UPPER PECOS SITE

PECOS MINE OPERABLE UNIT

1 LOCATION AND DESCRIPTION

The Upper Pecos Site comprises five operable units: Pecos Mine, El Molino, State Recreation Use Areas, State Highway 63, and Lisboa Springs Fish Hatchery. The Pecos Mine OU is located approximately 1.2 miles north of Terrero, and 15 miles north of Pecos, San Miguel County, New Mexico (figure 1). The site lies within Section 27 of T18N, R12E, along State Highway 63 at the junction of Willow Creek and the Pecos River. The Pecos Mine OU (figure 2) includes the mine, approximately 12.3 acres of associated waste rock dumps, contaminated soils surrounding the dumps, a wetland area of 5 to 10 acres, affected portions of Willow Creek and the Pecos River adjacent to and below the mine area, and affected ground water.

The main waste rock dump covers 9.8 acres along the east side of Highway 63 south of Willow Creek, with additional waste rock deposited north of Willow Creek. A smaller dump west of the highway, termed the disjunct pile, extends towards the Pecos River (figure 2). A lime pile has been stored north of Willow Creek on waste rock since 1993, but has never been used. Total volume of waste rock is estimated at 217,000 cubic yards, with 190,000 cubic yards in the main dump south of Willow Creek east of the highway, 20,300 cubic yards in the dump north of Willow Creek east of the highway, and 6,700 cubic yards in the dump west of the highway near the Pecos River.

The Pecos Mine OU lies at the surface outcrop of the contact between the Precambrian basement and Pennsylvanian Madera formation. The Precambrian includes metavolcanic and metasedimentary units. The Madera includes a lower limestone up to 100 feet thick and an upper sandstone up to 80 feet thick. Quaternary deposits of hillslope colluvium 0-45 feet thick and stream alluvium 0-15 feet thick overlie the older units.

There are several distinct zones of hydrologic flow at the site, including fracture flow through the Precambrian, saturated flow through water-bearing units in the Madera, and both saturated and unsaturated flow through the colluvium and alluvium. In addition, the waste rock pile constitutes a flow path for transient vadose-zone flow during runoff or snowmelt. Flow in all cases is primarily west, toward the wetlands and the Pecos River.

Seeps issue from both the waste rock and the colluvium. Most seeps vary in discharge seasonally, down to zero discharge in dry seasons, except for two major seeps, the explosive shed spring (ESS) and the white seep (WSBDT), which both flow year round, even in dry seasons. The explosive shed spring may be related to Willow Creek subsurface flow. Flow in the white seep may be related to its location at the terminus of one of the original topographic drainages for the area.

Willow Creek, a perennial stream, flows westerly near the north boundary of the site. It converges with the Pecos River along the west boundary of the site. The confluence area is a wetland of 5 to 10 acres. The wetland receives surface and subsurface flow from Willow Creek, from the alluvial flow system of the Pecos River, and from seeps and shallow subsurface flow through the colluvium and basement rock along the hillslopes. The wetland is mostly bounded along the Pecos River side by a levee constructed of trash and debris related to the original town site built for the mine.

Flow patterns are seasonal. High flow generally occurs in March through August. Seep flow patterns mostly follow those of surface flow, with the significant addition of high seep flow during times of snowmelt, both in Spring and Autumn.

2 SITE HISTORY

The first mineral discovery in the Pecos Mine ore deposit was made in 1882 by a prospector named Case. By 1883, three mines were in operation: the Katydid, Evangeline, and Ruby Rough. That year, the company was purchased by the Cowles family and operated on a limited basis as a copper mine. The mines remained idle through the late 1880's and 1890's, until in 1903 the Pecos Copper Company was created by Alfred Cowles. From 1903 to 1907, the mines again operated for copper extraction. The mines were again idle from 1907 to 1916, at which time the property was purchased by the Goodrich-Lockhart Company.

The first major operation started in 1925, when the American Metal Company (AMCO Ltd., later AMAX) and the Pecos Corporation (Goodrich-Lockhart Company) formed the American Metal Company of New Mexico (AMCONM) to develop the property. Primary production was lead and zinc, with smaller amounts of copper, gold, and silver. The company built underground workings going to more than 1,800 feet below ground surface, served by two shafts. Ore was transported by aerial tramway 12 miles to the mill in Alamitos Canyon (now included in the El Molino OU), near the town of Pecos. The mine and mill operated until 1939.

In 1939, when the mine and mill were closed, the American Metal Company of New Mexico transferred its mineral rights and real property to Pecos Estates, Inc., a New

Mexico corporation owned in substantially the same proportions as by the shareholders of AMCONM. In 1950, the New Mexico State Game Commission purchased all of the stock of Pecos Estates, Inc. The nominees transferred to the Game Commission all assets of Pecos Estates, Inc., excluding mineral rights. The New Mexico Department of Game and Fish (NMGF) is the current owner of the land, but the mineral rights are retained in a trust for the benefit of the original shareholders of Pecos Estates, Inc. In 1993, AMAX merged with Cyprus Minerals; the company is now Cyprus Amax Minerals.

From the 1940's to 1979, mine waste rock was used for various construction projects in the Upper Pecos Valley, including road base course and repair for State Highway 63, base for roads and pads in campgrounds and picnic areas on both State and US Forest Service grounds, and private property. State areas in which this was done are included in the State Recreation Area OU and the State Highway 63 OU of the Upper Pecos Site. The US Forest Service has conducted investigation and remediation of contaminated site on Federal land apart from the Pecos Mine OU.

3 PREVIOUS INVESTIGATIONS

An analytical study of the water quality in the upper Pecos was conducted by the NMED Surface Water Quality Bureau in 1982. The study showed metals in seeps and surface water discharges around the Pecos Mine. The Surface Water Quality Bureau has continued to study both water quality and fish tissue, but to date has issued no warnings regarding human consumption of fish caught in the area.

The US Fish and Wildlife Service (USFW) conducted a study of the upper Pecos watershed in 1990. The study found lead concentrations in the edible portions of fish to be near the USFW human consumption criteria. Lead in small mammals near the mine site exceeded the protection criteria for raptors.

The New Mexico Department of Health offered free blood lead screening tests to Pecos area residents in 1991. Seventy-one people took the tests, which were conducted as a voluntary survey. All individuals had blood lead levels below the recommended threshold level of concern of 10 μg/dl.

In 1982 the Lisboa Springs Fish Hatchery, located on the Pecos River approximately nine miles downstream of the mine, expanded its operations. The expansion included using Pecos River water in the fish raceways. Soon after, abnormally large fish kills were experienced by the hatchery. Kills were concentrated during times of snowmelt or runoff along the river, and were eventually attributed to metals loading (especially zinc) from mine runoff.

A Superfund investigative series was performed at the site by the New Mexico Environment Department (NMED) Superfund Section, under authority of the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The series was begun as an outgrowth of the Superfund investigations being conducted at the El Molino mill and tailings site near the town of Pecos, and due to concern presented by the fish kills at the Lisboa Springs Fish Hatchery. NMED conducted a Preliminary Assessment in August 1989. In September 1990, NMED prepared a Screening Site Investigation, and in March 1992 a Listing Site Investigation. The ongoing process of Superfund activity was the impetus for the State and Amax to negotiate a Consent Order as an overall enforcement document for site investigation and remediation.

The Consent Order was signed on December 2, 1992 between NMED and three Respondents: Amax Resource Conservation Company (AMAX), NMGF, and the New Mexico State Highway and Transportation Department (NMSHTD). The Consent Order designated five operable units for the Upper Pecos Site: Pecos Mine, El Molino, Lisboa Springs Fish Hatchery, State Highway 63, and State Recreation Use Areas. The Consent Order requires the Respondents to perform site investigations and remedial actions at the five operable units. The Consent Order designated NMED as oversight agency and authority over Consent Order requirements. The Consent Order also included as attachments a Cost Allocation Agreement, which described the partition of costs for site work, and a Statement of Work.

The Statement of Work (SOW) specifies which items the Respondents are responsible for completing or contracting. This includes most of the investigative and operational work at the Pecos Mine OU, the operable unit covered by this Decision Document. NMED, in addition to oversight duties, is responsible for the risk assessments, the community relations, and the Decision Document.

EPA has participated in the process through a memorandum of understanding (MOU) with NMED. The MOU provides for an exchange of information to allow EPA to review, comment upon, and offer assistance on site activities and reports. EPA has been furnished copies of deliverables, kept informed of activities, and has participated in critical scoping meetings. EPA has provided comments on this Decision Document proposal, and will be asked for concurrence on the final selected remedy. The Pecos Mine OU was deferred from inclusion on the National Priorities List by EPA, allowing the State of New Mexico to oversee the investigation and remediation.

4 COMMUNITY PARTICIPATION

The Statement of Work (SOW, Consent Order Attachment A), Section III E outlines the requirements for community participation. In general, it provides for public information meetings, for written informational flyers, for additional opportunities for public input (for example, individual interviews), and for the development of repositories allowing public access to all documents related to the site. NMED and its community relations contractor have met and exceeded the requirements through the community relations efforts for the Upper Pecos Site.

Community interest in the Upper Pecos Site has been high, but has focused primarily on the El Molino Operable Unit, which is near the Village of Pecos, the main population center for this part of the Pecos River valley. Interest in the Pecos Mine Operable Unit has generally focused on impacts to local residents and recreational visitors, on effects to the water quality in the upper Pecos watershed, and on items related to the effects remedial alternatives might have on the Village of Pecos.

Public meetings have been held in Pecos regularly by NMED, usually in conjunction with the issuance of major reports (including drafts) and documents for the Upper Pecos Site. The purposes of the public meetings have been to provide updates on activities at the site, review upcoming events, listen to comments and opinions from the public, and to answer questions. NMED personnel oversee all public meetings; community relations contractors often facilitate. Public meetings are announced through advertisements in the Santa Fe New Mexican, the Las Vegas Optic, on flyers distributed at Pecos commercial and public locations, and through a mailing list. The mailing list is kept and updated by the community relations contractor, Western Network.

As relates to the Pecos Mine OU, public meetings were held to review the Remedial Investigation (RI), the Feasibility Study (FS), the Human Health and Ecological Risk Assessments (HRA; ERA), the Natural Resource Damage Assessment (NRDA), and at other times in conjunction with meetings held primarily for El Molino OU review.

The Village of Pecos for three years received monies from the state to contract a technical assistant, who advised the Village on site activities. The technical assistant received copies of all pertinent documents for review, and participated in all public meetings. The contract activities of the technical assistant ended in June, 1997.

In addition to public meetings, NMED has overseen a technical review group, which meets regularly in roundtable fashion to review documents and activities at the site. Participants include agency personnel from various state and federal agencies, representatives from Cyprus Amax and their contractors, the technical assistant for the Village of Pecos, the community relations contractor, and any interested public member. The technical review group has been consulted for input on most report drafts before the drafts have been issued for general public comment. The group also provides insight into public response and presentation of information at regular public meetings.

NMED and Cyprus Amax have appeared before the Village of Pecos Trustees and the San Miguel County Commission at their invitation to answer questions and update officials regarding the site.

Administrative Records for each operable unit were established in 1993. One administrative record resides in the Library of NMED in Santa Fe, and one in the Village office of Pecos. Both record locations are publicly accessible, and include a document log listing all the documents available in the record.

The draft Decision Document was made publicly available for comment for a 60-day comment period. In addition, a public meeting was held to review the document and solicit public comment. The public meeting was recorded, and a transcript from that meeting is attached to this Decision Document. The document was also reviewed with the technical review group. Comments and NMED response are included as an attachment to the this Decision Document.

5 SCOPE AND ROLE OF THE RESPONSE ACTION

The Pecos Mine operable unit is one of five operable units addressed in the statement of work for the Consent Order. Operable units within the Upper Pecos Site are defined as geographically discrete subdivisions of the site with distinct physical characteristics meriting separate technical or operational approaches. The long-term remedy and restoration developed for each operable unit will be consistent with an overall long-term remedy and restoration for the Site. Work performed has been, and will continue to be, in accordance with the procedures set forth by the Consent Order, by NMWQCC regulations, NMWQCC Water Quality Standards for Interstate and Intrastate Streams in New Mexico, and, where feasible, the requirements and goals of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1976 (SARA) and the National Contingency Plan (NCP), the Resource Conservation and Recovery Act (RCRA), the New Mexico Mining Act Rules (1994), and the Closeout Plan Guidelines for mines (1996).

Respondents have conducted and submitted a Background Report, Remedial Investigation (RI), and Feasibility Study (FS). NMED has contracted or conducted a Human Health Risk Assessment (HRA), Ecological Risk Assessment (ERA), and Natural Resource Damage Assessment (NRDA). These documents have fulfilled the investigative requirements for the operable unit. Following the final Decision Document, further work will be required: the Remedial Design (RD), the Remedial Action (RA), the compliance monitoring plan, the operation and maintenance (O&M) plan, and quarterly monitoring.

The studies undertaken at the OU have identified the waste rock and associated seeps as the principal sources of contamination. Contaminated soils, sediment, ground water, and surface water may pose a threat both as contamination pathways and as secondary sources of contamination. Without remediation, runoff from the waste rock and release from the seeps will continue to contaminate shallow ground water, surface water, soils, and sediments of the uplands, Willow Creek, the wetlands, and the Pecos River.

Based on the investigative work that has been conducted at the site, NMED has outlined a remedial action in this Decision Document that will address the principal threats posed by metal contamination and acidification in soils, sediment, surface water, and ground water. If additional contamination sources and pathways are identified during the Remedial Design/Remedial Action (RD/RA) phase, NMED will ensure that these sources and pathways are addressed in accordance with applicable laws and regulations.

6 SITE CHARACTERIZATION

Details of site characterization are provided in the Remedial Investigation Report (Stoller, 1996). The following is a summary of this report.

6.1 Geology

Along Willow Creek are exposed Precambrian units of metavolcanic rocks, schist, amphibolite, and basic metadiabase of the greenstone sequence. Overlying the Precambrian at the site is a Mississippian sandstone that interfingers with overlying dolomite and limestone. All of these basement units are unconformably overlain by Quaternary colluvium on the hillslopes and alluvium in the drainages (especially Willow Creek) and the wetlands.

6.2 Ground Water Pathway

Ground water flow in the basement units includes fracture flow through the Precambrian units, and interstitial, solution, and fracture flow through the sandstone and limestone. The colluvial flow system includes areas of both saturated and unsaturated interstitial flow. Ground water flow is generally toward the Pecos River and locally toward Willow Creek, although preferential ground water pathways may be developed along fractures in the basement rock. The waste rock pile itself acts as a system for transient ground water flow during wet seasons after rainstorms and snowmelt.

6.3 Surface Water Pathway

Surface water flow is dominated by Willow Creek, a perennial stream that at the site skirts the north edge of the main waste rock pile. Willow Creek flows into a 5-10 acre wetland before joining the Pecos River. Water input to the wetland also comes from numerous seeps along the base of the hillslope, and surface drainage and shallow subsurface flow from the waste rock pile and colluvium. The wetland includes areas of unsaturated grassland or willow-alder, saturated grassland, beaver ponds, and anastomosing channels of Willow Creek.

The stretch of the Pecos River near the site is designated under the Wild and Scenic Rivers Act. The river is separated from the wetland by a levee built of dirt and trash from the old Tererro mining town site. The Pecos River generally does not flood the wetland area, even in high flow (in flood stage it might), although there is probable subsurface interchange between the wetland and Pecos River through the alluvium.

6.4 Air Pathway

Air monitoring was conducted at one location on the top of the main waste rock pile. No exceedences of Federal or State standards were detected in the air samples.

6.5 Contamination

Sample locations and summary tables of chemical analyses are provided in Appendix A.

Analysis of rock samples indicates that waste rock is heterogeneous with respect to metal content and potential to generate acid. The highest concentration trace metals associated with waste rock are copper, lead, and zinc. Comparison of acid generating potential (AGP) and acid neutralization potential (ANP) show that waste rock has the potential to generate acid; acidic seeps indicate that acid generation is ongoing.

The waste rock is a source of contaminant release into the environment. Bulk transport of material from the waste rock piles during runoff and wind erosion has resulted in deposition of waste rock in areas outside the piles, causing elevated concentrations of metals in soils and sediments. Metals that most exceed background concentrations in soils include cadmium, lead, and zinc, with the highest concentrations seen in soil samples nearest the waste rock dump. Elevated concentrations of metals are more extensive in shallow (0-6 inches) than in deeper (12-18 inches) samples.

Metals that exceed both background concentrations and state standards in ground water include barium, cadmium, iron, and manganese in the bedrock aquifer (Precambrian and Mississippian), and iron, lead, and manganese in the shallow flow system (alluvium and colluvium), with additional elevated metal concentrations in water samples within the waste rock dump. Other contaminants that exceed standards in ground water are fluoride and total dissolved solids (TDS).

Seeps are sources of contaminant release into the environment. Seep samples generally have the highest metal concentrations and lowest pH of any water flow. Seeps emanating directly from the waste rock pile contain the most and highest metals concentrations. The worst seep emanating from colluvium is WSBDT, the white seep below the drainage tunnel, which exceeds surface water standards for aluminum, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, and zinc. WSBDT flows into the wetland at the base of an original topographic drainage near the south end of the wetland.

Willow Creek water quality is affected by runoff and seep influx as the creek flows along the northern edge of the main waste rock pile, and by inflow from seeps and runoff in the wetland. Concentrations of cadmium, zinc, cobalt, copper, and lead in Willow Creek exceed surface water standards. The concentrations and frequency of exceedence were higher downstream of the seeps areas in the wetland than in the creek segment upstream of the wetland but downstream of the waste rock dump.

Pecos River water quality is affected by inflow of water from the Willow Creek wetland. Concentrations of 18 metals were elevated over upgradient conditions at sampling locations within one mile downstream of the site. State standards for surface water or drinking water were exceeded for aluminum, cadmium, copper, iron, selenium, and zinc. No exceedences of standards are seen below 1.5 miles of the site. Although it is possible that there are additional natural or anthropogenic sources of metals to the Pecos River, sampling results suggest some metals attributed to site sources are elevated above background concentrations at locations up to 16 miles downstream of the site.

6.6 *Ecological Effects*

Phytotoxic effects are visible in several areas of the site: the waste rock pile, the barren zone, downslope from the southern extension of the waste rock pile, and below WSBDT, the white seep below the drainage tunnel (Figure 2). Soils in the barren zone contain higher metal concentrations, lower pH, and lower alkalinity than soils in adjacent areas with no visible phytotoxicity. The barren zone is also directly below surface seeps emanating directly from that portion of the waste rock pile. Wetland sediment samples collected below seep WSBDT contained elevated concentrations of metals and sulfate, acidic pH, and depressed alkalinity.

7 CONTAMINANT FATE AND TRANSPORT

The transport and fate of contaminants from a source are dependent on the physical and chemical properties of the contaminant and the characteristics of the environmental media through which the contaminants travel when released. The mechanisms by which contaminants may be released from primary (waste rock) and secondary (contaminated soils, sediments, and water) sources at the Pecos Mine OU and become available for transport through the environmental media include leaching with subsequent infiltration to ground water, leaching or discharge to surface water, discharge of contaminated ground water to surface water, and physical transport of material in surface water runoff.

Metals are persistent in the environment, but their mobility varies with environmental conditions. Metals may be present in soils in elemental form, sorbed or chelated by organic matter oxides, sorbed on exchange sites of soil colloids, or dissolved in acid leachate. Most metals are immobile in neutral or basic soils and become significantly leachable only if acidic solutions infiltrate through the soils. In the pH range commonly found in natural soils (6 to 8.4), metals generally do not leach appreciably. However, acids formed by reactions of infiltrating rainwater and oxygen through sulfide ores, such as at the Pecos Mine waste rock pile, greatly increase the mobility of metals. Acidic soil conditions also enhances the bioavailability of metals to plants, increasing the likelihood of phytotoxic effects from those metals.

Through the mining process which took place at the Pecos Mine OU, sulfide-bearing ores and associated waste rock were brought to the surface, exposing them to an oxygen-rich atmosphere. Atmospheric oxygen at the surface and in the infiltration zone of the waste rock pile reacted with the sulfide minerals (e.g., iron sulfide, zinc sulfide, lead sulfide) in the presence of water to create an oxidation reaction, releasing hydrogen, sulfate, and the accompanying metals to the environment. The water migrated downward through the waste rock into the colluvium to migrate into the ground water aquifers, to discharge as seeps on the surface, to move through the subsurface into the wetlands, or to directly discharge from the waste rock pile as seeps into the surface water pathway. The exposure of the pile to rainfall and snowmelt also enhanced the potential for migration of particulates as runoff.

8 RISK AND DAMAGE ASSESSMENT DESCRIPTION

An evaluation of the potential risks to human health and the environment from site contaminants was conducted as part of the Consent Order. A baseline risk assessment is an analysis of the current and potential threats to human health and the environment that may be posed by contaminants migrating to ground water and surface water, transported through the air, leaching through or accumulating in soils and sediments, and bioaccumulating in the food chain. The results of the baseline risk assessment help establish acceptable exposure levels for use in developing remedial alternatives in the Feasibility Study. By definition, a baseline risk assessment evaluates risks that may exist under the no-action alternative (that is, in the absence of any remedial actions to control or mitigate releases). The baseline risk assessment helps to indicate the exposure pathways and contaminants of concern (COCs) that need to be addressed by the remedial action.

The role of the risk assessment is to document those chemicals and pathways at the site that constitute the greatest risk to human health or the environment. The risk developed in the assessments is a long-term probability of human health and ecological concerns that the site might pose over and above normal risk in the area were the site not there.

The Natural Resource Damage Assessment (NRDA) evaluates the injuries to natural resources that have resulted from releases of hazardous substances from the Pecos Mine OU. The injuries can be classified into two categories: existing injuries, and those injuries, termed residual injuries, that will remain following remediation. The NRDA evaluated on site restoration options (to restore or replace), and proposed additional off site natural resource projects that would compensate for (replace) the residual injuries remaining on site.

Remedial Action Objectives for the Pecos Mine OU were established in a manner which provides acceptable exposure levels that are protective of human health and the environment, by considering the risk assessments and the Remedial Action Criteria (RAC).

8.1 HUMAN HEALTH RISK ASSESSMENT

The Human Health Risk Assessment (HRA) is a quantitative estimate of the current and potential risks to human health from exposure to contaminants at the Pecos Mine OU. The objectives of the evaluation process are: 1) to provide an analysis of baseline risk and help determine the need for action at the site; 2) to provide a basis for determining levels /of chemicals that can remain onsite and still be adequately protective of public health; 3) to provide a basis for the risk manager to compare potential health impacts of various remedial alternatives; and 4) to provide a consistent process for evaluating and documenting long-term public health threats at the site. Details were provided in the full document "Human Health Risk Assessment: *Final*" dated 6 May 1997. Summary tables of risk calculations and results are provided in Appendix B.

Risks for the Pecos Mine OU were calculated looking at two current use scenarios, a vacation use scenario and a nearby recreational use scenario, and a reasonable maximum exposure future use residential scenario. Pathways of exposure examined were ingestion of drinking water and ingestion of soils. The Remedial Investigation was used as the data source. Contaminants of concern (COCs) used in the risk assessment are those chemicals that had elevated concentrations (compared to background - see tables in Appendix A) for a particular medium (water or soil) that appeared in several samples, are shown to have health affects associated with elevated concentrations, and had reference doses or slope factors available for risk calculations.

From a practical standpoint it is reasonable to expect that a house could not be built directly on waste rock. Therefore, for the soil pathway in the residential scenario, concentrations of COCs in soils were used for those areas outside the waste rock pile most reasonably expected to be able to support a house. These were also the areas that showed the highest soil concentrations of COCs. Shallower samples were used because these are the most likely soil exposure for human contact. For the recreational scenarios, concentrations of COCs in the waste rock were used for the soil pathway calculations.

COCs utilized in the drinking water pathway were barium and manganese for the basement aquifer, and manganese for the shallow aquifer. Other contaminants seen in some samples are not COCs either because they were seen in only one or a few samples (for example, fluoride and cadmium) or do not have health-based standards (total dissolved solids). Final COCs used for the soil pathway in the HRA were arsenic, barium, cadmium, chromium, copper, molybdenum, nickel, selenium, silver, and zinc. Lead was incorporated as a COC into all measured pathways using the lead model for risk.

For noncarcinogens, it is assumed that the human body's protective mechanisms must be overcome before adverse effects are manifested. The amount of chemical which will exceed this value is called the threshold. A chronic Hazard Quotient (HQ) is calculated as the quotient of the contaminant-specific chronic daily intake (CDI) divided by the contaminant-specific reference dose (RfD). It is recognized that some contaminants can work synergistically (multiplying each other's effects) or antagonistically (mitigating each other's effects). It is also recognized that different contaminants affect different organs of the body. However, there is not yet enough detailed information to allow the culling of specific effects of multiple metals on the body; to be conservative, the risk is considered to be additive. Hazard Quotients are summed across the various pathways and media. A total Hazard Index (HI) of greater than one exceeds the threshold value and suggests a potential human health risk. If a total HI greater than one is found, specific pathways and contaminants are examined to determine what is driving the risk.

For carcinogens, it is assumed that any amount of chemical may pose some hazard. Thus, there is no threshold value. However, it is also realized that zero risk is unobtainable, and therefore a value which defines an unacceptable risk is developed. A risk is calculated as the product of the contaminant-specific CDI and contaminant-specific slope factor. The potential upper-bound lifetime excess cancer risk (the additional risk of contracting cancer due to exposure to the contaminants of concern at the site) is estimated by summing the calculated risks for each contaminant in each pathway. EPA considers the target risk to be within the range 10^{-4} to 10^{-6}. The national average for cancer risk is presently over 0.25 (one-in-four). The target range, therefore, translates to an **additional** cancer risk from the site of one-in-10,000 to one-in-1,000,000. This is a probability, and would translate into one additional cancer in a population of 10,000 to 1,000,000 people *living at the site under a specific scenario*. The general recommended procedure is to use

10^{-6} as the *point of departure* for consideration of risk in a given scenario. It is the duty of the risk manager to determine whether a risk value elsewhere in the 10^{-4} to 10^{-6} risk range is acceptable for this site.

Neither a reference dose nor a slope factor is available for lead. Risk characterization is developed using the EPA Lead Uptake/Biokinetic (UBK) model. In this model, blood-lead concentration in residential children age 0-6 is calculated combining exposure along all pathways. The output is a probability function of blood-lead levels. The acceptable threshold value is a probability function showing 95% of the population with a blood-lead level less than 10 μg/dl. Note that the model results apply only to children in a residential setting; risk from lead to adults, or to any receptor in a non-residential scenario, cannot be calculated quantitatively.

In general, the lead model is used to estimate lead concentration goals for soils, because this is the pathway for which there are no standards. The procedure is to find the concentration of lead in soil that would result in 95% of the population with blood-lead levels less than 10 μg/dl, or a probability of blood-lead levels greater than 10 μg/dl in an individual of less than 5%. For the Pecos Mine site, a series of model runs were made in which the values for all pathways except soil were held constant, with soil concentrations varied. The result is a remediation target concentration of lead in soil.

For all pathways, arsenic was the only COC with an oral slope factor for carcinogenic risk. Calculated risk values in the vacation use scenario was 10^{-7} for adults and 10^{-6} for children, within the acceptable EPA point of departure of 10^{-6}.

For a vacation recreational use scenario, no pathway demonstrated a hazard index (HI) greater than the threshold value of 1.0. Using the highest drinking water HI (with the bedrock aquifer as the drinking water source) yields a total HI of 0.09 for adults and 0.57 for children.

An additional recreational scenario was examined in which nearby residents utilized the site for recreational purposes. Carcinogenic risk values calculated under this scenario were 1.3×10^{-5} for both youths and adults, which is greater than the EPA point of departure of 10^{-6} but within the risk management decision range of 10^{-4} to 10^{-6}. Adding the HI for ingestion in the soil and drinking water pathways yields a total HI in the nearby recreational scenario of 0.51 for adults and 0.89 for youths, using the highest drinking water HI (with the bedrock aquifer as the drinking water source). Both HI are below the threshold value of 1.0. The noncarcinogenic risk is driven primarily in the soil pathway for youths and in the drinking water pathway for adults.

In the residential scenario, risk was calculated for a single individual (child to adult) growing up and living in a residence on the site adjacent to the waste rock pile. Hazard indices in the drinking water pathway were 1.49 for the bedrock aquifer and 1.20 for the shallow aquifer. In the soil pathway, the hazard index was 0.96. Combining HI for the different pathways - ingestion of soil and ingestion of drinking water - yields a total HI for residents of 2.10 with the bedrock aquifer and 1.81 with the shallow aquifer. Both are above the threshold value of 1.0, indicating potential noncarcinogenic risk due to COCs at the site.

There appeared to be a carcinogenic risk associated with arsenic in the residential scenario. This risk was 8.7×10^{-3}, which is greater than the EPA acceptable risk range of 10^{-4} to 10^{-6}. However, to evaluate whether the carcinogenic risk from arsenic *due to the site* was significant, risk values were calculated using background soil arsenic concentrations. Using these concentrations in risk calculations gave risk values of 3.08×10^{-3} to 6.25×10^{-3}. Both background risk values are outside the acceptable range and similar to site risk, suggesting that the additional carcinogenic risk due to the site may not be significant.

Risk from lead was analyzed using the EPA Uptake Biokinetic (UBK) model (version 0.99), which develops a probability of blood-lead levels in residential children. Model runs were made varying the soil concentration input, to determine when the target level would be met. The model gave a soil target concentration of 420-450 mg/kg (ppm) lead when the basement aquifer was the drinking water source. EPA has set remedial action goals for lead in soil of commercial areas between 1,000 and 2,000 mg/kg; this model indicates that soils at the site, which are greater than 450 mg/kg lead, pose some risk to children in a residential setting. When the shallow aquifer was the drinking water source, there was an unacceptable residential risk calculated even with all other pathway concentrations set at 0.0. Therefore, the concentration of lead solely within the shallow aquifer constitutes an unacceptable risk (for children in a residential scenario).

There were a number of potential COCs which do not have associated RfDs. No risk could be calculated for these COCs. Therefore, the total risk may be higher than calculated for this assessment. However, in this instance, most of the chemicals that pose a significant risk have had RfDs developed, therefore the total risk should not be significantly different from that calculated. Some chemicals, for example chromium, have different RfDs depending on chemical speciation. Species differentiation was not analyzed, therefore for these chemicals, the most stringent RfD was used, leading to a probable overestimation of risk.

The lead Uptake Biokinetic model has many inherent uncertainties. It evaluates a probability of blood lead distribution only in residential children, therefore a recreational scenario or risk to adults cannot be evaluated. In addition, the model does not take into account variations in lead species which would result in differing biological uptake in the human body. For example, lead carbonate or small grain size results in greater bioavailability of lead than lead oxide or large grain size. Because of these uncertainties, the lead model probably overestimates risk, resulting in lower calculated soil target levels.

8.1.1 Summary of Site Risk

COCs evaluated for the drinking water pathway were barium and manganese for the basement aquifer, and manganese for the shallow aquifer. Final COCs evaluated for the soil pathway were arsenic, barium, cadmium, chromium, copper, lead, molybdenum, nickel, selenium, silver, and zinc.

For all pathways, arsenic was the only COC with an oral slope factor for carcinogenic risk. Calculated risk values in the vacation use scenario was 10^{-7} for adults and 10^{-6} for children, within the acceptable EPA point of departure of 10^{-6}.

For a vacation recreational use scenario, no pathway demonstrated a hazard index (HI) greater than the threshold value of 1.0. Using the highest drinking water HI (with the bedrock aquifer as the drinking water source) yields a total HI of 0.09 for adults and 0.57 for children.

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Risk from lead was analyzed using the EPA Uptake Biokinetic (UBK) model, which develops a probability of blood-lead levels in residential children. Model runs were made varying the soil concentration input, to determine when the target level would be met. The model gave a soil target concentration of 420-450 mg/kg (ppm) lead, when the basement aquifer was the drinking water source. This is within the EPA recommended residential cleanup concentration for lead in soil of 500-1000 mg/kg, but indicates that soils at the site, which are grater than 450 mg/kg lead, pose some risk to children in a residential setting.. When the shallow aquifer was the drinking water source, there was an unacceptable risk calculated even with all other pathway concentrations set at 0.0. Therefore, the concentration of lead solely within the shallow aquifer constitutes an unacceptable risk (for children in a residential scenario).

8.2 ECOLOGICAL RISK ASSESSMENT

The baseline Ecological Risk Assessment provides a qualitative evaluation of the environmental risks at the Pecos Mine OU (Hagler Bailly, 1997). The site ecology was evaluated to determine if contamination from the site could be causing any significant adverse ecological impact. The exposure media potentially presenting the greatest threat to biota were contaminated soils in the uplands (including waste rock itself) and wetlands, and surface water and sediment in Willow Creek and the wetlands. The primary sources of contaminants are the waste rock and seeps.

In the ecological risk assessment process the receptors must be selected (humans are the only receptor in HRA). The problem formulation includes the development of two key endpoints for the risk assessment. Assessment endpoints define the environmental parameters that will be evaluated in the risk assessment. They are the receptors whose risk best represents the risk to the entire community, but because of their sensitivity or scarcity may not be available for actual measurement (for example, eagles). Measurement endpoints are the actual environmental measurements made (for example, earthworms), or those receptors for which adequate laboratory study has been done (for example, mink), to evaluate the risk to assessment endpoints. One or more measurement endpoints are selected to appropriately represent each measurement endpoint. Risk is calculated using a combination of measurement of health effects on measurement endpoints, and modeling of the system using sampling data.

The metal and metalloid elements that are ecological COCs for the Pecos Mine OU include arsenic, cadmium, copper, lead, selenium, and zinc. These COCs differ from those in the human health risk assessment because the pathways for the ecological community differ from those for humans, and because certain chemicals have very different toxicity for ecological receptors than for humans.

At the site, the transport pathways for potential exposure of aquatic and terrestrial resources and receptors to site contaminants include:
- direct exposure of aquatic biota to contaminated surface water
- food chain exposure of piscivorous and benthivorous biota to contaminated aquatic fauna
- direct exposure of terrestrial vegetation, soil invertebrates, and grazing and burrowing mammals to contaminated soils
- direct exposure of terrestrial biota to contaminated ground water seeps and surface water
- food chain exposure of terrestrial herbivores to contaminated vegetation, of insectivores to contaminated invertebrates, and of carnivores to contaminated prey.

In the aquatic ecosystem, there is a risk to aquatic biota in both the Willow Creek wetland and the Pecos River, primarily from zinc. Major metal loading to the surface water pathway occurs during spring runoff and snowmelt, both from bulk transport of sediment and from increased seep outflow. In the terrestrial ecosystem, there is risk to vegetation and terrestrial invertebrates from direct exposure to contaminated soils. Within the wetland soils, only the soils around the white seep (WSBDT) show sufficient contamination to present unacceptable risk. The conclusion of the Ecological Risk Assessment was that there appears to be little risk through the food chain in either ecosystem.

8.3 NATURAL RESOURCE DAMAGE ASSESSMENT

The Natural Resource Damage Assessment (NRDA) evaluates the injuries to natural resources that have resulted from releases of hazardous substances from the Pecos Mine OU. The AOC limits damage claims to "restoring and replacing the loss of such resources." The injuries can be classified into two categories: existing injuries, and those injuries, termed residual injuries, that will remain following remediation. The NRDA evaluated on site restoration options (to restore or replace), and proposed additional off site natural resource projects that would compensate for (replace) the residual injuries remaining on site.

The NRDA rated existing injuries to resources at the site. Those injuries are as follows:
- Pecos River: Moderate near the site to minimal downstream after 11 miles.
- Willow Creek: Severe at the site.
- Uplands: Complete under the waste rock pile and in the barren zone; moderate in soils adjacent to the waste rock pile; slight to minimal in other site soils.

- Wetland: Complete next to major seeps; moderate downgradient of seep WSBDT; slight in the rest of the wetland.

Areas of slight injury in which remediation may create greater harm (e.g., removing wetland soils in the areas of slight injury would be much more destructive to the wetlands than leaving the soils) should not be remediated, leaving a slight residual injury. An additional slight residual injury will occur in the soils remaining beneath the consolidated waste pile.

The NRDA concluded that all areas of significant injury on site have the potential for full restoration. These include the barren zone, Willow Creek, upland soils outside of the consolidated waste pile, and some wetland areas. If possible, these areas will be restored to conditions reflecting those that existed prior to impact from the mine (termed resource baseline). Because of the long time factors for full restoration of some ecological communities (e.g., forest), the replacement option may be utilized to develop equivalent resources (such as meadowland for forest), or to produce the initial stages of resource restoration (such as developing a young-growth forest). The NRDA included additional suggestions to improve resources to produce multiple functions (e.g., restoration of the Willow Creek riparian zone could include improved habitat for native cutthroat trout).

To compensate for the residual injuries that will remain on site, the NRDA suggested options for off site projects that were rated in comparison to the residual injuries. As much as possible, off site projects were selected to improve resources similar to those at the Pecos Mine OU that constituted the residual injury. Off site projects also concentrated on resource restoration (e.g., restore riparian zone near a campground) over human impact management (e.g., create barriers to vehicle use in the campground). The NRDA created a list of off site projects that NMED could use as a guide in selecting one or more projects that would fulfill replacement requirements for on site residual injuries.

This Decision Document combines remediation and restoration for a comprehensive plan for the Pecos Mine OU. Where feasible, on site restoration of resources will be required; restoration plans will be included in the remedial design. Restoration success will be measured through compliance monitoring that must verify the presence of a viable, self-sustaining ecological community that is in a natural condition and will naturally proceed without intervention to resource baseline conditions.

9 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAO) are those categories that direct the environmental goals for the remediation. The Feasibility Study (FS) examined various technologies to evaluate their effectiveness in achieving the RAO. The specifics of remedial action are set out in the Remedial Design; effectiveness of the remediation is measured by the Remedial Action Cleanup Criteria (RAC).

The Remedial Action Objectives for the Pecos Mine OU are the following:

1. Prevent exposure of human and ecological receptors to metals in waste rock or contaminated soils at levels that exceed RAC.
2. Minimize generation of acid leachate from migration of water through the waste rock piles.
3. Prevent migration of contaminants to ground water and surface water to levels that would exceed RAC.
4. Minimize erosional transport of waste rock particulates to downgradient soils and surface water drainages.
5. Minimize transport of contaminated soils to downgradient areas and surface water drainages.
6. Remove highly contaminated soils in the uplands and wetlands.
7. Restore ground water quality to Remedial Action Cleanup Criteria (RAC).
8. Restore surface water quality to Remedial Action Cleanup Criteria (RAC).
9. Restore natural resources that have incurred injury due to the site; provide resource replacement for those resources that cannot be fully restored.

10 REMEDIAL ACTION CLEANUP CRITERIA

Remedial Action Cleanup Criteria (RAC), as defined in the Statement of Work (SOW) for the Consent Order for this site, are "site specific numerical standards for contaminants of concern, developed by NMED as part of the Record of Decision, and based upon results from the Health and Environment Risk Assessment and upon ARARs developed in the Remedial Investigation." For the purposes of this Decision Document, RAC will also be developed for natural resource restoration objectives and criteria. The Remedial Action Objectives for this site are primarily based on meeting RAC; compliance criteria function to meet RAC.

ARARs are Applicable, or Relevant and Appropriate Requirements, defined under the federal CERCLA program. Applicable requirements are those standards or regulations that directly apply to the site (e.g., state WQCC ground water standards). Relevant and appropriate requirements are those that, while not directly applicable, relate to situations similar enough to those at the site that their use is suitable. For the Pecos Mine OU, the RAC will be used as the remedial requirements, and may encompass any suitable state or federal requirement. The RAC will also outline, where practicable, requirements for the points of compliance for the particular RAC.

The AOC and SOW defines RAC compliance for the Upper Pecos Site:

* The Respondents shall propose, during the course of remediation, specific sampling stations, sampling parameters and frequency to demonstrate RAC. The Respondents may make phased proposals for different media or operable units. (Cyprus Amax has submitted "Compliance Monitoring Proposal for Pecos Mine Operable Unit" which at this time is under review by NMED).
* Soil remediation shall be deemed complete after all soil samples from NMED-approved compliance sampling stations meet RAC.
* Ground water remediation, and surface water and stream sediment remediation in the Pecos River and Willow Creek shall be deemed complete after eight consecutive quarterly samples from all NMED-approved compliance sampling stations meet RAC.
* Where any portion of the work requires a federal or state permit or approval, Respondents shall submit timely and complete application and take all other actions necessary to obtain all such permits or approvals.
* The wetland shall continue to be sampled biannually as part of the long-term operation and maintenance of the Site.

Compliance for natural resource restoration shall be demonstrated through sampling and inspection, as specified in an NMED-approved compliance monitoring plan, to verify the establishment of a viable, self-sustaining ecological community appropriate for the life zone of the area. Restoration success for a self-sustaining ecological community will be determined through comparison of ground cover and diversity and will be made on the basis of comparison with an NMED-approved reference area or other NMED-designated technical standards. Performance criteria for comparison will be specified in the Remedial Design and Compliance Monitoring Plan.

If the Respondents can conclusively demonstrate that background of any contaminants are greater than RAC, the RAC for those contaminants in the designated medium shall become the background concentration. NMED shall have approval authority over acceptance of the background concentration and sampling station location.

Under the terms of the SOW, the Respondents may also propose that further reductions in contamination are not feasible:

* Technical infeasibility may be proposed by a statistically valid extrapolation of the decrease in concentration of any constituent over the remainder of a twenty year period, such that projected future reductions during that time would be less than 20% of the concentration at the time the technical infeasibility proposal is prepared. A statistically valid decrease cannot be demonstrated without data from at least eight consecutive quarters.
* Technical infeasibility may be demonstrated by proving that RAC cannot be met using the best available demonstrated technology. Such proof shall include projected

reductions in contaminant concentration either by modeling or other appropriate means.

* In no event shall technical infeasibility be asserted unless the contamination level at the time of the claim is 200% or less of the RAC. The Respondents shall include in any technical infeasibility claim alternate cleanup criteria which are technically feasible, and shall meet RAC for all other constituents.
* The technical infeasibility claim is subject to NMED approval.

The Remedial Action Cleanup Criteria for the Pecos Mine OU are as follows:

10.1 Ground water

The New Mexico Water Quality Control Commission regulations Section 3103 sets standards for ground water in the state of 10,000 mg/l total dissolved solids (TDS) concentration or less. The standards apply to dissolved concentrations except for mercury, organic compounds, and non-aqueous phase liquids (NAPL). For the Pecos Mine OU, standards which will apply for compliance include, but are not limited to:

- Arsenic 0.1 mg/l
- Barium 1.0
- Cadmium 0.01
- Chromium 0.05
- Copper 1.0
- Cyanide 0.2
- Fluoride 1.6
- Lead 0.05
- Manganese 0.2
- Mercury 0.002 (total)
- Selenium 0.05
- Silver 0.05
- Sulfate 600.0
- TDS 1000.0
- Zinc 10.0
- pH 6-9

Compliance monitoring points for ground water shall be from monitoring wells installed such that samples are collected from:

1) The basement rock aquifer and the colluvial aquifer in at least two locations:
   - at the north end of the main waste rock pile, within the influence of Willow Creek subsurface flow
   - downgradient from the main waste rock pile, near where the hillslope meets the wetland

2) Seep affected locations:
- Near WSBDT, the white seep
- Near ESS, the explosive shed spring

10.2 Surface Water

Subpart II of "Standards for Interstate and Intrastate Streams" for the State of New Mexico designates uses for specified stream segments in the state. Section 2214 specifies "...the main stem of the Pecos River from the mouth of Alamitos Canyon upstream to its headwaters, including all tributaries thereto" which includes Willow Creek. For this stretch the designated uses are domestic water supply, fish culture, high quality coldwater fishery, irrigation, livestock watering, wildlife habitat, and secondary contact. Section 3101 applies standards to these designated uses; compliance for surface water at the Pecos Mine OU must meet the most stringent of these applicable standards. For the Pecos Mine OU, standards which shall apply include, but are not limited to:

♦ pH	6.6 to 8.8
♦ dissolved oxygen	not less than 6.0 mg/l
♦ dissolved arsenic	0.05 mg/l
♦ dissolved barium	1.0
♦ dissolved cadmium	0.010
♦ dissolved chromium	0.05
♦ dissolved lead	0.05
♦ total mercury	0.002
♦ dissolved nitrate	10.0 (as N)
♦ dissolved selenium	0.05
♦ dissolved silver	0.05
♦ dissolved cyanide	0.2
♦ total phosphorous	0.1
♦ turbidity	10 NTU
♦ conductivity (25°C)	300-1500 µmhos/cm

In addition, acute and chronic standards and sampling protocol for fisheries shall apply, as specified in Section 3101J.

Section 1102A states "The stream shall be free of water contaminants from other than natural causes that will settle and adversely inhibit the growth of normal flora and fauna or significantly alter the physical or chemical properties of the bottom. Siltation resulting from the reasonable operation and maintenance of irrigation and flood control facilities is not subject to these standards."

Section 1101A states that "No degradation shall be allowed in high quality waters...including waters designated by the U.S. Congress under the Wild and Scenic

Rivers Act..." The stretch of the Pecos River which includes the portion adjacent to the Pecos Mine OU has been so designated.

Section 1103C sets out sampling locations, which will be applied to the above compliance monitoring requirements. For streams, monitoring stations shall be located a sufficient distance downstream to ensure adequate vertical and lateral mixing.

Surface water compliance monitoring stations for surface water at the Pecos Mine OU shall include locations downstream (to ensure adequate vertical and lateral mixing) of seeps ESS and WSBDT, within the main braid of Willow Creek as it enters the Pecos River, and within the Pecos River downstream from where the main braid of Willow Creek enters the river.

10.3 Soils

Compliance monitoring points for soils shall be applied to those areas designated for soil remediation. Cleanup criteria shall be field XRF readings of less than 1200 mg/kg lead, subject to laboratory confirmation sampling. Such cleanup criteria are consistent with those previously implemented during remedial activities at the El Molino OU, and with EPA cleanup values for commercial areas (1000-2000 mg/kg).

10.4 Air

Air sampling during the Remedial Investigation showed no unacceptable concentrations in air of contaminants of concern. Because particulate emissions to air will decrease with completion of the remedy, it is assumed that air concentrations after the remedy is in place will remain at acceptable levels. However, construction activity during remediation could result in an increase of particulate emissions to air, potentially creating risk for workers at the site. Federal OSHA regulations cover worker health and safety at construction sites. During remediation at the Pecos Mine OU, all OSHA requirements regarding acceptable concentrations in air of contaminants of concern, as well as all requirements regarding worker health and safety, must be met. Air monitoring stations will be located to adequately test site concentrations, and an on-site safety manager will be present during construction activity.

11 COMPARATIVE ANALYSIS OF ALTERNATIVES

In developing remedial alternatives, a number of criteria must be met. In general, the criteria address the effectiveness, implementability, acceptability, and associated risks of each alternative. Details regarding the criteria are included in the description for each alternative. In addition, the remedial alternatives should be developed within the framework of remedial goals for the site. A Feasibility Study (FS) was conducted to provide a comparative analysis of remedial alternatives that would achieve these remedial goals. The alternatives were developed considering the following provisions:

- ◊ Remedial Action Objectives (RAO) - These are broad categories that seek to alleviate the threat from site contaminants to human health or the environment.
- ◊ Applicable or Relevant and Appropriate Requirements (ARARs) - Federal and State environmental laws, regulations, standards, requirements, criteria, or limitations that are legally applicable or relevant and appropriate, where:
    - "applicable" requirements are defined as those promulgated Federal and State requirements that legally regulate or address the activities, substances, or circumstances at the site; and
    - "relevant and appropriate" requirements are those promulgated Federal and State requirements that, while not "applicable," regulate or address problems or situations sufficiently similar to those encountered at the site that their use is well suited to this site.

  ARARs were developed as part of the Remedial Investigation (RI).
- ◊ Remedial Action Cleanup Criteria (RAC) - Site-specific numerical standards for contaminants of concern, developed by NMED as part of the Decision Document, and based upon results from the Health and Environment Risk Assessment and upon ARARs developed in the Remedial Investigation. RAC may include ARARs, risk-based values, or values based on background.
- ◊ Remediation - Implementing technologies and actions that will prevent migration of or exposure to contaminants at the site.
- ◊ Remediation baseline (baseline) - Those conditions that exist at the site now.
- ◊ Restoration - Returning a natural resource to a state that will most closely match its condition prior to site effects. Because some ecological communities may take a very long time to return to pre-effects conditions, restoration in a practical sense may mean creation of a viable, self-sustaining ecological community that is in a natural condition and will naturally proceed without intervention to resource baseline.
- ◊ Resource baseline - The natural ecological condition of the site prior to any mining activity or release of contaminants.

Several remedial action technologies were screened during the Feasibility Study process. The screening eliminated those technologies which were not technically feasible, could not meet state or federal regulations, would not be protective of human health and the environment, or would be prohibitively expensive. The Feasibility Study (FS) reported the screening process and presented remedial alternatives based on those technologies that would successfully fulfill the remediation requirements.

CERCLA and the National Contingency Plan (NCP) established nine criteria to evaluate alternatives for addressing a Superfund site. To these NMED has added an additional criterion dealing with natural resources. These criteria are useful for analysis at the Pecos Mine OU. The criteria are categorized into three groups: threshold, balancing, and modifying. The two threshold criteria must be met in order for an alternative to be eligible for selection. The five balancing criteria are used to weigh major tradeoffs among alternatives. The two modifying criteria help fine-tune the selections.

11.1 Threshold Criteria

11.1.1 Overall Protection of Human Health and the Environment

This criterion addresses whether or not the alternative in question can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by contaminants at the site, by eliminating, reducing, or controlling exposures to RAC. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, particularly long-term effectiveness and compliance with ARARs.

11.1.2 Compliance with RAC

EPA utilizes this criterion as compliance with ARARs, but under the Consent Order, remedial action cleanup criteria are more relevant. This criterion addresses whether or not the alternative can attain compliance with site-specific numerical standards for contaminants of concern that have been developed by NMED as part of the Decision Document.

11.2 Balancing Criteria

11.2.1 Long-term Effectiveness and Permanence

This criterion assesses the alternative for the long-term effectiveness and permanence that it affords, along with the degree of certainty that the alternative will prove successful. Factors that are considered include the magnitude of residual risk remaining from contaminants left on site following remediation, and the adequacy and reliability of controls such as containment systems and institutional controls. This factor addresses in particular the potential need for replacement of technical components of an alternative, such as a cap or treatment system, as well as the potential risks posed should the remedial action need replacement over and above O&M.

11.2.2 Reduction of Toxicity, Mobility, or Volume

This criterion addresses the degree to which an alternative may reduce the toxicity, mobility, or volume of contaminated material or contaminants. Factors considered include the effectiveness of any treatment, the degree to which a treatment is irreversible, and residual contaminants remaining following treatment. For Superfund purposes, this criterion focuses on treatment alternatives for reduction of toxicity, mobility, or volume, but for the Pecos Mine OU it may also be considered for alternatives such as containment or removal, if those alternatives can effectively cause similar reductions in either waste or contaminants.

11.2.3 Short-term Effectiveness

This criterion addresses the short-term impacts of alternatives. These short-term risks may be to human receptors at the site, ecological receptors at the site, any affected communities near the site or along routes affected by the alternative, or workers implementing the alternative. A comparison of the time until protection is achieved for various alternatives is also included under short-term effectiveness.

11.2.4 Implementability

This criterion addresses the ease or difficulty of implementing the alternatives by considering the following factors: technical feasibility, including technical difficulties and unknowns associated with construction and operation; reliability of a technology; administrative feasibility, including coordination among various agencies and required permits; and the availability of services, materials, and equipment.

11.2.5 Cost

This criterion addresses the cost of implementing various alternatives, including direct and indirect capital costs, annual operation and maintenance (O&M) costs, and net present values of capital and O&M costs.

11.2.6 Natural Resource Restoration

This criterion compares the relative ability to integrate natural resource restoration with the remediation. Integration would include the area of the site available for full restoration, as well as any residual injury left at the site due to the remediation itself.

11.3 Modifying Criteria

11.3.1 EPA Support

Under CERCLA (Superfund), state acceptance is a modifying criteria for evaluation of remedial alternatives. Because the Pecos Mine OU is a state-lead site, the modifying criteria under this Decision Document will be EPA support. A Memorandum of Understanding (MOU) between EPA and the State of New Mexico provides for EPA review and comment on all pertinent documents and actions at the Pecos Mine OU.

11.3.2 Community Acceptance

Assessment of community acceptance includes determining which components of the alternatives interested persons or groups in the affected communities support, have reservations about, or oppose. This criterion allows for a public comment period on the proposed remedy. Public comments were considered by the state in analyzing its final decision; a response to comments is developed as part of the Final Decision Document. A copy of written comments, a copy of the transcript to the public meeting on the proposed Decision Document, and a response to written and verbal comments is provided as an appendix to this Final Decision Document.

12 COMPARISON OF REMEDIAL ALTERNATIVES

The initial step in selecting remediation alternatives was identification of appropriate general response actions and technologies. General response actions are broad categories of activities that have the potential to satisfy the RAOs. The types of response actions considered for the Pecos Mine OU include:

- no action
- institutional controls
- treatment
- containment
- removal

All of the remedial alternatives except no action will provide some degree of overall protection of human health and the environment. The degree to which each alternative provides this protection is compared with the threshold criteria.

12.1 No Action

No action is a required component in a Feasibility Study, as a basis of comparison when evaluating other alternatives. The no action alternative would not involve any remedial actions, leaving the site essentially as it currently exists. The only costs associated with this alternative would be for monitoring. The no action alternative does nothing for remediation or restoration, it does not decrease the toxicity, mobility, or volume of contaminants, and would not decrease the threat to human health or the environment. The no action alternative is not favored by NMED.

12.2 Institutional Controls

Institutional controls are put in place to limit use of the site area and water, but this limited action would not remediate the contamination. Warning signs would be posted and fences would be erected to restrict access to the site. Deed restrictions would be put in place so that, if the land is ever sold, most activities would be prohibited, although legal action by future owners could negate the deed restrictions. Similar to the no action alternative, the site would be monitored, but there would be no reduction in contamination. Exposure to humans would be reduced, but little reduction to ecological receptors would take place. This alternative also is not favored by NMED, although institutional controls may be incorporated into other remedial alternatives.

12.3 Treatment

Treatment would involve some type of chemical or physical alteration of the contaminated material. For materials such as waste rock, treatments could include stabilization (e.g., mixing with concrete) or solidification (e.g., vitrification). Treatment reduces the toxicity and mobility of contaminants, but may often greatly increase the volume. For the Pecos Mine OU, increased emphasis on natural resource restoration as part of the Decision Document results in a limited area available for treated material leaving most types of treatments as questionable alternatives. Certain other treatment systems (e.g., vitrification) are generally not cost-effective for high volumes of material. Partial treatment may be included as part of the capping alternative, for example mixing waste rock with limestone in a layer just under the constructed cover.

Treatment of contaminated soils is an alternative separate from waste rock remediation. In the case of soils, treatment would consist of soil amendments to raise the pH of the soil to near neutral levels. The Ecological Risk Assessment concluded that metal uptake in plants was significantly reduced when soil pH was near neutral, therefore treatment of contaminated soils would reduce contaminant bioavailability and ecological toxicity. However, metals would still be in soils at elevated concentrations, therefore the amended soils would still constitute an exposure to human and ecological receptors, and a residual resource injury. Additionally, soil pH may change over time, recreating an ecological toxicity in the contaminated area.

Treatment of seeps will be required if the surface remediation does not result in a reduction in the contaminant concentration in seep flow. Treatment options will depend on the volume of seep flow and contaminant concentration at the time of treatment design, but a decision on treatment will occur no sooner than two years following surface remediation. Possible treatment options were described in the Feasibility Study.

Treatment of ground water may be required if the surface remediation does not result in a reduction in contaminant concentration in ground water. A decision on treatment options or institutional controls would be made by NMED and depend on the contaminant concentration at the time of the treatment design, but a decision would occur no sooner than two years following surface remediation.

12.4 Containment

Containment consists of consolidating the contaminated material and isolating it from the environment. Containment systems can range from concrete entombment to a simple soil cover. Containment options considered for the Pecos Mine OU include technologies that prevent water derived from precipitation, surface run-on, or subsurface flow from entering the waste rock pile in quantities that could result in acid leachate generation and subsequent discharge to surface water or ground water. Containment does not reduce the toxicity or volume of contaminated material, but if successful will greatly reduce the mobility of contaminants. The commonly accepted performance criterion for barriers (caps) is a permeability not greater than 10^{-7} centimeters per second (for example, section 2.2.1.1, Quality Assurance and Quality Control for Waste Containment Facilities, EPA 1993).

In each of the above alternatives (no action, treatment, containment), contaminated material remains at the site. The result is an increased potential for future exposure, increased operation and maintenance costs, a reduced area available for natural resource restoration, and a residual injury associated with the area where the remnant material remains. There will be some transportation of capping materials to the site. The amount of transportation would depend on the type of materials used in the cap and their availability.

12.5 Removal

The removal alternative results in elimination of contaminants from the site. All contaminated material would be excavated and transported to another location for disposal. For the Pecos Mine OU, the only feasible location for placement would be the tailings piles at the El Molino OU. Once transported, the Pecos Mine OU material would be added to the tailings, and the entire pile would be capped (the tailings will be capped whether or not Pecos Mine material is added). Removal results in total reduction at the Pecos Mine OU in the toxicity, mobility, and volume of contaminants. It is expected that with sources removed, eliminating contaminant release to environmental pathways, ground water and surface water would also be remediated. Full remediation is achieved, natural resource restoration can be completed on site, and there is no contaminant exposure to humans or the environment.

Because of greatly increased transportation needs, the removal alternative produces a greater burden and short-term hazard on the Village of Pecos, through which the material must be transported, and any traveler using Highway 63 and Highway 50, which are the routes from the Pecos Mine OU to the El Molino OU. Excavating and transporting all the contaminated material at the site, instead of the limited amount associated with consolidation, is also increasingly expensive compared to the other alternatives. Finally, transport of material to El Molino does not decrease its overall volume or toxicity (capping at the tailings would reduce contaminant mobility), but merely moves the source to another location, possibly increasing environmental problems at the El Molino OU.

13 DESCRIPTION OF ALTERNATIVES

Following comparison of available general response actions and technologies, several specific remedial alternatives were screened during the Feasibility Study process. The screening process eliminated those alternatives which were not technically feasible, could not meet state and/or federal regulations, or would not be protective of human health and the environment. Even though the no action alternative fails these tests, it was retained as a baseline comparison to the more protective alternatives.

The institutional controls alternative was rejected because it would not be protective of the environment (proper controls might be protective of human health), nor would it result in any reduction of contaminant migration and further environmental degradation. However, specific institutional controls could be included as part of other remedial designs, both for short-term protection, such as fencing during remediation, and long-term protection, such as deed restrictions on ground water use.

Large-scale treatment alternatives were rejected, either because of unsuitable technologies inappropriate for application to this site, or site restrictions disallowing treatments that would greatly increase the volume or area required for treated material (FS section 2.3.1.3). Treatment with neutralizing agents (such as laying lime over waste rock prior to capping) may be included in the selected alternative. Treatment options for seep water and ground water will be considered if contingency measures are implemented for these media.

The screening process produced five remedial alternatives for the Pecos Mine OU, including three types of containment options and one removal option:
1. No Action
2. Soil cap
3. Compacted clay cap
4. Geo-membrane cap
5. Removal to El Molino OU

All remedial options include an ongoing monitoring of seeps, surface water, and ground water. If the selected remediation does not result in attainment of RAC, then additional remedial activity will be developed to complete remediation. All remedial options also include restoration or replacement of injured resources, as required by the Consent Order.

13.1 Alternative 1, No Action

The no action alternative consists of monitoring and existing interim actions only. In addition to the monitor wells already in place, additional monitor wells would be installed at the base of the hillslope at the wetland, to monitor potential contaminant migration through the colluvial or bedrock aquifers. This alternative can be implemented and produces no additional short-term risk. Some cost would be associated with the installations of monitor wells and compliance monitoring of all media pathways. This alternative does not fulfill either threshold requirement (overall protection of human health and the environment, and compliance with RAC). It does not have long-term effectiveness, does not reduce toxicity, mobility, or volume, and meets neither community acceptance nor EPA support.

13.2 Alternative 2, Soil Cap

Waste rock would be consolidated and covered with a cap constructed of clay and soil. Contaminated soils from the barren zone would be excavated and added to the pile prior to cap emplacement. The cap consists of a 24-inch non-compacted clay soil, directly vegetated with grasses and forbs, over the top of the waste rock pile. The cap would be underlain by a 2-inch zone of crushed limestone incorporated into the surface of the waste rock immediately below the clay. The clay soil and vegetation layer prevent erosional transport of the waste rock and direct contact of human and ecological receptors. Vegetation also maximizes evapotranspiration of water that could infiltrate into the waste rock pile. The crushed limestone would add alkalinity to any water that does infiltrate into the pile, thus reducing the potential for net acid generation and mobilization of metals as water flows through the pile.

The sides of the pile would be covered with a 48-inch low permeability (10^{-7} centimeters per second) compacted clay layer overlain by an 18-inch vegetation layer. This would reduce infiltration through the sides of the pile by 99% compared to current conditions. The Remedial Design will determine whether sufficient clay of the appropriate quality is available on site, or whether additional clay would need to be acquired from off-site sources.

Contaminated soils underlying waste rock that is moved for consolidation would be treated by application of crushed limestone to add alkalinity, increase pH, and buffer additional acid production. The rate of limestone application will be calculated in the remedial design using methods that ensure adequate neutralization of existing acid conditions as well as acids produced by further weathering of sulfides remaining in the soils. The limestone would be incorporated into the uppermost six inches of soil. Treated soils would be revegetated with native grasses and forbs of mountain meadow habitat.

Subsurface and run-on surface flow to the pile would be intercepted and diverted around the pile. Ground water quality would be monitored in monitor wells completed in the colluvial aquifer, basement aquifers, and alluvial aquifer. The exact number and location of monitor wells would be determined in the remedial design. Institutional controls would be put in place limiting or prohibiting use of ground water at the site for drinking water purposes.

This cap would have a moderate permeability (variable but around 10^{-4} centimeters per second). Decreased percolation and leachate generation are expected to result in improved seep water quality and/or decreased seep discharge, as well as improved ground water quality. Seeps and ground water would be monitored to determine the remedial effect this alternative would produce. If seep water quality and ground water quality do not improve to RAC, further remedial effort will be enacted. The design of those efforts will be determined based on the water flow and quality seen in the seeps and monitor wells at that time.

Contaminated soils around seeps WSBDT and ESS will be excavated and included on the consolidated waste rock pile prior to cap placement. Excavated areas will be replaced with clean fill and restored to wetland habitat.

Waste rock in the Willow Creek channel and banks, as well as the lime pile will be removed and included in the consolidated waste rock pile prior to cap placement. Stream channel morphology, gradient, and riparian habitat will be restored to conditions that will result in natural recovery to resource baseline.

13.2.1 Overall Protection of Human Health and the Environment

A soil cap would provide protection to human health and the environment by consolidating contaminated material and isolating the pile from the environment.

13.2.2 Compliance with RAC

By preventing a pathway for contaminant migration this alternative has the potential to meet RAC. A cap would prevent contaminant release through the air pathway. However, the Feasibility Study determined that a soil cap should reduce infiltration by 91%, not enough to prevent infiltration during high precipitation events. Therefore prevention of contaminant migration is not assured. Other areas from which contaminated material was excavated for placement on the pile, for example below seep WSBDT, would meet RAC.

Compliance monitoring would determine if this alternative attains RAC. If RAC are not met, additional remedial efforts would be taken.

13.2.3 Long-term Effectiveness and Permanence

Cap technology has been used commonly at mine sites throughout the United States, and has been shown to be an effective long-term environmental remedy. There should be no degradation of the natural materials used in this alternative. The engineering design for the top and side slopes should create a stable surface. Because the design of Alternative 2 does not include a barrier, but relies primarily on vegetation for infiltration reduction, it may not have the potential for long-term effectiveness and permanence.

13.2.4 Reduction of Toxicity, Mobility, or Volume

Isolating the waste rock will not reduce its toxicity or volume. However, an effective cap will prevent acid generation, reducing the mobility of the contaminants.

13.2.5 Implementability

Standard materials and construction techniques would be utilized, therefore, this alternative is implementable. Capping materials might be obtained from on site, although these may have to be supplemented with materials obtained off site.

13.2.6 Short-term Effectiveness

Estimated time to implement this remedy is two years. Short-term risks on site would be mostly those associated with construction activities, and an added potential for contaminant migration through the air and surface water (runoff) pathways during construction. Interim actions would be emplaced to minimize short-term risk. Off-site short-term risks would be to the local communities on the routes used to transport some materials to the site. Flow of local vehicle traffic will also be affected, and damage to the roadways will probably result from the extended heavy truck traffic.

13.2.7 Cost

Cost estimated in the FS for this alternative is $3,431,379, with a present value O&M cost of $350,856.

13.2.8 Natural Resource Restoration

Areas from which contaminated material has been removed should be amenable to full resource restoration. Contaminated soils that are left in place but treated will retain a residual resource injury, due to the continued presence of metals left in the soil. There will also be a residual injury associated with the area where the consolidated pile remains, although some resource restoration will be developed on the cap itself. Restoration on the cap would be confined to native grasses and forbs of mountain meadow habitat.

13.2.9 EPA Support

EPA does not support a soil cap when other more effective feasible alternatives are available.

13.2.10 Community Acceptance

There were few public comments related to the specifics of a soil cap, but the sense of the community was that the remediation should utilize more effective feasible alternatives if available.

13.3 Alternative 3, Compacted Clay Cap

Waste rock would be consolidated and capped. Contaminated soils from the barren zone would be excavated and added to the pile prior to cap emplacement. The cap would consist of 18 inches of compacted clay, overlain by a 2-inch lateral drainage layer of 0.25 inch rock (D50), topped by an 18-inch layer of vegetated soil.

The compacted clay layer will have extremely low permeability to water (10^{-8} centimeters per second) and thus provides a barrier to downward vertical movement of water that is not eliminated by evapotranspiration or runoff. The lateral drainage layer provides a conduit for removal of water that accumulates on top of the clay layer. Drainage of this water helps reduce the vertical hydraulic head on the clay layer, further reducing the potential for passage of water through to waste rock. Modeling results in the FS indicate that the compacted clay cap will reduce percolation through the waste rock pile by more than 99% compared to baseline conditions.

The sides of the pile would be covered with a 48-inch low permeability (10^{-7} centimeters per second) compacted clay layer overlain by an 18-inch vegetation layer. This would reduce infiltration through the sides of the pile by at least 99% compared to current conditions.

Subsurface and run-on surface flow to the pile would be intercepted and diverted around the pile. Ground water quality would be monitored in monitor wells completed in the colluvial aquifer, basement aquifers, and alluvial aquifer. The exact number and location of monitor wells would be determined in the remedial design. Institutional controls would be put in place limiting or prohibiting use of ground water at the site for drinking water purposes.

This cap would have a low permeability (10^{-8} centimeters per second). Decreased percolation and leachate generation are expected to result in improved seep water quality and/or decreased seep discharge, as well as improved ground water quality. Seeps and ground water would be monitored to determine the remedial effect this alternative would produce. If seep water quality and ground water quality do not improve to RAC, further remedial effort will be enacted. The design of those efforts will be determined based on the water flow and quality seen in the seeps and monitor wells at that time.

Contaminated soils around seeps WSBDT and ESS, in the barren area, and other upland areas as designated in the remedial design will be excavated and included on the consolidated waste rock pile prior to cap placement. Excavated areas will be replaced with clean fill and restored to wetland or upland habitat.

Waste rock in the Willow Creek channel and banks, as well as the lime pile, will be removed and included in the consolidated waste rock pile prior to cap placement. Stream channel morphology, gradient, and riparian habitat will be restored to conditions that will result in natural recovery to resource baseline.

13.3.1 Overall Protection of Human Health and the Environment

A compacted clay cap would provide protection to human health and the environment by consolidating contaminated material and isolating the pile from the environment.

13.3.2 Compliance with RAC

By preventing a pathway for contaminant migration this alternative has the potential to meet RAC. Modeling for the Feasibility Study indicated that a compacted clay cap should reduce infiltration by 99% compared to baseline conditions, enough to prevent infiltration during almost all precipitation events. A cap would also prevent contaminant release through the air pathway. Other areas from which contaminated material was excavated for placement on the pile, for example below seep WSBDT, would meet RAC.

Compliance monitoring would determine if this alternative attains RAC. If RAC are not met, additional remedial efforts would be taken.

13.3.3 Long-term Effectiveness and Permanence

Cap technology has been used commonly at mine sites throughout the United States, and has been shown to be an effective long-term environmental remedy. There should be no degradation of the natural materials used in this alternative; a clay cap is considered to have permanence. The engineering design for the top and side slopes should create a stable surface. A clay layer is subject to desiccation and root penetration, although only simple operation and maintenance (O&M) actions are required to repair the layer and remove deeply rooting plants. Because a compacted clay cap would prevent infiltration during even moderate to high precipitation events, it has long-term effectiveness.

13.3.4 Reduction of Toxicity, Mobility, or Volume

Neither the toxicity nor the volume of contaminated material is reduced, however there is reduction in contaminant mobility due to preventing of infiltration into the waste rock pile, with subsequent reduction in acid generation and contaminant transport.

13.3.5 Implementability

Standard materials and construction techniques would be utilized, therefore, this alternative is implementable. Capping materials might be obtained from on site, although these may have to be supplemented with materials obtained off site.

13.3.6 Short-term Effectiveness

Estimated time to implement this remedy is 2-3 years. Short-term risks on site would be mostly those associated with construction activities, and an added potential for contaminant migration through the air and surface water (runoff) pathways during construction. Interim actions would be emplaced to minimize short-term risk. Off-site short-term risks would be to the local communities on the routes used to transport the required materials to the site. Flow of local vehicle traffic will also be affected, and damage to the roadways will probably result from the extended heavy truck traffic.

13.3.7 Cost

Cost estimated in the FS for this alternative is $3,725,945, with a present value for a 20-year O&M cost of $436,402.

13.3.8 Natural Resource Restoration

Areas from which contaminated material has been removed should be amenable to full resource restoration. There will be a residual injury associated with the area where the consolidated pile remains, although some resource restoration will be developed on the cap itself. Restoration on the cap would be confined to native grasses and forbs of mountain meadow habitat.

13.3.9 EPA Support

EPA supported this alternative, and suggested that the Decision Document allow for flexibility in the Remedial Design phase with regard to the specifics of the materials for the cap.

13.3.10 Community Acceptance

Public comments in general agreed with the general alternatives of capping in place. There was little discussion as to the technical specifics of cap design, but the sense of the community was support for an effective capping alternative.

13.4 Alternative 4, Geomembrane cap

Waste rock would be consolidated and capped. The cap would consist of 12 inches of compacted clay, overlain by a 30-mil polyvinyl chloride (PVC), overlain by 0.2-inch geonet/geotextile drainage layer, topped by an 18-inch layer of vegetated soil.

The PVC layer has very low permeability to water (10^{-13} centimeters per second). The compacted clay layer provides a smooth surface on which to lace the geomembrane, reducing the potential for punctures. The clay layer also provides a further barrier to vertical migration of water in the event of a leak in the geomembrane. The lateral drainage layer provides a conduit for removal of water that accumulates on top of the clay layer. Modeling in the FS indicates that a geomembrane cap will reduce percolation of water to the waste rock by more than 99.9% compared to baseline conditions.

The sides of the pile would be covered with a 48-inch low permeability (10^{-7} centimeters per second) compacted clay layer overlain by an 18-inch vegetation layer. This would reduce infiltration through the sides of the pile.

Subsurface and run-on surface flow to the pile would be intercepted and diverted around the pile. Ground water quality would be monitored in monitor wells completed in the colluvial aquifer, basement aquifers, and alluvial aquifer. The exact number and location of monitor wells would be determined in the remedial design. Institutional controls would be put in place limiting or prohibiting use of ground water at the site for drinking water purposes.

This cap would have an extremely low permeability (10^{-14} centimeters per second). Decreased percolation and leachate generation are expected to result in improved seep water quality and/or decreased seep discharge, as well as improved ground water quality. Seeps and ground water would be monitored to determine the remedial effect this alternative would produce. If seep water quality and ground water quality do not improve to RAC, further remedial effort will be enacted. The design of those efforts will be determined based on the water flow and quality seen in the seeps and monitor wells at that time.

Contaminated soils around seeps WSBDT and ESS, in the barren area, and other upland areas as designated in the remedial design will be excavated and included on the consolidated waste rock pile prior to cap placement. Excavated areas will be replaced with clean fill and restored to wetland or upland habitat.

Waste rock in the Willow Creek channel and banks, as well as the lime pile, will be removed and included in the consolidated waste rock pile prior to cap placement. Stream channel morphology, gradient, and riparian habitat will be restored to conditions that will result in natural recovery to resource baseline.

13.4.1 Overall Protection of Human Health and the Environment

A geomembrane cap would provide protection to human health and the environment by consolidating contaminated material and isolating the pile from the environment.

13.4.2 Compliance with RAC

The Feasibility Study determined that a geomembrane cap should reduce infiltration by 99.9% compared to baseline conditions, enough to prevent infiltration during almost all precipitation events. By preventing a pathway for contaminant migration this alternative has the potential to meet RAC. A cap would also prevent contaminant release through the air pathway. Other areas from which contaminated material was excavated for placement on the pile, for example below seep WSBDT, would meet RAC.

Compliance monitoring would determine if this alternative attains RAC. If RAC are not met, additional remedial efforts would be taken.

13.4.3 Long-term Effectiveness and Permanence

Because a geomembrane would prevent infiltration during even moderate to high precipitation events, it has long-term effectiveness. Cap technology has been used commonly at mine sites throughout the United States, and has been shown to be an effective long-term environmental remedy. Synthetic materials can degrade over time, although degradation is minimized when the materials are buried under soil, as in this alternative; a geomembrane cap is considered to have permanence. Because a geomembrane cap would prevent infiltration during even moderate to high precipitation events, it has long-term effectiveness. The engineering design for the top and side slopes should create a stable surface.

13.4.4 Reduction of Toxicity, Mobility, or Volume

Neither the toxicity nor the volume of contaminated material is reduced, however there is reduction in contaminant mobility due to preventing infiltration into the waste rock pile, with subsequent reduction in acid generation and contaminant transport.

13.4.5 Implementability

Standard materials and construction techniques would be utilized, therefore this alternative is implementable. Use of a geomembrane reduces the amount of clay material required to construct the cap, which would also reduce the number of truck trips required to bring the material to the site.

13.4.6 Short-term Effectiveness

Estimated time to implement this remedy is 2-3 years. Short-term risks on site would be mostly those associated with construction activities, and an added potential for contaminant migration through the air and surface water (runoff) pathways during construction. Interim actions would be emplaced to minimize short-term risk. Off-site short-term risks would be to the local communities on the routes used to transport the required materials to the site. Flow of local vehicle traffic will also be affected, and damage to the roadways will probably result from the extended heavy truck traffic.

13.4.7 Cost

Cost estimated in the FS for this alternative is $3,688,959, with a present value for a 20-year O&M cost of $470,620.

13.4.8 Natural Resource Restoration

Areas from which contaminated material has been removed should be amenable to full resource restoration. There will be a residual injury associated with the area where the consolidated pile remains, although some resource restoration will be developed on the cap itself. Restoration on the cap would be confined to native grasses and forbs of mountain meadow habitat.

13.4.9 EPA Support

EPA supported this alternative, and suggested that the Decision Document allow for flexibility in the Remedial Design phase with regard to the specifics of the materials for the cap.

13.4.10 Community Acceptance

Public comments in general agreed with the general alternatives of capping in place. There was little discussion as to the technical specifics of cap design, but the sense of the community was support for an effective capping alternative.

13.5 Alternative 5, Removal

Waste rock and secondary sources such as contaminated soils will be excavated and transported to the El Molino OU. There they will be deposited on the existing tailings piles and capped along with the tailings, using cap designs approved for that area. Because no pile would remain at the Mine OU, no interception drainage would be needed.

The depth to which materials underlying waste rock will be removed is uncertain because the vertical distribution of contaminants is not known for most areas of the site. Therefore, a range of estimates for volume of material to be removed was developed in the FS. The maximum volume assumed that all soil and colluvial materials beneath the existing waste rock pile and downgradient of State Highway 63 would be removed. The minimum volume estimate assumed 50% of the maximum volume would be removed. Excavated areas would be restocked with clean soils, and the entire site restored to upland habitat.

Waste rock in the Willow Creek channel and banks, as well as the lime pile, will be excavated and transported to El Molino. Stream channel morphology, gradient, and riparian habitat will be restored to conditions that will result in natural recovery to resource baseline.

Contaminated soils around seeps WSBDT and ESS, in the barren area, and other upland areas as designated in the remedial design will be excavated and transported to El Molino. Excavated areas will be replaced with clean fill and restored to wetland or upland habitat.

The elimination of source material should result in marked to complete decrease in leachate generation and improved seep water quality and/or decreased seep discharge, as well as improved ground water quality. Seeps and ground water would be monitored to determine the remedial effect this alternative would produce. If seep water or ground water quality does not improve to RAC, for example due to residual contaminants remaining in soils or colluvium, further remedial effort will be required. The design of those efforts will be determined based on the water flow and quality seen in the seeps and monitor wells at that time.

13.5.1 Overall Protection of Human Health and the Environment

Removal of source material would provide protection to human health and the environment by consolidating contaminated material and isolating the pile from the environment.

13.5.2 Compliance with RAC

By eliminating the sources of contamination this alternative has the potential to meet RAC. Other areas from which contaminated material would be excavated, for example below seep WSBDT, would meet RAC.

Compliance monitoring would determine if this alternative attains RAC. If RAC are not met, additional remedial efforts would be taken.

13.5.3 Long-term Effectiveness and Permanence

Because this alternative removes source material from the site, it has long-term effectiveness and permanence. Because waste material would be added to the tailings piles at the El Molino OU, long-term effectiveness for that operable unit may be reduced.

13.5.4 Reduction of Toxicity, Mobility, or Volume

For the Pecos Mine OU the volume of contaminated material is reduced, although the volume is increased in equal proportions at the El Molino OU. The piles at El Molino will be capped, reducing the mobility of contaminants within the waste rock and tailings.

13.5.5 Implementability

Standard materials and construction techniques would be utilized for excavation and transport, therefore, this alternative is implementable. Cap design and implementation has already been approved for the El Molino OU.

13.5.6 Short-term Effectiveness

Estimate time to implement this remedy is 5-6 years. Implementation of the remedy at the El Molino OU (capping of the tailings) would be delayed until all the material from the Pecos Mine OU is moved. Short-term risks on site would be mostly those associated with construction activities, and an added potential for contaminant migration through the air and surface water (runoff) pathways during excavation. Interim actions would be emplaced to minimize short-term risk. Off-site short-term risks would be to the local communities on the routes used to transport source materials to the El Molino OU. Flow of local vehicle traffic will also be affected, and damage to the roadways will probably result from the extended heavy truck traffic. There will be additional short-term risk to workers at El Molino as the material is emplaced.

13.5.7 Cost

Because of the much higher volume of material requiring excavation and transportation, cost estimated in the FS for this alternative is $16,511,359, with a present value O&M cost of $375,237.

13.5.8 Natural Resource Restoration

Because this alternative includes removal of contaminated material, the entire site should be amenable to full resource restoration.

13.5.9 EPA Support

EPA had concerns regarding moving waste material to a different site. The concerns included the potential for environmental damage to the locations to which the material is moved, the hazards associated with transportation, and the potential for violation of RCRA laws. EPA did not support this alternative.

13.5.10 Community Acceptance

As a concept, public opinion supported removal, but only on the condition the waste material would be moved far from the area. No public comments in previous public meetings supported moving the waste to the El Molino Operable Unit. The primary concerns were transportation hazards and the potential detrimental effects of moving waste material to a site much closer to the population center for this area (the Village of Pecos). Public opinion did not support this alternative.

14 NATURAL RESOURCE RESTORATION ALTERNATIVES

The Cost Allocation Agreement, an attachment to the Consent Order, requires the Respondents to restore or replace the loss of resources at the site. Restoration or replacement will include two major components: restoration on site of all resources where feasible; and off site replacement of resources that cannot be restored on site. The term injury will be used to mean resource loss. Resource loss remaining after remediation will be termed residual injuries. The original condition of resources prior to contamination is termed resource baseline.

In order to promote an efficient remediation for the site, this Decision Document has combined remedial alternative decisions with natural resource restoration alternatives, to create a single site remediation plan. Natural resource restoration will be incorporated into the remedial design and remedial action for the site.

A Natural Resource Damage Assessment (NRDA) was prepared for the Pecos Mine OU (Hagler Bailly, 1997; see summary and discussion in this Decision Document). The NRDA summarized injuries to (loss of) resources at the site, determined potential residual injuries based on various remedial alternatives, evaluated the feasibility of on site restoration and off site replacement options, and proposed various off site project alternatives that could be considered for replacement of residual injuries.

On site restoration feasibility and residual injuries for the various remedial alternatives are outlined below. The NRDA presents detailed findings. Current and potential future residual injuries were investigated for Willow Creek, the wetlands, the Pecos River, and the uplands (soils outside the surface water habitats).

- No Action: Because no remediation will be performed under this alternative, contaminant release would continue unabated, therefore on site resource restoration would be futile. Resources on site would not reach resource baseline in any reasonable time frame. All injuries would require off site replacement to fulfill Consent Order obligations. Because decision preferences are for maximum restoration on site, this is an unacceptable alternative.

- Capping: Consolidation of contaminant sources and their isolation from the environment would provide an opportunity for restoration on site at all locations from which contaminated material was removed and those areas that contamination has adversely affected. Areas that could be restored to resource baseline include the Pecos River, Willow Creek, the wetlands, and portions of the uplands. The upland area occupied by the capped pile could not be fully restored to resource baseline, although some resource restoration could be achieved utilizing the top vegetation layer of the cap. The majority of the wetlands soils have elevated concentrations of metals, but those concentrations are not high enough to warrant a remediation. In the terminology of the NRDA, the continued presence of slightly elevated concentrations of contaminants constitutes a slight residual injury. Some additional off site project would be required as a replacement for the residual injury associated with the upland area under the capped pile and the residual injury remaining in the wetlands.

- Removal: Because contaminated material would be moved off site, full on site restoration could be achieved for the Pecos River, Willow Creek, the uplands, and some of the wetlands. The majority of the wetlands soils are slightly elevated in metals concentrations. Those concentrations are not high enough to warrant a remediation, but they do constitute a slight residual injury. Some additional off site project would be required as a replacement for the residual remaining in the wetlands. In a removal, the contaminated material would be added to existing tailings piles at the El Molino OU, creating no additional off site natural resource injury.

On site restoration is included within the remedial decisions of this document. Specific designs for the restoration will be made as part of the remedial design phase for the remediation that is enacted. The Pecos River will most likely require no active restoration. Willow Creek will require riparian habitat restoration. Those portions of the wetlands that are remediated through removal of contaminated soils will require wetland habitat restoration. Upland areas that are remediated through removal of contaminated soils will require restoration as mountain meadow or forest habitat.

The NRDA evaluated a number of off site projects as alternatives for compensation for residual injuries remaining at the Pecos Mine OU after remediation. The first round of projects were proposed by entities and individuals, with no restrictions on proposals. The preliminary projects were then screened based on project relevance to the resources replaced, project relevance to laws and regulations, project consistency to land and resource management for the upper Pecos area, project feasibility, and project cost.

Final off site project alternatives were proposed that fulfilled the screening requirements.

1) For residual injury to the wetlands from remaining slightly contaminated soils:
   - Participation in restoration of Glorieta Creek reservoirs to native floodplain; project undertaken by National Park Service on Pecos National Historic Park property; estimated cost: $50,000
   - Improving riparian habitat at Mora Campground, property owned by New Mexico Department of Game & Fish; estimated cost: $65,000
   - Connecting Forest Road 645 to permit a closing of the Willow Creek road, in order to accommodate a full restoration of the Willow Creek riparian zone. At the time of the NRDA, this project appeared untenable due to the absence of any inter-agency agreements, therefore was not pursued in detail. Since the time of the NRDA, inter-agency discussion have made this project a viable possibility.

2) For residual injury to the uplands remaining underneath the consolidated waste rock pile:
   - Improving upland habitat by prescribed burns in appropriate areas; estimated cost: $15,000-$172,000, depending on area selected
   - Revegetating abandoned road on hillslope directly east of the Pecos Mine OU; estimated cost: $75,000
   - Expanding the habitat of the Holy Ghost Ipomopsis, a federally listed endangered plant species currently found only in Holy Ghost Canyon (a tributary of the Pecos River approximately one mile south of the site), by planting on the vegetation layer of the cap. This action would be completed by government agencies; estimated cost to this site: $0.

Because the NRDA determined that the residual injury remaining for each resource is slight (to moderate for one portion of the wetland) for all alternatives except no action, a single off site compensation project will be required. The FR645 connection would enable a comprehensive restoration of Willow Creek, and would suffice as a compensation project. If an agreement cannot be reached to complete FR645, the Glorieta Creek project is extensive and comprehensive, therefore it will suffice as an off site replacement compensation for all residual injuries at the Pecos Mine OU, provided all planned on site restoration is successful.

15 SELECTED REMEDY

The Remedial Action Objectives for the Pecos Mine OU are the following:

1. Prevent exposure to human and ecological receptors to metals in waste rock or contaminated soils.
2. Minimize generation of acid leachate from migration of water through the waste rock piles.
3. Prevent migration of contaminants to ground water and surface water.
4. Minimize erosional transport of waste rock particulates to downgradient soils and surface water drainages.
5. Minimize transport of contaminated soils to downgradient areas and surface water drainages.
6. Remove highly contaminated soils in the uplands and wetlands.
7. Restore ground water quality to Remedial Action Cleanup Criteria (RAC).
8. Restore surface water quality to Remedial Action Cleanup Criteria (RAC).
9. Restore natural resources that have incurred injury due to the site; develop a community of Holy Ghost Ipomopsis on site; provide resource replacement for those resources that cannot be fully restored.

NMED's selected remedy is **Alternative 3-4, a low-permeability cap**, with some additions and modifications. All screened alternatives were evaluated according to the nine selection criteria outlined earlier. This selection process ensured a comprehensive and thorough study of the benefits of each alternative. A containment alternative was found to be the most cost-effective, with efficient O&M requirements, and protective of human health and the environment of all alternatives studied.

A detailed outline of the selected alternative is outlined below.

1. Consolidate waste rock and underlying contaminated soils into one to two piles. Piles when completed shall have side slopes of demonstrated stability, but in no instance should overall slope be steeper than 3:1. Surface construction shall minimize

erosion. Completed piles shall not encroach upon the Willow Creek 100-year floodplain.

2. Completely remove waste rock, the lime pile, and contaminated soils from the Willow Creek floodplain and from the disjunct pile west of State Highway 63, and place the excavated material on the waste piles prior to capping. Determination of contaminated soils and cleanup criteria shall be field XRF lead concentrations of 1200 mg/kg or higher; XRF values will be subject to laboratory confirmation sampling. Such cleanup criteria are consistent with those previously implemented during remedial activities at the El Molino OU, and with EPA cleanup values for commercial areas (1000-2000 mg/kg). Vehicle access to the upper portion of Willow Creek, either through connecting FR645 or through maintaining access up Willow Creek road, shall not be prohibited. Vehicle travel along Highway 63 shall not be prohibited during remediation. If the FR645 project cannot be enacted, Willow Creek road through the site shall be replaced.
3. Excavate contaminated soils from the barren zone and other upland areas, and place those excavated soils on the waste pile prior to capping. Determination of contaminated soils and cleanup criteria shall be field XRF readings of 1200 mg/kg lead. XRF readings shall be subject to laboratory confirmation sampling.
4. Excavate contaminated sediments from the wetlands in the area of seeps WSBDT and ESS. The extent of contaminated sediments to be removed will be determined in the field, and based on visual inspection by a qualified ecological expert of the extent of discolored sediment and stressed vegetation caused by the seeps. Removal may include sediment within the channeled sections of the wetland.
5. Construct a cap for the top of the consolidated waste pile that will comprise three layers: A low permeability layer (10^{-8} centimeters per second or less; at least 18 inches of compacted low-permeability clay or a geomembrane fabric) on the waste pile, overlain by a lateral drainage layer (at least a 2-inch of 0.25 inch rock (D50) or a geonet fabric), topped by at least an 18-inch vegetation layer. The cap must decrease infiltration to the pile by greater than 99% compared to current conditions. Other cap materials that meet the performance standards may be proposed in the Remedial Design, subject to NMED approval. Include in the Remedial Design a Construction Quality Assurance Plan for construction of the cap.
6. Construct a cap for the sides of the consolidated waste pile that will comprise two layers: A low permeability clay layer (permeability of 10^{-7} centimeters per second or less) at least 48 inches in perpendicular thickness, overlain by a vegetation layer at least 18 inches in perpendicular thickness. The cap must decrease infiltration to the pile by greater than 99% compared to current conditions. Other cap materials that meet the performance standards may be proposed in the Remedial Design, and are subject to NMED approval. Include in the Remedial Design a Construction Quality Assurance Plan for construction of the cap.
7. Construct a surface/subsurface diversion structure along the entire uphill/upgradient side of the consolidated waste pile, to divert all surface run-on and colluvial subsurface flow from the pile. The subsurface portion of the diversion structure shall

be keyed to bedrock. The surface portion of the diversion structure shall be lined with PVC or other impermeable material and keyed to the cap of the consolidated waste pile. Diverted water will emit at Willow Creek or other suitable natural surface drainages. The diversion structure shall be capable of accepting a flow equal to a 100-year maximum precipitation event.

8. Operational safeguards shall be in place during remediation to ensure the health and safety of all workers and visitors at the site.
9. Institutional controls shall be implemented to prohibit use of site ground water as a drinking water source, and to prohibit construction of residences on site. These controls shall remain so long as site conditions warrant.
10. Monitoring of seeps WSBDT and ESS, surface water locations, and ground water monitoring wells will be used to assess the remediation effects on seep volume and quality, surface water quality, and ground water quality. Installation of additional monitoring wells or additional surface sampling points may be required to adequately assess ground water and seep water quality. If within five years the remediation enacted through this Decision Document does not attain, or is shown to be not successfully attaining, RAC for seep water, surface water and ground water, further remedial efforts will be required to address those pathways, as described below in "Contingency Measures".
11. The Willow Creek corridor within the site shall be restored to natural conditions. Restoration shall be deemed effective with the establishment of a viable, self-sustaining ecological community that is in a natural condition and will naturally proceed without intervention to baseline conditions for Willow Creek. If the restoration does not meet specified compliance standards, further restoration efforts will be required.
12. All areas from which waste rock and contaminated soils have been excavated, including the barren zone and the disjunct pile, will be restored to natural conditions of mountain meadow or appropriate forest habitat. Restoration shall be deemed effective with the establishment of a viable, self-sustaining ecological community that is in a natural condition and will naturally proceed without intervention to baseline conditions for uplands in this area. If the restoration does not meet specified compliance standards, further restoration will be required. Revegetation shall include an attempt to install a community of Holy Ghost Ipomopsis; the success of the Ipomopsis community will not be a RAC.
13. The vegetation layer on the cap of the waste pile shall be revegetated to grassland or meadow habitat appropriate for this area. Revegetation shall be limited to those plants that normally do not root deeper than the vegetation layer.
14. To replace residual injury to natural resources that cannot be restored on site, for example uplands under the consolidated waste pile, Respondents shall participate in the connection of Forest Road 645 and closing of the Willow Creek road between FR645 and State Highway 63. The FR645 project is contingent upon agreement between NMGF and USFS. If the FR645 project cannot be accomplished, Respondents shall participate in the US Park Service's restoration project along

Glorieta Creek in the Pecos National Historic Park. Participation in either project may take the form of active operation or financial assistance, but shall not be required to exceed a comparable value of $50,000.

15. Install and maintain measures to protect newly remediated and restored areas for the term of the Consent Order.
16. Develop and implement a compliance monitoring program, subject to NMED approval, for the term of the Consent Order, to assess the effectiveness of the remedy. The program shall include, but not be limited to, assessing residual and potential contamination of soil, assessing ground water and surface water quality, assessing success in meeting performance criteria established for natural resource restoration and replacement, including revegetation on cap areas, and assessing the engineering stability of the cap. After at least eight consecutive quarterly samples from a particular pathway show no contamination, Respondents may propose, subject to NMED approval, that portions of the compliance monitoring program may be amended and/or eliminated if data confirms effective remediation of specific media or pathways. Completion of the compliance monitoring program is subject to the terms and conditions of the Consent Order and Statement of Work (Consent Order Attachment A).
17. Air monitoring will be required during remedial construction to ensure worker and visitor safety.
18. Develop a long-term operation and maintenance plan for NMED approval. The plan shall be implemented upon meeting compliance criteria; implementation shall be the responsibility of NMGF, and shall be subject to review and possibly modification by NMED every five years.

15.1 Contingency Measures

If the selected remedy cannot meet the specified RAC at compliance monitoring points after five years, NMED shall require Respondents to submit a contingency plan for NMED approval, that will describe contingency measures and objectives to be implemented. In the event that NMED requires additional active remedial measures to be implemented, remediation shall be to the RAC specified for the site. For newly discovered contaminants without promulgated standards or listed RAC, maximum concentrations left untreated will be those that produce a human health risk of 10^{-6} or less, in the case of carcinogenic contaminants, and a Hazard Index (HI) of less than or equal to one for non-carcinogenic contaminants. Risk and Hazard Indices will be calculated using the assumptions in the site risk assessment for a future resident. If background is higher than the concentration producing the unacceptable risk or HI, the maximum concentration left untreated will be the background concentration.

If the natural resource restoration enacted through this Decision Document does not attain the standards provided in the Remedial Design and Compliance Monitoring Plan after five years, further restoration or replacement efforts may be required. Restoration design for this contingency will be based on monitoring results at the time of the decision to enact the contingency, and be proposed by the Respondents. The decision to enact the contingency and the approval of additional restoration or replacement work rests with NMED.

The contingency measures are considered protective of human health and the environment, and are technically practical under the corresponding circumstances. Under the selected remedy, NMED may require one or more of the following contingency measures to be put into effect if NMED determines that there is contamination in any medium above RAC, or that performance standards for natural resource restoration have not been met. NMED may also make such a determination if NMED has any other reason to believe that ground water contamination above RAC exists five years from completion of the consolidation and capping. The contingency measures will be one or more of the following as determined by NMED:

- Installation of additional monitoring wells, or collection at additional seep monitoring points, to confirm and better define the changing conditions in seep water, surface water, or ground water contaminant concentrations.
- Development and implementation of a Remedial Action Plan, subject to NMED approval, which provides for the extraction, treatment, and discharge of contaminated seep water, surface water, or ground water in order to achieve RAC.
- Development and implementation of additional site restoration efforts, or additional off-site natural resource replacement projects, to fulfill natural resource restoration requirements.

If contingency measures are implemented, NMED may require modification of the established compliance monitoring stations, changes in the type of analyses performed, or changes in the frequency of sampling, in order to identify changes in seep water, surface water, or ground water quality, or changes in natural resource restoration.

16 NMED DETERMINATIONS

Actual or threatened releases of contaminants and hazardous substances for this site, if not addressed by implementing the response action selected in this Decision Document, may present a current or potential threat to public health, welfare, or the environment.

Consolidating contaminated material and capping and revegetating the pile would provide protection of human health and the environment by reducing exposure to contaminants. A contingency to treat contaminated media that are not remediated by the capping and revegetation will provide additional protection if necessary.

Long-term risk associated with the waste rock and associated contaminated media would be minimized by implementing this remedy. Short-term risk would be addressed by ensuring that airborne particulates are controlled during implementation of the remedy. The selected remedy can be readily implemented because no special technologies would be required.

This Decision Document, and the remedy described herein, are required pursuant to an Administrative Order on Consent (AOC) entered into between NMED and the Respondents on 2 December 1992. The selected remedy complies with the AOC, federal and state requirements that are legally applicable or relevant and appropriate to the remedial action. This remedy is also cost effective in comparison to other alternatives. Compliance monitoring will ensure the continued effectiveness of the remedy.

Pursuant to the SOW, NMED may require Respondents to perform such additional work as may be reasonably necessary, in the event that the seeps continue to emit unacceptable levels of contaminants, if ground water quality does not improve, if natural resource restoration performance criteria cannot be met, or if additional substantial contamination, previously unknown, is discovered at the site.

17 REFERENCES

EPA, 1993, Quality Assurance and Quality Control for Waste Containment Facilities.

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New Mexico Environment Department, 1992, Investigation of the Terrero Mine: San Miguel County, New Mexico.

New Mexico Environment Department, 1997, Human Health Risk Assessment *Final*: Pecos Mine Operable Unit: Upper Pecos Site.

New Mexico Water Quality Control Commission, 1994, State of New Mexico Standards for Interstate and Intrastate Streams.

Stoller, 1996, Pecos Mine Operable Unit: Tererro Mine Site: Remedial Investigation Report.

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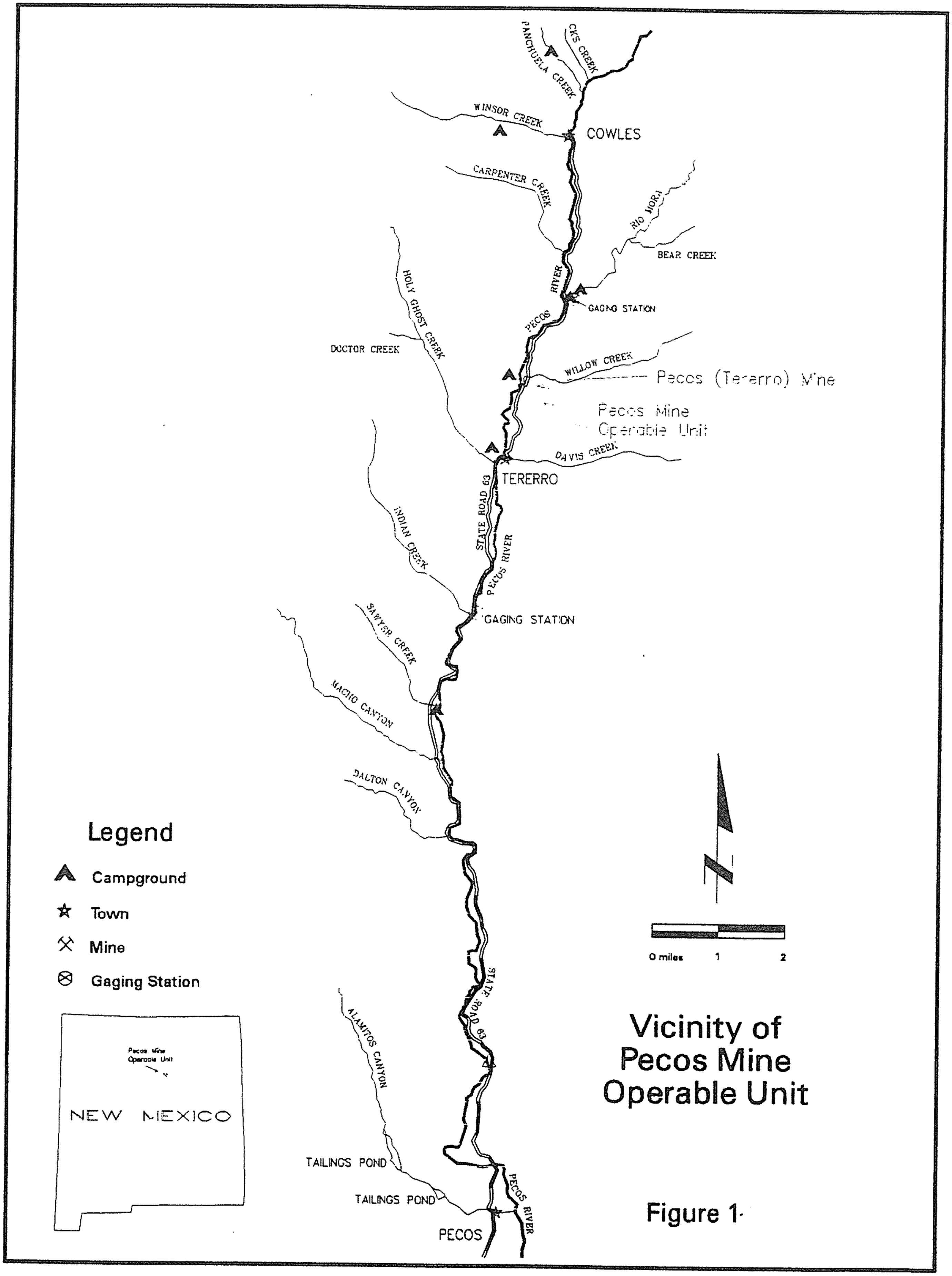
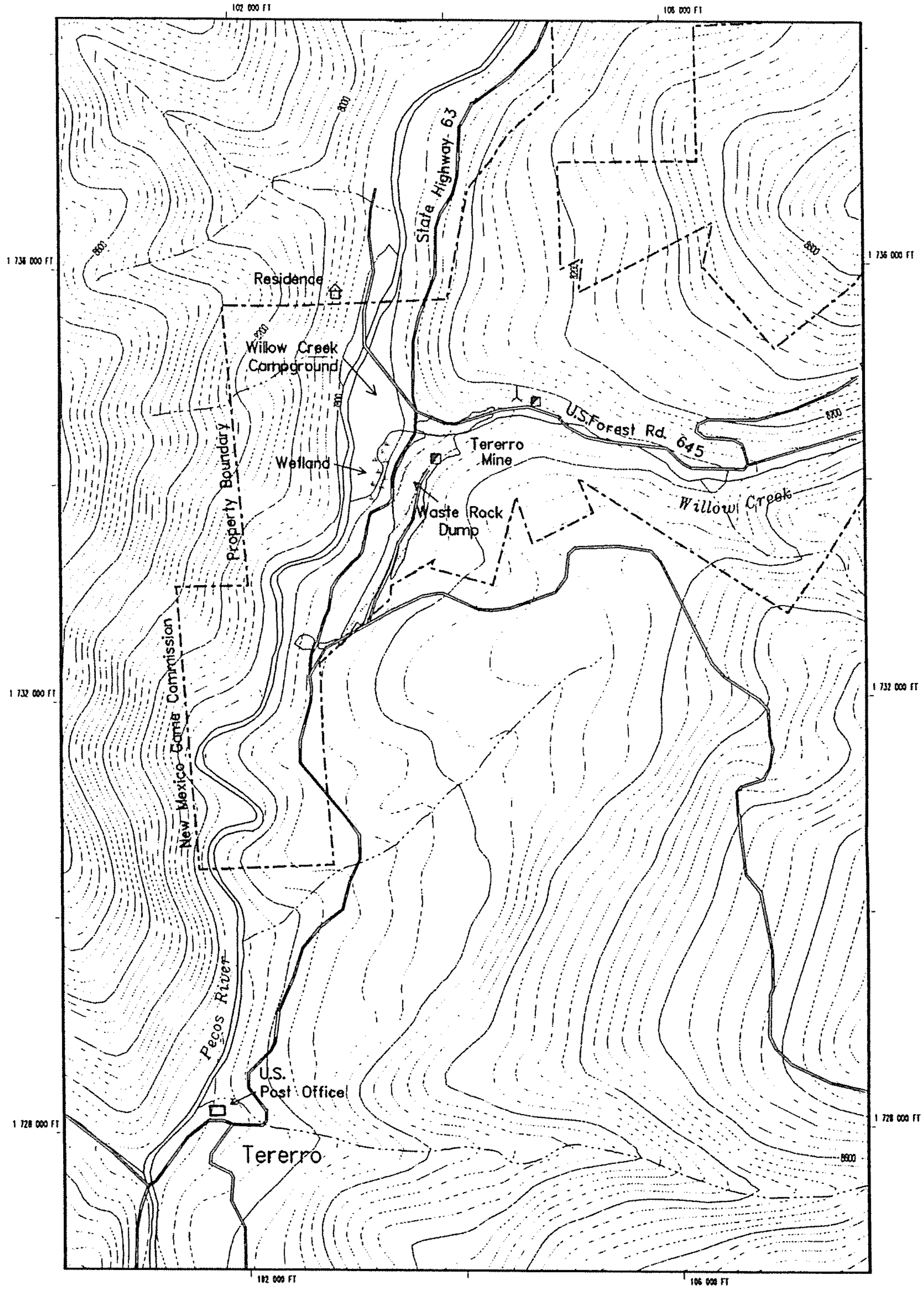
FIGURES



01/04/96 TERERRO2.MAP



Pecos Mine Operable Unit

Scale = 1 : 12,000
1 inch = 1,000 feet

500 0 1,000 2,000ft

Transverse Mercator Projection, 1927 North American datum
5,000-foot grid based on New Mexico coordinate system, east zone

Prepared by:
Stoller
established 1959

Figure .2

APPENDIX A

SUMMARIES TABLES
ANALYTICAL DATA
SAMPLE LOCATIONS

From Stoller, 1996

Table 4-7
Metal Concentrations (mg/kg) in Waste Rock Samples Collected in 1995

Sample Number	Aluminum	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Zinc
TSS 1	20,200	16.5	157	9	15.8	14.9	2,260	67,800	8,150	327	1.1	7.4	6.9	6.9	22.9	2,810
TSS 2	17,200	10.9	121	10	14.3	8.2	1,280	55,100	4,010	269	1.1	5.7	5.9	2.5	13.7	2,600
TSS 3	14,500	18.7	129	9.2	26.4	6.8	1,240	74,500	7,020	271	0.99	3.7	4.6	10.1	21.8	2,500
TSS 4	24,100	18.7	64.5	25.1	35.1	32.5	3,190	56,000	3,890	480	1.1	<2	20.5	2.6	9.2	7,790
TSS 5	9,050	17.2	124	10.3	12	6.2	441	20,500	1,690	358	0.72	<5.1	<5.1	1.1	6.3	2,750
TSS 6	19,100	28.4	128	7.7	27.5	8	1,230	69,200	12,500	353	2.5	6	5.3	7.5	36.7	2,220
WR0001ST	8,160	27.1	83.5	9.1	6.9	8.4	1,580	49,000	7,060	137	1.6	2.3	3.4	4.9	15.4	2,100
WR0002ST	18,700	<20.1	97.8	174	15.7	14.5	1,240	57,300	9,830	467	1.6	<10	<10	4	35.5	45,100
WR0003ST	24,000	33.9	199	10.4	13.2	9.1	1,680	78,800	7,490	420	1.5	8.3	4.7	<0.3	22.9	2,920
WR0004ST	15,100	25.6	116	9.2	10.2	7.3	1,920	50,300	6,410	233	2.4	5.6	4.4	<0.33	77.5	2,520
WR0005ST	12,400	15.1	103	7.5	10.4	8.9	991	47,300	5,160	184	3.1	4.8	6.8	4.8	11.8	1,770
WR0006ST	10,500	66.7	96.4	6.7	15.3	4.4	3,850	91,300	12,600	201	1.1	4.9	3.4	12	30.8	1,490
WR0007ST	17,400	11.2	18.6	6.4	32.7	12.6	570	35,200	1,970	292	1.5	<1	12.9	1.3	3.7	1,110
WR0008ST	6,840	10.9	50	6.9	9.3	4.5	430	14,700	1,100	274	0.35	1.3	5.4	2.7	4.9	1,470
WR0009ST	18,000	23.1	118	7.5	27.5	7.4	1,200	80,000	8,500	331	1.7	7.5	5.7	6.4	30.3	2,010

Table 4-8
Acid Generation and Neutralization Potentials of Waste Rock Samples

Sample Number	Sulfur Forms (weight percent)				pH	Acid-Base Accounting (tons $CaCO_3$/1,000 tons)				
	Total Sulfur	Pyritic Sulfur	Sulfate Sulfur	Organic (Residual) Sulfur		Acid Neutralizing Potential	Acid Generating Potential (Total Sulfur)	Acid Generating Potential (Pyritic Sulfur)	ANP/AGP (Total Sulfur)	ANP/AGP (Pyritic Sulfur)
TSS1	1.69	0	0.6	1.11	4.5	29	53	0	0.55	—
TSS2	1.56	0.26	0.65	0.65	3.8	16	49	8.13	0.33	2.0
TSS3	1.58	0.27	0.5	0.81	3.3	10	49	8.44	0.20	1.2
TSS4	1.39	0.4	0.13	0.86	5.9	36	43	12.5	0.84	2.9
TSS5	0.8	0.1	0.22	0.48	7.4	157	25	3.1	6.3	51
TSS6	2.03	0.1	0.91	1.02	3.6	7	63	3.1	0.11	2.3

T ;4-9

Results of Seep and Spring Sampling, April 1995

Analyte	SW5001ST ESS 4/13/95		SW5002ST WSBDT 4/13/95		SW5004ST WMS 4/13/95		SW5006ST GSBD 4/13/95		SW5013ST RPS 4/13/95		SW5014ST WSDZ 4/13/95		SW5015ST CBDT 4/13/95	
	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Dissolved Metals (µg/L)														
Aluminum	81.2	B	**53300**		30	U	30	U	30	U	**8370**		**89500**	
Antimony	0.2	U	0.2	U	0.28	B	0.57	B	0.2	U	0.2	U	0.2	U
Arsenic	1	U	**500**	**U**	6.7	B	1	U	1	U	50	U	**500**	**U**
Barium	228		**150**	**U**	203		61.8	B	48.8	B	60	U	150	U
Beryllium	2	U	**100**	**U**	2	U	2	U	2	U	**40**	**U**	**100**	**U**
Cadmium	0.26	B	**3740**		0.2	U	**0.2**	**U**	**9.1**		**1670**		**4650**	
Calcium	147000		366000		121000		230000		182000		266000		397000	
Chromium	0.2	U	**100**	**U**	0.2	U	0.2	U	0.2	U	10	U	**100**	**U**
Cobalt	0.67	B	**526**	B	1.2	B	2	B	6	B	**178**	**B**	**607**	**B**
Copper	3.2	B	**12700**		1.1	B	7.2	B	**10.9**	**B**	**3260**		**19000**	
Iron	5730		1160	B	22800		1350		9270		1500	B	500	U
Lead	0.14	B	**253**		0.1	U	0.1	B	0.1	U	**4.7**		**248**	
Magnesium	24600		299000		17400		68400		96800		165000		366000	
Manganese	**2230**		**17500**		**2760**		**1100**		**3730**		**14700**		**17800**	
Mercury	**0.2**	U	0.2	U	**0.2**	**U**	**0.2**	**U**	**0.2**	**U**	**0.2**	**U**	**0.2**	**U**
Nickel	10	U	**500**	**U**	10	U	10	U	10	U	**268**	**B**	**642**	**B**
Potassium	2100	B	15000	U	1550	B	3970	B	2130	B	6000	U	15000	U
Selenium	1.6	B	**4.3**	**B**	1	U	1	U	1	U	1.9	B	**4.5**	**B**
Silver	0.23	B	**0.15**	B	0.1	U	0.1	U	0.1	U	**0.22**	**B**	**0.41**	**B**
Sodium	11100		29100	B	8800		12800		10400		14600	B	31000	B
Zinc	8.3	B	**1270000**		3.8	B	19.7	B	**6710**		**531000**		**1480000**	
Anions (mg/L)														
Chloride	7.3		50		4	B	7.8		9.8		15.2		53	
Fluoride	1.1		**15**		1.1		1.1		1.6		**4.8**		**16**	
Nitrate/Nitrite	0.02	B	0.04	B	0.02	U	0.02	U	0.02	U	0.02	B	0.09	B
Sulfate	89		**4330**		2.2	B	**592**		**410**		**2090**		**5340**	
Water Quality Parameters (mg/L)														
Alkalinity ($CaCO_3$)	362		7	B	352		297		366		68		2	U
Total Suspended Solids	6	B	168		40		694		68		18	B	5	U
Field Parameters														
Eh (mv)	475.3		503		228.9		248.8		303.4		408.2		329.3	
Conductivity (µmho/cm)	764		1910		590		1260		420		1470		5140	
Temperature (°C)	10.8		15.5		10.9		11.6		8.1		8.2		5	
pH	7.09		**6.31**		7.68		7.56		7.23		**5.98**		**5.24**	

[1] State Standards for dissolved metals and water quality parameters in groundwater
[2] State standards for dissolved metals and water quality parameters in Surface Water
Bold Border = Analyte concentration exceeds groundwater standard
Bold Value = Analyte concentration exceeds most stringent surface water standard
NA = Standard not available
B = Result is greater than the instrument detection limit but less than the contract required detection limit
U = Analyte not detected. Result = Detection Limit.

Table 4-9
Results of Seep and Spring Sampling, April 1995

Analyte	SW5016ST DPS 4/14/95		SW5018ST ESNDT 4/14/95		SW5019ST ATB 4/14/95		SW5020ST ATA 4/14/95		SW5021ST CSNDT 4/14/95		SW5022ST DDS 4/14/95		SW5023ST BZ-1 4/14/95	
	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Dissolved Metals (µg/L)														
Aluminum	60	U	343000		345000		16900	B	30	U	4980		204000	
Antimony	0.2	U	0.46	B	0.55	B	0.57	B	0.2	U	10	U	10	U
Arsenic	1	U	500	U	500	U	500	U	1	B	50	U	50.2	B
Barium	33.2	B	300	U	300	U	300	U	37.5	B	11	B	7.4	B
Beryllium	4	U	200	U	200	U	200	U	2	U	4.2	B	63	
Cadmium	140		10100		10300		5720		92.5		2030		3720	
Calcium	219000		341000	B	339000	B	503000		234000		464000		237000	
Chromium	0.2	U	100	U	100	U	1280	B	0.2	U	10	U	10	U
Cobalt	0.89	B	1250	B	1300	B	780	B	1.4	B	279	B	834	B
Copper	19.5	B	46400		47900		16800		19.6	B	6510		39700	
Iron	20	U	3140	B	3400	B	1000	U	10	U	10	U	5890	
Lead	1.5	B	493		519		617		5.2		59.1	B	340	
Magnesium	41000		700000		704000		551000		76500		213000		294000	
Manganese	84		33000		33500		22800		1240		7070		15500	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Nickel	80.9		1330	B	1260	B	1000	U	16.1	B	189		461	
Potassium	4060	B	30000	U	30000	U	30000	U	443	B	9330		2500	B
Selenium	1.1	B	8.7		9.7		10.4		1	U	3.6	B	1	B
Silver	0.1	U	1.1	B	0.93	B	0.25	B	0.1	U	5	U	5	U
Sodium	7690	B	30000	U	30000	U	30000	U	8050		37400		4470	B
Zinc	59700		3090000		3120000		2090000		29900		622000		1030000	
Anions (mg/L)														
Chloride	4.3	B	3.4	B	4.2	B	1	B	3.8	B	34.1		0.9	B
Fluoride	0.4	B	38		37		10		0.6		5.6		4.6	
Nitrate/Nitrite	0.68	B	0.3	B	0.31	B	0.58	B	0.04	B	0.4	B	0.1	B
Sulfate	749		10500		11100		7340		609		2820		4800	
Water Quality Parameters (mg/L)														
Alkalinity ($CaCO_3$)	72		2	U	2	U	14		294		102		2	U
Total Suspended Solids	376		30		464		272		376		118		5	U
Field Parameters														
Eh (mv)	445.5		575.4		593.3		531.4		459		508		590	
Conductivity (µmho/cm)	1412		9380		8870		5000		1380		4770		4700	
Temperature (°C)	4.2		2.4		7.1		10.8		12.5		9		19.2	
pH	6.75		4.46		5.1		6.29		7.67		6.7		3.74	

[1] State Standards for dissolved metals and water quality parameters in groundwater
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T :4-9

Results of Seep and Spring Sampling, April 1995

Analyte	SW5026ST SNWC1 4/24/95		SW5027ST SNWC2 4/24/95		SW5028ST SSWC1 4/24/95		SW5029ST SSWC2 4/24/95		SW7013ST Dump Runoff #1 4/23/95		Most Stringent State Ground-water Standard[1]	Most Stringent State Surface Water Standard[2]
	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier		
Dissolved Metals (µg/L)												
Aluminum	30	U	30	U	30	U	30	U	**300**	U	5000	87
Antimony	20	U	0.2	U	10	U	20	U	100	U	NA	NA
Arsenic	**100**	U	1	U	50	U	**100**	U	**500**	U	100	50
Barium	123	B	246		327		486		30	U	1000	1000
Beryllium	2	U	**2**	U	2	U	2	U	**20**	U	NA	5.3
Cadmium	**33.1**	B	0.2	U	**10**	U	**20**	U	**1820**	B	10	1
Calcium	102000		133000		113000		103000		527000		NA	NA
Chromium	25	B	0.2	U	10	U	20	U	**156**	B	50	50
Cobalt	10	U	0.82	B	7.6	B	10	U	**139**	B	50	50
Copper	**100**	U	1	B	**50**	U	**100**	U	**500**	U	1000	9.8
Iron	99.8	B	9100		17400		12900		100	U	1000	NA
Lead	**11.4**	B	0.7	B	**5**	U	**10**	U	**196**	B	50	2.4
Magnesium	14000		15200		19000		18000		138000		NA	NA
Manganese	**4480**		**4520**		**3070**		**1450**		**5420**		200	50
Mercury	**0.2**	U	**0.2**	U	**0.2**	U	**0.2**	U	**0.2**	U	2	0.000012
Nickel	10	U	10	U	10	U	10	U	100	U	200	130.5
Potassium	1530	B	1600	B	2360	B	2100	B	6540	B	NA	NA
Selenium	1	U	1	U	1	U	1	U	1	U	50	2
Silver	**10**	U	0.1	U	**5**	U	**10**	U	**50**	U	50	0.1
Sodium	6450		7660		8550		8400		10300	B	NA	NA
Zinc	**6080**		7.9	B	**2360**		**5900**		**381000**		10000	87.7
Anions (mg/L)												
Chloride	2.2	B	3	B	2.2	B	2.2	B	4	B	250 (T)	NA
Fluoride	0.75		0.48	B	1.2		1.4		**3.6**		2	1.6
Nitrate/Nitrite	0.15	B	0.03	B	0.03	B	0.03	B	0.57	B	10	10
Sulfate	22.4		13.7		20.3		8.5		**2260**		600	250
Water Quality Parameters (mg/L)												
Alkalinity ($CaCO_3$)	302		395		313		333		67		NA	NA
Total Suspended Solids	5	U	80		28		24		20		NA	NA
Field Parameters												
Eh (mv)	370.2		251.1		820.1		322.2				NA	NA
Conductivity (µmho/cm)	549		683		662		609				NA	NA
Temperature (°C)	10.3		10.5		11.5		11.2				NA	NA
pH	**6.49**		**6.44**		**6.24**		**6.36**				6-9	6.6-8.8

[1] State Standards for dissolved metals and water quality parameters in groundwater
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Table 4-10
Chemical Characteristics of Seep Water at Locations Sampled

Analyte	N	Frequency of Detection	Range of Results (including nondetects)	Mean Result (including nondetects)	Maximum Detected Result	
					Value	Date
Location: ATA						
Dissolved Metals (µg/L)						
Aluminum	11	8/11	33.9 - 380,000	56,455	380,000	4/9/92
Antimony	3	1/3	0.57 - 100	67	0.57	4/14/95
Arsenic	10	0/10	2 - 500	152	No Detects	4/9/92
Barium	10	5/10	20 - 1,000	169	50	9/15/92
Beryllium	7	0/7	2 - 500	117	No Detects	3/31/93
Cadmium	11	11/11	5 - 18,000	4,559	18,000	4/9/92
Calcium	10	10/10	150,000 - 537,000	320,300	537,000	3/31/93
Chromium	10	4/10	1 - 1,280	149	1,280	4/14/95
Cobalt	10	7/10	10 - 1,400	481	1,400	4/9/92
Copper	11	10/11	15 - 54,000	16,155	54,000	4/9/92
Iron	11	2/11	10 - 7,200	1,185	7,200	4/9/92
Lead	11	8/11	1 - 730	288	730	3/30/94
Magnesium	10	10/10	38,000 - 730,000	290,090	730,000	4/9/92
Manganese	11	11/11	180 - 30,000	14,374	30,000	9/15/92
Mercury	10	0/10	0.2 - 0.2	0.2	No Detects	4/9/92
Nickel	10	5/10	11 - 2,000	487	860	4/9/92
Potassium	10	3/10	469 - 100,000	15,447	6,000	9/15/92
Selenium	10	2/10	1 - 200	28	10.4	4/14/95
Silver	10	6/10	0.1 - 50	11	2.1	4/9/92
Sodium	10	5/10	3,000 - 3,100,000	354,129	3,100,000	4/9/92
Thallium	3	1/3	0.51 - 50	34	0.51	4/14/95
Zinc	11	11/11	810 - 3,200,000	1,176,001	3,200,000	4/9/92
Total Metals (µg/L)						
Aluminum	10	10/10	490 - 480,000	81,870	480,000	4/9/92
Antimony	3	1/3	1.3 - 111	75	1.3	4/14/95
Arsenic	10	2/10	2 - 556	120	49	4/9/92
Barium	10	6/10	37 - 1,000	171	180	4/18/95
Beryllium	7	2/7	5 - 500	102	15.5	4/18/95
Cadmium	10	10/10	7 - 18,000	4,497	18,000	4/9/92
Calcium	10	10/10	140,000 - 541,000	313,000	541,000	3/31/93
Chromium	10	6/10	1 - 111	27	28	4/9/92
Cobalt	10	6/10	10 - 1,500	504	1,500	4/9/92
Copper	10	10/10	61 - 76,000	22,014	76,000	4/9/92
Iron	10	9/10	350 - 32,600	6,783	32,600	4/18/95
Lead	10	9/10	21 - 5,700	968	5,700	4/18/95
Magnesium	10	10/10	34,000 - 860,000	296,320	860,000	4/9/92
Manganese	10	10/10	170 - 31,000	13,033	31,000	4/9/92
Mercury	10	1/10	0.2 - 1.1	0.3	1.1	4/18/95
Nickel	10	4/10	20 - 2,000	479	950	4/9/92
Potassium	10	4/10	1,000 - 100,000	14,520	6,000	4/9/92
Selenium	10	2/10	1 - 200	31	17.3	4/14/95
Silver	10	8/10	0.1 - 55.6	12	5	4/9/92
Sodium	10	6/10	3,000 - 3,900,000	436,875	3,900,000	4/9/92
Thallium	3	1/3	0.52 - 55.6	37.2	0.52	4/14/95
Zinc	10	10/10	1,900 - 4,300,000	1,198,500	4,300,000	4/9/92
Anions (mg/L)						
Bicarbonate	7	5/7	5 - 300	119	300	7/7/92
Carbonate	7	1/7	5 - 46	11	46	7/9/93
Chloride	10	9/10	1 - 7.8	4	7.8	6/1/95
Fluoride	7	7/7	0.6 - 10	3	10	4/14/95
Hardness As $CaCO_3$	9	9/9	480 - 8,000	2,560	8,000	3/30/94
Nitrate as N	7	0/7	0.2 - 20	5	No Detects	4/9/92
Nitrate/Nitrite	3	3/3	0.05 - 0.58	0.25	0.58	4/14/95
Sulfate	10	10/10	62 - 36,000	6,705	36,000	4/9/92

Table 4-10
Chemical Characteristics of Seep Water at Locations Sampled

Analyte	N	Frequency of Detection	Range of Results (including nondetects)	Mean Result (including nondetects)	Maximum Detected Result Value[1]	Maximum Detected Result Date
Water Quality Parameters (mg/L)						
Acidity	7	7/7	1 - 13,000	2,663	13,000	4/9/92
Alkalinity ($CaCO_3$)	10	8/10	5 - 300	128	300	7/7/92
Total Dissolved Solids	9	9/9	620 - 18,000	5,487	18,000	4/9/92
Total Suspended Solid	10	10/10	5 - 272	131	272	4/14/95
Turbidity (NTU)	9	9/9	2.8 - 140	54	140	7/28/94
Other Analytes (µg/L)						
Cyanide, Total	2	0/2	10 - 20	15	No Detects	4/9/92
Cyanide, WAD	1	0/1	10 - 10	10	No Detects	4/14/95
Field Parameters						
Conductivity (µmho/cm	9	9/9	920 - 10,000	3,768	10,000	4/9/92
pH	9	9/9	3.5 - 8.3	6.2	8.3	7/9/93
Location: ATB						
Dissolved Metals (µg/L)						
Aluminum	9	8/9	50 - 780,000	348,006	780,000	9/15/92
Antimony	3	1/3	0.55 - 200	100	0.55	4/14/95
Arsenic	8	0/8	1 - 1,000	257	No Detects	4/9/92
Barium	8	1/8	3 - 1,000	395	50	4/9/92
Beryllium	6	1/6	62.9 - 500	294	62.9	4/18/95
Cadmium	9	9/9	440 - 22,000	11,271	22,000	9/15/92
Calcium	8	8/8	219,000 - 460,000	348,000	460,000	9/15/92
Chromium	8	4/8	1 - 200	58	29	9/15/92
Cobalt	8	8/8	50 - 3,000	1,606	3,000	9/15/92
Copper	9	9/9	480 - 98,000	53,120	98,000	9/15/92
Iron	9	7/9	20 - 16,000	5,887	16,000	9/15/92
Lead	9	8/9	3 - 1,100	568	1,100	3/31/94
Magnesium	8	8/8	93,000 - 2,100,000	863,875	2,100,000	9/15/92
Manganese	9	9/9	1,300 - 83,000	34,900	83,000	9/15/92
Mercury	8	2/8	0.2 - 0.22	0.2	0.22	3/31/94
Nickel	8	5/8	30 - 2,000	1,254	2,000	3/31/94
Potassium	8	2/8	1,000 - 100,000	34,735	8,000	9/15/92
Selenium	8	3/8	4.8 - 80	19	9.7	4/14/95
Silver	8	6/8	0.6 - 100	22	9	9/15/92
Sodium	8	3/8	8,670 - 1,800,000	322,959	1,800,000	3/31/94
Thallium	3	1/3	0.42 - 100	50	0.42	4/14/95
Zinc	9	9/9	90,000 - 7,500,000	3,356,667	7,500,000	9/15/92
Total Metals (µg/L)						
Aluminum	8	8/8	8,600 - 780,000	371,575	780,000	9/15/92
Antimony	3	1/3	14.8 - 222	116	14.8	4/14/95
Arsenic	8	1/8	1 - 1,110	226	67	4/14/95
Barium	8	2/8	3.3 - 1,000	372	67.3	4/14/95
Beryllium	6	2/6	60.7 - 500	274	60.9	4/14/95
Cadmium	8	8/8	480 - 25,000	12,185	25,000	9/15/92
Calcium	8	8/8	230,000 - 460,000	343,500	460,000	9/15/92
Chromium	8	6/8	4 - 222	53	30	9/15/92
Cobalt	8	8/8	50 - 3,000	1,655	3,000	9/15/92
Copper	8	8/8	1,600 - 110,000	55,938	110,000	9/15/92
Iron	8	8/8	1,300 - 60,000	14,355	60,000	4/14/95
Lead	8	8/8	120 - 13,900	2,393	13,900	4/14/95
Magnesium	8	8/8	84,000 - 2,100,000	862,750	2,100,000	9/15/92
Manganese	8	8/8	1,200 - 84,000	36,388	84,000	9/15/92
Mercury	8	4/8	0.2 - 1.4	0.4	1.4	4/14/95
Nickel	8	4/8	30 - 2,000	1,216	1,600	9/15/92
Potassium	8	4/8	1,000 - 100,000	26,054	8,000	9/15/92
Selenium	8	3/8	4 - 200	35	14.1	4/14/95
Silver	8	6/8	0.9 - 111	30	40.8	4/14/95

Table 4-10
Chemical Characteristics of Seep Water at Locations Sampled

Analyte	N	Frequency of Detection	Range of Results (including nondetects)	Mean Result (including nondetects)	Maximum Detected Result	
					Value[1]	Date
Sodium	8	4/8	7,830 - 1,000,000	220,172	1,000,000	7/28/94
Thallium	3	1/3	1.5 - 111	56	1.5	4/14/95
Zinc	8	8/8	90,000 - 7,500,000	3,555,000	7,500,000	9/15/92
Anions (mg/L)						
Bicarbonate	5	1/5	5 - 270	58	270	4/9/92
Carbonate	5	0/5	5 - 5	5	No Detects	4/9/92
Chloride	8	6/8	2.2 - 13	5	13	8/11/95
Fluoride	6	6/6	0.17 - 37	10	37	4/14/95
Hardness As $CaCO_3$	7	7/7	1,200 - 16,000	6,606	16,000	3/31/94
Nitrate as N	5	0/5	0.2 - 100	25	No Detects	4/9/92
Nitrate/Nitrite	3	3/3	0.21 - 0.31	0.26	0.31	4/14/95
Sulfate	8	8/8	1,200 - 39,000	14,534	39,000	9/15/92
Water Quality Parameters (mg/L)						
Acidity	5	5/5	320 - 24,000	5,271	24,000	9/15/92
Alkalinity ($CaCO_3$)	8	1/8	2 - 270	37	270	4/9/92
Total Dissolved Solids	7	7/7	1,800 - 40,000	18,729	40,000	9/15/92
Total Suspended Solid	8	7/8	5 - 464	114	464	4/14/95
Turbidity (NTU)	7	7/7	1.1 - 60	24	60	3/31/93
Other Analytes (µg/L)						
Cyanide, Total	1	0/1	10 - 10	10	No Detects	4/14/95
Cyanide, WAD	1	0/1	10 - 10	10	No Detects	4/14/95
Field Parameters						
Conductivity (µmho/cm	7	7/7	2000 - 19,000	9,836	19,000	9/15/92
pH	7	7/7	3.5 - 6.8	4	6.8	4/9/92
Location: WSBDT						
Dissolved Metals (µg/L)						
Aluminum	9	9/9	5,420 - 200,000	81,758	200,000	11/8/94
Antimony	4	0/4	0.2 - 200	100	No Detects	4/13/95
Arsenic	9	0/9	2 - 1,000	280	No Detects	7/9/93
Barium	9	2/9	6.6 - 1,000	313	14	7/9/93
Beryllium	9	3/9	13.4 - 500	169	35	9/9/93
Cadmium	9	9/9	5.9 - 10,000	4,715	10,000	11/8/94
Calcium	9	9/9	246,000 - 440,000	357,889	440,000	9/9/93
Chromium	9	4/9	1 - 200	59	116	11/15/95
Cobalt	9	8/9	336 - 1,700	846	1,700	11/8/94
Copper	9	9/9	5,800 - 38,000	19,416	38,000	11/8/94
Iron	9	7/9	740 - 3,100	1,701	3,100	11/8/94
Lead	9	8/9	50 - 622	275	622	9/9/93
Magnesium	9	9/9	127,000 - 730,000	390,889	730,000	11/8/94
Manganese	9	9/9	11,500 - 40,000	23,267	40,000	11/8/94
Mercury	9	0/9	0.2 - 0.2	0.2	No Detects	7/9/93
Nickel	9	4/9	200 - 2,000	828	1,100	11/8/94
Potassium	9	2/9	1,000 - 100,000	32,938	13,000	9/9/93
Selenium	9	2/9	1 - 20,000	2,229	4.3	4/13/95
Silver	9	5/9	0.1 - 100	23	1	11/8/94
Sodium	9	7/9	10,900 - 530,000	163,489	530,000	7/27/94
Thallium	4	0/4	0.1 - 100	50	No Detects	4/13/95
Zinc	9	9/9	454,000 - 3,000,000	1,600,222	3,000,000	11/8/94
Total Metals (µg/L)						
Aluminum	9	9/9	14,300 - 541,000	148,556	541,000	4/13/95
Antimony	4	1/4	0.65 - 222	111	0.65	4/13/95
Arsenic	9	2/9	2 - 1,110	252	11.7	4/13/95
Barium	9	4/9	9.1 - 1,000	306	72	9/9/93
Beryllium	9	4/9	14 - 500	173	123	4/13/95
Cadmium	9	9/9	5.9 - 11,000	4,842	11,000	11/8/94

Table 4-10
Chemical Characteristics of Seep Water at Locations Sampled

Analyte	N	Frequency of Detection	Range of Results (including nondetects)	Mean Result (including nondetects)	Maximum Detected Result	
					Value[1]	Date
Calcium	9	9/9	268,000 - 470,000	347,000	470,000	9/9/93
Chromium	9	5/9	1 - 223	64	223	11/15/95
Cobalt	9	8/9	367 - 1,800	865	1,800	11/8/94
Copper	9	9/9	6,200 - 43,000	21,417	43,000	11/8/94
Iron	9	9/9	1,800 - 48,500	14,958	48,500	4/13/95
Lead	9	9/9	261 - 1,690	695	1,690	4/13/95
Magnesium	9	9/9	148,000 - 780,000	382,111	780,000	11/8/94
Manganese	9	9/9	11,200 - 43,000	23,089	43,000	11/8/94
Mercury	9	1/9	0.2 - 0.4	0.2	0.202	9/9/93
Nickel	9	4/9	222 - 2,000	779	580	9/9/93
Potassium	9	4/9	3,650 - 100,000	32,179	15,000	9/9/93
Selenium	9	2/9	1 - 40	11	3.6	4/19/95
Silver	9	5/9	0.1 - 111	26	3.78	9/9/93
Sodium	9	6/9	3,000 - 780,000	154,389	780,000	7/27/94
Thallium	4	0/4	0.22 - 111	56	No Detects	4/13/95
Zinc	9	9/9	544,000 - 3,100,000	1,539,667	3,100,000	11/8/94
Anions (mg/L)						
Bicarbonate	5	0/5	5 - 5	5	No Detects	7/9/93
Carbonate	5	0/5	5 - 5	5	No Detects	7/9/93
Chloride	9	9/9	3.6 - 85	25	85	3/30/94
Fluoride	9	9/9	0.4 - 15	4	15	4/13/95
Hardness As $CaCO_3$	8	8/8	1,140 - 8,800	3,678	8,800	7/9/93
Nitrate as N	5	0/5	0.2 - 10	3	No Detects	7/9/93
Nitrate/Nitrite	4	3/4	0.02 - 0.09	0.04	0.09	8/11/95
Sulfate	9	9/9	1,850 - 10,000	5,840	10,000	11/8/94
Water Quality Parameters (mg/L)						
Acidity	5	5/5	220 - 500	400	500	7/9/93
Alkalinity ($CaCO_3$)	9	4/9	5 - 40.2	10	40.2	8/11/95
Total Dissolved Solids	8	8/8	1,500 - 15,200	7,078	15,200	11/8/94
Total Suspended Solid	9	9/9	42 - 820	323	820	9/9/93
Turbidity (NTU)	8	8/8	32 - 460	176	460	7/27/94
Other Analytes (µg/L)						
Cyanide, Total	1	0/1	10 - 10	10	No Detects	4/13/95
Cyanide, WAD	1	0/1	10 - 10	10	No Detects	4/13/95
Field Parameters						
Conductivity (µmho/cm	8	8/8	2,950 - 8,000	5,454	8,000	11/8/94
pH	8	8/8	4.2 - 5.7	4.6	5.7	8/11/95

[1]Maximum detected concentration may be less than maximum in range because of substitution of detection limit for values below the detection limit.

Table 4-11
Summary Statistics for Background Soils (0 to 6 inches)

Analyte	Number of Results	Pecentage of Nondetects	Distribution	Mean (mg/kg)	Standard Deviation	25th Percentile (1st quartile)	Median	75th Percentile (3rd quartile)	Maximum	Upper Tolerance Limit (95/95)
Aluminum	23	0	Normal	9,695	1,698	8,560	9,550	10,500	12,400	13,650[1]
Arsenic	23	0	Normal	3.58	1.7	2.3	3.5	5	6.7	7.5[1]
Barium	23	0	Log-normal	139	38.5	117	128	178	214	254[3]
Cadmium	23	43.5	Non-normal	0.22	0.16	0.01	0.20	0.33	0.62	0.62[2]
Chromium	23	0	Normal	15.7	3.4	12.7	15.5	17.8	25.6	23.6[1]
Cobalt	23	0	Non-normal	11.6	12.2	7.4	9	10.7	65.9	65.9[2]
Copper	23	0	Non-normal	14.4	27.1	7.7	8.4	10.4	138	21.38[2]
Iron	23	0	Normal	16,700	3,500	14,900	17,200	19,100	24,100	25,900[1]
Lead	23	0	Normal	22.4	5.3	18.9	22.8	26.2	32.8	34.8[1]
Manganese	23	0	Normal	571	185	458	544	676	1,020	1,001[1]
Mercury	23	100	ND	NC	NC	NC	NC	NC	0.1	NC
Molybdenum	23	100	ND	NC	NC	NC	NC	NC	1.4	NC
Nickel	23	0	Non-normal	12.8	2.0	11.6	13.2	14.5	15.4	15.4[2]
Selenium	23	30.4	Log-normal	0.3993	0.1774	0.267	0.37	0.52	0.88	0.94[3]
Silver	23	100	ND	NC	NC	NC	NC	NC	0.69	NC
Zinc	23	0	Normal	63.5	12.7	57.3	61.4	68.9	93.3	93.0[1]

ND = not determined. Distribution not determined for analytes with > 80% nondetects.
NC = not calculated. Summary statistics not calculated for analytes with >80% nondetects.

UTL determined by one of the following methods:
[1] The 95th Percentile at the 95% confidence level for a normal distribution
[2] Maximum concentration reported; on average the maximum estimates the n/(n+1) Percentile of population
[3] The 95th Percentile at the 95% confidence level for a normal distribution - value is exp(logUTL). Compare log of UTL to log of site value.

Table 4-12
Summary Statistics for Background Soils (12 to 18 inches)

Analyte	Number of Results	Percentage of Nondetects	Distribution	Mean (mg/kg)	Standard Deviation	25th Percentile (1st quartile)	Median	75th Percentile (3rd quartile)	Maximum	Upper Tolerance Limit (95/95)
Aluminum	21	0	Normal	12,200	3,700	10,000	11,600	13,500	19,900	20,900[1]
Arsenic	21	0	Non-normal	5.2	3.0	3.6	5.3	6.1	15.2	15.2[2]
Barium	21	0	Normal	99.9	27.1	76.5	99.1	123	145	164[1]
Cadmium	21	85.7	ND	NC	NC	NC	NC	NC	0.64	NC
Chromium	21	0	Normal	21.6	7.3	16.4	18.4	27.4	38.2	38.8[1]
Cobalt	21	0	Non-normal	12.9	15.5	6.4	8.9	12.8	77	77[2]
Copper	21	0	Non-normal	9.9	4.5	8	9	10.9	23.3	23.3[2]
Iron	21	0	Log normal	23,700	10,800	19,500	20,300	28,200	60,300	55,500[3]
Lead	21	0	Non-normal	13.4	3.6	10.1	14.8	16	17.8	17.8[2]
Manganese	21	0	Log-normal	370	283	155	378	514	1,040	2,680[3]
Mercury	21	100	ND	NC	NC	NC	NC	NC	0.13	NC
Molybdenum	21	100	ND	NC	NC	NC	NC	NC	1.3	NC
Nickel	21	0	Log-normal	16.5	6.1	12.8	14.3	20	29.9	35.8[3]
Selenium	21	33.3	Non-normal	0.3821	0.2552	0.32	0.1903	0.56	1.2	1.2[2]
Silver	21	100	ND	NC	NC	NC	NC	NC	0.63	NC
Zinc	21	0	Log-normal	38.7	8.0	32.3	35.8	45.5	59.4	60.6[3]

ND = not determined. Distribution not determined for analytes with > 80% nondetects.
NC = not calculated. Summary statistics not calculated for analytes with >80% nondetects.

UTL determined by one of the following methods:
[1] The 95th Percentile at the 95% confidence level for a normal distribution.
[2] Maximum concentration reported; on average the maximum estimates the n/(n+1) Percentile of population.
[3] The 95th Percentile at the 95% confidence level for a normal distribution - value is exp(logUTL). Compare log of UTL to log of site value.

Table 4-13
Results of Site to Background Soil Comparisons (0- to 3-inch Depth)

Analyte	Background UTL[1]	Number of Samples from Site	Number of Concentrations >UTL[2]	% of Concentrations >UTL[2]	Soil Contaminant[3]?
Aluminum	13,650	17	2	11.8	X
Arsenic	7.5	35	18	51.4	X
Barium	254	17	0	0	
Cadmium	0.62	35	31	88.6	X
Chromium	23.6	17	4	23.5	X
Cobalt	65.9	17	0	0	
Copper	21.38	35	20	57.1	X
Iron	25,900	17	2	11.8	X
Lead	34.8	35	31	88.6	X
Manganese	1,001	17	1	5.9	
Mercury	NC	17	1	5.9	
Molybdenum	NC	17	0	0	
Nickel	15.4	17	6	35.3	X
Selenium	0.94	35	1	2.9	
Silver	NC	17	2	11.8	X
Zinc	93	35	31	88.6	X

[1]Background upper tolerance limit (UTL) = one-sided 95-percent confidence interval for 95th percentile. NC = not calculated (100% nondetects).

[2]Number of sample results exceeding UTL value, or if UTL value not calculated (NC), number of detectable sample results.

[3]Analyte identified as contaminant because more than one sample results exceeds UTL value.

Table 4-14
Results of Site to Background Soil Comparisons (0- to 6-inch Depth)

Analyte	Background UTL[1]	Number of Samples from Site	Number of Concentrations >UTL[2]	% of Concentrations >UTL[2]	Soil Contaminant[3]?
Aluminum	13,650	61	21	34.4	X
Arsenic	7.5	63	36	57.1	X
Barium	254	61	3	4.9	X
Cadmium	0.62	63	59	93.7	X
Chromium	23.6	61	11	18	X
Cobalt	65.9	61	0	0	
Copper	21.38	63	49	77.8	X
Iron	25,900	61	21	34.4	X
Lead	34.8	63	56	88.9	X
Manganese	1,001	61	3	4.9	X
Mercury	NC	60	32	53.3	X
Molybdenum	NC	61	8	13.1	X
Nickel	15.4	61	18	29.5	X
Selenium	0.94	63	16	25.4	X
Silver	NC	61	25	41	X
Zinc	93	63	61	96.8	X

[1]Background upper tolerance limit (UTL) = one-sided 95-percent confidence interval for 95th percentile. NC = not calculated (100% nondetects).

[2]Number of sample results exceeding UTL value, or if UTL value not calculated (NC), number of detectable sample results.

[3]Analyte identified as contaminant because more than one sample results exceeds UTL value.

Table 4-15
Results of Site to Background Soil Comparisons (12- to 18-inch Depth)

Analyte	Background UTL[1]	Number of Samples from Site	Number of Concentrations >UTL[2]	% of Concentrations >UTL[2]	Soil Contaminant[3]?
Aluminum	20,900	34	3	8.8	X
Arsenic	15.2	52	5	9.6	X
Barium	164	34	9	26.5	X
Cadmium	NC	52	46	88.5	X
Chromium	38.8	34	1	2.9	
Cobalt	77	34	0	0	
Copper	23.3	52	24	46.2	X
Iron	55,500	34	1	2.9	
Lead	17.8	52	39	75	X
Manganese	2,680	34	0	0	
Mercury	NC	33	4	12.1	X
Molybdenum	NC	33	1	3	
Nickel	35.8	34	0	0	
Selenium	1.2	52	6	11.5	X
Silver	NC	34	4	11.8	X
Zinc	60.6	52	43	82.7	X

[1]Background upper tolerance limit (UTL) = one-sided 95-percent confidence interval for 95th percentile. NC = not calculated (100% nondetects).

[2]Number of sample results exceeding UTL value, or if UTL value not calculated (NC), number of detectable sample results.

[3]Analyte identified as contaminant because more than one sample results exceeds UTL value.

Table 4-17
Pecos Mine Operable Unit XRF Soil Survey Results—November 14, 15, and 16, 1995

XRF Location	Date	Lead		Zinc	
		Concentration[1] (mg/kg)	Standard Deviation	Concentration[2] (mg/kg)	Standard Deviation
5-5	16-Nov	79	22.8	196	49.3
5-6	16-Nov	9	17.6	118	43.4
5-7	16-Nov	ND		104	43.9
6-1	16-Nov	30	20.9	325	58.8
6-2	16-Nov	63	22.7	116	45
6-3	16-Nov	ND		93	41.2
7-1	16-Nov	ND		32	38
7-2	16-Nov	12	19	164	48.5
7-3	16-Nov	ND	17.2	48	37.7
7-4	16-Nov	51	22	246	55
7-5	16-Nov	41	21	63	41
7-6		ND		67	

ND = not detected

[1] instrument detection limit for lead = 16.8 mg/Kg

[2] instrument detection limit for zinc = 41.7 mg/Kg

Table 4-18
Summary of Metals and Water Quality Parameters in the Bedrock Aquifer Compared to Federal and State Standards

Analyte	Upgradient Median P3	Most Stringent Standard	P-1 Method ID	P-1 Median	P-1 Frequency > Standard	P-2 Method ID	P-2 Median	P-2 Frequency > Standard	P-5 Method ID	P-5 Median	P-5 Frequency > Standard	P-7 Method ID	P-7 Median	P-7 Frequency > Standard	P-8PL Method ID	P-8PL Median	P-8PL Frequency > Standard	Units
Federal Standards (Total Concentrations)																		
Total Metals																		
Aluminum	0.025	0.05*		0.025	3/14		0.025	0/13		1.6	15/15		0.025	2/14	HT	3	17/17	mg/L
Antimony	-	0.006	ND	-	0/3	ND	-	0/3	ND	-	0/4	ND	-	0/3		0.00083	0/6	mg/L
Arsenic	0.001	0.05	ND	-	0/15	ND	-	0/14		0.001	0/16	ND	-	0/15		0.001	0/18	mg/L
Barium	0.043	2	HT, HM	0.31	0/14	HT, HM	0.36	0/13		0.12	0/15	HT, HM	2.5595	14/14		0.106	0/17	mg/L
Beryllium	-	0.004	ND	-	0/11	ND	-	0/11	ND	-	0/12	ND	-	0/11	ND	-	0/14	mg/L
Cadmium	0.00005	0.005		0.00014	0/15		0.00023	0/14	HT, HM	0.00061	0/16		0.00005	0/15	HT	0.00067	0/18	mg/L
Calcium	64.87	NA	HT, HM	98.9	NA	HT, HM	100	NA	HT, HM	98	NA	HT, HM	104.155	NA	HT, HM	98	NA	mg/L
Chromium	0.0005	0.1		0.0005	0/15		0.0005	0/14	HT, HM	0.004	0/16		0.0005	0/15	HT, HM	0.002	0/18	mg/L
Cobalt	0.005	NA		0.005	NA		0.005	NA		0.005	NA		0.005	NA		0.005	NA	mg/L
Copper	0.0005	1*		0.0014	0/15		0.00075	0/14	HT, HM	0.0385	0/16		0.0005	0/15	HT, HM	0.0658	0/18	mg/L
Iron	0.260	0.3*		0.975	14/14		1.8	13/13		1.7	12/15	HT	2.9	14/14	HT, HM	3.86	17/17	mg/L
Lead	-	NA		0.0005	NA		0.00165	NA		0.00515	NA		0.0005	NA		0.01195	NA	mg/L
Magnesium	16.78	NA		16.85	NA		16	NA	HT, HM	23	NA		17	NA	HT	19.9	NA	mg/L
Manganese	0.0205	0.05*	HT, HM	0.529	14/14	HT, HM	0.624	13/13	HT, HM	0.12	15/15	HT, HM	0.745	14/14	HT, HM	0.55	17/17	mg/L
Mercury	-	0.002	ND	-	0/14	ND	-	0/13	ND	-	0/15	ND	-	0/14	ND	-	0/17	mg/L
Nickel	-	0.1		0.01	0/14	ND	-	0/13	ND	-	0/15	ND	-	0/14		0.01	0/17	mg/L
Potassium	1.09	NA		1.7	NA		1.68	NA	HT	2.1	NA	HT	2	NA		1.7	NA	mg/L
Selenium	-	0.05	ND	-	0/15	ND	-	0/14	ND	-	0/16	ND	-	0/15		0.001	0/18	mg/L
Silver	-	0.1*		0.00005	0/15		0.00005	0/14		0.00012	0/16	ND	-	0/15	HT, HM	0.00067	0/18	mg/L
Sodium	8.11	NA		7.45	NA		7.3	NA		12	NA		7.95	NA		11	NA	mg/L
Thallium	-	0.0005	ND	-	0/2	ND	-	0/2	ND	-	0/3	ND	-	0/2	ND	-	0/5	mg/L
Vanadium	-	NA		0.005	NA		0.005	NA		0.005	NA		0.005	NA		0.081	NA	mg/L
Zinc	0.011	5	HT, HM	0.14	0/14	HT, HM	0.149	0/13	HT, HM	0.12	0/15		0.011	0/14	HT, HM	0.38	0/17	mg/L
Water Quality Parameters																		
Acidity	0.35	NA		3.5	NA		3	NA		1.5	NA		3.2	NA		2.48	NA	mg/L
Alkalinity ($CaCO_3$)	190.5	NA	HT, HM	313.5	NA	HT, HM	308	NA	HT, HM	280	NA	HT, HM	330	NA	HT	236	NA	mg/L
Bicarbonate	190	NA	HT, HM	315	NA	HT, HM	300	NA	HT, HM	275	NA	HT, HM	330	NA	HT	240	NA	mg/L
Carbonate	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	mg/L
Chloride	1.5	250		1.5	0/14		1.5	0/13		1.5	0/15		1.5	0/14		3	0/17	mg/L
Conductivity	420	NA		570	NA		560	NA		590	NA		600	NA		590	NA	µmhos/cm
Cyanide, Total	-	0.2	ND	-	0/2	ND	-	NA	ND	-	0/2	ND	-	0/1	NA	NA	NA	mg/L
Cyanide, WAD	NA	NA	ND	-	NA	NA	NA	NA	ND	-	NA	NA	NA	NA	NA	NA	NA	mg/L
Fluoride	1.25	2		1.7	0/10		1.6	0/10		1.4	0/11		1.6	0/10		1.2	0/13	mg/L
Hardness as $CaCO_3$	220	NA		300	NA		300	NA		330	NA		325	NA		310	NA	mg/L $CaCO_3$
Nitrate/Nitrite	0.04	10	HM	0.08	0/2		0.05	0/2	HM	0.02	0/3		0.04	0/2		0.03	0/5	mg/L
Nitrate as N	-	10	ND	-	0/12	ND	-	0/11	ND	-	0/12	ND	-	0/12		0.1	0/12	mg/L
pH	7.6	6.5 to 8.5	HT	6.75	2/14	HT	6.8	2/13	HT	7.4	0/15	HT	6.8	2/14	HT	7.2	1/17	pH unit
Sulfate	33.46	250		0.8	0/14		0.65	0/13	HT, HM	48	0/15		0.38	0/14	HT, HM	84	0/17	mg/L
Total Dissolved Solids	240	500	HT	301	0/14	HT, HM	320	2/13	HT, HM	350	1/15	HT, HM	330	1/14	HT, HM	360	1/17	mg/L
Total Suspended Solids	2.5	NA		6	NA		2.5	NA		91	NA		3.75	NA	HT	100	NA	mg/L
Turbidity	2.55	NA		6.4	NA		10.5	NA		65	NA		24	NA		49	NA	NTU
State Standards (Dissolved Concentrations)																		
Dissolved Metals																		
Aluminum	-	5		0.025	0/14		0.025	0/13	HM	0.025	0/15		0.025	0/14	HM	0.025	0/17	mg/L
Antimony	0.0031	NA		0.0012	NA		0.00032	NA		0.001	NA		0.00079	NA		0.00087	NA	mg/L
Arsenic	-	0.1	ND	-	0/15	ND	-	0/14	ND	-	0/16	ND	-	0/15	ND	-	0/18	mg/L
Barium	0.04345	1	HT, HM	0.319	0/14	HT, HM	0.36	0/13		0.11	0/15	HT, HM	2.6	13/14		0.0795	0/17	mg/L
Beryllium	-	NA	ND	-	NA		0.0025	NA	ND	-	NA	ND	-	NA	ND	-	NA	mg/L
Cadmium	-	0.01	ND	-	0/15		0.00005	0/14		0.0002	0/16	ND	-	0/15	HM	0.0004	1/18	mg/L

Table 4-18
Summary of Metals and Water Quality Parameters in the Bedrock Aquifer Compared to Federal and State Standards

Analyte	Upgradient Median P3	Most Stringent Standard	P-1 Method ID	P-1 Median	P-1 Frequency > Standard	P-2 Method ID	P-2 Median	P-2 Frequency > Standard	P-8 Method ID	P-8 Median	P-8 Frequency > Standard	P-7 Method ID	P-7 Median	P-7 Frequency > Standard	P-8PL Method ID	P-8PL Median	P-8PL Frequency > Standard	Units
Calcium	65	NA	HT, HM	100.5	NA	HT, HM	100	NA	HT, HM	94	NA	HT, HM	110	NA	HT, HM	100	NA	mg/L
Chromium	0.0005	0.05		0.0005	0/15		0.0005	0/14	HM	0.0005	0/16		0.0005	0/15	ND	-	0/18	mg/L
Cobalt	0.005	0.05		0.005	0/14		0.005	0/13		0.005	0/15		0.005	0/14		0.005	0/17	mg/L
Copper	0.0005	1		0.0005	0/15		0.0005	0/14	HT, HM	0.0018	0/16		0.0005	0/15	HT, HM	0.0106	0/18	mg/L
Iron	0.0138	1	HT, HM	0.6365	2/14	HT, HM	1.245	10/13	HM	0.01	0/15	HT, HM	1.955	12/14	HM	0.01	0/17	mg/L
Lead	0.0005	0.05	ND	-	0/15		0.0005	0/14		0.0005	0/16	ND	-	0/15		-	0/18	mg/L
Magnesium	17	NA	HT	17.95	NA	HT	16.7	NA	HT, HM	23.5	NA	HT	17.8	NA	HT, HM	19	NA	mg/L
Manganese	0.021	0.2	HT, HM	0.545	14/14	HT, HM	0.62	13/13	HT, HM	0.1	0/15	HT, HM	0.77	14/14	HT, HM	0.503	17/17	mg/L
Mercury	-	0.002	ND	-	0/14	ND	-	0/13	ND	-	0/15	ND	-	0/14	ND	-	0/17	mg/L
Nickel	-	0.2		0.01	0/14	ND	-	0/13	ND	-	0/15	ND	-	0/14	ND	-	0/17	mg/L
Potassium	1.05	NA	HT, HM	1.785	NA	HT	1.8	NA	HT, HM	2	NA	HT, HM	2	NA		1.48	NA	mg/L
Selenium	0.001	NA	ND	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	mg/L
Silver	-	0.05	ND	-	0/15	ND	-	0/14	ND	-	0/16	ND	-	0/15		0.00005	0/18	mg/L
Sodium	8 8	NA		7 9	NA		7.4	NA		12.9	NA		7.6	NA		11.2	NA	mg/L
Thallium	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	mg/L
Zinc	0 005	10		0 005	0/14	HT	0.005	0/13	HT, HM	0.0426	0/15		0.005	0/14	HT, HM	0.07	0/17	mg/L
Water Quality Parameters																		
Acidity	0.35	NA		3.5	NA		3	NA		1.5	NA		3.2	NA		2.48	NA	mg/L
Alkalinity ($CaCO_3$)	190.5	NA	HT, HM	313.5	NA	HT, HM	308	NA	HT, HM	280	NA	HT, HM	330	NA	HT	236	NA	mg/L
Bicarbonate	190	NA	HT, HM	315	NA	HT, HM	300	NA	HT, HM	275	NA	HT, HM	330	NA	HT	240	NA	mg/L
Carbonate	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	mg/L
Chloride	1.5	250		1.5	0/14		1.5	0/13		1.5	0/15		1.5	0/14		3	0/17	mg/L
Conductivity	420	NA		570	NA		560	NA		590	NA		600	NA		590	NA	µmhos/cm
Cyanide, Total	-	0.2	ND	-	0/2	NA	NA	NA	ND	-	0/2	ND	-	0/1	NA	NA	NA	mg/L
Cyanide, WAD	NA	NA	ND	-	NA	NA	NA	NA	ND	-	NA	NA	NA	NA	NA	NA	NA	mg/L
Fluoride	1.25	1.6		1.7	8/10		1.6	7/10		1.4	2/11		1.6	8/10		1.2	0/13	mg/L
Hardness as $CaCO_3$	220	NA		300	NA		300	NA		330	NA		325	NA		310	NA	mg/L $CaCO_3$
Nitrate/Nitrite	0.04	10	HM	0.08	0/2		0.05	0/2	HM	0.02	0/3		0.04	0/2		0.03	0/5	mg/L
Nitrate as N	-	10	ND	-	0/12	ND	-	0/11	ND	-	0/12	ND	-	0/12		0.1	0/12	mg/L
pH	7.6	6-9	HT	6.75	0/14	HT	6.8	0/13	HT	7.4	0/15	HT	6.8	0/14	HT	7.2	0/17	pH unit
Sulfate	33.46	600		0.8	0/14		0.65	0/13	HT, HM	48	0/15		0.38	0/14	HT, HM	84	0/17	mg/L
Total Dissolved Solids	240	1000	HT	301	0/14	HT, HM	320	1/13	HT, HM	350	0/15	HT, HM	330	1/14	HT, HM	360	0/17	mg/L
Total Suspended Solids	2.5	NA		6	NA		2.5	NA		91	NA		3.75	NA	HT	100	NA	mg/L
Turbidity	2.55	NA		6.4	NA		10.5	NA		65	NA		24	NA		49	NA	NTU
No. of PCOCs that exceed Standard	4				6			6			4			9			6	

NA - Not available

Method ID - Method of identifying PCOC

HM - Analyte was identified as PCOC using hot measurement test

HT - Analyte was identified as PCOC using hypothesis testing

* Secondary Drinking Water Standard; all others are Primary Drinking Water Standards

Bold Border = Analyte exceeds standard at least once

Table 4-19
Summary of Metals and Water Quality Parameters in Shallow Flow System Compared to Federal and State Standards

Analyte	Upgradient Median	Most Stringent Standard	P-2S Method ID	P-2S Median	P-2S Frequency > Standard	P-7S Method ID	P-7S Median	P-7S Frequency > Standard	P-8WR Method ID	P-8WR Median	P-8WR Frequency > Standard	Units
Federal Standards (Total Concentrations)												
Total Metals												
Aluminum	14	0.05*		4.9	15/15	HM	11.795	14/14	HM	75.6	7/7	mg/L
Antimony	0.00055	0.006		0.00388	0/4	ND	-	0/3		0.05555	0/5	mg/L
Arsenic	0.002	0.05	HT, HM	0.0049	0/16	HT, HM	0.0061	0/15		0.2778	0/7	mg/L
Barium	0.185	2	HT, HM	0.344	0/15	HT, HM	0.4295	0/14		0.05	0/7	mg/L
Beryllium	-	0.004	ND	-	0/12		0.0025	1/11		0.025	1/7	mg/L
Cadmium	0.0008	0.005	HT, HM	0.01835	14/16	HT, HM	0.004	5/15	HM	2.14	7/7	mg/L
Calcium	85	NA	HT, HM	100	NA	HT, HM	126.5	NA	HM	240	NA	mg/L
Chromium	0.020	0.1		0.00615	0/16		0.0069	0/15		0.061	1/7	mg/L
Cobalt	0.0124	NA		0.005	NA		0.00655	NA		0.258	NA	mg/L
Copper	0.037	1*	HT, HM	0.18	2/15	HM	0.04	0/15	HM	7.64	7/7	mg/L
Iron	21	0.3*		9.4	15/15	HT, HM	33	14/14	HM	150	7/7	mg/L
Lead	0.021	NA	HT	0.525	NA		0.025	NA		0.939	0/7	mg/L
Magnesium	11.2	NA	HT	17	NA	HT, HM	25	NA	HM	202	NA	mg/L
Manganese	0.795	0.05*		0.755	15/15	HT, HM	3.855	14/14	HM	7.29	7/7	mg/L
Mercury	-	0.002		0.0001	1/15		0.0001	0/14		0.00034	0/7	mg/L
Nickel	0.015	0.1		0.01	0/15		0.01	0/14		0.2778	3/7	mg/L
Potassium	3.2	NA		2.3	NA	HT, HM	4.685	NA		5	NA	mg/L
Selenium	-	0.05		0.0015	0/16	ND	-	0/15		0.0046	0/7	mg/L
Silver	0.0001	0.1*	HT, HM	0.0016	0/16	HT, HM	0.0006	0/15	HM	0.0278	0/7	mg/L
Sodium	1.5	NA		5.7	NA		8.25	NA		8.333	NA	mg/L
Thallium	-	0.0005	ND	-	0/3	ND	-	0/2	ND	-	0/5	mg/L
Zinc	0.095	5	HT, HM	4.831	7/15	HT, HM	5.57	8/14	HM	709	7/7	mg/L
Water Quality Parameters												
Acidity	1	NA		3	NA		5	NA		120	NA	mg/L
Alkalinity ($CaCO_3$)	175	NA	HT, HM	300	NA	HT, HM	316.5	NA	ND	-	NA	mg/L
Bicarbonate	175	NA	HT, HM	300	NA	HT, HM	320	NA	ND	-	NA	mg/L
Carbonate	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	mg/L
Chloride	1.5	250	HM	1.5	0/15	HM	1.5	0/14	HM	3.2	0/6	mg/L
Conductivity	375	NA		500	NA		635	NA		3045	NA	µmhos/cm
Cyanide, Total	-	0.2	ND	-	0/1	ND	-	0/1	NA	NA	NA	mg/L
Cyanide, WAD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/L
Fluoride	0.1	2	HT, HM	1.4	0/11	HT, HM	1.4	0/10	HM	2.15	3/6	mg/L
Hardness as $CaCO_3$	235	NA		310	NA		381	NA		1340	NA	mg/L $CaCO_3$
Nitrate/Nitrite	0.08	10		0.02	0/3		0.04	0/2		0.4	0/5	mg/L
Nitrate as N	-	10	ND	-	0/12	ND	-	0/12	ND	-	0/1	mg/L

Table 4-19
Summary of Metals and Water Quality Parameters in Shallow Flow System Compared to Federal and State Standards

Analyte	Upgradient Median	Most Stringent Standard	P-2S Method ID	P-2S Median	P-2S Frequency > Standard	P-7S Method ID	P-7S Median	P-7S Frequency > Standard	P-8WR Method ID	P-8WR Median	P-8WR Frequency > Standard	Units
pH	7.1	6.5 to 8.5	HT	6.9	1/15	HT	6.8	2/14		4.3	5/5	pH unit
Sulfate	25.2	250		7.7	0/15		50.15	1/14		2680	6/6	mg/L
Total Dissolved Solids	240	500	HT, HM	300	0/15	HT, HM	399	2/14	HM	4070	5/5	mg/L
Total Suspended Solids	685	NA		280	NA		422	NA		521	NA	mg/L
Turbidity	460	NA		210	NA		417	NA		737.5	NA	NTU
State Standards (Dissolved Concentrations)												
Dissolved Metals												
Aluminum	0.025	5	HM	0.025	0/15	ND	-	0/14	HM	45.1	5/5	mg/L
Antimony	0.00055	0.1		0.0029	0/4	ND	-	0/3	.	0.1	0/4	mg/L
Arsenic	-	1.0		0.00133	0/16		0.001	0/15	ND	-	0/5	mg/L
Barium	0.0465	1	HT, HM	0.29	0/15	HT, HM	0.3445	0/14		0.03	0/5	mg/L
Beryllium	-	NA	ND	-	NA	ND	-	NA		0.02	NA	mg/L
Cadmium	0.0001	0.01		0.00005	0/16		0.00005	0/15	HM	2.1	5/5	mg/L
Calcium	79.2	NA	HT, HM	100	NA	HT, HM	120	NA	HM	237.5	NA	mg/L
Chromium	0.0005	0.05		0.0005	0/16	ND	-	0/15		0.05	0/5	mg/L
Cobalt	0.005	0.05		0.005	0/15		0.005	0/14		0.245	4/5	mg/L
Copper	0.0005	1.0		0.0005	0/16		0.0005	0/15		8	5/5	mg/L
Iron	0.01	1.0		1.02	8/15		12	13/14		0.265	1/5	mg/L
Lead	0.0005	0.05		0.00145	1/16		0.0005	0/15	HM	0.45	5/5	mg/L
Magnesium	4.49	NA	HT, HM	15.77	NA	HT, HM	18	NA	HM	188	NA	mg/L
Manganese	0.005	0.2	HM	0.71	15/15	HM	3.45	14/14	HM	6.75	5/5	mg/L
Mercury	-	0.002	ND	-	0/15	ND	-	0/14	ND	-	0/5	mg/L
Nickel	-	0.2	ND	-	0/15	ND	-	0/14		0.23	3/5	mg/L
Potassium	0.5	NA	HT, HM	1.78	NA	HT, HM	2.08	NA	HM	3	NA	mg/L
Selenium	-	0.05	ND	-	0/16	ND	-	0/15		0.0023	0/5	mg/L
Silver	-	0.05		0.00005	0/16	ND	-	0/15		0.025	0/5	mg/L
Sodium	1.5	NA		7	NA		8.15	NA		7.39	NA	mg/L
Thallium	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	mg/L
Zinc	0.005	10	HT, HM	0.063	0/15	HT, HM	1.566	0/14	HM	660	5/5	mg/L
Water Quality Parameters												
Acidity	1	NA		3	NA		5	NA		120	NA	mg/L
Alkalinity ($CaCO_3$)	175	NA	HT, HM	300	NA	HT, HM	316.5	NA	ND	-	NA	mg/L
Bicarbonate	175	NA	HT, HM	300	NA	HT, HM	320	NA	ND	-	NA	mg/L
Carbonate	-	NA	ND	-	NA	ND	-	NA	ND	-	NA	mg/L
Chloride	1.5	250	HM	1.5	0/15	HM	1.5	0/14	HM	3.2	0/6	mg/L
Conductivity	375	NA		500	NA		635	NA		3045	NA	µmhos/cm
Cyanide, Total	-	0.2	ND	-	0/1	ND	-	0/1	NA	NA	NA	mg/L

Table 4-19

Summary of Metals and Water Quality Parameters in Shallow Flow System Compared to Federal and State Standards

Analyte	Upgradient Median	Most Stringent Standard	P-2S Method ID	P-2S Median	P-2S Frequency > Standard	P-7S Method ID	P-7S Median	P-7S Frequency > Standard	P-8WR Method ID	P-8WR Median	P-8WR Frequency > Standard	Units
Cyanide, WAD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	mg/L
Fluoride	0.1	1.6	HT, HM	1.4	4/11	HT, HM	1.4	2/10	HM	2.15	3/6	mg/L
Hardness as $CaCO_3$	235	NA		310	NA		381	NA		1340	NA	mg/L $CaCO_3$
Nitrate/Nitrite	0.08	10		0.02	0/3		0.04	0/2		0.4	0/5	mg/L
Nitrate as N	-	10	ND	-	0/12	ND	-	0/12	ND	-	0/1	mg/L
pH	7.1	6 to 9	HT	6.9	0/15	HT	6.8	0/14		4.3	5/5	pH unit
Sulfate	25.2	600		7.7	0/15		50.15	0/14		2680	6/6	mg/L
Total Dissolved Solids	240	1000	HT, HM	300	0/15	HT, HM	399	1/14	HM	4070	5/5	mg/L
Total Suspended Solids	685	NA		280	NA		422	NA		521	NA	mg/L
Turbidity	460	NA		210	NA		417	NA		737.5	NA	NTU
No. of PCOCs that exceed Standard	3				11			10			16	

NA - Not available

Method ID - Method of identifying PCOC

HM - Analyte was identified as PCOC using hot measurement test

HT - Analyte was identified as PCOC using hypothesis testing

* Secondary Drinking Water Standard; all others are Primary Drinking Water Standards

Bold Border = Analyte exceeds standard at least once

Table 4-20
Exceedances of Water Quality Standards for Groundwater in the Bedrock Aquifer

Analyte	Upgradient Median	Most Stringent Standard	Median Concentrations at Downgradient Wells					Units
			P-1	P-2	P-5	P-7	P-8PL	
Federal Standards (Total Concentrations)								
Total Metals								
Aluminum	0.1774	0.05*	0.025	0.025	1.6	0.025	3	mg/L
Barium	0.0905	2	0.31	0.36	0.12	2.5595	0.106	mg/L
Iron	0.415	0.3*	0.975	1.8	1.7	2.9	3.86	mg/L
Manganese	0.084	0.05*	0.529	0.624	0.12	0.745	0.55	mg/L
Water Quality Parameters (total)								
pH	7.6	6.5 to 8.5	6.75	6.8	7.4	6.8	7.2	pH unit
Total Dissolved Solids	240	500	301	320	350	330	360	mg/L
State Standards (Dissolved Concentrations)								
Dissolved Metals								
Barium	0.076	1	0.319	0.36	0.11	2.6	0.0795	mg/L
Cadmium	0.00005	0.01	0.00005	0.00005	0.0002	0.00005	0.0004	mg/L
Iron	0.0138	1	0.6365	1.245	0.01	1.955	0.01	mg/L
Manganese	0.0388	0.2	0.545	0.62	0.1	0.77	0.503	mg/L
Water Quality Parameters (dissolved)								
None								

Median exceeds standard for highlighted (shaded) cells

* Secondary Drinking Water Standard; all others are Primary Drinking Water Standards

Table 4-21
Exceedances of Water Quality Standards for Groundwater in Shallow Flow System

Analyte	Upgradient Median	Most Stringent Standard	Median Concentrations at Downgradient wells P-2S	P-7S	P-8WR	Units
Federal Standards (Total Concentrations)						
Total Metals						
Aluminum	14	0.05*	4.9	11.795	75.6	mg/L
Beryllium	0.0025	0.004	0.0025	0.0025	0.025	mg/L
Cadmium	0.0008	0.005	0.01835	0.004	2.14	mg/L
Copper	0.037	1	0.18	0.04	7.64	mg/L
Iron	21	0.3*	9.4	33	150	mg/L
Manganese	0.795	0.05*	0.755	3.855	7.29	mg/L
Mercury	0.0001	0.002	0.0001	0.0001	0.00034	mg/L
Zinc	0.095	5	4.831	5.57	709	mg/L
Water Quality Parameters (total)						
pH	7.1	6.5 to 8.5	6.9	6.8	4.3	pH unit
Total Dissolved Solids	240	500	300	399	4070	mg/L
State Standards (Dissolved Concentrations)						
Dissolved Metals						
Aluminum	0.025	5	0.025	0.025	45.1	mg/L
Cadmium	0.0001	0.01	0.00005	0.00005	2.1	mg/L
Lead	0.0005	0.05	0.00145	0.0005	0.45	mg/L
Manganese	0.005	0.2	0.71	3.45	6.75	mg/L
Zinc	0.005	10	0.063	1.566	660	mg/L
Water Quality Parameters (dissolved)						
Fluoride	0.1	1.6	1.4	1.4	2.15	mg/L

Median exceeds standard for highlighted (shaded) cells

* Secondary Drinking Water Standard; all others are Primary Drinking Water Standards

Table 4-22b
New Mexico Chemical-Specific Numeric Standards for Dissolved Metals and Water-Quality Parameters in Surface Water

Notes, continued:

[g] The effluent discharge of: any two consecutive daily composite samples; more than one daily composite sample in any 30-day period (< 10 daily samples); more than 10% of daily composite sample in any 30-day period (10 or more samples); or a grab sample collected from an intermittent or infrequent discharge shall conform to these regulations. The pH requirement may be eliminated for effluent the director of the Environmental Department determines does not "unreasonably degrade" the watercourse. These regulations "shall not apply to any discharge which is subject to a permit under the National Pollutant Discharge Elimination System of P.L. 92-500." WQCC 82-1 2101

[h] Measured for both trivalent and hexavalent ions.

[i] Discharge shall not lead to bioaccumulation to toxic levels in any animal species when added to background concentrations. In absence of information, the standard becomes 0.002 mg/L (TR) for selenium and 0.000012 mg/L (T) for mercury.

[j] Standard becomes 0.25 mg/L in the presence of 500 mg/L or more SO_4.

[k] Discharge shall not contain ammonium or chlorine concentrations which will reduce biological productivity or diversity. In no case shall chlorine exceed 1 mg/L or ammonia exceed levels attainable using best available technology.

[l] Amenable to chlorination.

[m] Total ammonia (as N) standards vary between 29 and 0.75 mg/L for the temperature range of 0 to 20 °C and pH 6.5 - 9.0.

[n] Total ammonia (as N) standards vary between 2.5 and 0.12 mg/L for the temperature range of 0 to 20 °C and pH 6.5 - 9.0.

[p] 25 NTU in certain reaches where natural background prevents attainment of lower turbidity.

[q] Depends on stream background. In µmhos/cm at 25°C.

Equations for Calculation of Acute and Chronic Standards:

Acute Standards (in µg/L)	*Chronic Standards (in µg/L)*
Dissolved cadmium: e(1.128[ln(hardness)] - 3.828)	Dissolved cadmium: e(0.7852[ln(hardness)] - 3.49)
Dissolved chromium: e(0.819[ln(hardness)] + 3.688)	Dissolved chromium: e(0.819[ln(hardness)] + 1.561)
Dissolved copper: e(0.9422[ln(hardness)] - 1.464)	Dissolved copper: e(0.8545[ln(hardness)] - 1.465)
Dissolved lead: e(1.273[ln(hardness)] - 1.46)	Dissolved lead: e(1.273[ln(hardness)] - 4.705)
Dissolved nickel: e(0.8460[ln(hardness)] + 3.3612)	Dissolved nickel: e(0.846[ln(hardness)] + 1.1645)
Dissolved silver: e(1.72[ln(hardness)] - 6.52)	Dissolved zinc: e(0.8473[ln(hardness)] + 0.7614)
Dissolved zinc: e(0.8473[ln(hardness)] + 0.8604)	

Sources:

20 NMAC 6.1 Standards for Interstate and Intrastate Streams

Environmental Law Reporter (August 1995)

Table 4-23
Comparison of Total Constituent Concentrations at WCU-1 with Standards (mg/L)

Analyte	Median	Maximum	$UTL_{95/95}$[1]	Most Stringent Standard	Type of Standard[2]	Median > Standard	Maximum > Standard	$UTL_{95/95}$[1] > Standard
Total Metals (mg/L)								
Aluminum	0.168	1	1.0467	0.05	S	X	X	X
Antimony	0.0002	0.0002	—	0.006	P			—
Arsenic	0.0011	0.00165	—	0.05	P			—
Barium	0.0269	0.0294	0.0305	2	P			
Beryllium	0.0011	0.0025	—	0.004	P			—
Cadmium	0.0002	0.00061	0.0007	0.005	P			
Chromium	0.0005	0.0019	0.0019	0.1	P			
Copper	0.0011	0.0371	0.0261	1	S			
Iron	0.17	0.641	0.6778	0.3	S		X	X
Manganese	0.005	0.0249	0.0262	0.05	S			
Mercury	0.0001	0.00027	0.0002	0.002	P			
Nickel	0.0056	0.0158	0.0159	0.1	P			
Selenium	0.0005	0.001	—	0.05	P			—
Silver	0.0001	0.0001	—	0.1	S			—
Thallium	0.0001	0.0001	—	0.002	P			—
Zinc	0.0132	0.0351	0.0423	5	S			
Water Quality Parameters								
Conductivity (µmhos/cm)	280	300	346	NA	-			
Nitrate as N (mg/L)	0.10	0.10	—	10.00	P			—
pH	8.20	8.40	8.68	6.50 - 8.50	S			X
TDS (mg/L)	170	190	214	500	S			
Turbidity (NTU)	1.50	6.70	11.65	NA	-			

[1]Dash indicates $UTL_{95/95}$ not calculated if number of samples was < 3 and/or number of detects = 0
[2]P = Primary drinking water standard (federal)
S = Secondary drinking water standard (federal)
NA = No Standard available

Table 4-24
Comparison of Dissolved Constituent Concentrations at WCU-1 with Standards (mg/L)

Analyte	Median	Maximum	$UTL_{95/95}$[1]	Most Stringent Standard[2]	Type of Standard[3]	Median > Standard	Maximum > Standard	$UTL_{95/95}$[1] > Standard
Dissolved Metals (mg/L)								
Aluminum	0.0150	0.0610	0.0537	0.0870	A			
Antimony	0.0001	0.0008	0.0009	NA	-			
Arsenic	0.0005	0.0017	—	0.0500	D			—
Barium	0.0241	0.0271	0.0280	1.0000	D			
Beryllium	0.0010	0.0025	—	0.0053	A			—
Cadmium	0.0001	0.0006	0.0005	0.0016	A			
Chromium	0.0003	0.0005	0.0008	0.0500	D			
Cobalt	0.0005	0.0050	0.0083	0.0500	I			
Copper	0.0005	0.0083	0.0080	0.0177	A			
Iron	0.0050	0.0544	0.0450	NA	-			
Lead	0.0002	0.0005	0.0008	0.0058	A			
Manganese	0.0025	0.0050	—	NA	-			
Mercury (Total[4])	0.0001	0.0002	0.0002	0.000012	A			
Nickel	0.0050	0.0100	—	0.2347	A			—
Selenium	0.0005	0.0010	—	0.002 (T)	A			—
Silver	0.0001	0.0010	—	0.00012	A		X	—
Thallium	0.0001	0.0001	—	NA	-			—
Zinc	0.0043	0.0707	0.0692	0.1578	A			
Water Quality Parameters (mg/L)								
Chloride	0.90	1.50	—	NA	-			—
Fluoride	0.05	0.20	—	NA	-			—
Nitrate/Nitrite	0.08	0.12	—	NA	-			—
Sulfate	13.00	16.00	—	NA	-			—

[1]Dash indicates $UTL_{95/95}$ not calculated if number of samples was < 3 and/or number of detects = 0

[2]T = Total concentrations; all other values are dissolved concentrations

[3]D = Domestic Water Supply (state)

[4]Total = Total for mercury refers to total forms of dissolved mercury not total mercury

NA = Not Applicable because there is no dissolved standard

A = Aquatic life standard (state)

I = Irrigation standard (state)

Table 4-25
Comparison of Total Constituent Concentrations at PAW with Standards (mg/L)

Analyte	Median	Maximum	$UTL_{95/95}$[1]	Most Stringent Standard (mg/L)	Most Stringent Standard	Type of Standard2	Median > Standard	Maximum > Standard	$UTL_{95/95}$[1] > Standard
Total Metals (mg/L)									
Aluminum	0.6645	1.8600	1.8309	0.05	0.05	S	X	X	X
Antimony	0.0002	0.0009	0.0006	0.006	0.006	P			
Arsenic	0.0011	0.0026	0.0019	0.05	0.05	P			
Barium	0.0245	0.0290	0.0300	2	2	P			
Beryllium	0.0011	0.0025	—	0.004	0.004	P			—
Cadmium	0.0002	0.0147	0.0045	0.005	0.005	P		X	
Chromium	0.0007	0.0040	0.0029	0.1	0.1	P			
Copper	0.0030	0.0546	0.0221	1	1	S			
Iron	0.3695	1.0700	1.0436	0.3	0.3	S	X	X	X
Manganese	0.0061	0.0270	0.0204	0.05	0.05	S			
Mercury	0.0001	0.0003	0.0002	0.002	0.002	P			
Nickel	0.0056	0.0239	0.0152	0.1	0.1	P			
Selenium	0.0005	0.0018	0.0014	0.002	0.05	P			
Silver	0.0001	0.0001	—	0.1	0.1	S			—
Thallium	0.0001	0.0001	—	0.0005	0.002	P			—
Zinc	0.0219	0.2700	0.0847	5	5	S			
Water Quality Parameters									
Conductivity (μmhos/cm)	150	200	234		NA	-			
Nitrate as N (mg/L)	0.1	0.1	—		10	P			—
pH	8	8.3	8.92		6.5 - 8.5	S			X
TDS (mg/L)	95	120	140		500	S			
Turbidity (NTU)	2.6	6.5	9.12		NA	-			
Cyanide, Total (mg/L)	1.55	2.1	—	0.2	200	P			—
Cyanide, WAD (mg/L)	1.55	2	—	0	200	P			—

[1]Dash indicates $UTL_{95/95}$ not calculated if number of samples was < 3 and/or number of detects = 0

[2]P = Primary drinking water standard (federal)

S = Secondary drinking water standard (federal)

A = Aquatic life standard (state)

I = Irrigation standard (state)

NA = No standard available

Table 4-26
Comparison of Dissolved Constituents at PAW with Standards (mg/L)

Analyte	Median	Maximum	UTL$_{95/95}$[1]	Most Stringent Standard[2]	Type of Standard[3]	Median > Standard	Maximum > Standard	UTL$_{95/95}$[1] > Standard
Dissolved Metals (mg/L)								
Aluminum	0.0747	0.3000	0.2787	0.0870	A		X	X
Antimony	0.0001	0.0069	0.0046	NA	-			
Arsenic	0.0005	0.0017	—	0.0500	D			—
Barium	0.0223	0.0270	0.0276	1.0000	D			
Beryllium	0.0010	0.0025	—	0.0053	A			—
Cadmium	0.0001	0.0165	0.0051	0.0010	A		X	X
Chromium	0.0005	0.0013	0.0010	0.0500	D			
Cobalt	0.0004	0.0050	0.0063	0.0500	I			
Copper	0.0011	0.0092	0.0046	0.0103	A			
Iron	0.0517	0.2090	0.2050	NA	-			
Lead	0.0002	0.0042	0.0014	0.0026	A		X	
Manganese	0.0050	0.0102	0.0106	NA	-			
Mercury	0.0001	0.0003	0.0002	0.000012	A			
Nickel	0.0050	0.0100	—	0.1377	A			—
Selenium	0.0005	0.0021	0.0017	0.002 (T)	A			
Silver	0.0001	0.0010	—	0.00012	A		X	—
Thallium	0.0001	0.0001	—	NA	-			—
Zinc	0.0038	0.0543	0.0319	0.0925	A			
Water Quality Parameters (mg/L)								
Chloride	0.0008	0.0015	—	NA	-			—
Fluoride	0.0001	0.0003	—	NA	-			—
Nitrate/Nitrite	0.0001	0.0006	—	NA	-			—
Sulfate	0.0110	0.0170	—	NA	-			—

[1]Dash indicates UTL$_{95/95}$ not calculated if number of samples was < 3 and/or number of detects = 0

[2]T = Total concentrations; all other values are dissolved concentrations

[3]D = Domestic Water Supply (state)

[4]Total = Total for mercury refers to total forms of dissolved mercury not total mercury

NA = Not Applicable because there is no dissolved standard

A = Aquatic life standard (state)

I = Irrigation standard (state)

Table 4-27a
Potential Contaminants in Willow Creek Surface Water, Total Concentrations

Potential Contaminant	Most Stringent Standard[1]	WCU-1 (BKG) Median	WCU Method ID	WCU Median	WCU Samples > Standard (Low Flow/High Flow/Total)			WAW Method ID	WAW Median	WAW Samples > Standard (Low Flow/High Flow/Total)			WCD Method ID	WCD Median	WCD Samples > Standard (Low Flow/High Flow/Total)			BDT Method ID	BDT Median	BDT Samples > Standard (Low Flow/High Flow/Total)		
Total Metals (mg/L)																						
Aluminum	0.050	0.168	HM	0.27	10	9	19/20	HM	0.2455	2	4	6/8	HT, HM	0.6195	15	30	45/48	HT, HM	4	8	8	16/16
Barium	*2*	0.0269	HT, HM	0.032	-	-	0/21	HT, HM	0.0332	-	-	0/8	HT, HM	0.0380	-	-	0/49	HT, HM	0.07			0/17
Cadmium	*0.005*	0.0002	HM	0.0002	1	-	1/22	HM	0.0001	-	-	0/9	HM	0.0002	7	1	8/103	HT, HM	0.14	7	6	13/18
Calcium	NA	60	HT, HM	63	-	-	NA	HM	61.6	-	-	NA	HT, HM	62.02	-	-	NA	HT, HM	84	-	-	NA
Chromium	*0.100*	0.0005	HM	0.00067	-	-	0/22	HM	0.0005	-	-	0/9	HT, HM	0.001	-	-	0/51	HM	0.0008	-	-	0/18
Cobalt	NA	0.0005	-	0.005	-	-	NA	-	0.005	-	-	NA	HT	0.0011	-	-	NA	HT, HM	0.044	-	-	NA
Copper	1	0.0011	HM	0.0025	-	-	0/22	-	0.0005	-	-	0/9	HM	0.0058	-	-	0/103	HM	0.435	4	3	7/18
Iron	0.300	0.17	HM	0.22	3	5	8/20	HM	0.236	0	4	4/8	HT, HM	0.5515	13	23	36/48	HT, HM	1.98	8	8	16/16
Lead	NA	0.00035	-	0.00093	-	-	NA	-	0.0005	-	-	NA	-	0.0059	-	-	NA	-	0.0292	-	-	NA
Magnesium	NA	3.26	HT, HM	4	-	-	NA	HT, HM	3.7	-	-	NA	HT, HM	3.995	-	-	NA	HT, HM	25	-	-	NA
Manganese	0.050	0.005	HM	0.012	2	-	2/20	HM	0.0076	-	-	0/8	HT, HM	0.05	11	14	25/48	HT, HM	1.52	8	8	16/16
Mercury	*0.002*	0.0001	-	0.0001	-	-	0/21	-	0.0001	-	-	0/9	HM	0.0001	-	3	3/50	-	0.0001	-	-	0/17
Nickel	*0.100*	0.00555	-	0.0078	-	-	0/20	HM	0.01	-	-	0/8	-	0.0056	-	-	0/48	HM	0.0245	-	-	0/16
Potassium	NA	0.50	HM	0.66	-	-	NA	HT, HM	0.5	-	-	NA	HT, HM	0.771	-	-	NA	HT, HM	1	-	-	NA
Sodium	NA	1.20	HM	1.5	-	-	NA	HT	1.5	-	-	NA	HT, HM	1.5	-	-	NA	HT, HM	3	-	-	NA
Zinc	5	0.01315	HM	0.02	-	-	0/21	HM	0.0223	-	-	0/8	HM	0.0758	1	-	1/101	HT, HM	63	7	7	14/17
Water Quality Parameters																						
Acidity (mg/L)	NA	0.58	HM	2.5	-	-	NA	-	0.15	-	-	NA	HM	0.75	-	-	NA	HM	54.5	-	-	NA
Alkalinity (mg/L as $CaCO_3$)	NA	160	-	143	-	-	NA	HM	140	-	-	NA	-	147	-	-	NA	HM	120	-	-	NA
Bicarbonate (mg/L as $CaCO_3$)	NA	137.5	-	142.5	-	-	NA	-	140	-	-	NA	-	145	-	-	NA	HM	130	-	-	NA
Conductivity (µmhos/cm)	300 - 1500	280	HT	310	3	4	7/20	-	294	3	3	6/9	HT, HM	320	3	7	10/28	HT, HM	705	2	1	3/16
Hardness (mg/L as $CaCO_3$)	NA	160	-	168	-	-	NA	HM	160	-	-	NA	HM	168	-	-	NA	HM	410	-	-	NA
pH	6.5 to 8.5	8.2	-	7.9	-	-	0/21	-	8.2	-	1	1/9	-	7.8	1	-	1/29	-	6.6	5	3	8/17
Sulfate (mg/L)	250	13	HT, HM	17	-	-	0/21	HT, HM	16	-	-	0/9	HT, HM	15.2	-	-	0/95	HM	300	5	4	9/17
Total Dissolved Solids (mg/L)	500	170	-	180	-	-	0/21	-	170	-	-	0/9	HM	182	-	-	0/29	HT, HM	430	4	3	7/17
Total Suspended Solids (mg/L)	NA	6	HM	8	-	-	NA	HM	6	-	-	NA	HT, HM	20.5	-	-	NA	HT, HM	47.5	-	-	NA
Turbidity (NTU)	10	1.5	HT, HM	5.55	4	4	8/20	HT, HM	4.3	3	-	3/9	HM	6.9	6	6	12/28	HT, HM	27.5	6	6	12/16
Total No. of PCOCs			17					17					21					23				
No. of analytes that exceed the standard one or more times							6					5					9					11

PCOC = Potential contaminant of concern
NA = Not applicable
Method ID = Method of identifying PCOC
HM = Analyte identified as PCOC using $UTL_{95/95}$ hot measurement test
HT = Analyte identified as PCOC using inferential statistics hypothesis tests
- = Analyte not identified as a PCOC

[1] Human health-based (primary) standards shown in italics; secondary standards in normal type.

Table 4-27b
Potential Contaminants in Willow Creek Surface Water, Dissolved Concentrations

Potential Contaminant	Most Stringent Standard[1]	WCU-1 (BKG) Median	WCU					WAW					WCD					BDT				
			Method ID	Median	Samples > Standard (Low Flow/High Flow/Total)			Method ID	Median	Samples > Standard (Low Flow/High Flow/Total)			Method ID	Median	Samples > Standard (Low Flow/High Flow/Total)			Method ID	Median	Samples > Standard (Low Flow/High Flow/Total)		
Dissolved Metals (mg/L)																						
Aluminum	0.087	0.015	HM	0.025	2	-	2/19	HM	0.025	-	-	0/8	HM	0.015	3	-	3/47	HM	0.025	4	4	8/17
Barium	*1*	0.0241	HT, HM	0.03	-	-	0/18	HT, HM	0.03	-	-	0/8	HT, HM	0.033	-	-	0/45	HT, HM	0.0635	-	-	0/17
Cadmium	0.0016	0.0001	HM	0.0001	1	-	1/21	HM	0.0001	-	-	0/9	HT, HM	0.0001	7	2	9/75	HT, HM	0.1	7	8	15/19
Calcium	NA	59.25	HT, HM	64	-	-	NA	HT, HM	61.4	-	-	NA	HT, HM	61.95	-	-	NA	HT, HM	90	-	-	NA
Chromium	*0.05*	0.00026	-	0.0005	-	-	0/19	HM	0.0005	-	-	0/9	-	0.0005	-	-	0/47	HM	0.0005	-	-	0/18
Cobalt	0.05	0.00045	-	0.005	-	-	0/17	-	0.005	-	-	0/8	-	0.0006	-	-	0/44	HT, HM	0.039	4	3	7/16
Copper	0.01767	0.0005	HM	0.001	-	-	0/21	-	0.0005	-	-	0/9	HM	0.0014	-	4	4/75	HT, HM	0.1	6	6	12/19
Iron	0.3 (Total)	0.005	HM	0.01	2	-	2/19	-	0.01	-	-	0/8	HM	0.0207	2	-	2/47	HM	0.02	4	1	5/17
Lead	0.0058	0.00016	HM	0.0005	2	-	2/21	HM	0.0005	-	-	0/9	HM	0.0003	2	-	2/75	HM	0.0064	4	2	6/19
Magnesium	NA	3.235	HT, HM	3.91	-	-	NA	HT, HM	3.73	-	-	NA	HT, HM	4.02	-	-	NA	HM	25	-	-	NA
Manganese	0.05 (Total)	0.0025	-	0.005	1	-	1/19	-	0.005	-	-	0/8	HT	0.0313	8	3	11/47	HT	1.5	8	9	17/17
Mercury (Total)[2]	0.000012	0.0001	-	0.0001	-	-	0/18	-	0.0001	-	-	0/9	HM	0.0001	-	1	1/46	-	0.0001	-	-	0/17
Potassium	NA	0.5	HT, HM	0.602	-	-	NA	HT, HM	0.5	-	-	NA	HT, HM	0.5935	-	-	NA	HT, HM	1	-	-	NA
Sodium	NA	1.24	-	1.5	-	-	NA	HT	1.5	-	-	NA	HT, HM	1.5	-	-	NA	HT, HM	3	-	-	NA
Zinc	0.1578	0.00425	HT, HM	0.005	2	-	2/20	-	0.005	-	-	0/8	HT, HM	0.0268	8	3	11/73	HT, HM	47.5	8	9	17/18
Water Quality Parameters																						
Chloride (mg/L)	250 (Total)	0.9	-	1.25	-	-	0/20	-	1.5	-	-	0/9	HT, HM	1.1	-	-	0/48	HT, HM	1.5	-	-	0/16
Fluoride (mg/L)	2 (Total)	0.05	-	0.05	-	-	0/12	HT, HM	0.1	-	-	0/9	HM	0.05	-	-	0/40	HT, HM	0.8	-	1	1/9
Total No. of PCOCs			10					10					15					16				
No. of analytes that exceed the standard one or more times							6					0					8					9

PCOC = Potential contaminant of concern
NA = Not applicable
Method ID = Method of identifying PCOC
HM = Analyte identified as PCOC using $UTL_{95/95}$ hot measurement test
HT = Analyte identified as PCOC using inferential statistics hypothesis tests
- = Analyte not identified as a PCOC
[1] Human health-based standards shown in italics; aquatic life standards in normal type; cobalt standard is irrigation standard.
[2]Total for mercury refers to total forms of dissolved mercury

Table 4-28a
Potential Contaminants in Pecos River Surface Water, Total Concentrations

Potential Contaminant	Most Stringent Standard[1]	PAW (BKG) Median	PU					WC/P					PD					PE-UN					PTS				
			Method ID	Median	Samples > Standard (Low[2] Flow/High Flow/Total)			Method ID	Median	Samples > Standard (Low[2] Flow/High Flow/Total)			Method ID	Median	Samples > Standard (Low[2] Flow/High Flow/Total)			Method ID	Median	Samples > Standard (Low[2] Flow/High Flow/Total)			Method ID	Median	Samples > Standard (Low[2] Flow/High Flow/Total)		
Total Metals (mg/L)																											
Aluminum	0.05	0.66	HM	0.335	3/5	4/5	7/10	HM	0.21	7/10	8/9	15/19		0.105	7/9	7/9	14/18	HM	0.769	2/2	19/19	21/21		0.1			6/9
Antimony	*0.006*	0.0002		0.025	0/1	-	0/1		0.00065	0/1	0/3	0/4		0.0002	0/1	0/2	0/3	HM	0.0002	0/2	0/19	0/21		0.0002			0/1
Arsenic	*0.050*	0.0011		0.001	0/7	0/5	0/12		0.001	0/11	0/10	0/20	HM	0.001	0/11	0/9	0/20	HM	0.0011	0/16	0/19	0/35		0.001			0/9
Barium	2	0.0245	HM	0.024	0/6	0/5	0/11	HT, HM	0.0296	0/10	0/9	0/19	HM	0.025	0/10	0/9	0/19	HT, HM	0.0268	0/2	0/19	0/21		0.025			0/9
Cadmium	*0.005*	0.0002		0.00008	0/7	0/5	0/12	HT, HM	0.0016	2/11	1/9	3/20	HT, HM	0.00045	3/11	1/9	3/20	HT, HM	0.00053	0/20	2/62	2/82		0.00035			0/9
Calcium	NA	29.7	HT, HM	32	-	-	NA	HT, HM	36	-	-	NA	HT	33	-	-	NA	HM	30.9	-	-	NA	HT	33			
Chromium	*0.1*	0.00065	HM	0.00075	0/7	0/5	0/12	HM	0.0005	0/11	0/9	0/20	HM	0.0005	0/11	0/9	0/20	HM	0.00089	0/2	0/19	0/21		0.0005			0/9
Copper	1	0.00295		0.00075	0/7	0/5	0/12	HT, HM	0.00528	0/11	0/9	0/20	HM	0.0016	0/11	0/9	0/20	HT	0.0044	0/20	0/62	0/82		0.0016			0/9
Iron	0.3	0.3695	HM	0.33	1/5	4/5	5/10	HM	0.26	3/10	6/9	9/19	HT, HM	0.165	1/11	4/9	5/18	HT, HM	0.463	0/2	17/19	19/21		0.15			0/9
Lead	NA	0.00035		0.0005	-	-	NA	HT, HM	0.002	-	-	NA	HM	0.00085	-	-	NA	HT, HM	0.001	-	-	NA	HM	0.0005			
Magnesium	NA	3.08	HT, HM	3.3	-	-	NA	HM	3.7	-	-	NA	HT, HM	3.3	-	-	NA		3.12	-	-	NA		3.3			
Manganese	0.050	0.0061	HM	0.005	0/5	0/5	0/10	HT, HM	0.03	2/10	1/9	3/19	HT, HM	0.01385	0/9	0/9	0/18	HT, HM	0.0138	0/2	0/19	0/21	HT, HM	0.012			0/9
Mercury	*0.002*	0.0001		0.0001	0/6	0/5	0/11	HT	0.0001	0/10	0/9	0/19		0.0001	0/10	0/9	0/19	HM	0.0001	2/2	17/19	3/21		0.0001			0/9
Nickel	*0.1*	0.00555		0.01	0/5	0/5	0/10		0.01	0/10	0/9	0/19		0.0001	0/9	0/9	0/18		0.00555	0/2	0/19	0/21		0.01			0/9
Potassium	NA	0.6005	HM	0.5	-	-	NA	HM	0.5	-	-	NA	HM	0.5	-	-	NA	HM	0.649	-	-	NA	HM	0.5			
Selenium	*0.002*	0.0005	HM	0.001	0/7	1/5	1/12	HM	0.001	0/11	2/9	2/20		0.001	0/11	0/9	0/20	HM	0.0005	0/2	0/19	0/21		0.001			0/9
Sodium	NA	1.5	HM	1.5	-	-	NA	HM	1.5	-	-	NA	HM	1.5	-	-	NA		1.82	-	-	NA		1.5			
Zinc	5	0.0219		0.01	0/6	0/5	0/11	HT, HM	0.389	1/10	0/9	1/19	HT, HM	0.129	0/10	0/9	0/19	HT, HM	0.07685	0/20	0/62	0/82	HT, HM	0.094			0/9
Water Quality Parameters																											
Acidity (mg/L)	NA	0.15	HM	2.5	-	-	NA	HM	0.58	-	-	NA	HM	1	-	-	NA		ND	-	-	ND		0.15			
Alkalinity (mg/L as $CaCO_3$)	NA	74	HM	80	-	-	NA	HT, HM	85	-	-	NA		80	-	-	NA		ND	-	-	ND	HT	81			
Bicarbonate (mg/L as $CaCO_3$)	NA	72	HM	80	-	-	NA	HT, HM	84.5	-	-	NA	HM	78	-	-	NA		ND	-	-	ND		80			
Conductivity (µmhos/cm)	*300 - 1500*	150		185	5/5	5/5	10/10	HT, HM	190	9/10	9/9	18/19		179	9/9	9/9	18/18		ND	-	-	ND		160			9/9
Hardness (mg/L as $CaCO_3$)	NA	85.2		96	-	-	NA	HM	100	-	-	NA	HM	96	-	-	NA	HM	96.6	-	-	NA		100			
pH	*6.5 to 8.5*	8		7.9	0/6	1/5	1/11		7.8	0/10	0/9	0/19		7.9	0/10	0/9	0/19		ND	-	-	ND		8			0/9
Nitrate as N (mg/L)	*10*	0.1		0.1	0/6	0/4	0/10		0.1	0/10	0/6	0/16		0.1	0/10	0/9	0/16		ND	-	-	ND		0.1			0/8
Sulfate (mg/L)	250	11	HT, HM	15.18	0/6	0/5	0/11	HT, HM	15.3	1/10	0/9	1/19	HT, HM	13	0/10	0/9	0/19		11.5	0/6	0/59	0/65	HT, HM	12			0/9
Total Dissolved Solids (mg/L)	500	95		110	0/6	0/5	0/11	HT, HM	122	0/10	0/9	0/19		116	0/10	0/9	0/19		ND	-	-	ND		100			0/9
Total Suspended Solids (mg/L	NA	2.5		2.5	-	-	NA	HT	6	-	-	NA		2.5	-	-	NA		2.5	-	-	NA		2.5			
Turbidity (NTU)	10	2.6	HM	4.5	0/5	3/5	3/10	HM	4.6	2/10	4/9	6/19	HM	3.4	0/9	2/8	2/17		ND	-	-	ND		2.3			0/9
Total No. of PCOCs			15					24					18					16					7				
No. of analytes that exceed Standard one or more time		3					6					9					5					4					2

NA = Not available
ND = No data
Method ID = Method of identifying PCOC
HM = Analyte identified as PCOC using hot measurement test
HT = Analyte identified as PCOC using hypothesis tests
Bold Border = Analyte concentration exceeds standard in at least one sample

[1] Human health-based standards shown in italics; aquatic life standards in normal type; cobalt standard is irrigation standard
[2] Low flow = July-March; high flow = April-June

Table 4-28b
Potential Contaminants in Pecos River Surface Water, Dissolved Concentrations

Potential Contaminant	Most Stringent Standard[1]	PAW (BKG) Median	PU Method ID	PU Median	PU Samples > Standard (Low[2] Flow/High Flow/Total)			WC/P Method ID	WC/P Median	WC/P Samples > Standard (Low[2] Flow/High Flow/Total)			PD Method ID	PD Median	PD Samples > Standard (Low[2] Flow/High Flow/Total)			PE-UN Method ID	PE-UN Median	PE-UN Samples > Standard (Low[2] Flow/High Flow/Total)			PTS Method ID	PTS Median	PTS Samples > Standard (Low[2] Flow/High Flow/Total)		
Dissolved Metals (mg/L)																											
Aluminum	0.087	0.0747	HM	0.025	0/5	3/6	3/11	HM	0.025	0/10	3/9	3/19	HM	0.0395	1/9	3/9	4/18		0.0914	2/2	11/1	11/20		0.025			0/9
Antimony	0.006 (Total)	0.0001	HT	0.025	0/1	-	0/1	HT	0.001	0/1	0/3	0/4	HT	0.00081	0/1	0/2	0/3	HM	0.0001	1/2	9/18	1/20		0.00061			0/1
Arsenic	*0.05*	0.0005	HT	0.001	0/7	0/5	0/12	HT	0.001	0/11	0/9	0/20	HT	0.001	0/11	0/9	0/20		0.0005	0/16	0/18	0/34	HT	0.001			0/9
Barium	*1*	0.0223	HM	0.02	0/6	0/5	0/11	HT, HM	0.025	0/10	0/9	0/19	HM	0.0231	0/10	0/9	0/19	HM	0.0239	0/2	0/18	0/20		0.023			0/9
Beryllium	0.0053	0.001	HT	0.0025	0/3	-	0/3	HT	0.0025	0/9	0/5	0/14	HT	0.0025	0/7,	0/5	0/12	HT	0.001	0/2	0/18	0/20	HT	0.0025			0/9
Cadmium	0.001	0.0001	HT	0.00005	0/7	0/6	0/13	HT, HM	0.00105	5/11	4/9	9/20	HT, HM	0.00039	2/11	2/9	4/20	HT, HM	0.00046	5/16	6/44	11/57	HT	0.00026			2/9
Calcium	NA	29.4	HT, HM	35	-	-	NA	HT, HM	38	-	-	NA	HT, HM	35.7	-	-	NA	HT, HM	33	-	-	NA	HT	32	-	-	NA
Chromium	*0.05*	0.0005	HT, HM	0.0005	0/7	0/5	0/12	HT	0.0005	0/11	0/9	0/20	HT	0.0005	0/11	0/9	0/20	HM	0.00028	0/2	0/18	0/20	HT	0.0005			0/9
Cobalt	0.05	0.00041	HT	0.005	0/5	0/5	0/10	HT	0.005	0/10	0/9	0/19	HT	0.005	0/9	0/9	0/18		0.00029	0/2	0/18	0/20	HT	0.005			0/9
Copper	0.01	0.0011		0.0005	0/7	0/6	0/13	HT, HM	0.0034	2/11	2/9	4/20	HT, HM	0.0015	2/11	1/9	3/20	HT, HM	0.0018	0/16	0/41	0/57		0.0012			0/9
Iron	0.3 (Total)	0.0517	HM	0.028	0/5	0/6	0/11	HT, HM	0.0132	0/10	0/9	0/19		0.017	0/9	0/9	0/18	HM	0.0645	0/2	0/18	0/20	HT	0.021			0/9
Lead	0.0026	0.0002	HT	0.0005	0/7	0/6	0/13	HT, HM	0.0005	0/11	0/9	0/20	HT, HM	0.0005	0/11	0/9	0/20	HT, HM	0.00023	0/16	0/41	0/57	HT	0.0005			0/9
Magnesium	NA	3.07	HT, HM	3.47	-	-	NA	HT, HM	3.71	-	-	NA	HT, HM	3.5	-	-	NA	HT	3.33	-	-	NA		0.33	-	-	NA
Manganese	0.05 (Total)	0.005	HT, HM	0.005	0/5	0/6	0/11	HT, HM	0.021	0/10	0/9	0/19	HT, HM	0.00975	0/9	0/9	0/18	HT, HM	0.0083	0/2	0/18	0/20	HT, HM	0.0076			0/9
Mercury (Total)[3]	0.000012	0.0001		0.0001	0/6	0/5	0/11		0.0001	0/10	0/9	0/19		0.0001	0/10	0/9	0/19	HM	0.0001	0/2	2/18	2/20		0.0001			0/9
Nickel	0.1377	0.005	HT	0.01	0/5	0/5	0/10	HT	0.01	0/10	0/9	0/19	HT	0.01	0/9	0/10	0/18	HT	0.005	0/2	0/18	0/20		0.01			0/9
Potassium	NA	0.501	HT, HM	0.5	-	-	NA	HT, HM	0.5	-	-	NA	HT	0.5	-	-	NA	HT, HM	0.5175	-	-	NA		0.5	-	-	NA
Selenium	0.002 (Total)	0.0005	HT	0.001	0/7	0/5	0/12	HT	0.001	0/11	0/9	0/20	HT	0.001	0/11	0/9	0/20	HT	0.0005	0/2	0/18	0/20		0.001			0/9
Sodium	NA	1.53	HT, HM	1.5	-	-	NA	HT, HM	1.5	-	-	NA	HT, HM	1.5	-	-	NA	HM	1.85	-	-	NA		1.509	-	-	NA
Zinc	0.09254	0.00375		0.005	0/6	0/6	0/12	HT, HM	0.2	8/10	4/9	12/19	HT, HM	0.034	4/10	1/9	5/19	HT, HM	0.0618	12/1	8/41	20/57	HT, HM	0.03			1/9
Water Quality Parameters																											
Alkalinity (mg/L as $CaCO_3$)	NA	75		ND	-	-	ND		ND	-	-	ND		ND	-	-	ND	HM	78.5	-	-	NA		ND			ND
Chloride (mg/L)	250 (T)	0.8	HT	1.5	0/5	0/5	0/10	HT, HM	1.5	-	-	0/19	HT	1.5	-	-	0/18		0.8	-	-	0/21	HT	1.5			0/9
Total No. of PCOCs			18					20					19					19					11				
No. of analytess that exceed Standard one or more time							1					4					4					5					2

NA = Not available

ND = No data

Method ID = Method of identifying PCOC

HM = Analyte identified as PCOC using hot measurement test

HT = Analyte identified as PCOC using hypothesis tests

Bold Border = Analyte concentration exceeds standard in at least one sample

[1] Human health-based standards shown in italics; aquatic life standards in normal type; cobalt standard is irrigation standard

[2] Low flow = July-March; high flow = April-June

[3] Total for mercury refers to total forms of dissolved mercury

Table 4-29
Distances to Surface Water Stations From Just Below the Confluence of Willow Creek and Pecos River

Location	Distance (miles)
PE-JA	-5.23
PAW-AUTO	-0.32
WCS	-0.18
WCU-1	-2.31
PE-UN	0.98
PE-HG	1.42
PE-IN	3.81
PE-WB	4.82
PE-MA	6.67
PE-DA	7.93
PE-FHI	11.77
PE-ALU	15.00
PE-ALD	16.19
PE-SY	30.53

Week No.	Sampling Date
1	3/27/95
2	4/3/95
3	4/10/95
4	4/17/95
5	4/24/95
6	5/1/95
7	5/8/95
8	5/15/95

Table 4-30
Metal Concentrations in Pecos River Sediments

Analyte	PAW						WC/P						PTS						PE-FHI	
	April		August		November		April		August		November		April		August		November		October	
	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Total Metals (mg/kg)																				
Aluminum	4,580		5,530		5,230		6,840		12,800		7,570		3,950		5,850		5,320		4,710	
Arsenic	2.1	B	3	B	2.6	U	4.2	B	5.3	B	3	B	3.5	B	3.9	B	2.4	U	3	U
Barium	55.5		49.5		62.8		68.9		112		71.9		42.3		67.2		51.8		42	
Cadmium	0.64	B	0.35	U	0.99		5.2		11.2		4.6		4.7		0.79		1.8		0.96	
Chromium	9.5		10.4		9.8		13.7		21.1		13.5		6.5		10.4		9.7		8.1	
Cobalt	4.2	B	6.3		5.9	B	8.3		12.9		8.3		4.3	B	5.4	B	5	B	3.6	B
Copper	13.4		32.2		14.8		164		383		100		121		12.5		26.5		15.4	
Iron	15,000		19,500		18,600		1,840		24,100		20,900		12,600		21,900		15,700		10,100	
Lead	23.5		10.4	B	21.7		237		279		132		380		31.1	B	97.9		21.1	
Manganese	218		248		322		307		476		267		191		253		197		167	
Mercury	0.13	U	0.12	U	0.13	U	0.13	U	0.14	U	0.14	U	0.12	U	0.12	U	0.12	U	0.15	U
Molybdenum	1.3	U	1.2	U	1.3	U	1.3	U	1.4	U	1.4	U	1.2	U	1.2	U	1.2	U	1.5	U
Nickel	13.4	B	11.7	B	12.6		14.1	B	15.3	B	15.4		13.2	B	13	B	12		7.7	
Selenium	0.13	U	0.15	B	0.23	B	0.13	U	0.63	B	0.56	B	0.12	U	0.24	B	0.38	B	0.2	B
Silver	0.67	U	0.58	U	0.64	U	0.65	U	0.7	U	0.68	U	0.91	B	0.61	U	0.61	U	0.75	U
Zinc	151		78.3		124		1,590		2,630		1,250		1,260		286		457		274	
pH	7.8		7.6		7.5		7.7		6.8		7.2		7.6		7.5		7.4		8.09	
Total Organic Carbon	1.58		0.438		1		1.13		1.82		1		1.17		0.948		0			

U - Analyte analyzed but not detected at the quantitation limit
B - Reported value is less than CRDL but greater than IDL

Table 4-31
Metal Concentrations in Willow Creek Sediments

Analyte	WCU-1						WCU						WCD					
	April		August		November		April		August		November		April		August		November	
	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
Total Metals (mg/kg)																		
Aluminum	5,800		8,440		8,450		6,610		12,000		8,550		6,450		7,750		8,940	
Arsenic	2.9	B	2.4	B	2.4	U	3	B	2.8	B	2.5	U	15		15	B	3	U
Barium	75.2		209		106		80.6		107		86.5		48		58	B	81	
Cadmium	0.84		0.39	U	0.92		2.8		1.1		13		13		31		11	
Chromium	14.9		18.6		19.1		13.5		22.8		17.7		8		14		14	
Cobalt	6.6		7.1		10.3		7.3		7.8		8.5		8		17	B	7	
Copper	8.7		9.7		8.1		31.6		18.8		265		534		2,900		371	
Iron	23,100		23,800		23,700		18,000		19,000		23,200		23,100		44,100		19,700	
Lead	12.2		11	B	11.9		386		213		360		399		1,120		640	
Manganese	306		361		707		256		264		383		385		267		293	
Mercury	0.12	U	0.13	U	0.12	U	0.13	U	0.13	U	0.15		0		0		0	
Molybdenum	1.2	U	1.3	U	1.2	U	1.3	U	1.3	U	1.2	U	1	U	6	U	1	U
Nickel	17.5	B	24.5	B	20.1		18.4	B	19.8	B	15.5		15	B	55		14	
Selenium	0.12	U	0.19	B	0.38	B	0.13	U	0.33	B	0.66		0	U	1		1	
Silver	0.62	U	0.65	U	0.61	U	0.66	U	0.64	U	1.4		4		27		2	
Zinc	53.4		63.4		76.5		680		314		3,480		4,430		9,350		3,510	
pH	7.6		7.6		7.5		7.8		7.3		7.5		8		7		7	
Total Organic Carbon	1.49		0.767		1		0.795		2.43		1		0		0		2	

U - Analyte analyzed but not detected at the quantitation limit

B - Reported value is less than CRDL but greater than IDL

Table 4-32
Metal Concentrations in Wetland Sediments

Location	Metal Concentrations (mg/kg) In Sediment							TOC Wt. Percent	CEC	Sand Percent	Silt Percent	Clay Percent
	Arsenic	Cadmium	Copper	Iron	Lead	Manganese	Zinc					
WS01	7.6	27.60	408.0	23,500	815.0	609	4,940	5.65	21.60	48	31	21
WS02	6.4	18.50	646.0	26,700	1,740.0	299	5,060	5.95	21.60	75	6	19
WS03	5.1	12.70	560.0	96,500	1,790.0	1350	3,380	6.42	21.10	15	73	13
WS04	3	0.63	25.4	16,400	41.9	409	187	1.37	4.53	83	10	8
WS05	2.6	1.50	38.6	13,400	71.2	117	318	2.62	8.78	78	14	9
WS06	2.6	1.00	30.7	18,800	56.6	187	316	3.63	14.00	63	24	14
WS07	5.1	12.60	322.0	29,800	894.0	263	3,280	7.89	23.20	30	54	16
WS08	7	10.10	228.0	20,900	539.0	733	2,320	11.00	29.80	63	25	13
WS09	3.9	9.60	285.0	25,800	849.0	353	3,320	5.15	20.60	53	19	29
WS10	3.1	13.90	259.0	24,000	530.0	416	3,970	5.17	17.30	50	31	19
WS11	3.2	2.70	82.9	19,600	255.0	176	822	6.05	18.50	50	33	18
WS12	3.1	11.50	215.0	24,900	630.0	705	3,230	5.75	20.90	28	55	18
WS13	6.1	14.00	296.0	36,100	753.0	1640	4,280	5.81	22.90	35	48	18
WS14	4	16.20	522.0	44,600	1,060.0	667	4,200	8.06	18.40	40	45	15
WS15	4.8	60.90	737.0	28,300	628.0	878	14,600	5.54	19.80	40	46	14
WCU-1[1]	2.4 - 2.9	0.39 - 0.92	8.1 - 9.7	23,100 - 23,800	11 - 12.2	306 - 707	53.4 - 76.5					
WCD	2.8 - 14.9	11.4 - 31	371 - 2,900	19,700 - 44,100	399 - 1,120	267 - 385	3,510 - 9,350					

[1]Range of concentrations provided for comparison (refer to Table 4-31).

Table 4-33
Pecos Mine Operable Unit 1995 Air Monitoring Results

Sample Date	Mine PM_{10} [1]		Mine TSP [2]	
	Filter Number	Concentration (mg/m^3)	Filter Number	Concentration (mg/m^3)
05/11/95	2	7.03	3	13.67
05/12/95	4	11.33	5	30.26
05/13/95	7	5.05	6	10.68
05/14/95	8	5.21	9	10.80
05/15/95	12	5.13	11	11.14
05/16/95	14	6.15	13	27.29
05/17/95	16	1.20	15	2.64
05/18/95	18	5.30	17	2.25
05/19/95	20	4.98	19	8.34
05/20/95	22	6.51	21	10.96
05/21/95	NC		NC	
05/22/95	24	6.29	23	18.56
05/23/95	26	4.88	25	14.71
05/24/95	28	4.64	27	6.95
05/25/95	30	4.32	29	10.34
05/26/95	32	5.97	31	13.15
05/27/95	34	8.68	33	14.89
05/28/95	NC		NC	
05/29/95	36	1.74	35	3.98
05/30/95	38	3.07	37	5.43
05/31/95	40	4.62	39	9.44
06/01/95	42	8.07	41	24.57
06/02/95	44	8.28	43	20.31
06/03/95	46	8.32	45	25.06
06/04/95	48	12.30	47	23.82
06/05/95	NC		NC	
06/06/95	52	6.80	49	15.18
06/07/95	54	0.00	51	0.00

Note: NM Air Quality Standard: 150 $\mu g/m^3$ (24-hour average), 90 mg/m^3 (30-day average).

[1] particulate matter <10 µm in diameter

[2] total suspended particulates

NC = not collected

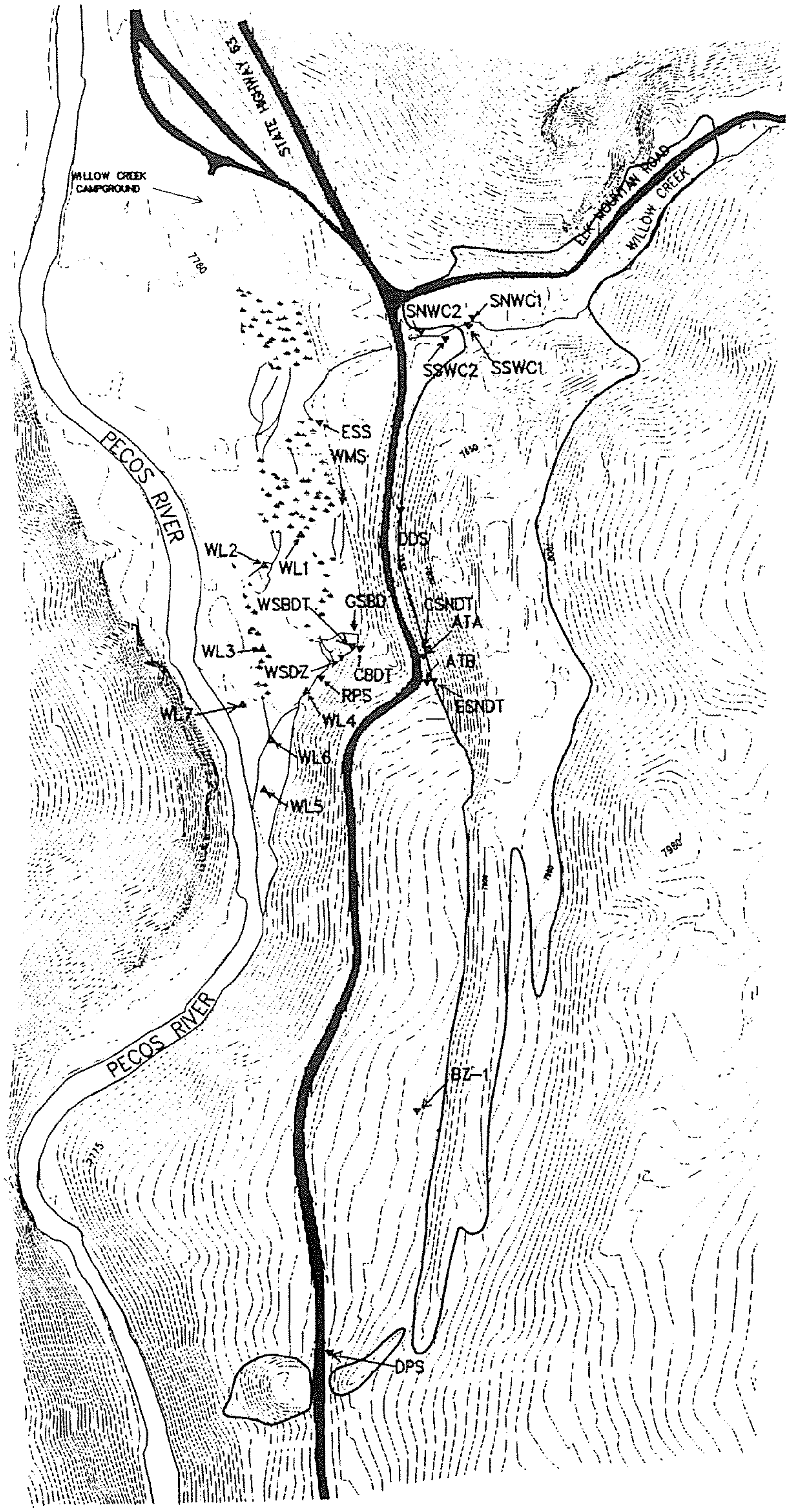
Table 4-34

Summary of PCOCs in Environmental Media at the Pecos Mine Operable Unit

	Soil		Groundwater		Surface Water		Sediment		Air
Analyte	0 to 6 Inches	12 to 18 Inches	Bedrock Aquifer	Shallow Flow System	Pecos River	Willow Creek	Pecos River	Willow Creek	
Metals									
Aluminum	✓✓	✓	T&D	T&D	T&D	T&D	X		
Antimony					T&D				
Arsenic	✓✓	✓		T	T&D		X	X	
Barium	✓✓	✓	T&D	T&D	T&D	T&D	X		
Beryllium		✓		T	D				
Cadmium	✓✓	✓✓	T&D	T&D	T&D	T&D	X	X	
Calcium			T&D	T&D	T&D	T&D			
Chromium	✓		T&D		T&D	T&D	X		
Cobalt					D	T&D		X	
Copper	✓✓	✓✓	T&D	T	T&D	T&D	X	X	
Iron	✓		T&D	T	T&D	T&D		X	
Lead	✓✓	✓✓		T&D	T&D	T&D	X	X	
Magnesium			T&D	T&D	T&D	T&D			
Manganese	✓		T&D	T&D	T&D	T&D	X		
Mercury	✓	✓		T	T&D	T&D		X	
Molybdenum	✓							X	
Nickel	✓			D	T&D	T	X	X	
Potassium			T&D	T&D	T&D	T&D			
Selenium	✓	✓		T&D	T&D		X	X	
Silver	✓✓	✓✓	T	T&D			X	X	
Sodium					T&D	T&D			
Vanadium			T						
Zinc	✓✓	✓✓	T&D	T&D	T&D	T&D	X	X	
Anions									
Bicarbonate			T	T	T	T			
Chloride				D	D	D			
Fluoride				D	D	D			
Nitrate/nitrite			D	D	T (Nitrate as N)				
Sulfate			D		T	T			
Indicator Parameters									
Acidity					T	T			
Alkalinity			T	T	T&D	T			
Conductivity					T	T			
Hardness					T	T			
pH			T	T	T	T			
TDS			T	T	T	T			
TSS			T		T	T			
Turbidity					T	T			
Others									

✓ - Identified as PCOC based on comparison to UTL only
✓✓ - Identified as PCOC based on comparison to UTL and spatial distribution
T - total
D - dissolved
X - identified as PCOC based on qualitative comparison to upstream sediment

\PECOS\SECT_4\FNL_4TBL XLS sumcontam 6/17/96



Explanation

▲ Surface Water Sampling Sites

▼ Seep and Spring Sampling Sites

—— Waste Rock Boundary

Barren Seep Area

North

Stoller

0 Feet 250 500

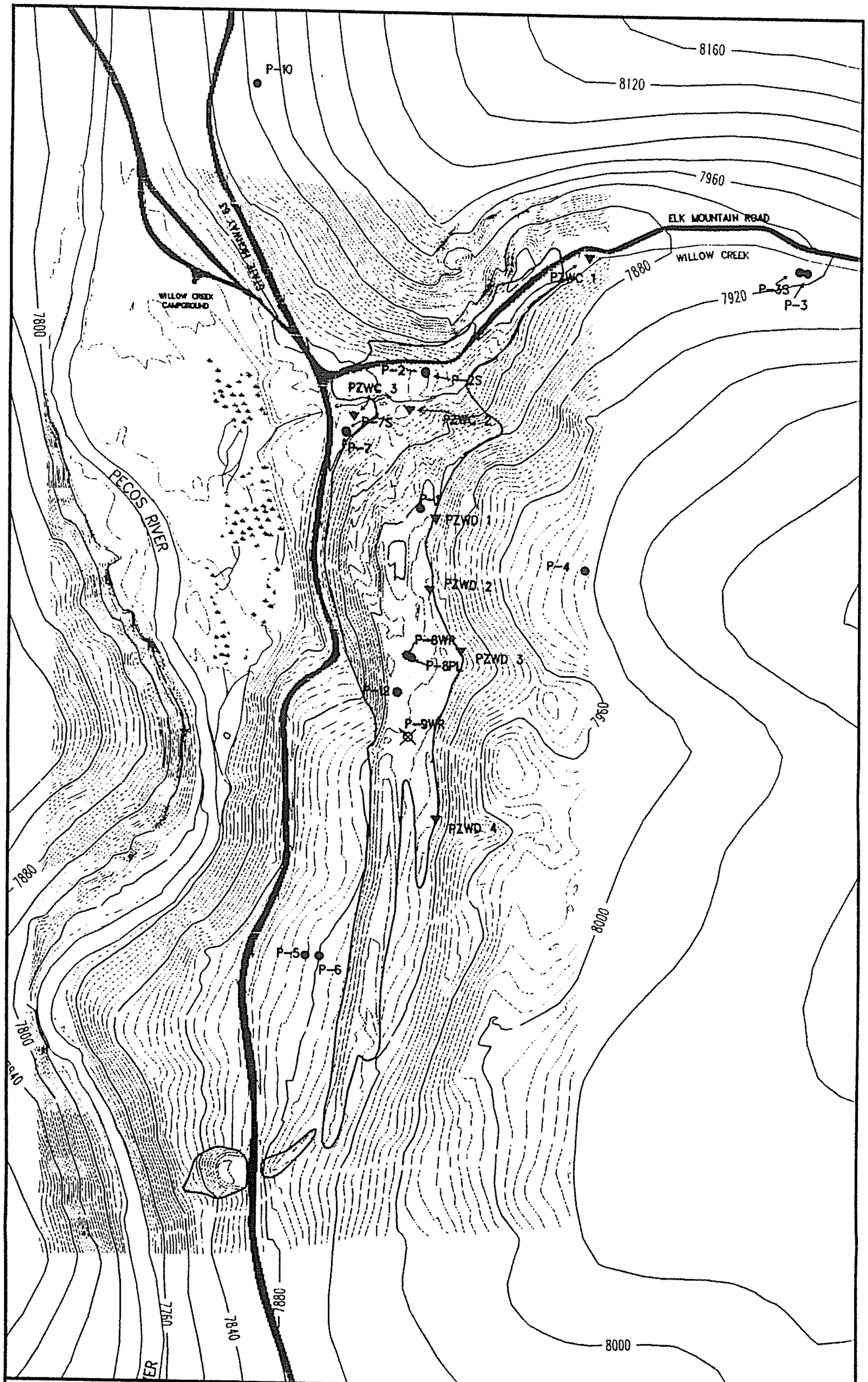
Contour Interval 5 Feet

Pecos Mine Operable Unit

Source Characterization Sampling Locations April 1995

Figure 2-13

02/21/96 SEEP_CHARMAP



Explanation

- ▼ Piezometers
- ● Bedrock Monitoring Wells
- ● Shallow Monitoring Wells
- ⊠ Abandoned Well
- □ Waste Rock Dump

North

0 Feet 300 600

Operable Unit topography from aerial photography performed in 1992; contour interval 5 feet. Surrounding topography from USGS DEM; contour interval 40 feet.

Stoller

Pecos Mine Operable Unit

Groundwater Monitoring Wells and Piezometers

Figure 2-3

01/04/96 MON_PIEZ.MAP

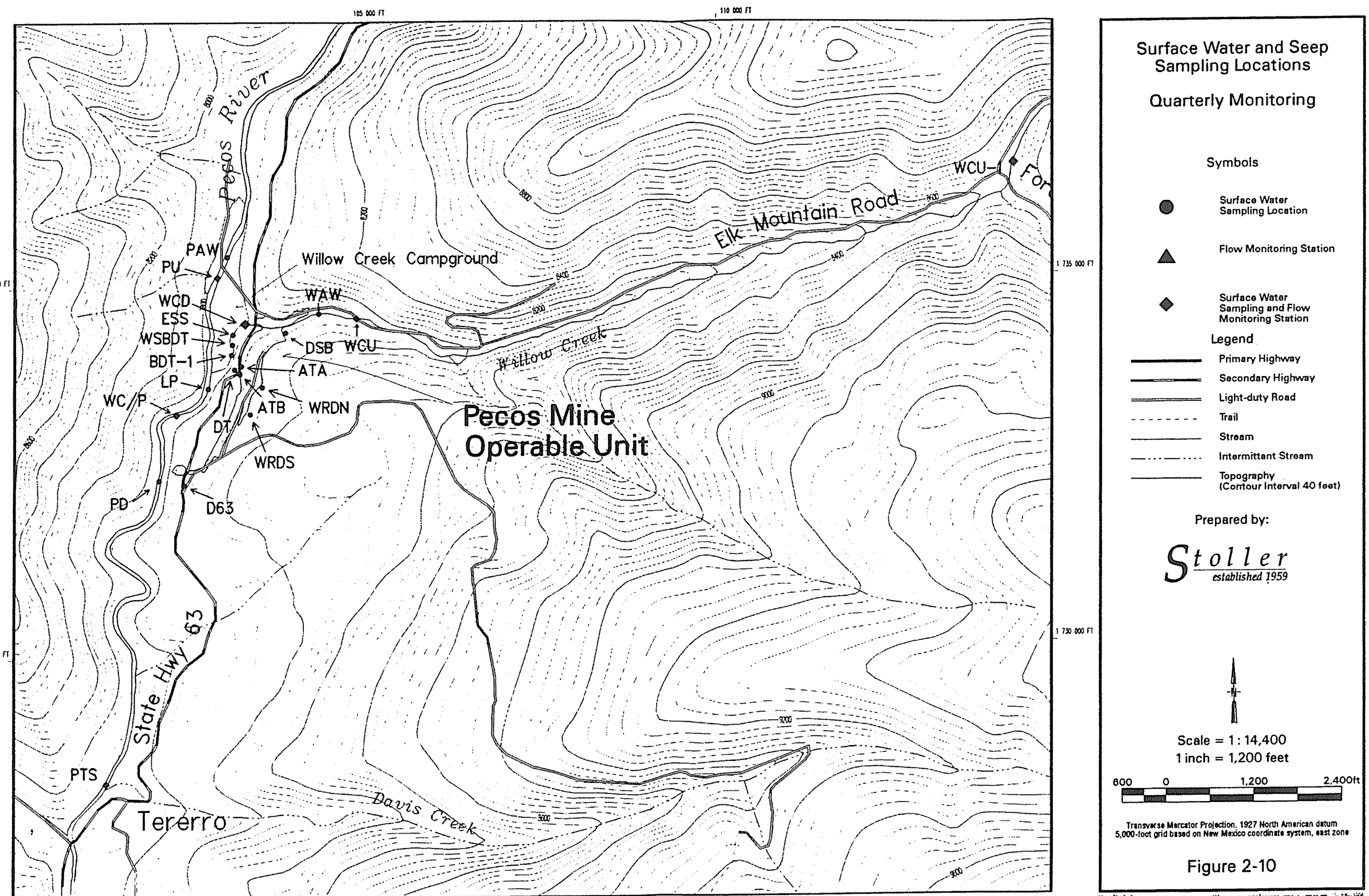
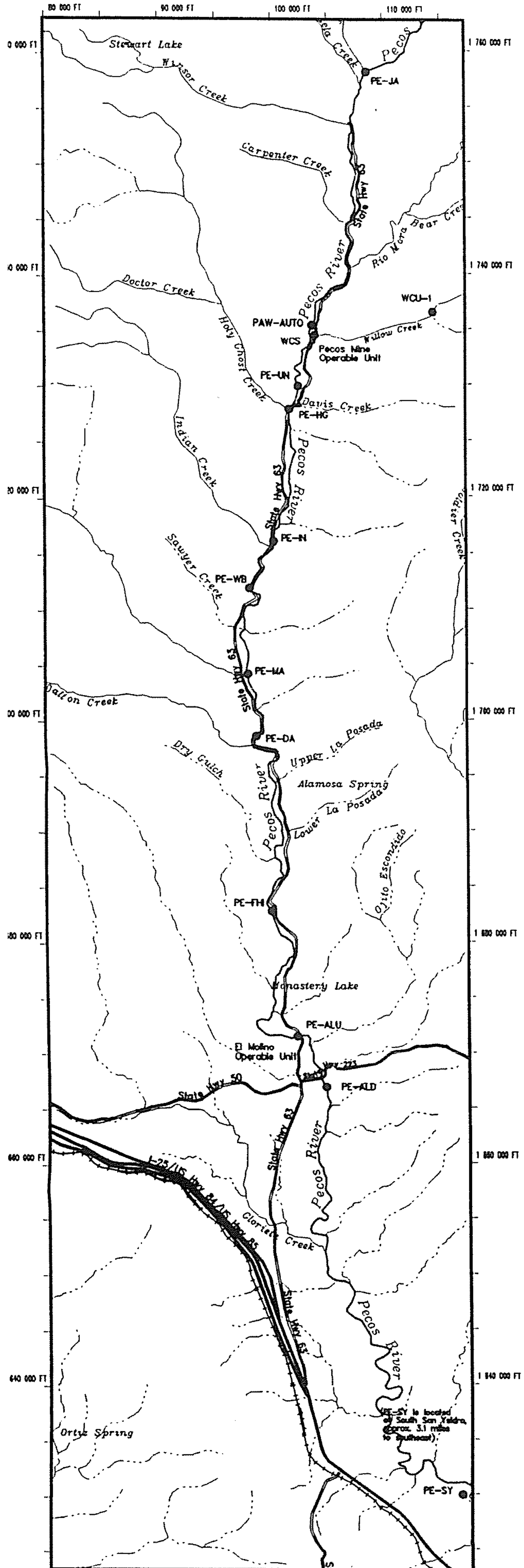

105 000 FT
110 000 FT
1 735 000 FT
1 730 000 FT
Pecos River
Elk Mountain Road
WCU-
Willow Creek Campground
Willow Creek
Pecos Mine
Operable Unit
PAW
PU
WCD
ESS
WSBDT
BDT-1
LP
WC/P
PD
D63
DT
ATB
WRDN
WRDS
ATA
DSB
WCU
WAW
PTS
State Hwy 63
Tererro
Davis Creek
Surface Water and Seep Sampling Locations
Quarterly Monitoring
Symbols
Surface Water Sampling Location
Flow Monitoring Station
Surface Water Sampling and Flow Monitoring Station
Legend
Primary Highway
Secondary Highway
Light-duty Road
Trail
Stream
Intermittant Stream
Topography (Contour Interval 40 feet)
Prepared by:
Stoller established 1959
Scale = 1 : 14,400
1 inch = 1,200 feet
600
0
1,200
2,400ft
Transverse Mercator Projection, 1927 North American datum
5,000-foot grid based on New Mexico coordinate system, east zone

Figure 2-10



Surface Water Sampling Locations

Nature and Extent of Contamination

Symbols

● Surface Water Sampling Location for Nature and Extent Sampling

Legend

- Primary Highway
- Secondary Highway
- Light-duty Road
- Trail
- Stream
- Intermittent Stream

Prepared by:

Stoller
established 1959

N

Scale = 1 : 108,000
1 inch = 9,000 feet

4,500 0 9,000 18,000ft

Transverse Mercator Projection. 1927 North American datum
5,000-foot grid based on New Mexico coordinate system, east zone

Figure 2-14

CRA $DATA3/pecos/maps/ri-extent2.gra ... 04-JAN-1996

APPENDIX B

SUMMARY TABLES
HUMAN HEALTH RISK CALCULATIONS

From NMED, 1997

TABLE 1
Risk calculation
Recreational Vacation
Children

Pecos Mine Operable Unit
Upper Pecos Site

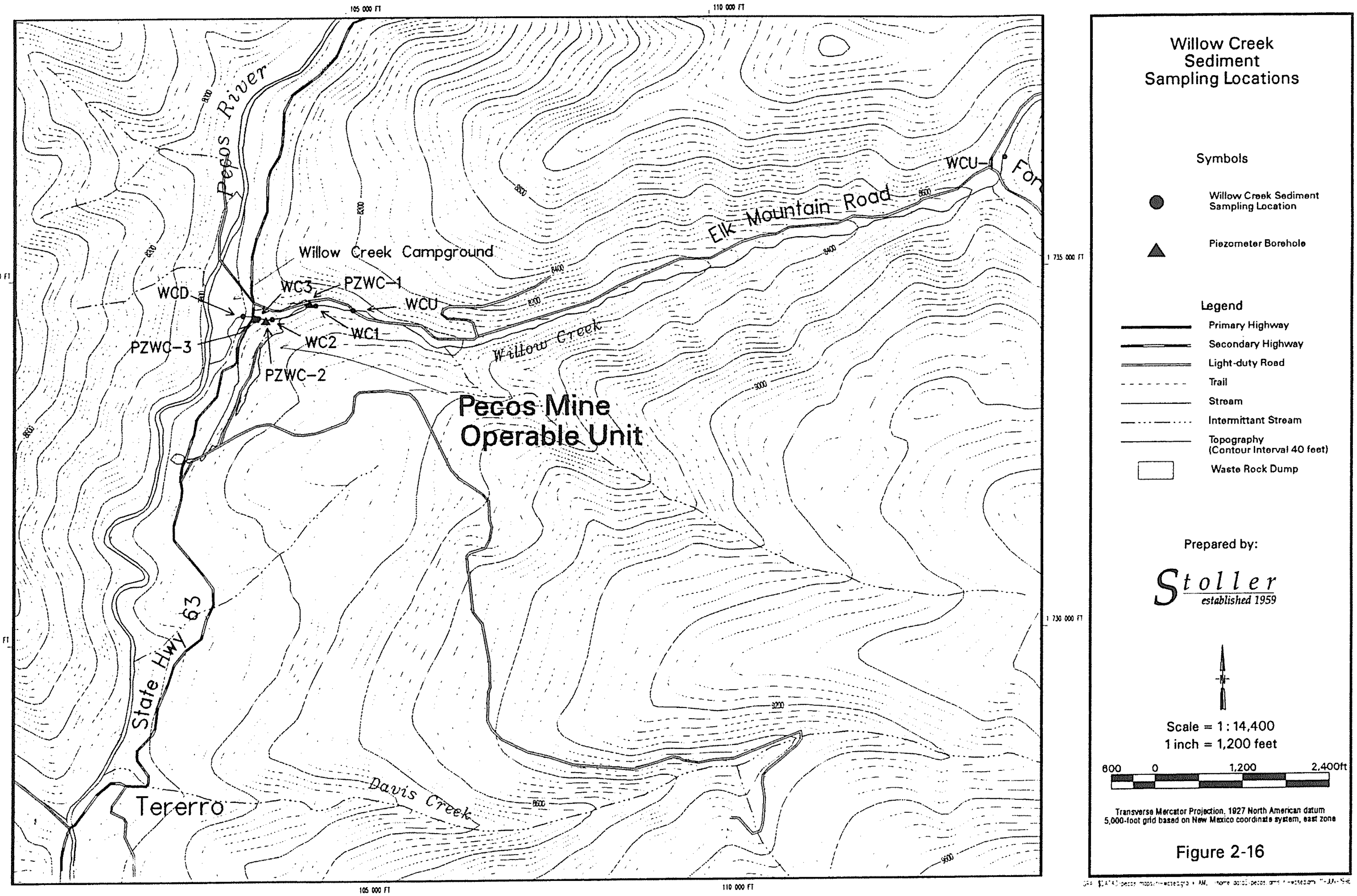
Contaminant	Concentrations - mg/kg Soil - Waste rock	Concentrations - mg/l Water - br	Water - sh	Factor - soil ingestion - car	Factor - soil ingestion - non	Factor - water ingestion - non
Arsenic	66.7			7.83E-08	5.48E-07	2.74E-03
Barium	199	2.649			5.48E-07	2.74E-03
Cadmium	174				5.48E-07	2.74E-03
Chromium	35.1				5.48E-07	2.74E-03
Copper	3850				5.48E-07	2.74E-03
Manganese		0.765	4.897		5.48E-07	2.74E-03
Molybdenum	8.3				5.48E-07	2.74E-03
Nickel	20.5				5.48E-07	2.74E-03
Selenium	10.1				5.48E-07	2.74E-03
Silver	77.5				5.48E-07	2.74E-03
Zinc	45100				5.48E-07	2.74E-03

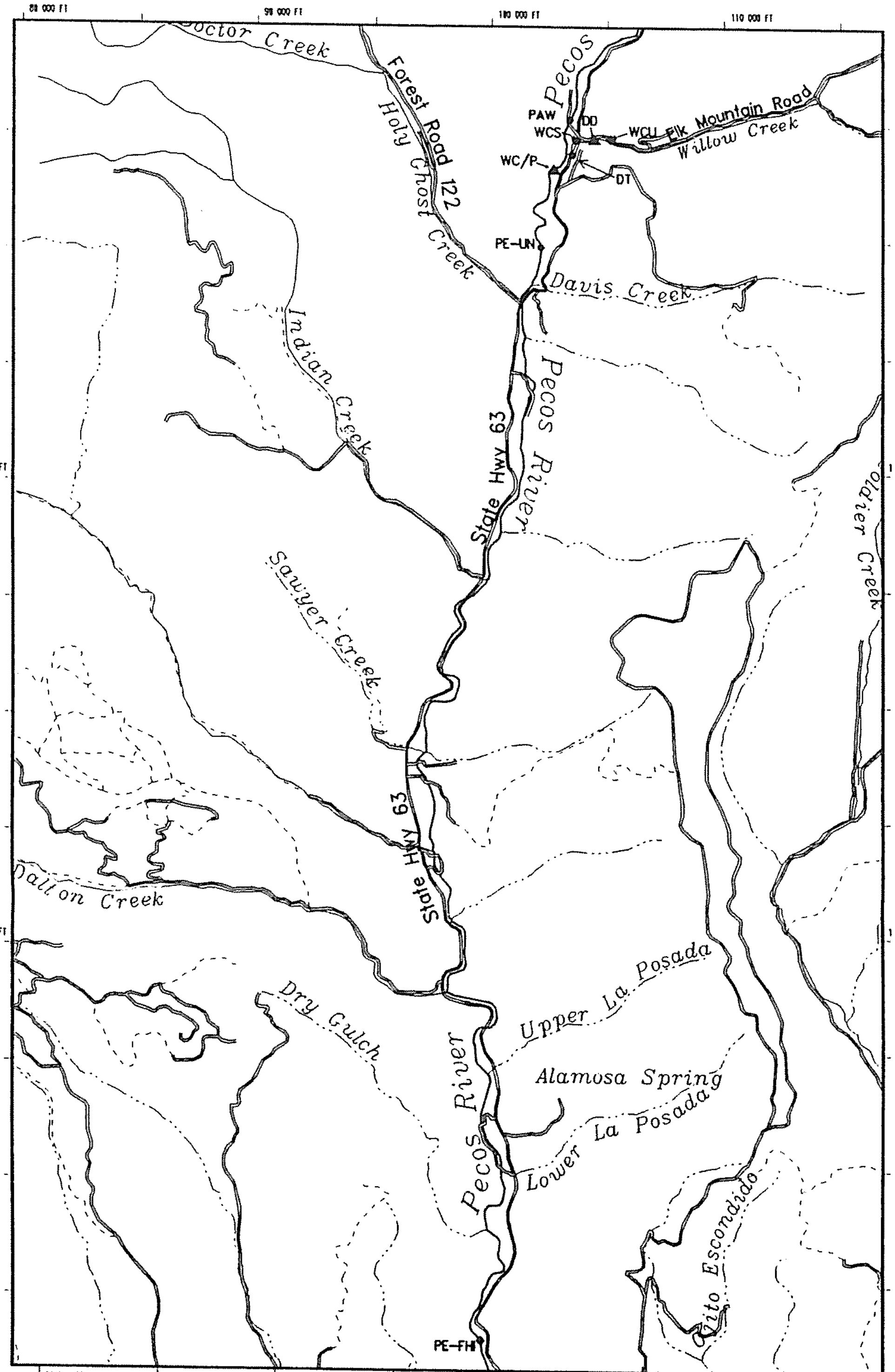
	INTAKE - mg/kg/day Soil - non	Soil - car	br aquifer	sh aquifer	RfD	SF	Soil - ingestion HI	Risk	Water - ingestion HI - br	HI - sh
Arsenic	3.66E-05	5.22E-06			0.0003	1.5	0.12	7.8E-06		
Barium			7.26E-03		0.07	ND			0.10	
Cadmium	9.54E-05				0.0005	Inhal only	0.19			
Chromium	1.92E-05				0.005	Inhal only	0.00			
Copper	2.11E-03				ND	NC				
Manganese			2.10E-03	1.34E-02	0.14	NC			0.01	0.10
Molybdenum	4.55E-06				0.0005	NA	0.01			
Nickel	1.12E-05				0.02	ND	0.00			
Selenium	5.53E-06				0.005	NC	0.00			
Silver	4.25E-05				0.005	NC	0.01			
Zinc	2.47E-02				0.3	NC	0.08			
TOTAL							0.42	7.8E-06	0.12	0.10

br = bedrock aquifer
sh = shallow aquifer

HI = hazard index
RfD = reference dose
SF = slope factor

car = carcinogenic
non = non-carcinogenic


105 000 FT
110 000 FT
1 735 000 FT
1 730 000 FT
Pecos River
Willow Creek Campground
WCD
WC3
PZWC-1
WCU
WC1
WC2
PZWC-3
PZWC-2
WCU-1
Elk Mountain Road
Willow Creek
Pecos Mine
Operable Unit
State Hwy 63
Tererro
Davis Creek
Willow Creek
Sediment
Sampling Locations
Symbols
Willow Creek Sediment Sampling Location
Piezometer Borehole
Legend
Primary Highway
Secondary Highway
Light-duty Road
Trail
Stream
Intermittant Stream
Topography
(Contour Interval 40 feet)
Waste Rock Dump
Prepared by:
Stoller
established 1959
N
Scale = 1 : 14,400
1 inch = 1,200 feet
600
0
1,200
2,400ft
Transverse Mercator Projection, 1927 North American datum
5,000-foot grid based on New Mexico coordinate system, east zone
Figure 2-16



Symbols

- ● Surface Water Sampling Location for Spring and Fall 1995 Event Sampling
- ▲ Surface Water Sampling Location for Spring 1995 Event Sampling
- ◆ Surface Water Sampling Location for Fall 1995 Event Sampling

Legend

- Primary Highway
- Secondary Highway
- Light-duty Road
- Trail
- Stream
- Intermittant Stream

Prepared by:

Stoller
established 1959

Surface Water Sampling Locations
Event-Related Monitoring

N

Scale = 1: 60,000
1 inch = 5,000 feet

2,500 0 5,000 10,000ft

Transverse Mercator Projection. 1927 North American datum
5,000-foot grid based on New Mexico coordinate system, east zone

Figure 2-15

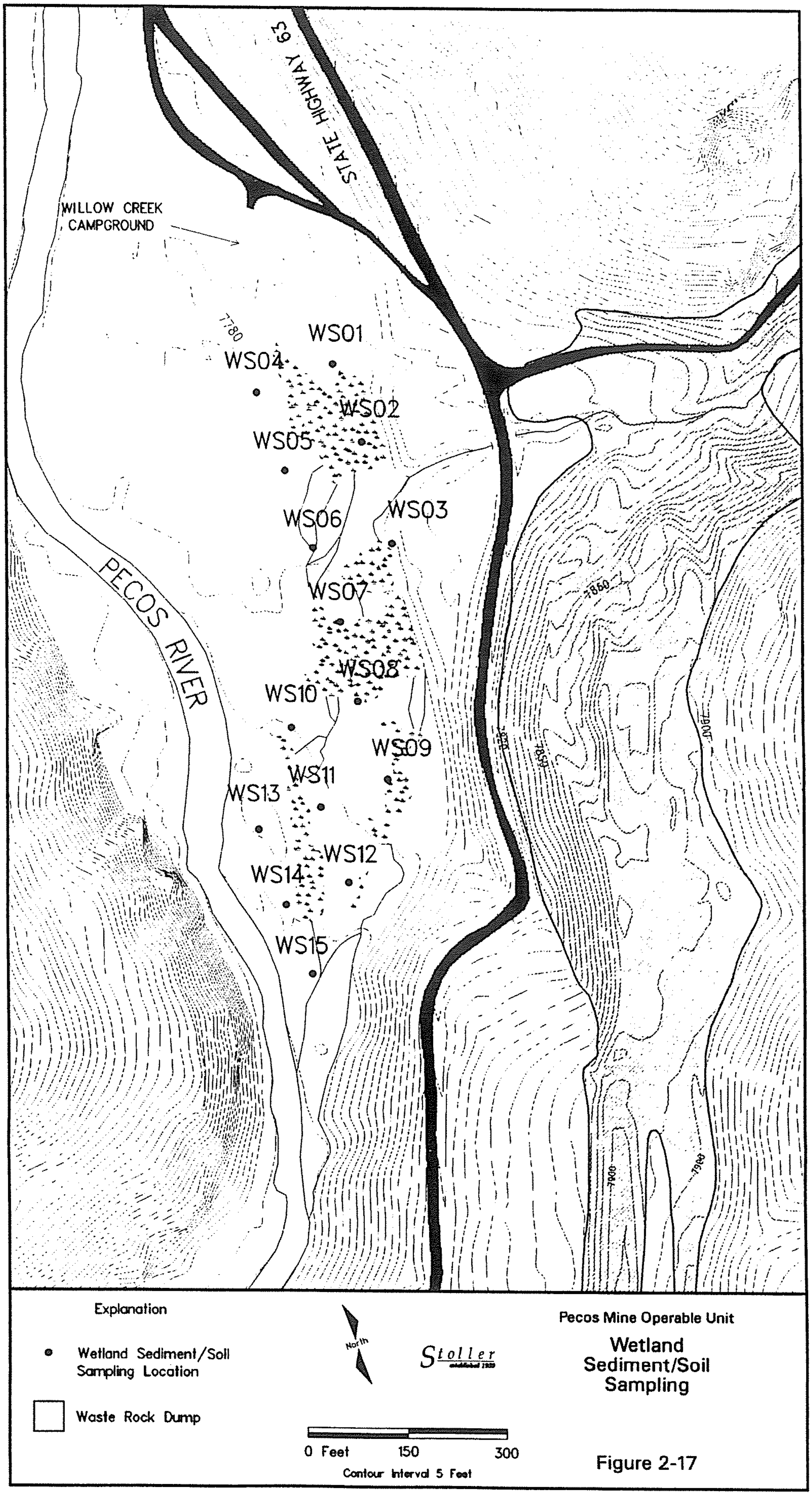


Figure 2-17

01/10/96 WETSAMP.MAP

TABLE 2
Risk calculation
Recreational Vacation
Adults

Pecos Mine Operable Unit
Upper Pecos Site

Contaminant	Concentrations - mg/kg Soil - Waste Rock	Concentrations - mg/l Water - br	Water - sh	Factor - soil ingestion - car	Factor - soil ingestion - non	Factor - water ingestion - non
Arsenic	66.7			8.39E-09	5.87E-08	1.17E-03
Barium	199	2.649			5.87E-08	1.17E-03
Cadmium	174				5.87E-08	1.17E-03
Chromium	35.1				5.87E-08	1.17E-03
Copper	3850				5.87E-08	1.17E-03
Manganese		0.765	4.897		5.87E-08	1.17E-03
Molybdenum	8.3				5.87E-08	1.17E-03
Nickel	20.5				5.87E-08	1.17E-03
Selenium	10.1				5.87E-08	1.17E-03
Silver	77.5				5.87E-08	1.17E-03
Zinc	45100				5.87E-08	1.17E-03

	INTAKE mg/kg/day Soil - non	Soil - car	br aquifer	sh aquifer	RfD	SF	Soil - ingestion HI	Risk	Water - ingestion HI - br	HI - sh
Arsenic	3.92E-06	5.60E-07			0.0003	1.5	0.01	8.4E-07		
Barium	1.17E-05		3.10E-03		0.07	ND	0.00		0.04	
Cadmium	1.02E-05				0.0005	Inhal only	0.02			
Chromium	2.06E-06				0.005	Inhal only	0.00			
Copper	2.26E-04				ND	NC				
Manganese			8.95E-04	5.73E-03	0.14	NC			0.01	0.04
Molybdenum	4.87E-07				0.0005	NA	0.00			
Nickel	1.20E-06				0.02	ND	0.00			
Selenium	5.93E-07				0.005	NC	0.00			
Silver	4.55E-06				0.005	NC	0.00			
Zinc	2.65E-03				0.3	NC	0.01			
TOTAL							0.04	8.4E-07	0.05	0.04

br = bedrock aquifer
sh = shallow aquifer

HI = hazard index
RfD = reference dose
SF = slope factor

car = carcinogenic
non = non-carcinogenic

TABLE 3
Risk calculation
Nearby Recreational
Youth

Pecos Mine Operable Unit
Upper Pecos Site

Contaminant	Concentrations - mg/kg Soil - Waste Rock	Concentrations - mg/l Water - br	Water - sh	Factor - soil ingestion - car	ingestion - non	Factor - water ingestion - non
Arsenic	66.7			1.30E-07	9.07E-07	4.53E-03
Barium	199	2.649			9.07E-07	4.53E-03
Cadmium	174				9.07E-07	4.53E-03
Chromium	35.1				9.07E-07	4.53E-03
Copper	3850				9.07E-07	4.53E-03
Manganese		0.765	4.897		9.07E-07	4.53E-03
Molybdenum	8.3				9.07E-07	4.53E-03
Nickel	20.5				9.07E-07	4.53E-03
Selenium	10.1				9.07E-07	4.53E-03
Silver	77.5				9.07E-07	4.53E-03
Zinc	45100				9.07E-07	4.53E-03

	INTAKE mg/kg/day Soil - non	Soil - car	br aquifer	sh aquifer	RfD	SF	Soil - ingestion HI	Risk	Water - ingestion HI - br	HI - sh
Arsenic	6.05E-05	8.67E-06			0.0003	1.5	0.20	1.3E-05		
Barium	1.80E-04		1.20E-02		0.07	ND	0.00		0.17	
Cadmium	1.58E-04				0.0005	Inhal only	0.32			
Chromium	3.18E-05				0.005	Inhal only	0.01			
Copper	3.49E-03				ND	NC				
Manganese			3.47E-03	2.22E-02	0.14	NC			0.02	0.16
Molybdenum	7.53E-06				0.0005	NA	0.02			
Nickel	1.86E-05				0.02	ND	0.00			
Selenium	9.16E-06				0.005	NC	0.00			
Silver	7.03E-05				0.005	NC	0.01			
Zinc	4.09E-02				0.3	NC	0.14			
TOTAL							0.69	1.3E-05	0.20	0.16

br = bedrock aquifer
sh = shallow aquifer

HI = hazard index
RfD = reference dose
SF = slope factor

car = carcinogenic
non = non-carcinogenic

TABLE 4
Risk calculation
Nearby Recreational
Adult

Pecos Mine Operable Unit
Upper Pecos Site

Contaminant	Concentrations - mg/kg Soil - Waste rock	Concentrations - mg/l Water - br	Concentrations - mg/l Water - sh	Factor - soil ingestion - car	Factor - soil ingestion - non	Factor - water ingestion - non
Arsenic	66.7			1.34E-07	3.13E-07	6.26E-03
Barium	199	2.649			3.13E-07	6.26E-03
Cadmium	174				3.13E-07	6.26E-03
Chromium	35.1				3.13E-07	6.26E-03
Copper	3850				3.13E-07	6.26E-03
Manganese		0.765	4.897		3.13E-07	6.26E-03
Molybdenum	8.3				3.13E-07	6.26E-03
Nickel	20.5				3.13E-07	6.26E-03
Selenium	10.1				3.13E-07	6.26E-03
Silver	77.5				3.13E-07	6.26E-03
Zinc	45100				3.13E-07	6.26E-03

	INTAKE mg/kg/day Soil - non	Soil - car	br aquifer	sh aquifer	RfD	SF	Soil - ingestion HI	Soil - ingestion Risk	Water - ingestion HI - br	Water - ingestion HI - sh
Arsenic	2.09E-05	8.94E-06			0.0003	1.5	0.07	1.3E-05		
Barium	6.23E-05		1.66E-02		0.07	ND	0.00		0.24	
Cadmium	5.45E-05				0.0005	Inhal only	0.11			
Chromium	1.10E-05				0.005	Inhal only	0.00			
Copper	1.21E-03				ND	NC				
Manganese			4.79E-03	3.07E-02	0.14	NC			0.03	0.22
Molybdenum	2.60E-06				0.0005	NA	0.01			
Nickel	6.42E-06				0.02	ND	0.00			
Selenium	3.16E-06				0.005	NC	0.00			
Silver	2.43E-05				0.005	NC	0.00			
Zinc	1.41E-02				0.3	NC	0.05			
TOTAL							0.24	1.3E-05	0.27	0.22

br = bedrock aquifer
sh = shallow aquifer

HI = hazard index
RfD = reference dose
SF = slope factor

car = carcinogenic
non = non-carcinogenic

TABLE 5
Risk calculation
Residential

Pecos Mine Operable Unit
Upper Pecos Site

Contaminant	Concentrations - mg/kg Soil - ES	Concentrations - mg/l Water - br	Concentrations - mg/l Water - sh	Factor - soil ingestion -car	Factor - soil ingestion -non	Factor - water ingextion - non
Arsenic	21.1			2.74E-04	4.36E-06	3.43E-02
Barium	413	2.649			4.36E-06	3.43E-02
Cadmium	11.7				4.36E-06	3.43E-02
Chromium	44.6				4.36E-06	3.43E-02
Copper	737				4.36E-06	3.43E-02
Manganese		0.765	4.897		4.36E-06	3.43E-02
Molybdenum	10.3				4.36E-06	3.43E-02
Nickel	18.7				4.36E-06	3.43E-02
Selenium	1.8				4.36E-06	3.43E-02
Silver	3.8				4.36E-06	3.43E-02
Zinc	2350				4.36E-06	3.43E-02

	INTAKE mg/kg/day Soil - non	Soil - car	br aquifer	sh aquifer	RfD	SF	Soil - ingestion HI	Soil - ingestion Risk	Water - ing br - HI	Water - ing sh - HI
Arsenic	9.20E-05	5.78E-03			0.0003	1.5	0.31	8.7E-03		
Barium	1.80E-03		9.09E-02		0.07	ND	0.03		1.30	
Cadmium	5.10E-05				0.0005	Inhal only	0.10			
Chromium	1.94E-04				0.005	Inhal only	0.04			
Copper	3.21E-03				ND	NC				
Manganese			2.62E-02	1.68E-01	0.14	NC			0.19	1.20
Molybdenum	4.49E-05				0.0005	NA	0.09			
Nickel	8.15E-05				0.02	ND	0.00			
Selenium	7.85E-06				0.005	NC	0.00			
Silver	1.66E-05				0.005	NC	0.00			
Zinc	1.02E-02				0.3	NC	0.03			
TOTAL							0.61	8.7E-03	1.49	1.20

br = bedrock aquifer
sh = shallow aquifer

HI = hazard index
RfD = reference dose
SF = slope factor

car = carcinogenic
non = non-carcinogenic (systemic)

APPENDIX C

PUBLIC COMMENTS ON DECISION DOCUMENT PROPOSAL:

WRITTEN COMMENTS
TRANSCRIPT FROM PUBLIC MEETING ON PROPOSAL
NMED RESPONSE TO COMMENTS

0001

PUBLIC MEETING FOR THE DECISION DOCUMENT

FOR THE TERRERO SITE

January 21, 1998
7:00 p.m.
Community Center
Pecos, New Mexico

PRESENTATION BY: STEPHEN L. WUST, Ph.D.
Project Manager
Terrero Remediaton Project

REPORTED BY: PAULA WEGEFORTH, NM CCR #140
Barbara Harris Court Reporters
201 Twelfth Street, Northwest
Albuquerque, New Mexico 87102

0002

Wednesday, January 21, 1998, 7:00 p.m., Pecos, New Mexico

MR. WUST: What we're doing tonight on this meeting is looking at the decision document for the Pecos mine operable unit, and I'm going to go through tonight first and give a presentation on this document, how it fits into the other things we're doing at that operable unit and the site as a whole, and then we're going to have time for comments and questions.

The only thing I'd like to ask you is, because we're recording this, I want to make sure we get the comments straightforward, that we might ask you -- we will ask you to give your name before you give your comment or your question. That's the other reason for the sign-in sheet. That way we don't have any misspellings or anything like that. And, also, if you have a question or comment, please speak up so the recorder can take it down.

The decision document for the operable unit is the final major document in terms of our investigation and decision on cleaning up of the mine, and what I'm going to do on this screen -- it's a little small, but I'm going to try to leave out as we go along pictures -- I hope that's a little clearer -- and we'll go through the maps and things, and over here you're going to see basically an outline or a summary of the stuff I'm talking about. So, hopefully,

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you'll be able to follow along on both sets.
The "site," as we call it, to review, consists of five operable units, and these operable units were defined under the agreement called the AOC, which we've talked about a lot, that designates, first off, the Environment Department is the oversight agency of the site and the responsible parties for the site. The site responsible parties include the State Department of Game and Fish, the -- which owns the land that the mine and El Molino are on, the State Highway Department, because waste rock was used along Highway 63, and originally Amax, now Cyprus Amax, the mining company that operated the site -- the mine back in its day under a different name but through time has become Cyprus Amax. Right now we're looking at the mine unit itself, and so we're looking at the responsible parties being the Department of Game and Fish and Cyprus Amax.
The map here shows the Pecos River. Here's the town right here. Here's Alamitos Canyon where the tailing piles are; Highway 63, which one of these operable units runs up along the river. These little caps you see are the the various recreational areas, campgrounds, picnic areas like that, which is another operable unit, which is not part of what we're doing tonight. And then the mine itself you see in green. It's labeled "Willow Creek" right here.

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So we're going to be talking about this.
This is the first time I've tried these little flap-type overheads. We'll see how it works.
Okay. What we're looking at tonight is the decision document, again. Now, this has been building up to -- remember, for those of you who have been coming to the meetings -- and I can see most of you here are very familiar faces and you attend a lot of these meetings -- we've gone through several years of investigation and sampling and analysis, and then we went through a process where we looked at risks and the different ways we could clean it up and -- to reach this decision.
What happens is that the decision document is issued by the Environment Department as the oversight agency. Right now it's called the Decision Document Proposal, and there's two copies -- two copies -- there's one more than what we usually put in -- in each repository, one repository being here in city hall in Pecos, one being at the Environment Department library in our building, the Runnel's Building, in Santa Fe.
It's got a 60-day comment period. We're right in the middle of that right now. We're 30 days into the comment period. There's another 30 days to go.
Some of this is going to be repeating. You'll see some things up in writing that will repeat some of

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this.
What we tried to do is give people enough time to look at it before the meeting but also give enough time for people to come to the meeting and say, "Oh, I'd like to check out a few of these things," and you still have time to go look at the document itself. It's about a 55-page document, so it's pretty long and intense and detailed. But there's a summary section in the front that you can get an overview of what's going on.
Comments will be accepted through February 19th, and the department then will take the comments, respond to them, revise the document based on the comments as appropriate, and then we'll issue the final -- issue the final decision document. And all that's going to come up here, too, in a minute.
A couple of things to bear in mind as we go through this tonight -- because this is kind of a specialized meeting. Again, for those of you who have been coming for a while, you know in most of our meetings we'll talk about the whole site, whatever comes up, the highway, wells, Alamitos, whatever comes up. But tonight we're trying to concentrate on the decision document for the mine, and this is so we can provide an opportunity for people to give comments to us verbally, to understand the decision document for the mine, and all the other operable

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units we have discussed at other meetings -- and we will discuss at other meetings as time goes -- this is not, by far, the last meeting for this site. But tonight we want to make sure we're working on the decision document for the mine operable unit itself.
So the document itself, the whole idea of it is that it looks at the cleanup decision. Again, the Environmental Department is cast with taking all the information we've got to date and to decide what is the best way we should go about cleaning up the site. That's really -- to sum it in one line, that's the purpose of this document.
The other operable units are not part of this document. A decision document was already issued a couple of years ago for El Molino. The cleanup is already completed at the recreation areas along the highway. So this is specifically looking at the cleanup decision for the Pecos mine, or Terrero, whichever term you'd like to use, operable unit.
You'll also notice if you read through this decision document that it at times seems general, and that's on purpose. What we call the remedial design is another document yet to come, and the difference is that the decision document basically says, for example, "We want you to put a cap on it, and it's going to have these three

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kinds of layers."

Well, the remedial design is basically that engineering document that says, "Okay. If we're going to have a cap at least three layers, how much material do we need? How long will it take to truck it up there? How will we get it up there? How will we put it together? Specifically, what shape will it be in? What size will it be?" things like that. All those are the specifics of the design. A lot of it's engineering. Some of it's biology and geology and things like that. But all the specifics come into play at this remedial design.

Right now the decision document is really looking at the overall decision on how we're going to clean up the site. The only specifics that go into the decision documents are those that we really want to make sure are definitely part of the design or those that are tied to laws and regulations, like standards for water, things like that. So we do have some specifics, but, in general, it's a broader statement than what you'll see later, which is this remedial design.

And we will have a public meeting to go over the remedial design. It still has to be submitted to the Environment Department for approval before it comes into play.

What I'm going to put up here right now as this

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next one is a map just of the -- I'm going to pull it out of the sleeve because that seems to fuzz it up, and I will get out of your way -- the mine area itself.

As you recall, the -- here's, again, Highway 63, the Pecos River. Here's Willow Creek here, a slight blue line up the mountain road right next to it. All this pink area is probably the most significant thing you can see from anywhere besides the front row. This is the waste rock pile itself, and it stretches and actually crosses the road at one location. This is the main portion of it. This is a lower volume and it starts to stretch out.

Right below the waste rock pile is a wetlands area, which includes, occasionally, beaver ponds, also saturated/unsaturated soils, some trees, some grasslands, things like that. Willow Creek goes into the wetlands. It moves around through various channels and pops out in the Pecos River right down around here.

This other road that you see taking off just a little to the north of the waste rock pile is the campground. That's the part that had a cleanup done on it a few years ago where they removed contaminated soils. They added those to the waste rock pile to get one remedial unit.

This is pretty much done now. There's some wells there that are sampled as part of the project, but

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the cleanup there is pretty much done. The major things we have to worry about in this area, of course, the waste rock itself, runoff in the waste rock pile, and the seeps that come off the waste rock pile, especially down in this area, which is an old topographic drainage. It will come into play in a few minutes when we talk about the cleanup, what we call the "white seep." There's another major seep right here where the wetlands and Willow Creek come to meet, and they put a significant amount, in terms of the site, of metals into the environment.

What we're looking at in terms of the problem here we have to deal with is -- and this is what the remedial investigation that we spent those two years looking at samples was all about, to try to understand this -- is that this waste rock contains minerals that, upon exposure to oxygen, or air, in the atmosphere and water, create a chemical reaction that creates an acidic environment, acid drainage. And that acid all by itself is horrible. It also picks up metals, and that's the main way that metals are transported out of the waste rock into the river.

So what we want to look at here -- and during the investigation leading up to this -- is trying to understand how the transport of contaminants gets into the environment, what's the effect on the environment; and if

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we know all that, it will tell us something about how we should go about cleaning it up.

So if we do that -- this is what we looked at through the last few years. You may remember some of these from some of the other meetings. "Other pertinent documents," I called it. There were a number of others besides these, but these are probably the ones critical to the decision document.

The remedial investigation: That's the one where we spent all that time and all those samples. We sampled all over the place -- the groundwater, the surface water, sediment, soil, waste rock itself -- in order to try to get a handle on what chemical contaminants -- chemicals that are contaminants that are present, are they being released into the environment; and, if so, how are they being released into the environment, and those that are being released to the environment, can they cause harm or potential harm to either people or the ecological community.

And that's what these documents that you see here are all about. And I usually put these up at meetings, and you might notice, as we progress, I've been adding as we go along.

Remedial investigation: That's all that sampling. The human health risk assessment, which we had a

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meeting on and talked about. Basically the conclusions of that were that the -- there was a potential -- again, the human health risk assessment talks about probability of risk, potential of risk, because it's a statistical thing because nobody lives here right now. So it's a little difficult to equate health with people to a potential for risk, so we do a risk assessment.

It basically showed that there was a potential for risk if someone lived right at the site, right on this waste rock pile, most days of the year. For people who visit occasionally, recreational use, ate the fish, visited, picked up rocks, there did not seem to be a potential for risk there from contaminants at the site. And that's what it showed.

The ecological risk assessment does the same kind of thing but for plants and animals, and we did the same kind of thing there. We looked at this area. This was done by a company out of Boulder, Colorado, and they specialize in biological and ecological things like this.

Is there a potential for risk with what the contaminants do to plants and animals, the same kind of thing as we did for people. And it showed that indeed the waste rock was, obviously. Now, because they are looking at the ecological community and not people, they look at things like the creek, which unless people are swimming in

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it and using it for drinking water, you usually don't look at things like that for human populations. They looked at the seeps. They looked at the wells. They looked at areas that we don't necessarily look at for human populations because humans don't -- people don't get into these areas very often.

So they looked at the seeps. They looked at the creek. They looked at the waste rock, and they showed that the waste rock indeed posed a potential for risk. The seeps posed a potential for risk, and because the seeps were bad enough, they actually destroyed parts of the wetlands which are dead right now. The seeps also destroyed parts of the forest land that are up here called the "uplands." Obviously a risk there; things are dead. There's a slight to negligible risk in the rest of the wetlands. There's some risk in the creek.

The main thing the ecological risk assessment showed, though, as well as the human health risk assessment, is that if you can stop the contaminants from getting out into the environment where people and plants and animals could be exposed to them, then you've taken care of the problem. If people are not exposed to horrible things, they can't be harmed. That's one of the ways to clean up.

But the risk assessment showed that. It defined

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which chemicals again and how they get out to the environment to expose people, plants and animals.

The other doctrine, the natural resource damage assessment -- it's often confusing how that relates to the ecological risk assessment, but basically what the difference is is that the natural resource damage assessment looks at what is -- what has actually been harmed, not the potential for harm, but what has actually been harmed in the plant and animal community right now. So there's a potential for risk and there's what's actually been harmed.

On the human health side, that part will be called the health assessment, to see are people actually getting sick from the site. The difference is if people seem to be getting sick from the site, immediate action is taken. It's called "emergency response." That's not true here.

But there has been harm, definite visible harm, to the plant and animal community, like the dead wetlands area. So that's what the national resource damage assessment does. It comes into play in the decision document in that in this instance -- it's not always true at sites, but in this site this is what we've done. In the decision document we've not only talked about how to clean up the site but how to restore these natural resources --

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revegetation, to put it simply -- but also restore the animal community in the creek and things like that. So natural resource restoration is part of the decision, as well as how we clean up the site. So there's two parts of it here.

The feasibility study, the last document -- you might recall from the last public meeting we had where Mark Lewis presented the feasibility study. And, actually, if you remember, there we talked a lot about how we're going to go about the decision for the cleanup as part of the feasibility study, because that's part of its purpose. The feasibility study's purpose is that -- now that we have all this information -- the risk assessment, the remedial investigation -- somebody has to go on and say, "Now, technologically, what ways do we have at our disposal to clean this place up?"

And we've got to look through those. Some of them are better than others for various reasons. Some of them just can't be done because the technology is too new or unproven or is only designed for a small volume instead of big or not designed for metals; it's designed for something else, things like that.

And we looked at other things, too. If you recall from the feasibility study, for example, removal would take a hundred truck trips a day five days a week for

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six years, I think is what they calculated. So they looked at things like that, the practicality of the thing and how that would affect the community around it. So we looked at all those things in the feasibility study, and that was done.

And once all that is done, the Environment Department takes all this information and we put it all together and say, "Okay. Now that we've looked at everything, this is how we think is the best way to produce a cleanup of this site."

And as you recall, which we discussed -- which I discussed as part of the feasibility study presentation, if you look at the three big ones first here, they're -- start with the major options. We have three major options for dealing with waste rock. We're looking at high volume, several hundred thousand cubic yards, but moderate to low toxicity, which means it takes a large amount to produce harm to you. But that's what we have, a high volume. Some things like PCB, which you may have heard about, have a high toxicity but they occur in low volumes. So overall they can cause harm, but they're only in low volumes. Metals have a lower toxicity, but they often occur in very high volumes associated with things like mines, and that's what we're looking at here. So we have a few ways to deal with this because we have to take into

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account the fact that we have a high volume and a low toxicity.

We can remove it; we can just take it away.

Now, that produces a great cleanup for this site because you've taken everything away. Of course, we revegetate, restore the natural resources when we're done. So that's an option. We can remove it.

We can do what's called a "treatment," and a treatment is just any way you manipulate this stuff in order to make it less toxic or less mobile; that is, not allow those metals to get into the environment by some kind of treatment. Often with this kind of waste, when we talk about treatment, they look at things like mixing it with concrete. And I'll go through the -- some details of these things and why we went through our selection process in a second. But that's what treatment is.

The other thing -- and I've called it "isolation," and that is, separate the contaminants from the rest of the environment so that the contaminants can't get out.

So those are really our three primary options in general for looking at ways to clean up a site like a mine site. Not like a mine site; it is a mine site.

Okay. Let's go back a little bit and I want to go through the thought process that the Environment

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Department went through using, again, all this information that we've had to date.

So we know there's metals. That's our contaminants. We know how they are getting into the environment: through seeps, through runoff. There didn't seem to be much in the way of wind dispersion, so it's mainly through runoff and through the seeps, the groundwater and the surface water, sediments. They have a potential to cause harm for people if people live near the site or visit it every day. They also have caused a definitive harm which is visible and have the potential to cause further harm to the ecological community, the plants and the animals. So we know all that stuff.

So we looked at removal first. Again, it causes -- it creates a great cleanup option here. The question you have to ask, though, if you're going to take it away, where do you take it to? That's the big issue, and as we've discussed in the feasibility study, the only viable location is to put it on the pavement pile here by the Town of Pecos.

The trouble is there's some really big problems involved with that. I just put one up there: greatly increased truck traffic and cost. Cost is a factor when it's significant. The cost estimates for what you'll see later, in terms of the isolation, is about three and a half

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million dollars. For removal it runs about twelve million dollars. That's a pretty significant difference. The -- but for the community of Pecos and for everybody who lives up and down the Pecos River along Highway 63 you're talking about a lot of truck traffic: ten-ton trucks all day long and every day for years, and that's a significant impact on the community. So that's important when we consider these things.

The other thing we considered here is the technological part or the environmental part of it. The tailings pile here is -- in terms of its contaminant release, is -- has some but it's fairly stable. It's not nearly the kind of acidic and metals-producing release we see at the site. And there was a question that if we added this type of acid-generating potential to a pile that's fairly stable, could we actually create a problem there or more of a problem than there is now. So we looked at those things. And so this looked less and less good as we went along for a number of reasons: community impact, environmental reasons and feasibility reasons.

The treatment: Treatment's not a bad idea in a lot of cases because it binds up the material, again, like mixing it with concrete. There's a lot of processing involved. You can't put a giant rock in concrete, so they've got to grind it up and mix it with concrete.

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But one of the biggest problems with treatment, when we looked at it, is that, first off, you don't remove it; it stays here. We're looking at something now that's on site. But you can imagine when you're -- anybody's worked with concrete, you're going to end up with a volume that's three, four times bigger than what you have now. And so you're going to have to basically sacrifice a bigger part of the forest, a larger part of the recreational area or something in order to have this big concrete block they basically would bury in the ground. And, still, after that time you have to worry that -- concrete is not a hundred percent stable forever. It can break down. That's why they bury it, try to get it out of the weather or things like that so it doesn't weather out. So you've put controls on this area because it's on site, even though it's mixed with concrete and buried. You don't allow much recreational use, certainly no residential use in that area, because you've got this treated waste on the site. You're talking about a much greater area than you would just by the waste rock pile itself.

So that didn't look so overly good either, again, for two main reasons. We would greatly increase our volume, which means we would greatly increase the damage to the area around it, the area we have to sacrifice to put it

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in. And there's a lot of processing that would be involved, grinding up the waste rock to get it into a fine enough size we can mix it with concrete and things like that.

There's some other treatment technologies, but they are just not feasible for things like that. There's a thing called vitrification, as an example, where they heat it so hot it turns to glass. And that's extremely difficult to do with things like big waste rock piles. They usually use that for soils, soils treated with organics. Incineration: It's hard to burn rocks. So that didn't look as great an option.

So what we're kind of left with here is isolation. Isolation: That's more informally known as capping, but I like to use the word "isolation" because -- to remind myself that what we're trying to do here is separate or isolate the contaminants from getting out to the environment. And there can't be harm if you cannot come in contact, including the environmental contact, with the contaminants.

And, if you remember, when I talked about what the remedial investigation showed, it showed that the waste rock contained minerals that, upon contact with water -- water and oxygen in the air, created the acidic environment that transported the metals out into the environment. So

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if you can stop the water and the air from getting to the rock, you, first off, will prevent this chemical reaction. And secondly, as water moves through the rock, of course it moves the metals out and the acid out with it, so you won't allow a flushing effect. If you can stop the water and the oxygen, you won't have this flushing effect.

Now, what goes on here, of course, it stays on site, just like the treatment option. It's not being removed. It's isolation. It would be on site itself. Now, the volume would remain the same because we're not getting rid of it. We're not incinerating it or anything like that. But the area could be reduced if you put it all in one big pile instead of having it all spread out like this. And that, as we turned it around, is what the Environment Department looked at in terms of our what we call "selected remedy," which is the official term for our proposal on how to clean up this site.

Now, I want to say, when we do this, what we're doing in this proposal, the Environment Department said, "This is the decision on how to clean up the site." And we have public input and comments and things like that, and then when it's issued as an official decision, that's the decision on how to clean up the site. It's still the responsibility of the responsible parties, Cyprus Amax and the Department of Game and Fish, to do the cleanup. The

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Environment Department has the responsibility of selecting and making the decision on the cleanup. It's the responsible parties' responsibility to actually enact that cleanup.

And I'll go into some more a little later, but we actually put measurements into place in order to measure whether or not the cleanup was effective. If it's not, then more work gets done. But we need a way to measure to make sure we did the job right. We just don't do it and leave. We make sure we did the job right. And then there's a long-term keep an eye on it, called "Operation Measure," to make sure nothing happens once it's all affected.

So here is the selected remedy. Consolidation, which means get all the material and push it all together so it's not spread out all over the place. You'll note it says, "one or two piles." There's a reason for this. There's certain -- I'm going to throw out this term and then you might hear me use it a little later -- "performance criteria." You'll also hear "compliance criteria," but I'll start with performance criteria. And all that is is a fancy way of saying these are the things that you have to meet, because if you meet these, it will tell us that you're doing a good job. Okay? One of the performance criteria is the

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consolidation must expose this whole drainage. A lot of water goes through that drainage. So it's not just consolidate. The pile can't go anywhere. Certain performance criteria must be met. One is that this drainage has to be exposed. See where that white -- nasty white seep is? There's a high probability there's a nasty white seep there because an awful lot of water goes through this drainage. Not necessarily on the surface; it could be going through the colluvium, which is just weathered soil above the bedrock on the hillside. It's a geologic term. There's bedrock and there's kind of a dirt, weathered material layer we call colluvium.

The water moves through the surface and the colluvium down this whole drainage, and it picks up contaminants from the waste rock and comes out this seep. So if we can remove the waste rock from this drainage, we're way ahead of the game for this seep. So that's part of one of the things that must be included in the performance criteria for consolidation.

The other thing is, you notice there's waste rock in Willow Creek here. We've got to get it out of Willow Creek, try to keep the flood plain of Willow Creek. So it's going to be removed all the way out of Willow Creek.

So now we go back and say the reason it says

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"one or two piles" is that one other performance criteria is the thing can't be too steep on the sides. Otherwise, you start to get slumps and slides and things like that, and we don't want that. So there's a performance criteria that the sides can only be a certain steepness.

Well, it may not be possible to get all this material into one pile that will meet of all this performance criteria. You might have to have two to keep the sides shallow. Plus, you don't want this big monstrosity looming over everybody who comes up that road. So, if you can get the piles shorter, shallower sides and still expose these areas that must be exposed.

So we may have two piles, one around here and one around here, or it may be done in one. That's part of this -- if you go back to an earlier slide, the remedial design. The engineers are going to look at the specifics and say, "Can you do one pile that won't be too high, won't be too steep and still expose these areas?" I'm not sure. The engineers are looking at that. Maybe not, but if so, well, maybe then they'll propose one pile in the remedial design. If not, they'll probably propose two piles in the remedial design but still expose this, expose this and not have the sides too steep and not have it too big. Same volume but now a smaller area. So all this area is going to -- the waste rock will be removed. It's

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going to be removed at least from this end. It's going to be removed out of Willow Creek. It's going to be removed out of this drainage.

In addition, contaminated material -- remember, I talked about the dead areas of the wetlands. There's a batch here and a batch here. That includes contaminated soil now, highly contaminated soil. That's going to be removed too, but all consolidated. That's what consolidated is all about. We're going to get everything that's contaminated and put it into this one or two main piles -- anything that's contaminated through here, through here, that may not be shown on here. If the soil is contaminated, it's going to be removed. After you pick up the waste rock, if you find out that there's soil or colluvium underneath it that's contaminated, it's consolidated, too.

A similar thing took place at El Molino with the tailings. All the contaminated material at the mill itself was put on the two main piles. Contaminated tailings of material from Willow -- from Alamitos Creek was taken out and put on the main pile, and the main piles have been capped together. Just a comparison example. Again, we're talking -- the decision document's for the mine, but to give you an idea of what we mean by consolidation, that's a good example. One to two piles, that's the first step.

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Then the piles themselves, once we've consolidated them, we've got to isolate them from the environment with these caps. What we're trying to do again in the caps and the decision is give performance criteria. The caps have to meet certain designs. We want to provide a little bit of flexibility in exactly what material's used in that design because we'd like to use -- for example, if there's available material on site, clay, that would be a good thing to use. You don't have to be trucking things up the road. If there's not enough material like clay, we want to be able to use an equivalent, things like plastic.

What we specify in the decision document -- there's two things: again, performance criteria, but we relate that back to the technologies that were looked at in the feasibility study. Remember, the feasibility study looked at a lot of different ways to perform a certain design. And so we related back to it. We're not going to give performance criteria and say, "You can use anything you want." We're going to look at performance criteria and say, "Things that will do the job that were examined in the feasibility study and shown to be effective can do the job." Though we have preferences.

So, the cap pile. Now, to do this -- I'm going to show you another slide. First off, a general -- this is from -- this is actually from the feasibility study, the

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feasibility study presentation, so if you remember that, you saw this slide. It's just a quick three-dimensional cross-sectional sketch.

The pile's consolidated here. This shows the river. Here's the cap on top. You see this red barrier on top. You remember that water may move through the colluvium. We've got to stop that, too, so if we're stopping air and water -- we don't have to stop air and water from the top, rainfall, for example, or snowmelt, but we've got to stop it from coming in through the colluvium above. And this is a quick sketch of, in essence, the general design of what that's going to look like. But I'd like to concentrate a little bit more on the specifics as we go through this.

Now, this shows several alternatives for meeting certain performance criteria, again, out of the feasibility study presentation. Can you tell the ones that were done by a consultant and the ones that I had to figure out how to do on my own? I kept the text mostly.

The big thing we want to look at in a cap design, again, keep out the air and water. Also, though, once it's done, we want to make sure that we're not left with a big pile with dirt on top. We want to revegetate. So that's an important part of the cap design, is revegetation, restoration of natural resources.

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So the cap itself consists of several layers, a low -- what we call low-permeability layer. That's to keep the water and the air out. Now, this particular design you can see is compacted clay. Let's look at this one. It can also be a plastic, PVC. That works, too. The idea is to stop water from infiltrating and air from moving into the waste rock itself. That keeps the acid from forming, and it also prevents any water from flushing any material out through and out to the environment. So essentially you're left with a dry pile of rock that doesn't react with anything, and so the environment is protected. That's the low-permeability layer.

That, by the way, is the lowermost layer. Above that -- here it says "geomembrane." Here it says "rock drainage." It could be several materials. It can be -- a geonet is a plastic-felt combination. It acts like -- you can imagine -- and can be used -- gravel. The idea is that as water -- if water gets through to this layer, it can't get past it. You don't want to just pond it in here. You want it moving away. So you slightly slant this layer and you give it a pathway.

Imagine a layer of gravel, like a French drain. As the water gets there, it moves through the gravel and pops out. So it's all clean because it's rain water or snowmelt. So it pops out the side and doesn't get into the

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waste rock. You've got to give it a path to get out of there so it doesn't just sit on there as a permanent layer.

So that's a layer, one of the performance criteria that's required for this cap. So we've got a low-permeability layer to keep things out of the waste rock, a drainage layer to drain any water that may get to that low-permeability layer.

And then on top would be a surface that we can plant plants on. Now, this is more than just esthetics. You can imagine nice grasslands is a nice thing to have. We don't want to have trees because they might send deep roots that would go through everything. So we look at grasses, wildflowers, bushes, things like that that don't root too deeply.

That does more than just give a nice view to the area. Plants actually take up 80 percent or more of all moisture that hits the soil, so they are actually a very effective barrier against water even getting to the low-permeability layer. That's why we really want to have as a performance criteria a vegetation layer. It's, one -- for restoration, resource restoration; but, one, it's a performance basis for this cap.

There are some places and some kinds of climates where they don't need this stuff down there. Actually, the vegetation layer will take out all the water available.

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For this area, that's -- it's not a hundred percent effective like that, so we add these extra items in there. But vegetation is acutally really high performance when we're taking out water -- and air, by the way. Of course, they're using air. The roots are sucking up air and things like that. So they are very helpful in terms of performance as well as natural resource restoration.

And if we go back to the figure just before -- I'll reiterate -- again, you see this last thing, run-on prevention, upgrade to the side. That's this red thing again. We want to prevent water not only from getting through the surface but sneaking in underneath. That is not an issue where the waste rock sits on bedrock because the water table is below that level. But it can move just down the hill, soaking through the colluvium, and we want to prevent that.

So what's going to be done is a trench will be dug through the colluvium, the whole colluvium depth, which is about ten feet here, to bedrock and they'll put in what's in essence a French drain, a gravel layer and then a drainage layer on top. So any water that gets to here -- and this will have a plastic layer, again, to prevent infiltration into the waste rock. The water runs into here, hits this plastic, can't go any further downhill, so it runs down the ditch and then comes out at Willow Creek

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or the other drainage that we've exposed. So that's the idea here on this isolation, to prevent water and air from getting to the waste rock and preventing contaminants from getting out of the waste rock into the environment.

That's for the waste rock and soils surface remedies. Remember, we also had the seeps and we worry about groundwater, seep and groundwater. Well, if it's true from the study that the main contaminants flow into the seeps and the groundwater from the waste rock because air and water get into them and flush the metals out, if we stop that, we should be stopping contaminated seeps and contaminated groundwater. That all should get fixed by this cap.

But we can't guarantee that until we see it happen, so what we've put in here is a second criteria term, "compliance criteria." What are we going to measure to make sure we're doing the job right? And one of the things we're going to measure to make sure that this cap effectively also cleans up groundwater and the seeps -- because it stops all contaminant release, we're going to, first off, sample quarterly -- and we've been quarterly sampling for a while -- for at least five years.

Now, I want to go into a little detail on that. There's a reason we say five years. It doesn't mean five years and nothing else. But what we're trying to say is

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that one near may not be enough time to truly evaluate whether this is working or not. You need a few years to do that, because things move slowly in the environment. So it could be effective, but you want to make sure you've measured it a long enough time to see that it's effective. And if it's not effective over that long enough time, then it will tell you it's not working right.

So you've got to give it a few years, and the general rule we use in the Environment Department is five years. You see that in a lot of our state discharge plans. They say, "Monitor for five years to examine the effectiveness." Operation maintenance plans are examined every five years. It's a general -- general term.

However, if this thing cleans up in a year and a half, that's great. That's okay. You know, we don't have to measure something that's absolutely clean for five years to get an idea that it's working. So it could be a shorter time frame.

But on a longer time frame we're going to have to look at the details. If the contaminant level starts here in the seep and in five years it's going like this, and even though it's still above standards after five years, we may say, "Well, it seems to be going down every year. Let's give it a couple more years. It may be working. It's just maybe taking a little longer than we

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thought."

If it's five years and it's done this and all of a sudden flat -- I shouldn't say "all of a sudden," but over five years it's gone flat and that flat is way above the standard, then we can say, "It's not working. We've got to do something else." And that's what's called the contingency, and that's in the decision document. There's a contingency section, and it basically says, "If seeps and groundwater are still contaminated after this examination, we know this thing may be working for the waste rock, it may be working for the runoff, it may be working for the surface, but it's not working for the seeps and the groundwater. So we've got to do something else for them."

And in the feasibility study there were different alternatives proposed for what to do with seeps if we need to treat them. That's usually how it's going to work. It's going to have to be treatment. The same with groundwater: it has to be treated. The reason that's not specified in the decision document -- there's two reasons. One is that we're going to give it five years to see if this works and we don't have to treat. The other reason is that this may partially work, and we don't want to design a treatment system now for what we have now that may not be proper for what we have if this partially works.

For example, what if the seep is still

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contaminated but it has half the volume of water that it does now? Well, if you design your seep treatment that assumes a certain amount of water is coming in every day and you're not getting that water, that treatment may not work. So you want to design it for what you have at that time.

So that's what the contingency is all about. It says, "If the seeps and groundwater are not effectively treated or taken care of by this design, then we will see what we have then and we will design a system to take care of it then." But that's in there. We're not ignoring it. That's what this is all about. It's in the decision document that we will take care of it if this does not.

However, indications are that this will take care of the seeps and the groundwater, too, so it may be a done deal. But if it's not a done deal, we'll do something else. That's what this contingency is all about.

The other item in here was -- I mentioned earlier natural resource restoration. In one public meeting you may remember Steve Carey from the Natural Resources Trustees Office for the state talked a bit about the natural resource damage assessment, which at that time was in the work plan stage. But natural resource restoration, as I said earlier, is part of the decision here. The cleanup and the natural resource restoration go

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together. And think of it in broad terms as revegetation, but it includes more than just plants getting replanted, so that's why we call it natural resource restoration. And there's several items of that. Let me go back to the map here to help me.

Waste rock is in Willow Creek. We're going to remove the waste rock out of Willow Creek, but then we have to restore Willow Creek to what it was before, which is riparian habitat. "Riparian" basically means streamside, so natural streamside habitat. So we want to do that.

The wetlands: As I said, there were a couple of areas that were deeply affected by the release. We want to -- we're going to remove the contaminated materials. We've got to restore that to wetlands. We're a little fortunate there because we've got a large wetlands area and only a couple of small areas have been severely affected, and wetlands are very good at growing in on themselves and restoring themselves if you remove the bad stuff. We're going to assist that, but the wetlands should be very good at replacing themselves as we go along.

Restoration of affected uplands areas: Those are these areas that I talked about. For example, we remove waste rock and consolidate it and underneath -- of course, waste rock has been sitting there and nothing has been growing. Contaminants have been getting out in the

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soils. We've got to replace that with decent soils and revegetate and things like that.

Vegetation of the cap piles: I mentioned that earlier. We've got to plant some new grasses, bushes, wildflowers and things like that on the cap. That will be some restoration itself.

This next one just came out of a request from the state forestry division, which deals with threatening endangered species. Up Holy Ghost Canyon, which is near here, near this site, is a species of plant called the Holy Ghost ipomopsis, which is endangered because it grows nowhere else but there. It's specific to Holy Ghost Canyon.

The state forestry division would like to try to see if they may be able to spread its range. It's a wildflower that gross almost like a weed. It comes into areas that are newly cleared off, like after burns or areas that have been cleared. So all the state forestry industry division asks is if we could give them a chance to try to plant those plants there. That's really all that says.

If if doesn't, if they don't take, then that's okay. They may be specific to Holy Ghost Canyon and not do well here. But they'd just like to be given a shot at it, and we said fine. So since this is a newly replanted area and that's the kind of thing this Holy Ghost ipomopsis

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likes, they're going to give it a try. So that's where this comes from.

And then the last thing you see, assistance in off-site project, where this comes in is that in the agreement with AOC it says the obligation of the responsible parties is to restore or replace injured resources. Now, Willow Creek, they'll be able to restore it all because all the materials will be cleared and they'll take care of it.

The uplands area, no problem. Wetlands, no problem; you still restore it. But you've still got this waste rock pile. You can never restore the forest, grassland, meadow, whatever was under here, because you've still got a waste rock pile on the site. So the AOC says "restore, replace and do resources," so we've got to look at the "replace" part. So we have to do something to replace the areas of meadow, grassland, forest that can never be restored because we've got a waste rock pile sitting on top of it.

The way we look at that -- of course, we have to go off site in terms of the replacement. And the natural resource damage assessment, the document that's out, looked at various projects -- they tried to be specific to the Pecos drainage because they want to keep it nearby, a similar type of environment -- projects that would be

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equivalent to replacing these things that we can't restore on site.

And the Environment Department looked at those just like in the feasibility study. We looked at the various cleanup options, and we thought, Which one can we select that would be a good connection that would sufficiently fulfill that obligation to replace injured resources? And the Pecos National Historic Park, that way, they put forth a proposal for a project -- they're doing a bigger project, and all they asked was that -- for the replacement option, if there could be an assistance for that project.

And what they are trying to do is restore their area that's now -- for a while on the land it was stock tanks, and they are trying to return those to wetlands, a riparian area, and they want some -- they put forth a proposal for a project for the replacement thing, assistance with that. And so that's what we selected.

There were a number of other projects that were proposed also, but the Environment Department and the decision document selected this one as best fitting a replacement for these injured resources and the same size and scope that it represents for these injured resources. So that's where this comes in. It's what we call an off-site project. It fulfills this replacement obligation.

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Okay. So that's the decision on the cleanup and the natural resource restoration and the contingency that was in the seeps and the groundwater, and the last thing we have to worry about in terms of this package is, How do we measure whether we've been successful? And that's this compliance criteria. What do we measure to show that we did successfully do the cleanup like we are planning to?

Now, we've done all this investigation. Everything tells us that that cleanup and the decision document will effectively clean up the site, take care of all contaminant release. But we have to have a way to measure that. We can't just say the study suggests this. We have to have a way to measure. That's what compliance is.

And I put them into two categories. Remedial monitoring are the things you measure while you're doing the cleanup, and you see here the soils and air. Air: A lot of that is the safety of the workers. As you're working, things get blown up into the air, and OSHA has a lot of legal requirements that that amount of stuff that gets into the air that people may be breathing -- and it's really a risk to the workers because they are there every day for eight hours a day. There's very little risk for people driving by or stopping at the site for a while, things like that. It's really a risk to the workers.

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So OSHA has certain standards involved with that, and they -- workers working at the site that can't see those things. It's as simple as that. So things are going to be measured. They have air monitors that measure the contaminants in the air, make sure they don't exceed the standards. That's a remedial monitoring, because once the site is completely done and capped, nothing else gets into the air because you have a cap on top of it, so air is not an issue. In fact, we've measured it as-is during windy times, and we still don't get any potential for risk from the air. But while we're working, there's going to be some very clear air monitoring.

Soils: The way soils are done is that -- how do you know when you've cleaned up enough contaminated soils? Well, we put a number on that and we say, "You need to clean up soils to this level." And we've -- we've been using 1,200 parts per million lead in the soils, and based on field -- what's called SRF -- it's an instrument in the field that will actually give you a measurement of metals' concentrations in soils right while you're standing there. It's a wonderful instrument. The engineer has one and the contractor has one. You ususally lease them, so they are available.

So while we're doing the cleanup it's important to know that we got everything for this consolidation. We

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don't want to consolidate and then come back later and find out we missed a spot. So that's why the soils monitoring is done during the remediation. But, again, it's similar to the air. Once all the contaminated soils are consolidated and the cap is put on, we don't have to worry about the soils anymore. So there's no need for a long-term monitoring of soils, because if you've cleaned them up to a certain level, then they are clean and the rest of it's under the cap and the pile.

But then we look at, again, the measuring to make sure the remediation is effective. Now we've got these measurements, remedial measurements, to tell us that we've adequately cleaned up and kept the workers safe as we clean up, as we're going along. Now we've got to measure things to make sure that the -- once the cleanup is there and done, that it's working, and that's these other two: quarterly monitoring, groundwater and surface water, because -- again, going back to the remedial investigation, contaminants are released because minerals react with the air and water to create an acid environment, and the water moving through the waste rock takes those contaminants out to the environment.

So if we measure the water going out into the environment, we'll see if there's any metals or acid. That's what this monitoring is all about. And if that's

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clean, then we know there's no contaminants getting out of the waste rock pile, because that's the way they get out to the environment, is through the water. Because the cap's on top, it's not getting out through the air, and it won't get out through runoff because we have that French drain up above. So we don't have to worry about the surface runoff. We don't have to worry about the air, but we do have to worry about things getting out through the water, the seeps and the groundwater, the wetlands area, things like that.

So that's what we're going to measure, to see -- to make sure nothing is getting out once we put the cap on. That's what this quarterly monitoring is all about. That's the compliance criteria. And there's official designation in the AOC that says if you have -- you notice this is quarterly, four times a year -- if you have eight consecutive quarters of clean samples, then that's when we designate it -- that's how it's officially designated as being shown to be measured clean.

And that can vary. If all the groundwater shows clean but some of the seeps don't, then you can say, "Well, the groundwater seems to be effective but not the seeps," or vice versa. But that's the criteria, the legal criteria, that's used, eight consecutive quarters. If you go six and get a hit, you start all over again. It's not

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eight out of ten or just eight over the course of how many years. It's eight consecutive quarterly samples. That's what we use for compliance criteria. That's how we're going to measure the success of this cleanup.

A couple of other things that will be coming along in the future in conjunction with that, all through related documents. Remedial design: I've talked about that. The health and safety plan is what they put into place, again, to protect the workers on the site, not just from breathing dust that may come up, but physical safety and things like that. That's required at any site that work's being done on.

NPDES is a National Pollution Discharge and Elimination System. Don said yes. He's with EPA, so that must be right. Don't worry about that. It won't be a test.

Basically what that is is a federal permit that says if you mess around in an area that may -- while you're working on it -- not in the future but while you're working on it -- may cause a release of things to surface water, like Willow Creek, like the wetlands, like Pecos River, you need to get a permit. And what the permit is for is not to say, "Yeah, go ahead and do it." It is to say, "Here are the steps you have to take to make sure this doesn't happen." And the permit is your agreement that you'll

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follow the steps to make sure nothing is released out. That's what it's all about.

The discharge plan is for groundwater and surface water, but it's kind of a state relationship to the NEPDS. Again, it's saying, "Are you -- do you have a potential while you're doing this work -- or for discharge plans actually in the future, too -- to release stuff that may get into the surface water, the groundwater? If you do, you need a permit." And the permit, again, will outline the steps you agree to take so this doesn't happen.

These are some of the permits that are required when you do work like this, so they go along. They are not the decision document themselves. They are not defining the cleanup, but there are permits required any time anybody mucks around in places like this and may create a release.

So I'll give you a quick example. If you put silt fences out here, or berms or settling ponds so even sediment won't get flashed out in a storm into the river, a permit will define things like that. That's what it's for.

Okay. This is the last one. This is the schedule. Everybody wants to know when all this stuff is going to happen. Let me start by reviewing the schedule to date. The AOC was signed in December 1992, so it's been in effect just a little over five years now. And as I was

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stating to someone earlier, the average time frame at a superfund site -- I won't use the long-term average -- today the average from being declared a superfund site to starting cleanup is six years. Correct? Six years. So we're ahead of that schedule because some work has been done and we're going to be ready to start the work. So it's been about five years.

The remedial investigation was done a year ago. So, actually, all those documents that you saw earlier -- the risk assessment, the feasibility studies -- were all done in pretty much the course -- the space -- the span of one year, maybe a year and a half. That's actually pretty quick on an environmental site.

We're also within budget, by the way, that was originally designated by the state.

So for more immediate concerns, as I mentioned, we're right in the middle of the 60-day comment period for the decision document. So the comments are due out -- due to the Environment Department by the 19th of February. The thing was issued on the 20th of December. Whatever it comes out to. So the 19th of February is the deadline for comments on this decision document proposal.

The final decision document -- what happens then is the Environment Department takes those comments, we respond to them. Now, we respond to them in a number of

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ways. We may revise the decision document based on the comments. We may just write something and say, you know, "We've looked into your question. We've looked into your comment, and this is what we found out about it." It may simply be a question. It may be someone prefers a different alternative, things like that. Whatever the comment is, we have a response to it.

We can generalize those. If we get twenty questions that are all pretty much the same, we can say, "Here's all these questions that pretty much said this. This is our response." And that's what that is all about.

But that and the final decision document, revised and put out, will come out in March. We are going to try to get it out 30 days from this date, from when the comments come in. And that will be the final.

The remedial design: That's that document that gives all the engineering specifics -- what's the exact size, what's the exact shape, how much material is going to be here or there and the rest of it, what's the size of the slope, what's it going to look like -- all that comes in the remedial design -- that will probably be in the spring.

That takes a while. We're going to sit down and do all these exact numbers. So we're looking at that by the spring. Probably over the summer, more realistically.

But, again, that's going to be proposed. The

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Environment Department's going to look at comments on it. We'll have a public meeting. It will be in the repository. We'll take comments on it. It will, more than likely, be revised, and then it will have to be -- come out in final before the work starts.
The remedial design will also include in it some of the measurements that we use for things like the contingency -- where exactly will we measure that seep in order to figure out whether the thing is working? Where are we going to put those wells that we're going to measure the groundwater? Things like that will be part of the remedial design. So a number of the measurement specifics will be part of the remedial design also.
Then the remedial activity, or the cleanup. You can see it begins in the summer 1999. That still looks like a pretty good estimate. If you're just using a time scale, it could probably start in winter, but middle of winter is a really bad time to start moving stuff around, especially in the wet areas. So at that point we'll have to wait on the weather, until it dries up in the spring.
So that's why we're looking at the summer of 1999 for the beginning of cleanup.
It will probably take two years. It may take less, but that's the estimate. Probably about two years for completion. Again, that's the surface completion,

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because you notice that I have compliance here below it. So that's -- about two years when the cap is on, the vegetation is in and it's ready to go. But then we start that quarterly monitoring to see if we get cleanup of the groundwater and the seeps and things like that. That's this compliance. And, remember, that's going to take five years or so.
So that's the schedule. That's the proposed decision by the department based on the preceeding documents, and this is the schedule of events to come.
So how are we doing? Would people prefer a five-minute break, or should we go right into the comments and questions? I'll let you all decide.
(A recess was taken.)
MR. WUST: Let's go ahead and continue. I'm going to start by sitting down. I've been told these lights are about as bright as we can get them without having a whirlwind from the fan, so this is about the lighting we're going to stay with right now.
At this point, if there's any questions or comments, feel free. Again, we're talking about the decision document for the mine operable unit. That's what we'd like to concentrate on. And please state your name before you say anything so that the reporter can make sure she has the correct attribution.

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So, any comments or questions?
Go ahead, Eloy.
MR. GONZALES: Is name is Eloy Gonzales. I'm one of the San Miguel County Commissioners and also a concerned citizen. My question is, why don't you pump these mine tailings back into the mine?
MR. WUST: Why don't we put it back into the mine?
MR. GONZALES: Yes.
MR. WUST: That's been suggested at a number of sites. It actually causes a lot of problems because the groundwater is exposed and contained within that mine shaft, and what happens when the rock is mined out is it's -- you break it up so you get a larger surface area for exposure. You've exposed it to the air now, and if you stick it back in the water, you've in essence pushed contamination right into the water system. And it might be viable if the mine shafts were all completely dry, but in this case they're not. And so it -- it's like putting contaminants directly into the water, and that's something we're trying to avoid, is preventing this rock from contacting water and air.
MR. GONZALES: You do have a lot of stopes underground, don't you?
MR. WUST: Yes. Yes, there are.

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MR. GONZALES: Are those full of water?
MR. WUST: It's also -- not all of the water level's at a certain depth. The other problem, of course, is that engineering-wise it's difficult. You can't just drop it in. You'd actually have to transport it in with carts or something, and a lot of those stopes and shafts are very unstable, and probably they'd be totally unsafe for someone to try to go in there. So you can't just dump it in.
And the other thing is, when you bring rock out and break it up, you increase its volume by a lot, similar to digging dirt out of a hole; it's always more than what was in the hole to begin with. And so the volume is more, and so it would be very difficult to pack it into those shafts and stopes.
So there's a number of reasons. One is the water, one is the technical feasibility of the thing, and the safety issue.
MR. GONZALES: Am I correct to say that that's what they are doing in the uranium mines in Grants on their cleanup?
MR. WUST: I don't know that for sure. Mora, do you know? Since I did it before -- let me interrupt here.
Mora Hennings, who I just asked that question of, is the superfund program manager for the state Environment

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Department, another state agency person.
I don't know. I don't know what they're doing there. I can't answer that. I'm sorry.
MR. GONZALES: Am I correct to say that they are also doing it in Golden, here in Golden, on their cleanups?
MR. WUST: Golden, New Mexico?
MR. GONZALES: Yes.
MR. WUST: By the San Pedro mines?
MR. GONZALES: Yes.
MR. WUST: I don't believe they are doing that there. They are not doing it at San Pedro, are they?
MALE VOICE: I'm not aware of activities at San Pedro.
MR. WUST: I don't believe they are doing that because they actually have a proposal at San Pedro to continue mining. It's not approved, but that's one of the proposals.
A difference, though, I could say for Grants, is that they're dealing with tailings, not waste rock. So it's a different material. But I do know at one of the uranium mines -- uranium tailings areas -- I wish I could remember the name of it -- but they put a cap on the tailings pile. That's one of -- the only one I'm familiar with, because I've seen some air photos of it. They put a

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cap on the tailings pile. They didn't move it anywhere. They left it in place. But the other ones I don't -- I'm not -- I'm not familiar with.
Are there any other questions or comments?
While you're thinking, I'll interject that my address and phone number and e-mail were all in the ads for this meeting tonight, and you are free to send comments through any method you'd like. Give me a call, if you'd like. You could send me an e-mail, if you'd like, or you can just mail something to me at work. And all that information is in those ads.
So all of those are valid comments, if you don't want to present anything tonight but would like to comment a little later on or think of something a little later on. There's a number of ways to send comments to the department, and all of those are equally valid and we will include those and respond to them.
Yes.
MR. RAPANOT: My name is Victor Rapanot. I'm a resident here in El Molino. Have you seen any other sites the same as the El Molino that you're familiar with to give an idea to the people that when they do this work what they are going to have to accomplish, like the size and how much work is being involved and what it should look like when they are done?

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MR. WUST: I take it you mean the Pecos mine -- the Terrero mine?
MR. RAPANOT: The Terrero mine, the capping and tailings and everything.
MR. WUST: Yes, there's a number of sites in the State of New Mexico that are having work done on them in various ways. Also, outside of the state, and probably if Don wants to throw something in, he can.
MR. RAPANOT: So do you know like where -- like from experience --
MR. WUST: Oh, I see what you're asking. Yes.
MR. RAPANOT: -- when they go in and do work --
MR. WUST: How much it's going to take, how big a pile and things like that?
MR. RAPANOT: And what would be most effective choices.
MR. WUST: Yes. That's -- we've looked at it a couple of ways. The people who did the investigation have experience with mines. I'm a geologist myself. I have experience in mines. And the engineers who are going to design the remedial design have done a number of these designs for mining sites, so they do -- they do have a really good idea. And the project manager for Cyprus Amax, Johnny Green, is here tonight. He works mines all over the world. So, yeah, there's a lot of experience.

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MR. RAPANOT: I was thinking there might be a lot of jobs, and like when you get subcontractors in and things like that, things like that, sometimes if you go and show them other sites and stuff, it makes them a lot -- it makes it a lot easier so they can see what they are doing, and that's why I asked the question.
MR. WUST: If there's some close by, that would be viable. Again, if it's contracted to some company -- it depends on the company it's contracted to. Some things, like if you use plastic for the low-permeability layer, like I said was a possibility, you contract that with a company whose business is to put those things in. That's their job. That's all they do. You don't just hire somebody and give them a roll of plastic. It's actually a company. They come in. They have their own materials, their own trucks, their own people, and they do things like that.
So for some of these it's a specialty contract. For things like materials acquisition and moving, you can go with several contracts. But the people who are designing it and putting the plans together and telling everybody where everything goes, those will all be experienced people.
MR. RAPANOT: Okay. Thank you.
MR. WUST: Okay. Anything else?

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I'm hoping everyone remembers from the feasibility study that this is indeed what we discussed a lot of at that time, so we've been going along a similar trend all this time.

MR. TETTEMER: I have a question.

MR. WUST: Yes.

MR. TETTEMER: I'm Bruce Tettemer. I'm a resident of Pecos. This is the first meeting I have been to, but I know you mentioned lead. Would you talk about the other specific metals that are leaching out?

MR. WUST: Sure. The -- and that actually brings up an interesting question, because we're using lead for cleanup criteria, but it's not -- it's not the problem metal that we see at the site. That's not the metal that we really think is an ecological and human health problem at the site.

The reason we use -- I'm going to sort of start at the end and come back to the beginning. The reason we use lead for cleanup is that you could see it pretty easily with this SRF. And when you see it, you know these other metals are there, too, but they are harder to detect. So we use lead as what we call the indicator metal. So if we know we get it below a certain level, all the other metals are below a level also.

That's why -- that's one reason we use lead. We

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don't use it because we're trying to say that's the problem there. Lead is certainly there. But the main problem there is actually zinc. Zinc comes out in much greater concentrations than any other metal from those seeps. It's not harmful, except in massive quantities, to humans. In fact, people put it in their vitamins. They take vegetables with zinc. But it's really deadly to fish.

Mainly it's the fish we see in the hatchery, because fish have a natural metals avoidance system, and if in the river -- where we see it is during runoff or snowmelt, so it kind of comes down in pulses. And fish in the river can get away from it and then get back to wherever they were. Fish in the hatchery can't do it, so fish were actually dying in pretty large numbers. People who have been here for a few years probably remember the fish kills, and it was zinc. And essentially what it does is sufficate them because it coats their gills, chemically coats their gills.

So zinc is a real problem there. It's a real problem ecologically. It's not really a problem for human health values. It's a real problem ecologically. Because the metals go down in pulses, they don't accumulate in fish tissue so there's never been shown to be a problem in like people catching fish and eating them or anything like that for any metal. But some of the other metals we see there

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usually associated in an area like this or rock of this type would be cadmium, which has a high toxicity for metal but tends to occur in fairly low concentrations. And, again, that's toxicity concentration equivalency. But cadmium has a pretty high toxicity for metal.

We have -- we had some arsenic there, but, interestingly enough, arsenic is really high naturally there, so it was hard to tell whether it was a concern at the site. Although, again, once the cleanup is done, it's going to take care of this entire list, which is the nice thing about this kind of cleanup. Arsenic potentially but not definitively.

Copper was one. Again, copper is one of those that can be a lot more harmful ecologically than to humans, although if it gets up to a certain level in water, it could be very harmful to people. So it's one of these threshold values that once you get up to a certain number, you're okay, but after that number it can be pretty bad all of a sudden. But we haven't seen those real high numbers, but we have seen numbers that are harmful ecologically.

The primary harm at this site has been ecological and mostly through the surface water pathway. We see very few of the low end of the food chain organisms in the wetlands. In the little streams where the seeps are coming out, things like that, what's called

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macroinvertebrates, may flies, for example, things like that, a lot of ecological harm.

So those are the main things, I think. There was some barium seen in one of the wells. Barium actually had a significant enough toxicity to humans that it was used in the human health risk assessment, and it was shown that if somebody drank water out of that well that had the barium in it as a resident, it had the potential for harm. So barium is one. It's not widespread, but we did see it in some of the groundwater.

Manganese, which is really common in mining sites as a release metal. It's very commonly seen naturally in the State of New Mexico, but it was much higher concentrations at the site. Manganese doesn't have much of a health connection to it, but it has what's called an esthetic standard connected to it. It coats sinks and makes them black, and it can mess up the water in terms of taste and smell. It does have some health effects at high enough levels.

That's -- if someone wants to throw out another one, that's pretty much the list. But that's significant enough, I would say. I mean, the zinc alone made it significant enough, but all these others were also seen. Does that answer your question?

MR. TETTEMER: Yes.

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MS. CANYONRIVERS: I had a question. I'm sorry; I came late. Pamela Canyonrivers. I couldn't be here sooner. I was here last year when you were talking and I had made comments several times last winter. And you may have covered this, and if you have, I'll get it from somebody else.
What about -- you mentioned about fish and you mentioned about the relationship with humans, but what about the wildlife, like the wild ducks that are there and some of the other animals that are along the river, you know, between, say, the fish hatchery and the monastery lake? That's one question I'd like to know, if they are being impacted.
And then -- you probably covered this, but I hike where the old mine is sometimes, and I see the reclamation work that has been done, you know, over the past few years, and it's all piled up -- I guess that's what you were talking about last time -- where nothing is growing there. It looks God awful, horrible, and I'm wondering if anything is going to grow there or if that's always going to be there.
And I also want to know -- and I guess I have to read the report -- where you are in the stage of the reclamation project, because that, to me, doesn't look finished.

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MR. WUST: Well, it's not. That's what the decision is all about. The decision document states the decision on how to clean up the site and then the cleanup is done, and that will include revegetation of those areas, like the waste rock pile after the cap is put on.
MS. CANYONRIVERS: The cap still hasn't been put on?
MR. WUST: Oh, no. No, no. It hasn't even been consolidated. The only thing that you've seen in place that you're calling reclamation work is what we call interim actions; that is, try to put a few things in place that will prevent runoff from occurring as much as possible. We can't stop the seeps, but things like runoff. You might see some berms and sediment ponds and things like that, silt fences. Those are interim actions to try to prevent some of this runoff, and that's what you see. But nothing else has been done. There's been no consolidation, no plants, no revegetation, no capping, none of that. That's why it looks like it does.
The -- I'm trying to remember what your first question was.
MS. CANYONRIVERS: My first question was about the wildlife.
MR. WUST: Oh, the wildlife, yes.
MS. CANYONRIVERS: Before you move on to that,

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when is the next phase happening? What are we all waiting for?
MR. WUST: Well, the schedule that I just put up here of the remedial design is the next step, which is the engineering designs of the specifics of exactly how to clean it up, because you can't go out there and say, "Let's start moving stuff." Somebody is going to ask, "Where do you want me to move it to, and how much?" Somebody has to do that through remedial design. That's going to be -- that's documented. That can't be done until the decision document is final because the engineers can't design something until the decision is there.
MS. CANYONRIVERS: So the decision document that you're now contending for a document has to do with the decision you were talking about last winter, which was whether you're going to cap it or whether you were going to move it?
MR. WUST: The general decision on the cleanup.
MS. CANYONRIVERS: A cap?
MR. WUST: Correct. A cap, that's correct.
MS. CANYONRIVERS: So it just seems on the outside looking in -- and I apologize since I haven't come since last winter -- that this thing is moving at a snail's pace, and I don't know whether it's because before you can cap you have to wait for certain reactions in the

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environment in the soil or whether it's a matter of the political decisions being made that's taking it so long. And meanwhile, until it's contained, I guess there's always the threat if you keep testing, whether it's going to go into the groundwater.
MR. WUST: I understand that concern. Actually, for an environmental site this is moving quite rapidly. As I said, from the remedial investigation report to now has been about a year, and that's actually quite rapid for a site like this.
This happens to be geologically and hydrogeologically, for the water, a complicated site. It took quite a while to do the investigation so we could understand what the contaminants were and how they were getting into the environment. It took over a year's worth of sampling because we had to do different seasons of sampling to do the ecological risk.
And that segues into your question on the wildlife. The ecological risk assessment examined all the ecological community from macroinvertebrates through the food chain up to eagles and hawks and beavers and voles and shrews and earthworms and birds and pretty much everything. And all the plant community, too, from grasses to bushes to trees. And so all of that is included in the ecological risk assessment.

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What the ecological risk assessment showed was that the major ecological harm was through the water pathway and mainly through macroinvertebrates, and the reason it's mainly macroinvertebrates is they tend to stay in one place. Plus, they are very susceptible to changes in the water. Fish are bigger so they are more like us; they are a little more adaptable. Plus, they can move somewhere else. But macroinvertebrates tend to be in a small place. That's why they are often used as the sensitive end of species.

But everything was looked at, and it was looked at several ways. For example, can birds be -- let's say, eagles. Can they be harmed just by direct contact if they perched on the waste rock? Also, can they be hurt by the food chain --

MS. CANYONRIVERS: What about --

MR. WUST: -- eating things that eat the earthworms?

MS. CANYONRIVERS: -- all the birds that are drinking water that has metals in it?

MR. WUST: That was looked at, direct ingestion of the water, all the pathways. So if you look at the ecological risk assessment, which is in the repository, we did look at all the variability of the wildlife and all the variability of the pathways. So that was looked at, as a

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matter of fact.

MS. CANYONRIVERS: And on a scale of one to ten, how bad is it for those animals, for that wildlife, the birds and the ducks? Of course they can move, but they come back every year.

MR. WUST: Actually, the ecological risk assessment showed that, for the larger wildlife, very little risk because their areas are so large. And it's just like people again. If you're a resident on that, living next to the waste rock, you have a lot more exposure than if you visit it once a year or even several times a year. If you are a bird that has a large feeding area, part of which is that site, there is some risk, but it's not large because the exposure is smaller.

The major risk, again, are for those parts of the ecological community that don't go anywhere -- plants. There's parts of the wetlands that are dead. I guess that's about as risky as it gets. And that's got to be taken care of.

So on that scale that's a ten. Stuff's dead.

But on the scale of things like larger animals, browsers, the grazers, the carnivores, the risk is minimal.

MS. CANYONRIVERS: In terms of their survival and their eating habits and drinking the water, but we don't know about the studies -- or is anything known over a

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long period of time in how it's affecting, say, their eggs and their ability to -- you know, whether it's affecting the birds and all that in terms of raising successive generations?

MR. WUST: That's looked at in the ecological risk assessment.

MS. CANYONRIVERS: I guess I have to definitely read it.

MR. WUST: Yes. The way it's looked at is that there's been plenty of studies on different kinds of animals that tell you how different contaminants affect those very things you just mentioned -- reproduceability, living viability, habits, things like that. And the way you have to go about it -- because it's a risk assessment. There's not enough -- large enough population that's resident at the site to do a health assessment to know their health and to relate it to the site. So they do a risk assessment, the same thing as people. Say, if we have contaminants, studies show that contaminants at a certain level create this kind of harm. How do we compare that level to what we have at the site?

Also, the exposure, because that has to be included. Toxicity and exposure are the two major things in a risk assessment. And that -- but that was all looked at, every bit of it. And they did look at things like

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reproduceability and viability.

Plants: The reproduceability was actually looked at directly because that was one of the studies. They put fast-growing plants, fast-reproducing plants in contaminated soil to see how -- how well or poorly they did at different concentrations. All of this is in there.

MS. CANYONRIVERS: Thank you.

MR. WUST: You're welcome. Yes.

MR. GONZALES: Again Eloy Gonzales. You made a statement a while ago about moving some of the tailings down here to the pueblo.

MR. WUST: No. No. I'm sorry. I misspoke on that. The natural resource restoration, which is -- like revegetation, cannot be fully done at the site because the waste rock pile is there. Obviously what's below it, you're never going to grow anything back there. So they wanted to find a way to replace what they couldn't re-grow at the site. Plant -- just plant communities, things like that, revegetation. You can't revegetate under the pile, so they -- the consent order requires them to restore or replace resources, so they need to replace that grassland, meadow, whatever it is, that can't be done because the pile is there. That's what's going to be done at the park. No -- nothing is going to be moved there. They just -- the decision document includes an assistance to a

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natural resource restoration project that's already going on at the park, which is they're trying to restore some wetlands and some creek area down where the old stock tanks are.

So all that's being done is to work on that. Nothing from this mine it going to be there. It's just like helping revegetate that area, basically.

MR. TETTEMER: Bruce Tettemer again. So the documents in the repository, are they to be removed from the room, or do they have to be viewed there?

MR. WUST: Is there someone here from the city who can answer that?

I can only answer for the repository at our department because the one here is -- falls under the policy of the Village of Pecos, and I don't know what that is. If somebody does, please speak up.

I can tell you what it is in our department, that they can -- they cannot be removed. They are available during our working hours. You can look at them. If you'd like copies of them, we can arrange to have some copies made. If it's not too many, we'll just do it. If it's a lot, we charge and it takes a little while. I don't know what it is here.

MR. WUST: Okay. Lydia, do you have --

MS. ULIBARRI: My name is Lydia Ulibarri, and

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I'm a concerned citizen. My question is regarding the -- you're saying you're going to do some work over at the national park. Weren't there any other sites within this other area that were to be considered?

Because, you know, the national park there, they get federal grants. They have federal money, and I don't know about the others. Did you make any inquiry to know about it, or did you have some other proposals for some other projects?

MR. WUST: There were a number of projects that were considered in the natural resource damage assessment, and they were all evaluated like the feasibility study evaluated cleanups, and they ranged in location from places along the Pecos River upstream from here. I think that's where almost all of them were, and they ranged in style from revegetation to -- actually, there was a parking lot paving that was included as a proposal.

What the natural resource damage assessment looked at in terms of considering the different projects was trying to select one that was similar to a restoration that is being done at the mine site already; that is, trying to restore resources in the same way as they are being done at the site. Similarity, in other words.

So things like a parking lot paving is so different from trying to create a mountain meadow that it

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scored low on the list of viability. And the one at the park is very similar in the type of restoration it's doing to what's being done at the site. And that was a really strong consideration because this is a natural resource restoration. So that was a real important consideration.

However, the natural resource damage assessment draft is out, and it lists all those projects, and if you'd like to go through those and you think there's a project that you believe is preferable that should be selected, please include that as a comment on the decision document.

MS. ULIBARRI: Well, my concern is -- and I know you said this is not the time to bring up the El Molino site, which you know is my primary concern. There was an area there in El Molino, you know, that back fish water that I keep complaining about, and that needs to be restored. And I thought if you're looking for, well, equitable or similar areas that need to be restored, and I think that this one should be -- that should be taken into consideration, unless you have already place in plans for restoration of those areas.

It seems to me that since -- preference should have been given to areas along the El Molino site because the situation that we have in El Molino, all the contaminants and all the destruction of the ecological system around there, was because of the mines that were up

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there. So I think that that should have been given a priority.

And another factor to add to that is the fact that here in El Molino we are poor. We don't have all the federal funds that we have unless we get superfunding. But we don't have the funds of the National Historic Park. They have other areas that they can get their funding, and I'm not against the National Historic Park. I think it's one of the areas that we have to be very proud of and certainly very supportive. But I think our priority should be with restoring, finding things to do. Since the Terrero mine was the principal culprit for causing all of this other contaminations and all this destruction of the ecological sites and causing all these health risks and also contaminating our groundwater, not just our surface water but our groundwater in our acquifer, I think there should be some consideration.

I didn't know that you had said that you people could submit projects, because I certainly would have been interested in doing something even further than what you people have in mind. If you have this money available and if you have the resources available, I think that the El Molino, all that area, you know, all the way from the Terrero mines -- and I know that the Pecos River has been impacted but so has the El Molino area.

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Did you give consideration on any of the El Molino areas?
MR. WUST: The area you mention at El Molino is already included in the cleanup plans for El Molino itself, and what we did not include in terms of the restoration projects for the mine are areas that are already being covered by other parts of the consent or the AOC. And that area you mentioned is required for cleanup and restoration in Alamitos Canyon.
So that's being taken care of under the AOC, actually. So it's being handled. The area along the creek there, all that stuff is going to be wetlands development and riparian development. That's part of the El Molino cleanup, and so it wasn't included in the --
MS. ULIBARRI: It's going to include that area that I've been so concerned about and also the area -- the drainage, you know, and the creek all the way down to the river, you know, where you have the ponds and you have buried all that contamination. Then there's some other areas, I think, that could -- you know, I think that there should be. Even along the road.
And I don't know if you're concerned with restoring just areas that are close to a water drainage area, you know, like the creek. Anyone that drinks -- I don't know if the National Park Service, they are going to

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restore along the Glorieta Creek, but to me it seems that this area should have been given a more thorough look. That's just my opinion.
MR. WUST: Thank you.
MR. GONZALES: Eloy Gonzales again. Is there anything going to be done on Highway 63 of the Pecos Canyon? You know, we have a bottleneck from Bush Ranch all the way up to Cowels. Are they going to be doing anything before they start, on the traffic?
MR. WUST: You mean like widen the road or straightening it or something like that?
MS. GONZALES: Yes.
MR. WUST: I don't know of any plans, and that would be up to the Highway Department. It's not included in the plan under this cleanup proposal, but I know the highway looked at that once. But whether they are still considering it or not, I do not know. But it is not part of the cleanup proposal.
Anything else?
MS. CANYONRIVERS: So how long is the comment period?
MR. WUST: February 19th --
MS. CANYONRIVERS: Okay.
MR. WUST: -- is the deadline for comments.
MS. CANYONRIVERS: Do you have copies of the

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draft here with you, or do we have to come to the office to get them?
MR. WUST: Two copies of the draft decision document are available in each public repository, the one here and the one at our department. And I have one here, but it's the one I borrowed from our repository, so I cannot leave it. But so you know, this is what it looks like, a beautiful blue blank front cover. But it's -- I believe at the moment it's also the last document in the the repository, and for those of you familiar with repository numbers, we just file them in consecutively by date. So this is about -- I think it's number four hundred and -- 447. So, obviously, there's been a lot of paperwork come out of this.
But this is what it looks like, and there should -- I know there's two of them in our department in the repository because I just pulled this one out, and I'll put it back tomorrow. But this is it, and that's where it's available. And that's -- unfortunately, I can't leave this because I've got to get it back to our repository.
Is there anything else?
I appreciate you all coming. It's good to see you all. I think this is a great room, and we're going to try to have all the rest of our meetings here. It seems to be just the right size and comfort level.

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So thanks again. We'll have another meeting.
Again, we try to set these up so we time them when things happen or documents come out or activity takes place. And so probably the next major event, which is really not that far away, would be either the specific engineering designs for the cap at El Molino and the remedial design for the mine site. So we'll have a meeting in conjunction with one or both of those.
MS. CANYONRIVERS: The decision to cap is now final?
MR. WUST: This is the proposal. It's the comment period. The final document comes out after we get the comments and consider them, and the Environment Department will issue that within 30 days, we're shooting for, of the end of the comment period, so in March. Look forward to March.
If there's a major revision to the decision document -- like we decided we got a lot of comments and capping was a bad idea and removal is a better idea -- that's pretty drastic; I don't expect it -- but something major -- if it's something major, we're going to have another comment period and we'll have another meeting.
That's the rules.
If the revision is -- the changes are minor, some of the details, some of the wording -- I've already

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gotten comments on some of the wording sounded confusing to some people, they are not sure what is meant -- but in those categories we're not going to have an extra comment period and meeting. But if there's a major change, then we have another comment period meeting.

But, of course, we'll fully inform people. I assume everybody saw the ads because there's a good turnout, and we'll do the same kind of thing.

MS. CANYONRIVERS: And the rest of the time frame for the way things should follow, if they are just minor changes and there isn't another, you know, revised proposal and another comment period, then the time frame, is that listed in the first proposal?

MR. WUST: No, the time frames are not, but --

MS. CANYONRIVERS: Did you discuss that earlier?

MR. WUST: Let's see. I've got to find the switch. Here you go. Schedule. I'll just leave that up.

MS. CANYONRIVERS: Summer of '99.

MR. WUST: Things take a little while, but if we take a little while, we may get them done right.

Okay. Thank you again. It's good seeing you.

(The meeting adjourned at 8:55 p.m.)

* * * * *

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CERTIFICATE OF REPORTER

I, Paula Wegeforth, New Mexico CCR #140, DO HEREBY CERTIFY that I did report in stenographic shorthand the meeting and questions and answers set forth herein; and that the foregoing is a true and correct transcript of the public meeting for the decision document for the Terrero site had on January 21, 1998.

I FURTHER CERTIFY that I am neither employed by nor related to any of the parties in this matter, and that I have no interest in the final disposition of this matter.

Paula Wegeforth
CCR No. 140
License Expires: 12/31/98

T

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Folders ⇒ **Inbox** ⇒

From: lflong@roadrunner.com (GATE.NMENV:lflong@roadrunner.com)
To: stephen_wust@edser
CC:
Sent: 24 Jan 1998 17:59:24
Subject: Terrero

Good Morning Stephen,

Eugene and I have several comments to pass on to you during the public comment stage of the decision process. I am sorry I was not able to attend the meeting but caught up on it from several sources.

#1. As frequent travelers of HWY 63 (eight miles north of Pecosz), we know the hazards of driving in the summer/vacation season. It is frightening to be turning a sharp corner and find a huge RV driver taking their half out of the middle of the road. From Thursday night thru Monday night, there is a steady stream of traffic up and down the canyon. Many of these drivers are unfamiliar with the road, practice extreme-hazardous caution in driving very slow. Some are kind enough to utilize the occassional pull-off areas, but most are unaware of them and afraid to give up their position.

From this highway-usage knowledge, we would like to encourage you to proceed in the fall and winter in the process of hauling the capping material. Then during the summer, the highway truck traffic would be kept to a minimal and the tourists can have the road and the canyon. Tourist season is important to many of the area residents. Fishing along HWY 63 with continuous truck traffic would not be enjoyable, nor safe for those walking along the road from vehicle to fishing spot.

Please consider utilizing the road during non-peak times.

#2. In reference to the "extra" money available to give back to the community, along the highway, a separate walk-jog-bike-horse path would be a great addition to this canyon. It would be utilized all year long by local residents and during vacation season by tourists. In order not to have to blast rock and widen the road, though that is very much needed, a guard rail could be added along the river side of the road and a sub-walk-way could be added just below the road and along the river. The other areas which are further from the river, should not be a problem adding a right-of-way walk area.

#3. A second suggestion for the "extra" money would be to improve or add to the camp ground facilties in the canyon. In the past, travelers relied upon rental cabins for overnight lodging, today, they bring their own and require a safe, prepared place to park. The spaces are limited. For instance, the Field Tract is a wonderful camp area. The fishing area is very limited. Campers must then get into their vehicle and travel up or down the canyon, find a parking space along the road, and walk to the river. Many of the canyon residents have their own fishing access. This need is for those not lucky enough to live on the river. For the local residents, we suggest building an enclosed meeting building to be reserved and utilized by families and friends as an outdoor gathering spot.

Please consider our suggestions. This has been a long process for all. Getting it moving and having an area improvement would be appreciated by all.

Thank you for listening.

GOVERNOR
Gary E. Johnson

DIRECTOR AND SECRETARY
TO THE COMMISSION
Gerald A. Maracchini

STATE OF NEW MEXICO

DEPARTMENT OF GAME & FISH

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February 16, 1998

Dr. Stephen Wust, Project Manager
Terrero Remediation Unit
New Mexico Environment Department
P.O. Box 26110
Santa Fe, NM 87501

Re: Decision Document Proposal; Pecos Mine Operable Unit. Tracking #6115.

Dear Dr. Wust:

The Department of Game and Fish (Department) has reviewed the **Decision Document Proposal for the Pecos Mine Operable Unit, Upper Pecos Site, Terrero, New Mexico** (Document). We submit the following comments for the New Mexico Environment Department's (NMED's) consideration in determining a final remediation alternative for the Terrero Mine.

The Department is discussing the feasibility of rerouting the Elk Mountain road (Forest Road 645) with the U.S. Forest Service (USFS). The road may be closed to limit Department liability during remediation and may be closed to protect riparian restoration in Willow Creek after remediation. The Elk Mountain road closure would require an alternative road for access to Elk Mountain and private inholdings. Therefore, please delete the statement that F.R.645 will remain open during and after remediation (page 52, #2., last sentence). The Department will notify NMED when a final decision is made on the Elk Mountain road.

The Department is concerned that several statements in the Document suggest that an off-site restoration project has already been selected. For example, page 3, Criterion 8 states: "Complete the designated off-site natural resource project for replacement of injured resources remaining on site." Also, page 51, middle paragraph, states: "The Glorieta Creek project is extensive and comprehensive, therefore it may suffice as an off site replacement compensation for all residual injuries at the Pecos Mine OU." In the Department's review of the **Draft Pecos Mine Operable Unit Natural Resource Damage Assessment Report** (NRDA), we recommended additional on-site restoration projects and rerouting F.R.645 to allow full restoration of floodplain wetlands along a two-mile segment of Willow Creek. Our understanding is that the NRDA has not been finalized, and we request that NMED withhold the final restoration decision until negotiations with the USFS are complete.

The Department supports an on-site capping method for the waste rock pile as the most practical remediation alternative to reduce leaching of heavy metals. Leaching of heavy metals from the waste rock pile to the Pecos River threatens affected aquatic habitats and fish raised in Lisboa Springs Fish Hatchery. Our 2 July 1997 comments on the **Draft Feasibility Study** for the Terrero Mine supported Alternative 4, which proposes a geomembrane liner in the cap design, predicted to reduce meteoric water percolation through the waste rock pile by more than 99.9%. By comparison, the clay cap design is predicted to reduce infiltration by 99%. Both the geomembrane liner and clay cap alternatives are considered to provide permanence and long-term effectiveness.

The Document does not select a specific remedial design alternative from the Draft Feasibility Study. Page 51 of the Document states that NMED's selected remedy is: "Alternative 3-4, a low permeability cap, with some additions and modifications" Page 2, Description of Selected Remedy, suggests that the clay cap is the preferred cap design. The Document should state that the final cap design will be presented in the Remedial Design report.

The Department will be responsible for the long-term operation and maintenance (O&M) costs for the Terrero Mine. Projected 20 year O&M costs for Alternatives 3 and 4 are $436,402 and $470,620, respectively. Clay and synthetic liner caps are new waste-containment technologies, and little data exists on O&M costs. Therefore, we consider these costs to be estimates, and costs may not differ significantly between the two alternatives. Please revise sections 13.3.7 on page 43 and 13.4.7 on page 46 to show that these projected O&M costs are for 20 years.

The Department's primary interest in the selection of a cap design is to provide maximum protection while minimizing long-term operation and maintenance costs. Since O&M costs may not be substantially different for Alternatives 3 and 4, we continue to support a remedial design that incorporates a synthetic liner, unless it can be shown that the clay liner will provide additional long-term effectiveness, or a newer technology is proposed that would provide similar protection and additional long-term effectiveness. We understand that the final cap design must meet the permeability performance specification of 10^{-8} centimeters per second or less.

Please strike the sentence on page 9 which states that the wetland is protected from high flows of the Pecos River by a levee constructed of garbage and debris. We do not feel that this statement is accurate.

Please correct page 10, last paragraph, to show that Lisboa Springs Fish Hatchery was expanded in 1982, not 1986.

We appreciate the opportunity to review the Decision Document. Should you have any further questions, please contact Mark Watson of my staff at 827-1210.

Sincerely,

Andrew Sandoval AF.

Andrew V. Sandoval, Chief
Conservation Services Division

AVS/MW/dt

cc: Johnnie Greene (Cyprus Amax Minerals Company)
Heather Himmelberger (New Mexico Engineering Research Institute)
Virginia Trujillo (San Miguel County Manager)
Kathy Kretz (New Mexico State Highway and Transportation Department)
Bobby Simpson (Pecos National Historical Park)
Scott Brown (Assistant Director, NMDGF)
Amy Fisher (Conservation Services Assistant Division Chief, NMDGF)
John Pittenger (Aquatic Biologist, NMDGF)

Tierra Y Montes Soil and Water Conservation District
1926 7th Street, Las Vegas, New Mexico 87701
(505) 425-9088

RECEIVED
JAN 27 1998

January 22, 1998

Stephen Wust
Terrero Project Manager
New Mexico Environment Department
P.O. Box 26110
Santa Fe, NM 87502

Dear Stephen,

Based on your presentation last night in Pecos, I think the Decision Document is an excellent plan for the Pecos Mine Remediation. The landowners in the vicinity, in my opinion, should be very pleased with the cleanup decision. I hope they come to appreciate the time, effort and money that is going into this cleanup effort.

I will be facilitating numerous outreach efforts in Pecos through 319(h), Environmental Justice and Wetlands EPA grant funding in 1998 and 1999. If the Terrero Project comes up, please know that you have the support of the Tierra y Montes Soil & Water Conservation District.

I would very much like to have a tour of the site to further my understanding of the project. If I could tag along on a visit at some time, please let me know. I can be reached at my office number above or at home at 425-1555.

Sincerely,

Wendy

Wendy Easton
Project Facilitator

2-25-98
at 930 AM
at USFS Pecos Dist office

CYPRUS AMAX
MINERALS COMPANY

Cyprus Amax Minerals Company
9100 East Mineral Circle
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(303) 643-5000

RECEIVED
FEB 16 1998

February 9, 1998

Mr. Mark E. Weidler, Secretary
New Mexico Environment Department
P.O. Box 26110
Santa Fe, NM 87501

RE: Comments on "Decision Document Proposal, Pecos Mine Operable Unit, Upper Pecos Site, Terrero, New Mexico" (New Mexico Environment Department, December 19, 1997)

Dear Secretary Weidler:

Cyprus Amax Minerals Company respectfully submits the attached comments on the draft Decision Document for the Pecos Mine prepared by the New Mexico Environment Department and signed by you on December 19, 1997. As you can see, many of the items noted are suggested wording changes or clarification of terms. We do, however, have some concern over certain proposed conditions which appear to go beyond the scope of the original AOC for this site. In particular, the items of concern relate to monetary compensation or completion of an off-site project for natural resource damages, development of plans and installation of a historical exhibit at the site, and issues with the designation of surface water compliance monitoring stations. If any of the attached comments require additional explanation, we would be happy to meet with you or your staff for further discussion on these items.

We feel that all of the issues noted can be satisfactorily addressed to maintain the projected March 19, 1998 date for the final Decision Document. We look forward to the next phase of the project and to completing the on-site reclamation work.

Please call me at (303) 643-5147 if there are any questions.

Sincerely,

Johnnie W. Greene

attachment

cc: E. Kelley, NMED
K. Kretz, NMSH&TD
M. Lewis, Schafer & Assoc.
M. Patel, NM LFC
K. Paulsen, Kenneth R.Paulsen Consulting
A. Sandoval, NMDG&F
V. Trujillo, San Miguel County
D. Williams, USEPA (2 copies, certified mail)
S. Wust, NMED (5 copies, including 2 for repositories)
file 3.8.2.31.34

COMMENTS ON DECISION DOCUMENT PROPOSAL
PECOS MINE OPERABLE UNIT, UPPER PECOS SITE
TERRERO, NEW MEXICO

FEBRUARY 12, 1998

Cyprus Amax Minerals Company (Cyprus Amax) has reviewed the document *Decision Document Proposal, Pecos Mine Operable Unit, Upper Pecos Site, Terrero, New Mexico* (dated December 19, 1997) (DD) prepared by the New Mexico Environment Department (NMED). As a result of the review, we submit the following comments on the document.

Comments:

1. Throughout the document, reference to "groundwater" should be changed to "subsurface water." Groundwater has distinct meanings which may yet include shallow subsurface waters. Subsurface water is more accurate.
2. Page 1, 1st paragraph. Why is compliance with CERCLA, SARA and the NCP qualified by the words "to the extent practicable"? Possibly use "to extent applicable".
3. Page 2, 1st paragraph. The word "encourage" before "public opinion" should be replaced with a term such as "ascertain" or "gauge."
4. Page 2, Item 1, 2nd sentence. The waste rock dump located west of Highway 63 has traditionally been referred to as the "disjunct" dump in the RI/FS process. This sentence refers to the disjunct dump as "separated"; other portions of the DD refer to the "disjoint" dump (e.g., 2nd paragraph, page 8). Consistent nomenclature within the DD and adherence to the traditional name may prevent confusion.
5. Page 2, Item 1, 2nd sentence. According to the Feasibility Study, sediments will not be removed from sections of the wetland that have elevated metal concentrations but show no phytotoxicity. As stated in Item 4 on page 52 of the DD, wetland sediments will be removed from areas around the seeps that have discolored sediments or show vegetative stress. Therefore, the phrase *"from contaminated wetland areas"* may be more accurately stated as *"from designated wetland areas."*

   This comment may also be applied to soils. According to the DD, soils with lead concentrations of 1200 ppm or greater will be removed. However, soils with lower concentrations may contain lead concentrations that are elevated with respect to background.
6. Page 2, Item 2. The DD should allow the alternative of using a synthetic material in place of the 18-inch clay layer as specified on page 52. In addition, the thickness of the clay layer required to attain the desired performance may depend on the characteristics of the materials obtained for the project and should not be specified in the DD, or at the least prefaced by the word "approximate". The actual thickness will be addressed in the remedial design. This comment should be utilized throughout the document, as well as specifically on pages 38, 41, 43, 44 and 52.

   (Page 26, Remedial Action Objectives). Cyprus Amax has previously commented that remedial action objectives that require *prevention* of infiltration or exposure to contaminated media are impossible to implement. The discussion in the DD should, at a minimum, recognize that prevention is impossible to accomplish and verify, and that the objective of the remediation is to reduce

infiltration or exposure to the extent necessary and practicable to protect human health and the environment.

7. Pages 2 and 3. List of required actions should include institutional controls to prohibit the use of site groundwater as a drinking water supply as noted on page 37 and in several other places subsequent to that. Institutional controls should also prohibit the construction of residences on the site.

8. Page 3, Item 8. Cyprus Amax does not agree that the AOC recognizes residual injuries or provides for compensation projects for residual injuries. A good faith effort to restore and replace resources on site will fulfill our obligations. This comment applies to several sections of the DD, including page 51. See Comment #44.

9. Page 3, Item 11. Cyprus Amax does not agree that development and establishment of a historical exhibit for visitors should be a component of the DD. Such an exhibit does not enhance protection of public health or the environment or help restore natural resources at the site, and is clearly beyond the scope of the AOC.

10. Page 3, Item 15. Under provisions of the AOC, Cyprus Amax is not obligated to monitor subsurface water or other environmental media beyond the time required to demonstrate compliance with RACs. Compliance with RACs is defined in the AOC as eight consecutive quarters of samples that meet appropriate numerical criteria for concentration of target chemicals. Therefore, Cyprus Amax obligation for monitoring subsurface water could be as short as 2 years post remediation.

11. Page 9, 2nd paragraph. Change "garbage and debris" to "dirt and trash" to match the description on page 15, 2nd paragraph.

12. Page 10, 1st paragraph. Change the statement that the mineral rights are retained by the original shareholders to a statement that the mineral rights are in trust for the benefit of the original shareholders. Change "AMAX was acquired by Cyprus" to "AMAX merged with Cyprus." Add the word "Company" after Cyprus Amax Minerals.

13. Page 10, 2nd paragraph, last sentence. Please make it clear that the US Forest Service conducted remedial actions at areas remote from the PMOU.

14. Page 11, 3rd paragraph. It needs to be made clear that Cyprus Amax and the State of New Mexico are not contracting for work together, but that each entity contracts work for which it is responsible under the AOC.

15. Page 13, 4th paragraph. The New Mexico Mining Act (1994) and the Closeout Plan Guidelines for mines (1996) post-date the AOC (December 1992) and, therefore, are not applicable to the Pecos Mine OU. Reference to these regulations and guidelines should not appear in the DD. The responsible parties will take reasonable measures to ensure that remediation and reclamation of the Pecos Mine site is successful.

16. Page 15, last paragraph. It should be stated that most exceedences of standards are found in the shallow subsurface water. Also, delete reference to exceeding background, as we are not required to meet background, only state standards.

    The FS and RI reports provide discussions regarding the potential source of barium in subsurface water at well P-7. Basically, barium becomes insoluble in the presence of sulfate at concentrations well below those typical of water affected by mine waste at the Pecos Mine OU. The sulfate levels in P-7 are extremely low, therefore, dissolved barium concentration appears to be elevated in subsurface water samples. The lack of sulfate in subsurface water from P-7 indicates that it is not affected by mine waste and, therefore, is not due to mine activities. This point is critical to the DD and remediation because barium concentrations could be a primary factor in determining whether site subsurface water should be remediated through an active treatment system in the future.

17. Page 16, 3rd full paragraph. It should be stated that standards were exceeded "occasionally" or "from time to time", as the current wording makes it appear that standards are constantly exceeded.

18. Page 16, 3rd paragraph, last sentence. The statement that some constituents exceed background 23 miles downstream appears to imply that this effect is due exclusively to the mine, and therefore is misleading. As Cyprus Amax has noted in the past, the background concentrations on which this statement is made were from samples collected near the headwaters of the Pecos River. Samples from the headwater areas are not a valid estimate of background conditions in the river at the mine site, even if no anthropogenic sources were present. Metals concentrations tend to increase naturally as the size of the watershed drained increases with distance downstream. This is especially true in regions such as the upper Pecos Canyon where the river passes through mineralized areas. Therefore, natural background metal concentrations at the mine site are expected to be higher than at the headwaters. In addition, other anthropogenic sources such as runoff from roads, campgrounds, the Lisboa Springs hatchery, and natural sources could contribute to water chemistry. Comparison of water quality from throughout the Pecos River to headwaters background locations is not sufficient to conclude that the mine site is responsible for degradation of water quality in the Pecos River 23 miles downstream.

19. Page 17, 2nd full paragraph. Sulfate combined with water does not create "concentrated" sulfuric acid. In fact, the oxidation of natural sulfide minerals generates sulfate ions and protons (H^+), one of the agents responsible for "acidity." In addition, iron sulfide is the most important mineral contributing to acid production. Zinc sulfide and lead sulfide are not considered "acid-generating" Please clarify.

20. Page 18, 2nd paragraph. By regulatory definition, mine waste is excluded from classification as "hazardous." The presence of such a statement could confuse the regulatory requirements for handling materials at the mine site. Please clarify.

21. Page 19, 3rd full paragraph, sixth sentence. This sentence seems to imply that knowledge of toxicity is inadequate to assess toxicity at the site, and that conservative assumptions are used to compensate. While this is true in part, it is also true that the extent of risk characterization at a site must only be adequate to support risk management and remediation decisions (EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, 1988). Such statements could lead to the notion that more toxicological studies are needed to adequately characterize risk. The information currently available for the Pecos Mine OU is adequate and appropriate to support the remediation decisions in the DD.

22. Page 20, last sentence. The words "driven primarily in" are not the right words.

23. Page 22, last paragraph. Cyprus Amax reiterates our objection the use of the residential scenario in assessing risks for the Pecos Mine OU. The site is currently owned by NMGF, and current and future land use is best described as recreational.

24. Page 23, 2nd paragraph. Typo, "grater." Also two periods at end of sentence.

25. Page 23, 2nd paragraph, last sentence. Please state that the lead concentrations in the subsurface water well cited in this paragraph did not exceed background or state standards.

26. Page 24, last paragraph. Change "AOC sets damage claim" to "AOC limits damage claims."

27. Page 26, RAO list. First "to" should be "of." See comment #5. Remedial Action Objectives 7, 8, and 9 should include reference to a point of compliance.

28. Page 26, 1st paragraph under 10. Not clear what is meant by the statement "compliance criteria are also related to RAC."

29. Remedial Action Objectives. Cyprus Amax has previously commented that remedial action objectives that require *prevention* of infiltration or exposure to contaminated media are impossible to implement. The discussion in the DD should, at a minimum, recognize that prevention is impossible to accomplish and verify, and that the objective of the remediation is to reduce infiltration or exposure to the extent necessary and practicable to protect human health and the environment.

29. Page 27, 3rd bullet. The reference to Alamitos Creek is extraneous to the Pecos Mine OU DD. Since the text is not a direct quote from the SOW, please remove reference.

30. Page 27, 2nd full paragraph. The AOC does not provide for RACs that address restoration performance. In fact, the AOC specifically defines RACs in terms of chemical concentrations. Expressing restoration performance criteria in terms of an "ecosystem" is not useful in defining the ecological properties of the restored site. The term "ecosystem" refers to an area or system that is much larger than the Pecos Mine area. We suggest replacing ecosystem with "community" or "habitat."

31. Pages 28 and 29, Section 10.1 and Section 10.2. Cyprus Amax would object to inclusion of mercury on the list of analytes for compliance monitoring if measurements require ultra-clean sampling and analysis procedures currently being developed. This seems to be unnecessary since mercury was not identified as a COC for the risk assessments, and RI data indicate other sources in the canyon besides the Pecos Mine area.

32. Page 29, Section 10.2. The list of standards is somewhat misleading, being a mix of fisheries standards and domestic water supply standards. The use of the statement that acute and chronic standards for fisheries shall apply, means that much smaller numbers than those shown in the list will apply for metals. In addition, the list omits cadmium and zinc, the two most important metals in assessing exceedence of water quality standards in the Pecos River.

33. Page 29, top of page, and page 30, 3rd paragraph. Cyprus Amax believes that monitoring shallow subsurface water by wells near the seeps was discussed with NMED as an alternative to monitoring surface water from the seeps, not in addition as seems to be required here.

34. Page 30, 1st paragraph. This paragraph is confusing. Should the sentence read, "*Section 1101A states that no degradation shall be allowed in waters that have water quality better than state standards, including Wild and Scenic Rivers."?* As noted previously, Cyprus Amax would object to use of data from the headwaters area as a basis for assessing water quality degradation downstream of the mine.

35. Page 30, 3rd paragraph. Specify which Willow Creek braid. Not clear what is meant by "immediately downstream of the site." Could a specific sampling station be referenced?

36. Page 30, 4th paragraph. This paragraph states that the EPA cleanup values for commercial areas are 1,000 to 2,000 ppm lead. This suggests that cleanup criterion for the Pecos Mine OU could be higher, possibly up to 2,000 ppm.

37. Page 30, 5th paragraph. Use of the plural for air monitoring stations not justified. Site safety requirements will be implemented as required by Occupational Safety and Health Administration (OSHA) requirements.

38. Page 31, 1st bullet. *"... that seek to alleviate ~~any~~ threat to human health or the environment from site-related conditions."*

39. Page 35, 1st paragraph. At the end of the paragraph insert phrase "by itself" after the word "alternative" and before the word "also".

40. Page 37, 2nd paragraph. Institutional controls should be required, instead of merely noting that they "could be included." The statements at the top of page 39, and in the 3rd paragraph on page 44 seem stronger. Also, as previously stated, residential use should be prohibited.

41. Page 37, last paragraph. The No Action alternative includes monitoring AND existing interim measures (i.e., the interceptor ditch).

42. Page 39, 3rd paragraph. Insert the word "highly" at the beginning of the paragraph.

43. Page 41, 2nd paragraph, last sentence (and page 43, last paragraph, last sentence). "*...topped by an 18-inch layer of vegetated soil.*"

44. Page 49, 1st paragraph, 1st line. After "Consent Order," replace the remainder of the sentence with "includes a provision requiring evaluation of loss of natural resources at the site, and of restoration or replacement thereof." This is a more accurate statement.

45. Page 49, last paragraph. Cyprus Amax believes that resources on the area occupied by the capped pile can and will be restored or replaced on site. All surface areas of the waste rock cap will be reclaimed with a soil layer which will be vegetated with plant species typical of similar areas in the immediate vicinity of the site.

46. Page 51, 3rd bullet. The cost of obtaining and planting Holy Ghost Ipomopsis will be greater than $0. If the state intends to conduct seed collection and planting of the Ipomopsis, this should be indicated in the DD.

47. Page 51, 2nd paragraph. This paragraph currently indicates that participation in the Glorieta Creek restoration MAY suffice. As noted earlier, Cyprus Amax does not agree that an offsite restoration project is required to satisfy NRDA requirements. However, if a project could be required and the Glorieta Creek restoration is identified as the state's preference, then the DD should state that this project WILL satisfy requirements.

    The $50,000 proposed as compensation for residual injury to natural resources at the Pecos Mine OU is not supported. This figure was identified in the NRDA Draft Report (Hagler Bailly 1997) as the total cost to restore Glorieta Creek to its natural floodplain in the Pecos National Historic Park. However, the NRDA did not relate the amount to the residual injury at the Pecos Mine OU.

    The NRDA describes the residual injury as *slight*. The decision to allow wetland sediments to remain in place was based on the apparent lack of biological effect in the wetland. Removing sediments with elevated metals would necessitate extensive damage to an otherwise healthy wetland community.

    All resources will be restored or replaced when remedial actions are complete. Vegetation success and compliance with performance standards over the entire site must be demonstrated prior to termination of the AOC. Cyprus Amax believes that remedial actions at the site will meet or exceed all obligations of the AOC relative to natural resource damages, and that any attempt to impose a monetary payment or off-site project violates the intent and agreements in the AOC.

    Cyprus Amax also assumes that any proposed compensation or off-site project for residual injury is subject to provisions of the Cost Allocation Agreement and dispute resolution clauses associated with the AOC.

48. Page 52, Item 1. Cyprus Amax does not believe that the DD should specify the grade of slopes for the reclaimed waste rock dump. The DD should require stable slopes based on standard engineering safety factors, the steepness of which depends on the material used in construction. NMED will be able to evaluate the potential for slope stability in the Remedial Design document.

49. Page 52, Item 2. Cyprus Amax suggests that the DD allow for brief closures of Elk Mountain Road at the mine site. Effect on traffic along the road will be minimized, but brief road closures may occur during removal of waste rock north of Willow Creek and during construction of the new road. We suggest that the DD require that vehicle access across the mine site be provided within 24 hours of request by the USFS or other parties that require access for essential activities. This will allow time to clear material that may block access.

RESPONSE TO COMMENTS
DECISION DOCUMENT
PECOS MINE OPERABLE UNIT

A. COMMENTS SUBMITTED BY THE PUBLIC
(copy of written comments in this appendix)

1. A comment at the public meeting questioned whether putting the waste rock into the mine shafts at the Pecos Mine OU would be a viable remedial option.
   R. There are several problems associated with placing waste rock into the shafts.
      i) With exposure to the surface, the waste rock is now highly acid generating. It would be environmentally unsound to place such material into the ground water system. The shafts intersect the basement aquifer.
      ii) The shafts and stopes have been abandoned for many years. They are unsafe and would most likely collapse if machines or material were moved through them.
      iii) Removing and breaking rock greatly increases its occupancy volume. The waste rock may not fit into the available space of the existing mine shafts and stopes.
2. A comment at the public meeting (and similar comments submitted by a resident – see comments in this appendix) suggested other uses for what was termed the "extra money" available for community projects. This extra money was assumed to be payment from the Natural Resource Damage Assessment (NRDA).
   R. There is no extra money available. Off-site projects were evaluated as part of the NRDA as compensation for residual injury to resources that could never be fully restored at the site. The evaluation criteria for such projects specified that they restore similar resources in similar habitats to those at the site, and they be close to the site or within the same watershed. As such, community projects or projects primarily improving human facilities were rated low in effectiveness for fulfilling the criteria.
3. A comment suggested that transportation of materials to be used in the remediation be limited to seasons of low recreational traffic (see comments this appendix).
   R. Traffic control will be imposed during transportation of materials as part of the Remedial Design and Remedial Action (RD/RA) phase of the project. It will include as necessary speed controls and safety warnings. However, there is limited storage area on site for materials. Therefore, material need to be transported to the site as they are needed. Because much of the remediation will take place during good weather and low surface flow, it will be necessary to transport material during the summer and fall months.

B. COMMENTS SUBMITTED BY THE NEW MEXICO DEPARTMENT OF GAME & FISH
(copy of comments in this appendix)

1. A comment suggested the possibility of connecting upper Willow Creek with the Willow-Davis road (FR 645), allowing a closing of most of the Willow Creek road, particularly the stretch within the site.
   R. NMED agrees that this would enable a more effective remediation and restoration at the site. NMED is also aware that there is to date no agreement with the US Forest Service for such a plan, although negotiations are in the works. If enacted, the closing of the Willow Creek road would be an effective restoration project, and could be utilized as the compensatory (off-site) project instead of the Glorieta Creek project proposed. The Decision Document has been revised to include the FR 645 project as an alternative compensatory restoration project. The Glorieta Creek project also remains as an alternative if agreement cannot be reached with the US Forest Service to allow the FR 645 project.
2. Several comments stated a preference for a synthetic liner as the impermeable and drainage layers in the cap, suggesting lower operation and maintenance (O&M) costs for NMGF.
   R. Remedial decisions are not based upon minimizing costs for the respondents. In the case of the two alternatives for the cap layers given in the decision, the costs are not significantly different. Both alternatives are effective in both short-term and long-term. If material is available on or near

to the contrary, it is appropriate to evaluate risk based on the interpretation yielding the reasonable maximum exposure.

8. Comment 18 suggested that the elevated concentrations of constituents in the Pecos River far downstream of the site are a result of natural conditions and not site release.
   R. The plot of zinc concentrations in the river (plotted in the Ecological Risk Assessment) clearly shows a decreasing curve of concentration that starts at a very high level at the site. Because of the absence of sampling between mile 16 and mile 30, it is possible that the concentration at mile 30 represents conditions in the river unaffected by the site. However, the concentrations up to mile 16 do show an impact due to the site. The language in the Decision Document has been revised to reflect this interpretation.
9. Comment 20 referenced regulations exempting mine waste from classification as hazardous waste.
   R. Hazardous waste and the associated mine exemption derive from RCRA. The term used in the Decision Document was hazardous substance, a term derived from CERCLA, refers to the constituents and not the waste, and is applicable to this site.
10. Comment 29 objected to the use of the term prevention in stating the Remedial Action Objectives.
    R. The Remedial Action Objectives are the ultimate goals for the remediation, but they cannot always be obtained. The measurements that are binding are contained within the RAC; the compliance criterion is reduction of infiltration by 99% or more.
11. Comment 30 objected to RAC applied to natural resource restoration, as such criteria are not specified in the AOC.
    R. Natural resource restoration is required for successful remediation of the site, and as such needs measurements to assess its effectiveness. RAC were developed for restoration and are appropriate to this Decision Document. Language was added to the referenced section to enable inclusion of restoration RAC.
12. Comment 33 questioned the use of seep monitoring if monitor wells are to be installed by the seeps.
    R. Two separate RAC and standards are to be monitored: monitor well samples will be compared to ground water RAC, and seep samples (at the appropriate sampling location) will be compared to surface water standards.
13. Comment 36 proposes using 2000 ppm lead as the cleanup criterion, which is the maximum of the EPA suggested range for commercial areas.
    R. Because 1000-2000 ppm is a suggested range, it is a risk management decision as to where within that range to place the criterion. The number used in this Decision Document, 1200 ppm, is consistent with the value used during the mill foundation cleanup at the El Molino OU.
14. Comment 40 suggested requiring institutional controls as part of the remediation decision.
    R. Institutional controls are allowable by this Decision Document, and may be proposed as part of the Remedial Design and the long-term O&M. However, institutional controls should only be imposed if necessary, and are not an assumed first step in this Decision Document.
15. Comments 8, 45, 47, and 55 claimed that full natural resource restoration will be enacted on site, and therefore no compensation (off site) projects should be required.
    R. The NRDA clearly demonstrated that the capping alternative, as selected in this Decision Document, will result in diminished resource capacity for the upland area under the remaining waste rock pile. In addition, there was a residual injury in the wetland from soils with slightly elevated concentrations of metals that will remain after remediation. To compensate for these residual injuries, which cannot be rectified on site, an off site project was included in the decision.
16. Comment 46 questioned the zero dollar cost for planting the Holy Ghost Ipomopsis as a natural resource restoration project.
    R. The planting of the Holy Ghost Ipomopsis will be performed by State agencies, at no cost to the site remediation.

Appendix B

PMOU 2016 Compliance Monitoring Report

2016 Compliance Monitoring Activities Conducted at Pecos Mine Operable Unit

Prepared for Cyprus Amax Minerals Company
Phoenix, Arizona

November 15, 2017

Daniel B. Stephens & Associates, Inc.

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Appendix

Pecos Mine Operable Unit
2016 Compliance Monitoring Report

1. Introduction

On behalf of Cyprus Amax Minerals Corporation (CAMC), Daniel B. Stephens & Associates, Inc. (DBS&A) has completed compliance monitoring during 2016 at the Pecos Mine Operable Unit (PMOU) near Tererro, New Mexico. Compliance monitoring locations and analytes are based on the *Final Compliance Monitoring Plan, Groundwater and Surface Water Quality, Pecos Mine Operable Unit* (CMP) (DBS&A, 2007) that was approved by the New Mexico Environment Department (NMED) on August 29, 2007, as subsequently modified based on NMED's approval of a request for the removal of monitoring sampling locations and constituents (NMED, 2010).

In 2013, CAMC proposed annual sampling with a reduced constituent list and use of the HydraSleeve® sampling methodology at EMOU to more efficiently collect representative groundwater quality samples and reduce monitoring costs. The revised monitoring proposal was discussed with the NMED and subsequently documented by ARCADIS (2013). The proposed HydraSleeve® sampling methodology approach was to be followed up by an evaluation to assess the comparability between the historical bailing or low-flow sampling methodologies, and the new HydraSleeve® methodology was approved by the NMED in September 2013 (NMED, 2013a and 2013b). In order to establish comparability between analytical results obtained from the current sampling methods and the proposed Hydrasleeve® implementations, CAMC collected samples from each well using the HydraSleeve® sampling methodology for two consecutive semiannual sampling events. The comparison semiannual sampling events were conducted during the fourth quarter of 2013 and the second quarter of 2014.

A draft evaluation and comparison report with data for five monitor wells at PMOU was provided electronically to NMED in October 2014 (DBS&A, 2014). NMED provided comments on this draft report acknowledging that the comparison methodology documented by ARCADIS (2013) was followed, but concluded that "NMED does not regard the results obtained to show acceptable comparability" (NMED, 2014). Groundwater samples from PMOU monitor wells were collected using HydraSleeve® sampling methodology during three semiannual sampling events (fourth quarter of 2013, second and fourth quarters of 2014). The HydraSleeve® sample results are included in this annual report to show that compliance monitoring was completed, but the data are not used for comparison with other sample results.

In 2015, CAMC petitioned NMED for a further reduction in the sampled analytes and locations for groundwater at PMOU (DBS&A, 2015); specifically to remove groundwater sampling locations and constituents that (1) do not exceed New Mexico Water Quality Control Commission (NMWQCC) standards, or (2) do not have NMWQCC standards. NMED approved this request in 2016 (NMED, 2016).

Annual monitoring activities were completed in October 2016 using traditional sampling methods (i.e., bailing). Monitoring locations are shown in Figure 1. The monitoring activities included the following:

- Gauging depth to water and collecting groundwater samples from compliance monitor wells P-7, P-7S, P-13, and P-13S
- Examining the toe of the waste rock pile for seeps (none were noted)
- Inspecting surface water and seep sites and collecting samples if water was flowing

Section 2 discusses sample collection and water quality sampling results. Section 3 summarizes the site hydrogeology and water level monitoring results. Section 4 summarizes the 2016 compliance monitoring.

2. Water Quality Sampling

Analytical samples were collected from PMOU groundwater monitor wells and surface water sites (Table 1). Samples from the groundwater sites, including quality assurance samples (i.e., field duplicate, field blank, and equipment blank), were collected and analyzed during the fourth quarter of 2016. Surface water samples and a field duplicate were also collected during the fourth quarter.

During 2016, water quality samples were collected in accordance with the DBS&A standard operating procedures (SOPs) for water sampling presented in Appendix D of the CMP (DBS&A, 2007). Traditional monitor well sampling by bailing began by measuring the depth to water in each monitor well with an electronic water level indicator. These measurements were used to calculate the purge volume for each monitor well. As each monitor well was purged, field parameters (pH, temperature, and electrical conductivity [EC]) were measured at regular intervals. Dissolved oxygen (DO) concentration was measured from the first purged water, and turbidity was measured after purging when the analytical laboratory sample was collected.

Surface water samples were collected as grab samples by submerging a 1-liter cubitainer (or 1-gallon cubitainer for the duplicate sampling location) into flowing water, slowly allowing it to fill, and then decanting the sample into the appropriate sample bottle. Field parameters (DO, pH, temperature, EC, and turbidity) of surface water samples were measured in situ whenever possible.

Surface water and groundwater samples to be analyzed for dissolved metals and anions were field-filtered using a peristaltic pump and a 0.45-micron inline filter. ACZ Laboratories, Inc., the laboratory providing analytical services, supplied pre-preserved sample bottles as necessary.

Based on CMP modifications approved by NMED in 2013 and 2016 (NMED, 2013a, 2013b, and 2016), groundwater and surface water samples collected during 2016 were analyzed for the following constituents:

- Groundwater: barium (P-7 and P-7S only), cadmium (P-13S only), cobalt (P-13S only), fluoride (P-7 and P-13S only), iron, manganese, total dissolved solids (TDS) (P-13S only), and zinc (P-13S only)

- Surface water: alkalinity, aluminum (ESS only), arsenic, bromide, cadmium, calcium, chloride, hardness, iron, lead (ESS only), magnesium, manganese, phosphorus (total), potassium, sodium, sulfate, TDS, and zinc

There was no flow at the ESS sampling location during the fourth quarter monitoring event.

2.1 Analytical Results

Tables 2 through 3b present analytical results for groundwater and surface water samples for the annual sampling event performed during 2016, along with established water quality standards. Appendix A provides time-series plots for the PMOU groundwater and surface water sampling analytical results collected subsequent to remedy completion. The majority of the constituents regulated by the New Mexico Water Quality Control Commission (NMWQCC) have fixed numeric standards. A horizontal line is plotted on the time-series plots to represent these fixed NMWQCC standards. Four constituents monitored in surface water at PMOU (cadmium, lead, manganese, and zinc) have chronic numerical standards that must be calculated for each sampling event based on sample hardness. Hardness-based standards were calculated for the surface water samples collected during the fourth quarter of 2016 (Table 3b).

Where analytes were not detected in a given sample, data points in the time-series plots were set at one-half the method detection limit (MDL). For some currently monitored constituents, such as arsenic, bromide, cadmium, cobalt, and zinc, this procedure resulted in data points plotting directly on top of one another; therefore, not all data points at one-half the MDL are visible in the plots.

The following monitor locations have been assigned a threshold value based on historical concentration data (ARCADIS, 2013):

- P-7: Barium concentration equal to or above 4 milligrams per liter (mg/L)
- P-13: Iron and manganese concentrations equal to or above 35 mg/L and 2 mg/L, respectively
- P-13S: Cadmium and fluoride concentrations equal to or above 0.1 mg/L and 2.2 mg/L, respectively

If the concentration of the annual sample is above the threshold value, a second sample is required to be collected that year. Constituent concentrations detected in these wells during 2016 were all below the listed threshold values (Table 2).

The 2016 analytical results for the sample locations at the PMOU site are consistent with historical data, with the following exceptions:

- *Fluoride concentration at monitor well P-7:* A decreased fluoride concentration (0.31 mg/L) was noted at monitor well P-7 during the 2016 annual sampling event. Post-reclamation fluoride concentrations have generally ranged between 1.5 and 1.7 mg/L.

- *Elevated major ions at WSBDT:* Detected concentrations of calcium, chloride, magnesium, sodium, potassium, and sulfate showed decreases during the 2016 sampling event compared to the 2015 sampling event, but remain higher than previous post-reclamation concentrations during 2004 to 2011.

Appendix B provides historical analytical data tables for the PMOU groundwater and surface water samples collected subsequent to remedy completion. Copies of the 2016 annual field notes are provided in Appendix C. Complete 2016 laboratory analytical reports are provided in Appendix D.

2.2 Quality Assurance

Quality assurance samples consisted of a field duplicate for groundwater, a field duplicate for surface water, an equipment blank, and a field blank. Precision is typically evaluated by calculating the relative percent difference (RPD) on duplicate samples using the following equation:

$$\mathrm{RPD} = \frac{|\mathrm{A} - \mathrm{B}|}{(\mathrm{A} + \mathrm{B})/2} \times 100\%$$

where A = primary sample concentration
B = duplicate sample concentration

The RPD acceptance criterion as set forth in the PMOU sampling and analysis plan (DBS&A, 2007, Appendix D) is 50 percent or less. RPD comparisons are not considered appropriate when the measured concentrations approach the MDL. If the reported concentration of the primary and/or duplicate sample is less than 5 times the MDL, the precision of the samples is evaluated using the criterion of ±1 times the MDL rather than using the RPD method.

Table 4 provides the RPD comparisons for the duplicate metal concentration analytical results in 2016. All of the results from the RPD analysis for the 2016 samples were below the 50 percent or less acceptance criterion, and indicate that quality assurance was maintained this quarter.

3. Water Level Monitoring

This section provides a brief summary of site hydrology and an evaluation of PMOU water levels. In the CMP approval letter, NMED indicated that a potentiometric surface map is required as part of the annual monitoring report for PMOU (NMED, 2007).

3.1 Site Hydrogeology

Two aquifer units have been identified at the Pecos Mine site: (1) a local alluvial/colluvial aquifer that occurs along the Pecos River and Willow Creek at depths of less than 20 feet below ground surface (bgs) (shallow aquifer), and (2) an underlying regional aquifer that occurs in multiple bedrock units beneath the entire site (regional aquifer). Groundwater monitor wells are located both upgradient and downgradient of the mine site and reclaimed waste rock pile (Figure 1), in both the shallow and regional groundwater systems. At monitor well locations where the shallow aquifer was identified during drilling, the monitor wells are paired, with an “S” designation used for the shallow well (e.g., P-7S) and no “S” designation for the deeper regional wells (e.g., P-7).

Shallow groundwater in the alluvial/colluvial aquifer was initially characterized in the remedial investigation (RI) (Stoller, 1996) using six wells. Of these initial wells, only P-3S and P-7S remain. Well P-13S was installed in 2005 to monitor the alluvial/colluvial aquifer at a depth of approximately 10 feet bgs. Groundwater flow in the alluvial/colluvial aquifer generally mimics the flow directions of Willow Creek and the Pecos River.

Regional groundwater in the bedrock aquifer was also initially characterized in the RI using six wells. Of these initial wells, P-3, P-4, and P-7 remain; P-3 and P-4 are upgradient of the waste rock pile. Two additional wells, P-13 and P-14, were installed in 2005. P-4 was previously monitored for water levels only because a bend in the casing precluded sampling the well. Monitor well P-1 was placed in the center of the historical mine's Main Shaft and was previously monitored for water levels only; it was not sampled for water quality because a sample from the disturbed formation would not be representative of aquifer conditions. In late 2009 or early 2010, the mine shaft appears to have caved in around 80 feet bgs, above the potentiometric surface of the regional aquifer. Although several lithologic units comprise the regional aquifer, they are all hydrologically connected and are considered to be a single hydrologic unit. Groundwater in the regional aquifer generally flows from east to west beneath the site.

3.2 Monitoring Results

Table 5 summarizes well construction data for all of the existing monitor wells at PMOU. Table 6 provides groundwater elevation data measured since November 2009. Separate potentiometric surface maps for shallow and regional groundwater have been prepared for the October 2016 monitoring event (Figures 2 and 3). Time-series plots depicting groundwater elevations over time in the existing wells for the shallow and regional groundwater aquifers are provided in Appendix E.

Figure 2 presents the potentiometric surface for the alluvial aquifer in October 2016. The alluvial aquifer is currently monitored from near the confluence of Willow Creek with the Pecos River (P-7S) to between the waste rock pile and the Pecos River, on the west side of the waste rock pile and State Highway 63 (P-13S). Since 2005, water levels within the alluvial aquifer have varied by 1 to 2 feet (Appendix E). Between November 2015 and October 2016, water levels in the alluvial wells decreased slightly (by less than 1 foot).

Figure 3 presents the potentiometric surface for the regional aquifer in October 2016. The most northern well monitored in the regional aquifer (P-7) is near the confluence of Willow Creek with the Pecos River, while the most southern well (P-13) is located on the west side of the waste rock pile near State Highway 63. The groundwater flow direction in the regional aquifer is generally to the southwest. Since 2005, water levels in the regional aquifer wells have varied by 3 to 8 feet (Appendix E). Between November 2015 and October 2016, water levels in the regional wells decreased slightly (by less than 1 foot).

A review of the water level data for PMOU indicates that hydrologic conditions at the site are fairly static. Hydrographs prepared for the two aquifers reveal that some slight seasonal fluctuations in water levels occur; however, no large-scale trends, such as consistently rising or falling water levels, are discernable (Appendix E).

4. Summary

DBS&A completed PMOU compliance monitoring during October 2016 for the monitoring locations and analytes required by the CMP (DBS&A, 2007; NMED, 2010, 2013a, 2013b, and 2016). For the majority of analytes, the 2016 analytical results for groundwater and surface samples collected at the PMOU site are consistent with historical data (Appendix A), although elevated concentrations of major ions (calcium, chloride, magnesium, sodium, and sulfate) were noted at the WSBDT sampling location during the annual sampling event (Section 2.1). Based on the annual groundwater monitoring results, water levels are relatively stable, with only a slight decrease in water levels observed during 2016 (Appendix E).

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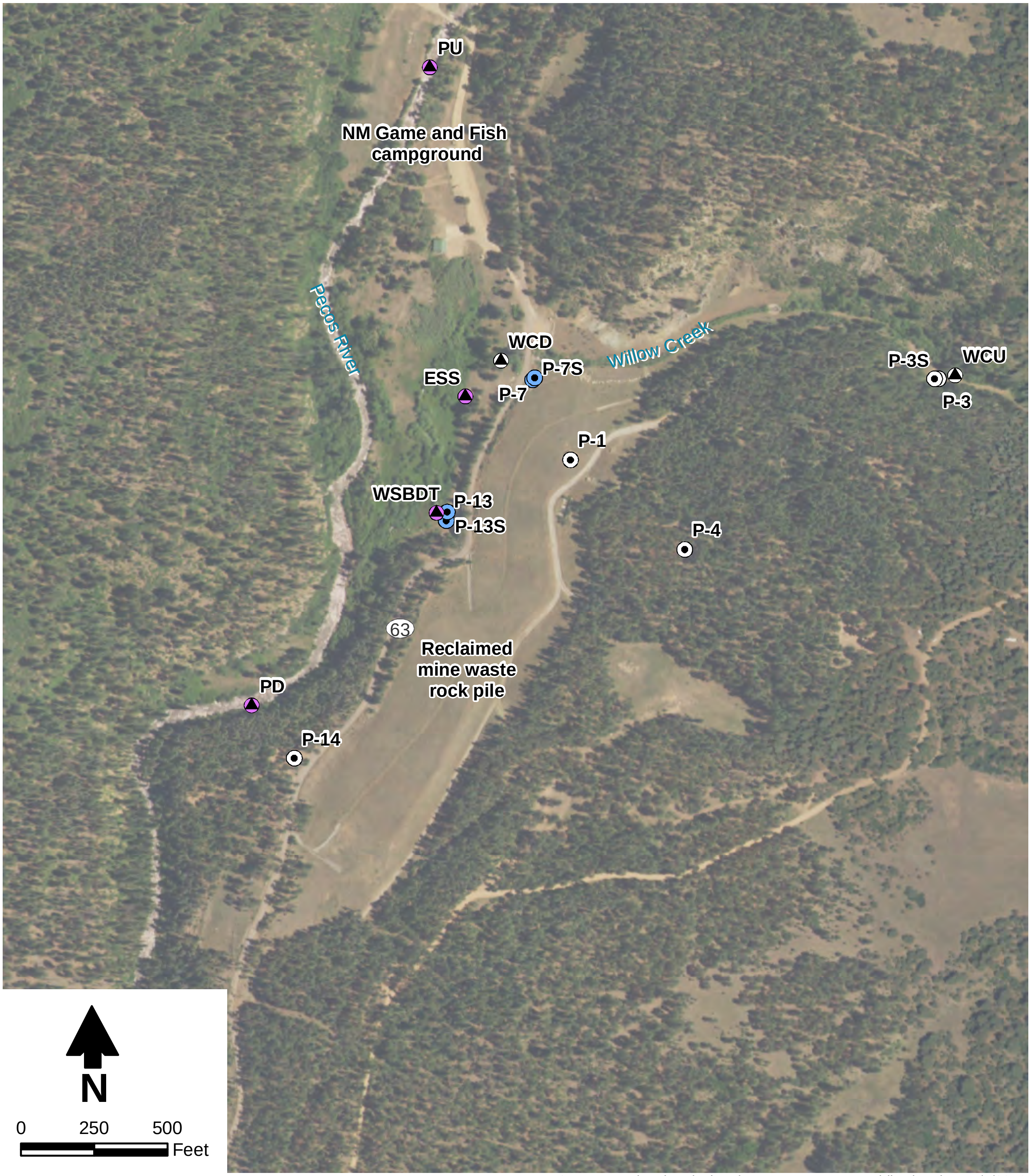
Figures



Source: National Agricultural Imagery Program, publication date: 7/7/2016

Explanation

- Monitor well and sample location
- Surface water or seep sample location (sample if flowing)
- Monitor well (no longer monitored)
- Surface water (no longer monitored)

PECOS MINE OPERABLE UNIT

Groundwater and Surface Water Monitoring Locations

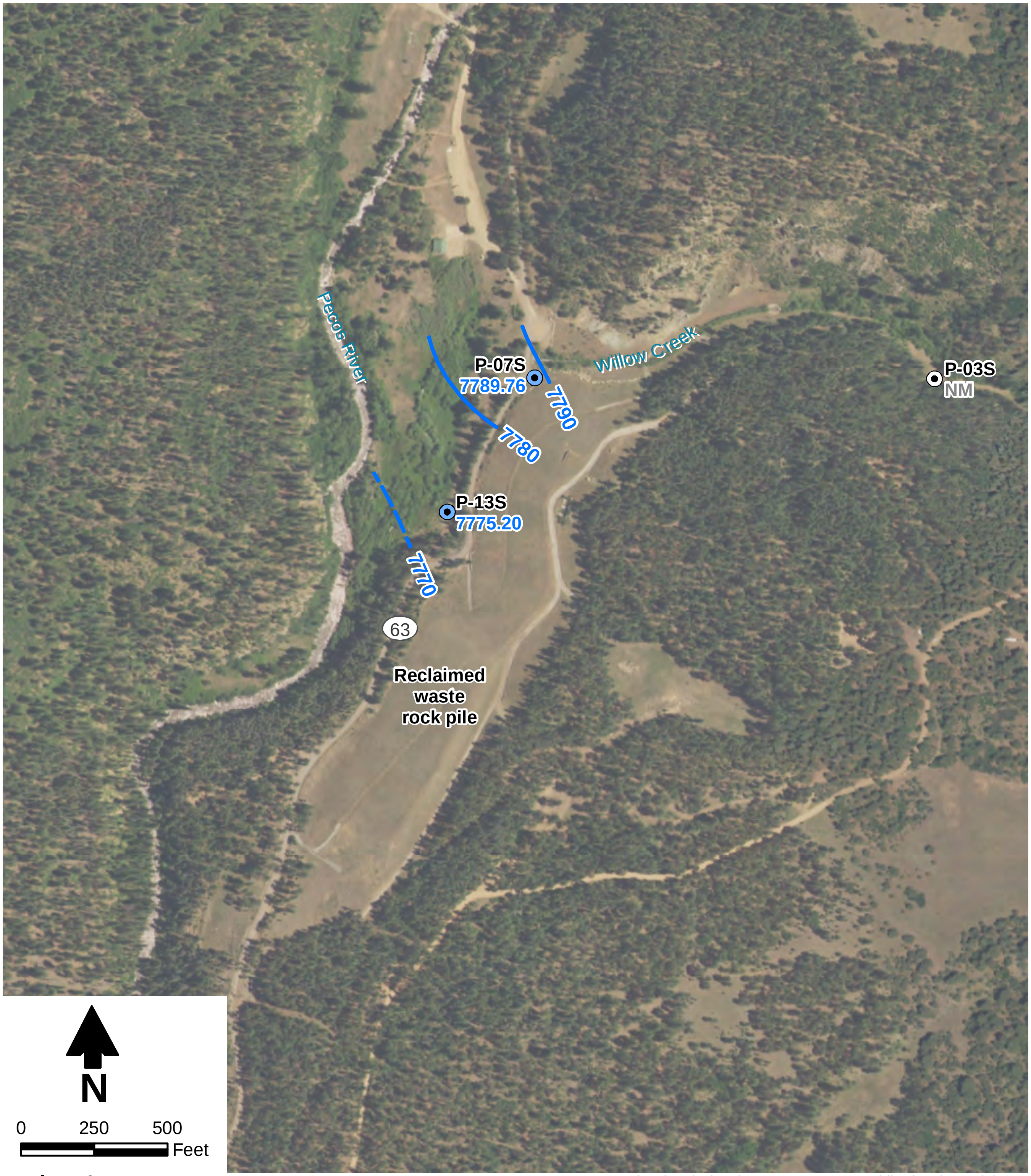
Daniel B. Stephens & Associates, Inc.

11/9/2017

JN ES06.0038

Figure 1

S:\PROJECTS\ES06.0038_PMOU\GIS\MXDS\REPORT\ANNUAL_REPORT\2016\FIG01_GROUNDWATER_AND_SURFACE_WATER_MONITORING_LOCATIONS.MXD



Source: National Agricultural Imagery Program, publication date: 7/7/2016

Notes: NM = not measured

Explanation

- PMOU monitor well and sample location
- PMOU monitor well (no longer monitored)
- Potentiometric surface elevation (ft msl)

P-13S Well designation
7775.20 Groundwater elevation (ft msl)

PECOS MINE OPERABLE UNIT

Shallow Aquifer Potentiometric Surface October 2016

Daniel B. Stephens & Associates, Inc.
11/14/2017 JN ES06.0038

Figure 2

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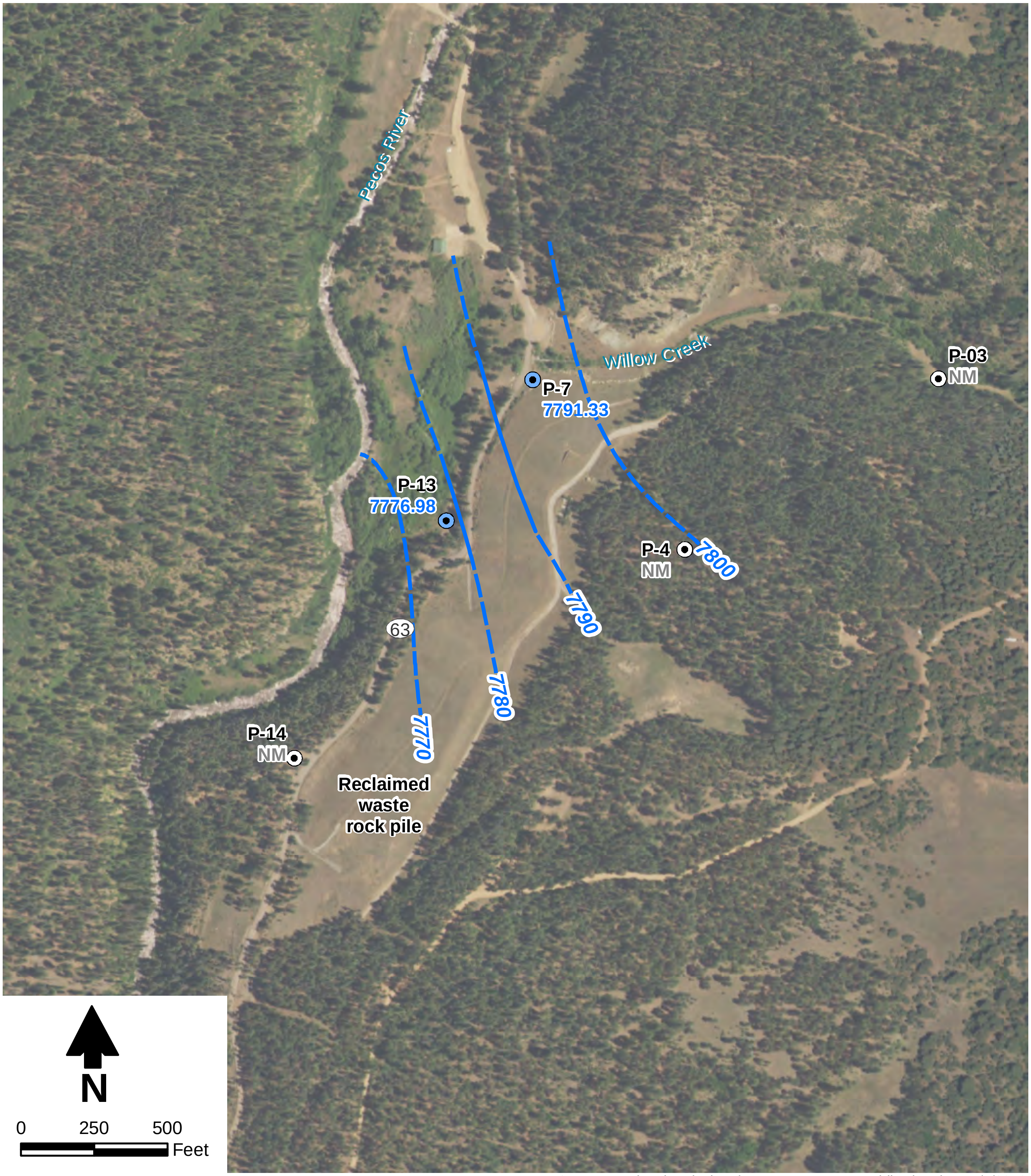


Source: National Agricultural Imagery Program, publication date: 7/7/2016
Notes: NM = not measured

Explanation

- PMOU monitor well and sample location
- PMOU monitor well (no longer monitored)
- Potentiometric surface elevation contour (ft msl)

P-13 Well designation
7776.98 Groundwater elevation (ft msl)

PECOS MINE OPERABLE UNIT

Regional Aquifer Potentiometric Surface October 2016

Daniel B. Stephens & Associates, Inc.
11/14/2017 JN ES06.0038

Figure 3

S:\PROJECTS\ES06.0038_PMOU\GIS\MXDS\REPORT\ANNUAL_REPORT\2016\FIG03_REGIONAL_AQUIFER_POT_SURF_201610.MXD

Tables

Table 1. Summary of 2016 Quarterly Samples
Pecos Mine Operable Unit

Quarter	Number of Samples		
	Groundwater [a]	Surface Water [a]	QA/QC [b]
Fourth	4	3	4

[a] Springs and seeps are monitored as surface water, with results compared to surface water standards.
[b] Quality assurance/quality control (QA/QC) samples include a blind duplicate for groundwater and surface water, a field blank, and an equipment blank.

Table 2. Groundwater Analytical Results
Pecos Mine Operable Unit, Fourth Quarter 2016

Analyte	Concentration [a] (mg/L)				
	NMWQCC Standard	P-7	P-7S	P-13	P-13S
Barium	1.0	**3.400**	0.858	—	—
Cadmium	0.01	—	—	—	**0.0148**
Cobalt	0.05	—	—	—	**0.05**
Fluoride	1.6	0.31	—	—	**1.63**
Iron	1.0	**4.18**	**14.60**	**31.80**	**11.60**
Manganese	0.2	**1.00**	**2.200**	**1.680**	**4.540**
Total dissolved solids	1,000	—	—	—	**1,050**
Zinc	10	—	—	—	**12.30**

Bold indicates that value equals or exceeds standard.
[a] Metal analyte concentrations are dissolved unless otherwise noted.
mg/L = Milligrams per liter
NMWQCC = New Mexico Water Quality Control Commission
— = Not analyzed (no longer required)

Table 3a. Surface Water Analytical Results
Pecos Mine Operable Unit, Fourth Quarter 2016

Analyte	Concentration [a] (mg/L)				
	NMWQCC Standard	PU	PD	ESS	WSBDT
Alkalinity	NA	78.8	81.2	No flow	338
Aluminum	5	—	—		—
Arsenic	0.009	<0.0002	<0.0002		<0.0002
Bromide	NA	<0.05	<0.05		<0.5
Cadmium	See Table 3b [b]	<0.0001	<0.0001		0.0006
Calcium	NA	32.5	33.8		243
Chloride	NA	1.15 B	1.17 B		51.9
Hardness	NA	93	97		839
Iron	NA	<0.02	0.02 B		1.19
Lead	See Table 3b [b]	—	—		—
Magnesium	NA	2.9	3.0		56.4
Manganese	See Table 3b [b]	<0.005	0.009 B		**3.690**
Phosphorus (total)	NA	<0.02	<0.02		2.1
Potassium	NA	0.7 B	0.7 B		9.9
Sodium	NA	1.8	1.9		40.2
Sulfate	NA	13.0	13.2		510
Total dissolved solids	NA	110	114		1,330
Zinc	See Table 3b [b]	<0.01	<0.01		**4.38**

Bold indicates that value equals or exceeds standard.
[a] Metal analyte concentrations are dissolved unless otherwise noted.
[b] Hardness-based standard

mg/L = Milligrams per liter
NMWQCC = New Mexico Water Quality Control Commission
NA = No applicable standard
— = Not analyzed
< = Analyzed for but not detected at the indicated method detection limit (MDL)
B = Detected at a value between the MDL and the practical quantitation limit (PQL)

Table 3b. Calculated Chronic Hardness-Based Standards
Pecos Mine Operable Unit, Fourth Quarter 2016

Analyte	NMWQCC Standard [a] (mg/L)			
	PU	PD	ESS	WSBDT
Hardness (mg/L)	*93*	*97*	—	*839* [b]
Cadmium	0.0004	0.0004	No flow	0.0012
Manganese	1.610	1.633		2.618
Lead	NA	NA		NA
Zinc	0.11	0.12		0.43

[a] New Mexico Water Quality Control Commission (NMWQCC) surface water standards (20.6.4 NMAC), December 1, 2010. Dissolved metals (cadmium, lead, manganese, and zinc) have hardness-based standards. Chronic standards have been calculated for each metal for each site. The formulas used to calculate these standards are listed in 20.6.4.900 NMAC, paragraph I.

[b] Where the measured hardness was greater than 400 milligrams per liter (mg/L), a default value of 400 mg/L was used per NMWQCC guidance.

— = No sample collected

NA = Not analyzed

Table 4. Comparison of Duplicate Analytical Results for Metals Pecos Mine Operable Unit, Fourth Quarter 2016

Analyte	Concentration [a] (mg/L)		RPD (%)	Concentration [a] (mg/L)		RPD (%)
	P-13S	Duplicate		PD	Duplicate	
Aluminum	—	—	—	—	—	—
Arsenic	—	—	—	<0.0002	<0.0002	0
Cadmium	0.0148	0.0146	1	<0.0001	<0.0001	0
Calcium	—	—	—	33.8	32.8	3
Cobalt	0.05	0.04 B	22	—	—	—
Iron	11.60	11.60	0	0.02 B	0.03 B	40
Lead	—	—	—	—	—	—
Magnesium	—	—	—	3.0	2.9	3
Manganese	4.540	4.550	0.2	0.009 B	0.009 B	0
Potassium	—	—	—	0.7 B	0.7 B	0
Sodium	—	—	—	1.9	1.8	5
Zinc	12.30	12.30	0	<0.01	<0.01	0

Notes: 1. The RPD comparison method is not recommended if one or both of the results is within 5 times the method detection limit (MDL); results should be within ± the MDL (U.S. Environmental Protection Agency. 2004. *USEPA Contract Laboratory Program, national functional guidelines for inorganic data review, final.* OSWER 9240.1-45, EPA 540-R-04-004. October 2004).

2. The RPD acceptance criterion as set in the Pecos Mine Operable Unit (PMOU) SAP (DBS&A, 2007) is 50% or less.

3. RPD is calculated as follows: $RPD = \frac{|A - B|}{(A + B)/2} \times 100\%$

where A = first duplicate concentration (the MDL if the analyte is not detected)
B = second duplicate concentration (the MDL if the analyte is not detected)

[a] Metal analyte concentrations are dissolved unless otherwise noted.

mg/L = Milligrams per liter
RPD = Relative percent difference
— = Not analyzed (no longer required)
< = Analyte was analyzed for but not detected at the indicated MDL
B = Analyte detected at a value between the MDL and the practical quantitation limit (PQL)

Table 5. Well Construction Summary
Pecos Mine Operable Unit

Well Name	Top of Casing Elevation (feet msl)	Total Depth (feet bgs)	Elevation of Screened Interval (feet msl)		Geologic Unit of Completion
			Bottom	Top	
Wells No Longer Monitored					
P-1 [a]	7,887.52	275	7,612.52	7,642.52	Mine workings
P-3	7,881.45	125	7,759.45	7,799.45	Bedrock
P-3S	7,882.60	10.6	7,872.60	7,877.60	Alluvium
P-4	7,995.21	305	7,695.21	7,745.21	Bedrock
P-14	7,852.00	101.4	7,747.60	7,767.60	Bedrock
Wells Monitored for Water Level Measurements and Water Quality					
P-7	7,798.78	94	7,703.78	7,753.78	Bedrock
P-7S	7,799.08	15	7,783.08	7,793.08	Alluvium
P-13	7,781.00	30	7,748.00	7,758.00	Bedrock
P-13S	7,781.50	10	7,768.50	7,773.50	Alluvium

[a] The casing for P-1 has broken off.
msl = Above mean sea level
bgs = Below ground surface

Table 6. Groundwater Elevations
Pecos Mine Operable Unit

Well Name	Groundwater Elevation (ft msl)																			
	Nov 2009	Feb 2010	Apr 2010	Aug 2010	Oct 2010	Mar 2011	May 2011	Aug 2011	Nov 2011	Feb 2012	May 2012	Aug 2012	Nov 2012	Feb 2013	Jun 2013	Dec 2013	May 2014	Dec 2014	Nov 2015	Oct 2016
Alluvial (Shallow) Aquifer																				
P-3S	7,872.49	7,872.63	7,873.26	7,872.25	7,872.45	7,872.89	7,872.37	7,872.63	7,872.49	7,872.61	7,872.53	Dry	Dry	7,873.18	7,872.39	NM	NM	NM	NM	NM
P-7S	7,789.88	7,789.87	7,791.03	7,790.48	7,789.79	7,790.13	7,789.95	7,790.04	7,789.69	7,789.96	7,790.09	7,789.64	7,789.48	7,789.61	7,789.58	7,790.23	7,790.39	7,789.79	7,790.26	7,789.76
P-13S	7,774.85	7,774.66	7,776.05	7,775.35	7,774.87	7,775.34	7,774.90	7,775.50	7,774.88	7,775.09	7,775.20	7,775.01	7,774.66	7,774.73	7,774.72	7,775.78	7,775.68	7,775.36	7,775.79	7,775.20
Bedrock (Regional) Aquifer																				
P-1	7,794.19	Well casing has broken off; water level cannot be monitored.																		
P-3	7,863.09	7,862.34	7,863.94	7,864.43	7,863.43	7,862.37	7,861.59	7,862.45	7,862.72	7,860.78	7,862.60	7,862.15	7,862.04	7,862.13	7,861.78	NM	NM	NM	NM	NM
P-4	7,794.63	7,794.06	7,796.34	7,795.76	7,794.46	7,794.28	7,793.98	7,794.01	7,793.41	7,794.08	7,794.71	7,794.00	7,793.81	7,793.38	7,793.77	NM	NM	NM	NM	NM
P-7	7,791.50	7,791.30	7,792.59	7,792.19	7,791.38	7,791.54	7,791.40	7,791.38	7,791.24	7,791.43	7,791.73	7,791.16	7,790.96	7,791.02	7,791.14	7,792.00	7,792.17	7,791.47	7,792.01	7,791.33
P-13	7,777.07	7,776.70	7,777.40	7,777.53	7,777.12	7,776.94	7,776.66	7,777.13	7,776.76	7,776.78	7,776.91	7,776.88	7,776.64	7,776.42	7,776.54	7,777.51	7,774.09	7,777.05	7,777.65	7,776.98
P-14	7,757.25	7,757.05	7,757.56	7,758.37	7,758.14	7,757.42	7,757.09	7,756.98	7,756.87	7,756.81	7,756.79	7,756.85	7,756.39	7,756.65	7,756.70	7,757.31	7,757.34	7,756.97	7,758.35	NM

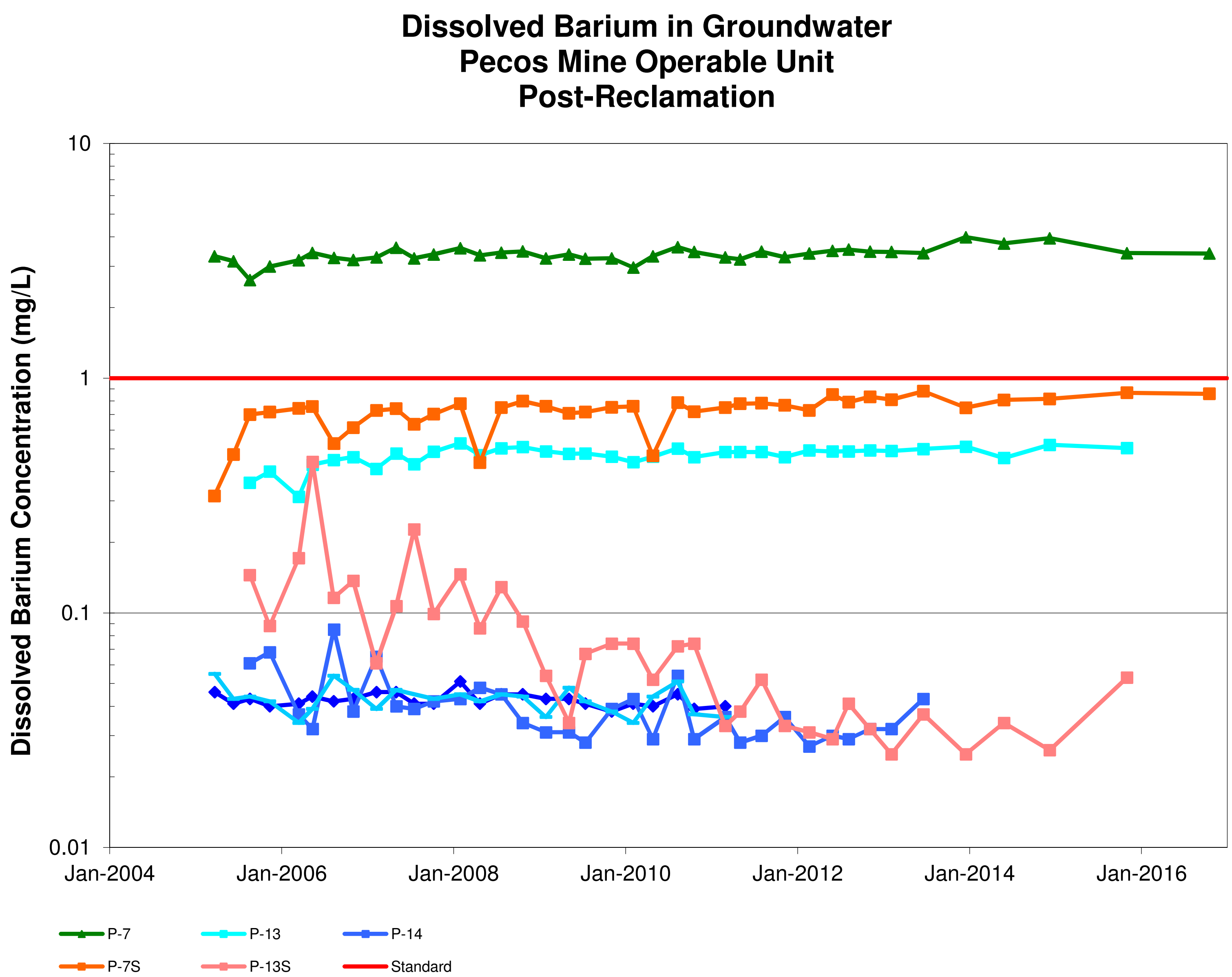
ft msl = Feet above mean sea level
NM = Not measured

Appendix A

Chemistry Time-Series Plots

Groundwater

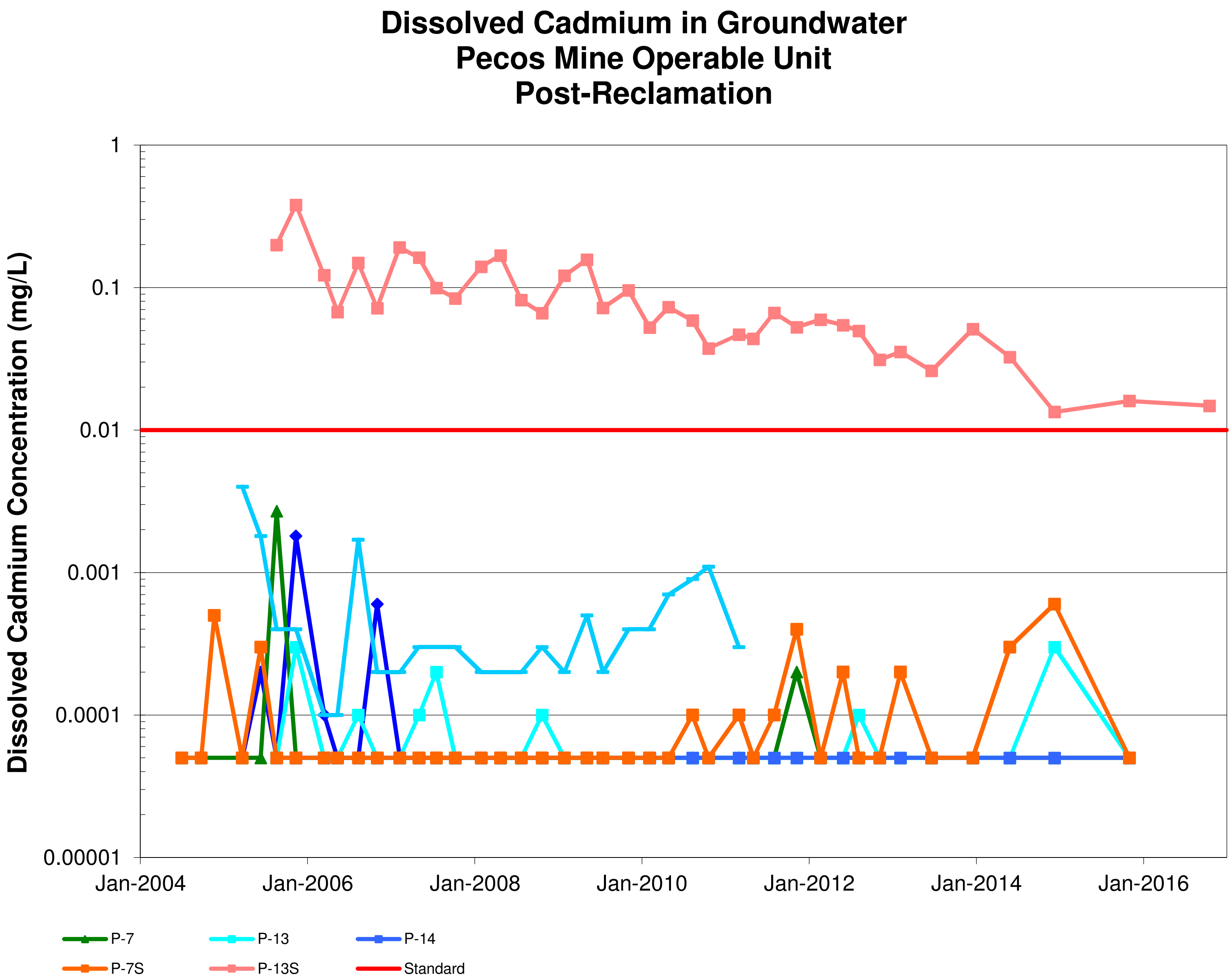
NMWQCC standard = 1.0 mg/L



Non-detect values plotted as one-half the method detect limit.
Samples collected using hydrasleeve methodology
during December 2013 through December 2014.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU GW_thru 4Q-16.xlsBarium

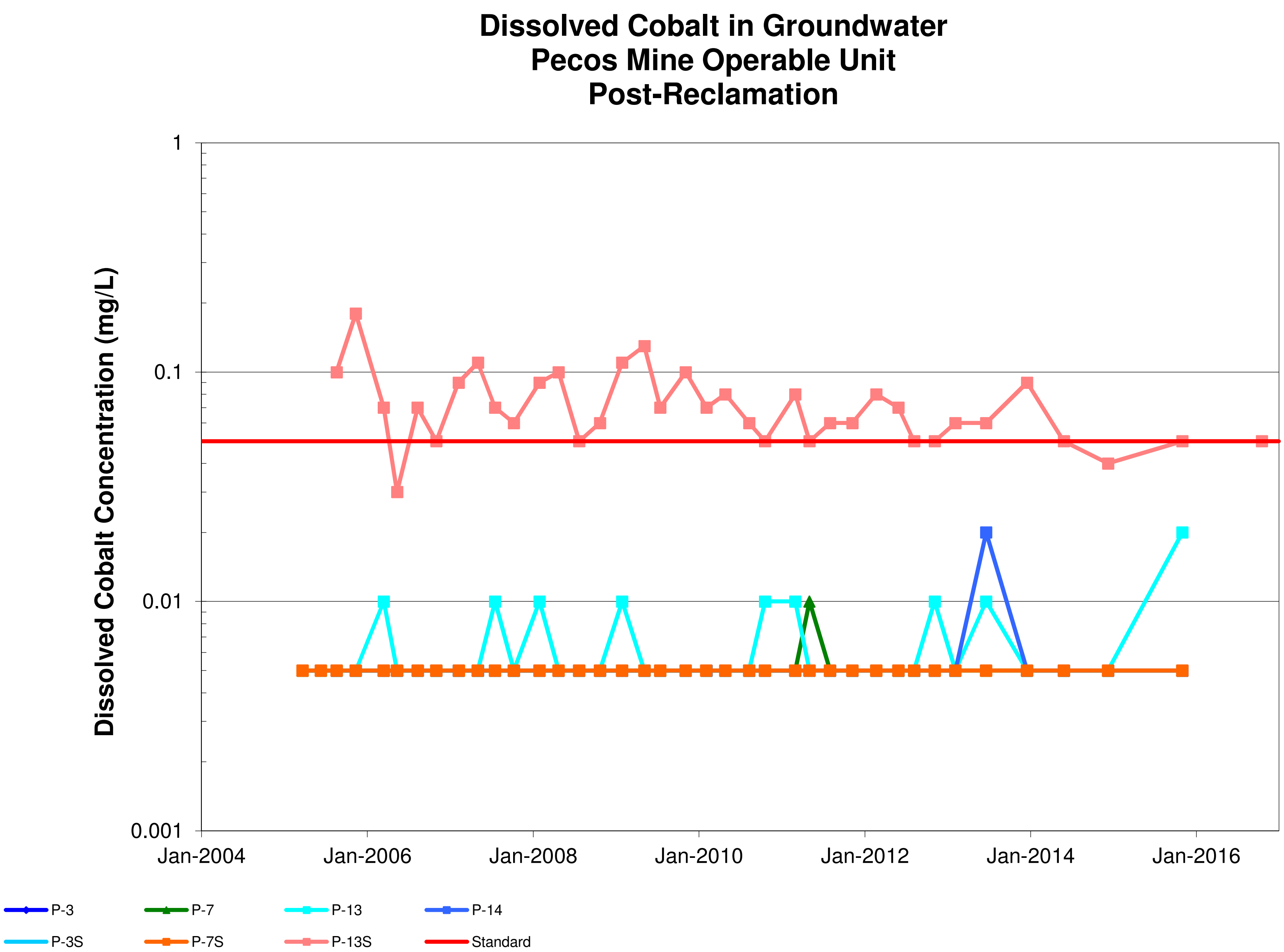
NMWQCC standard = 0.01 mg/L



Non-detect values plotted as one-half the method detect limit.
Samples collected using hydrasleeve methodology
during December 2013 through December 2014.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU GW_thru 4Q-16.xlsCadmium

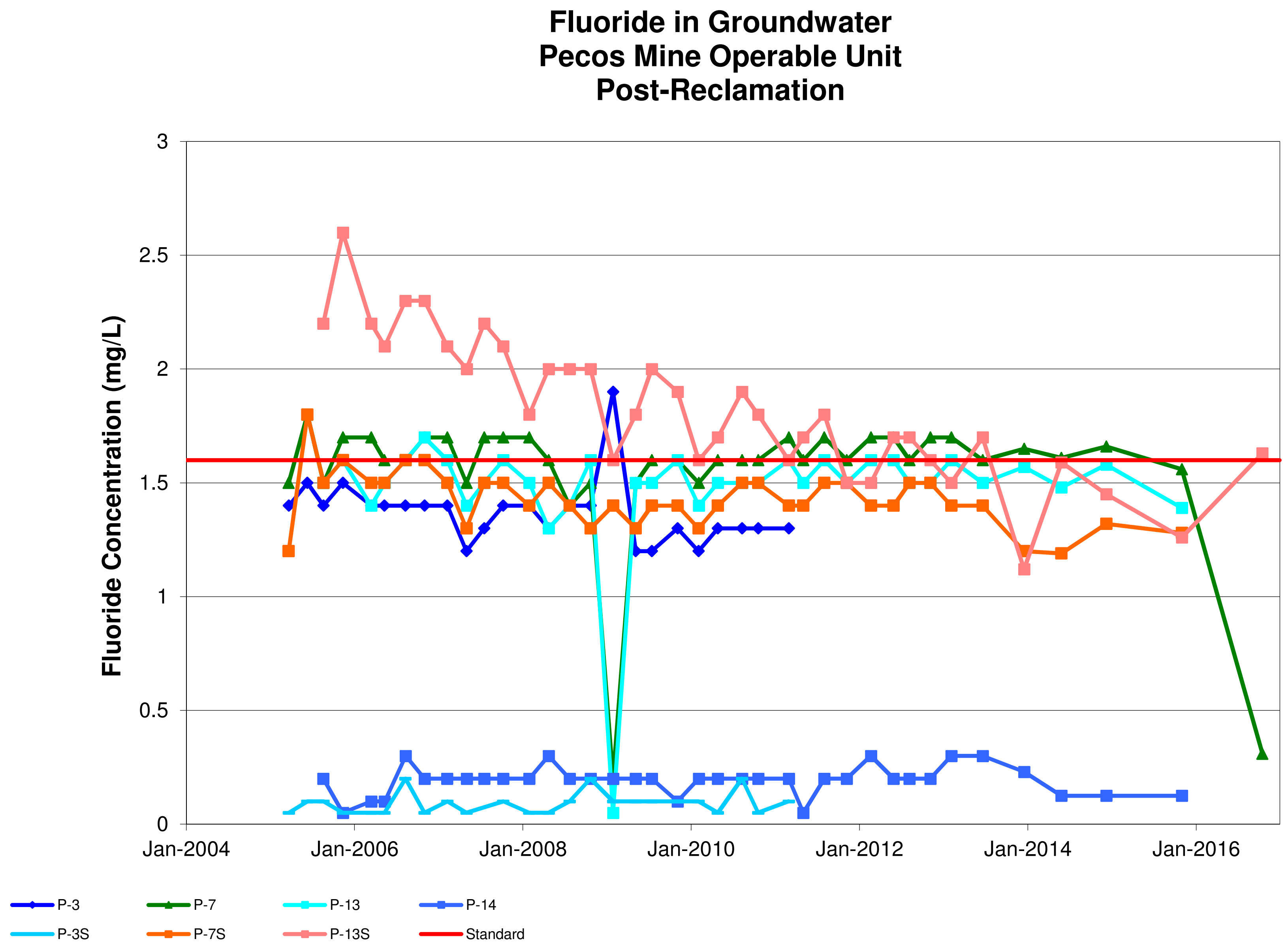
NMWQCC standard = 0.05 mg/L



Non-detect values plotted as one-half the method detect limit.
Samples collected using hydrasleeve methodology
during December 2013 through December 2014.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU GW_thru 4Q-16.xlsCobalt

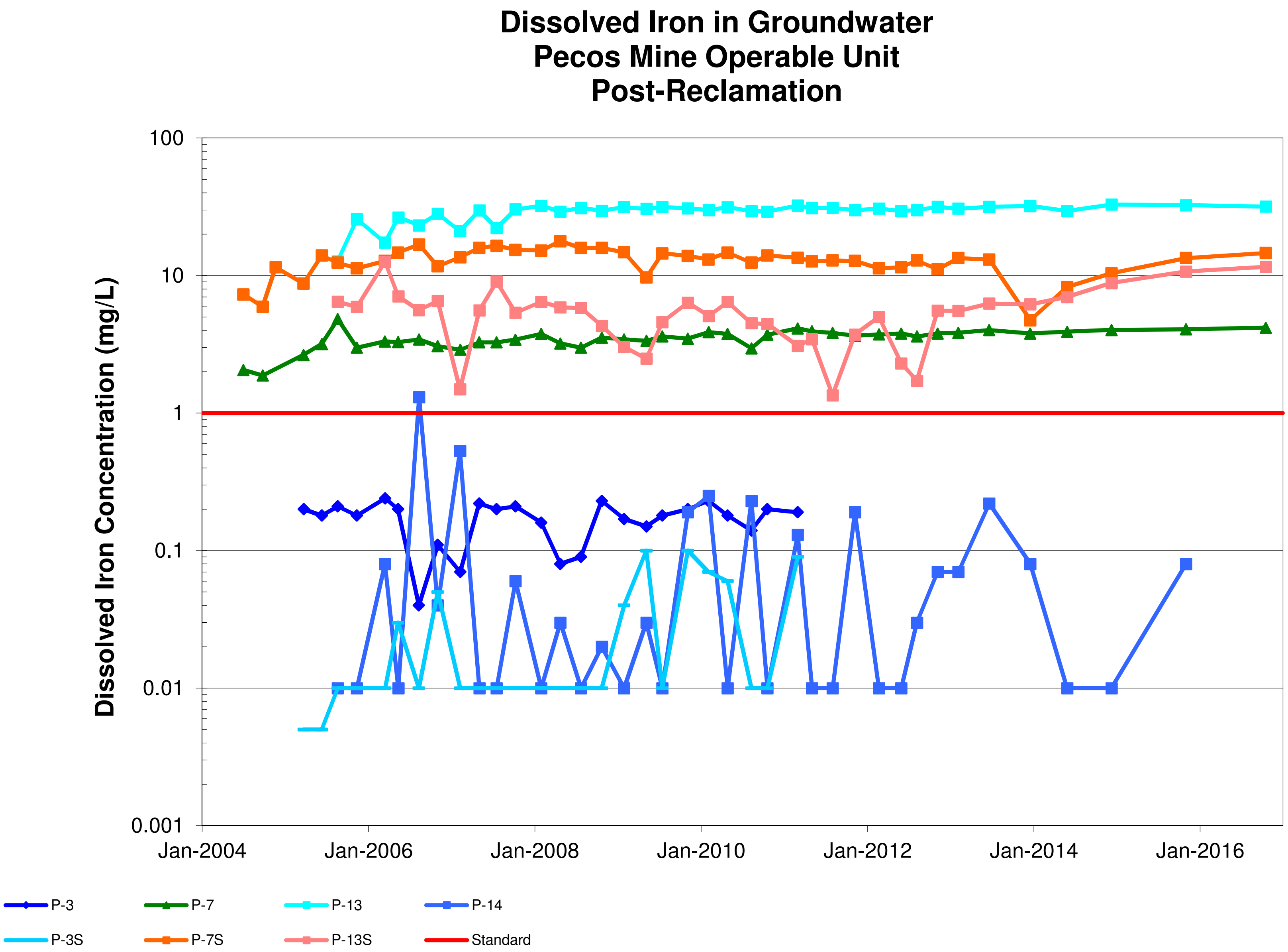
NMWQCC standard = 1.6 mg/L



Non-detect values plotted as one-half the method detect limit.
Samples collected using hydrasleeve methodology
during December 2013 through December 2014.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU GW_thru 4Q-16.xlsFluoride

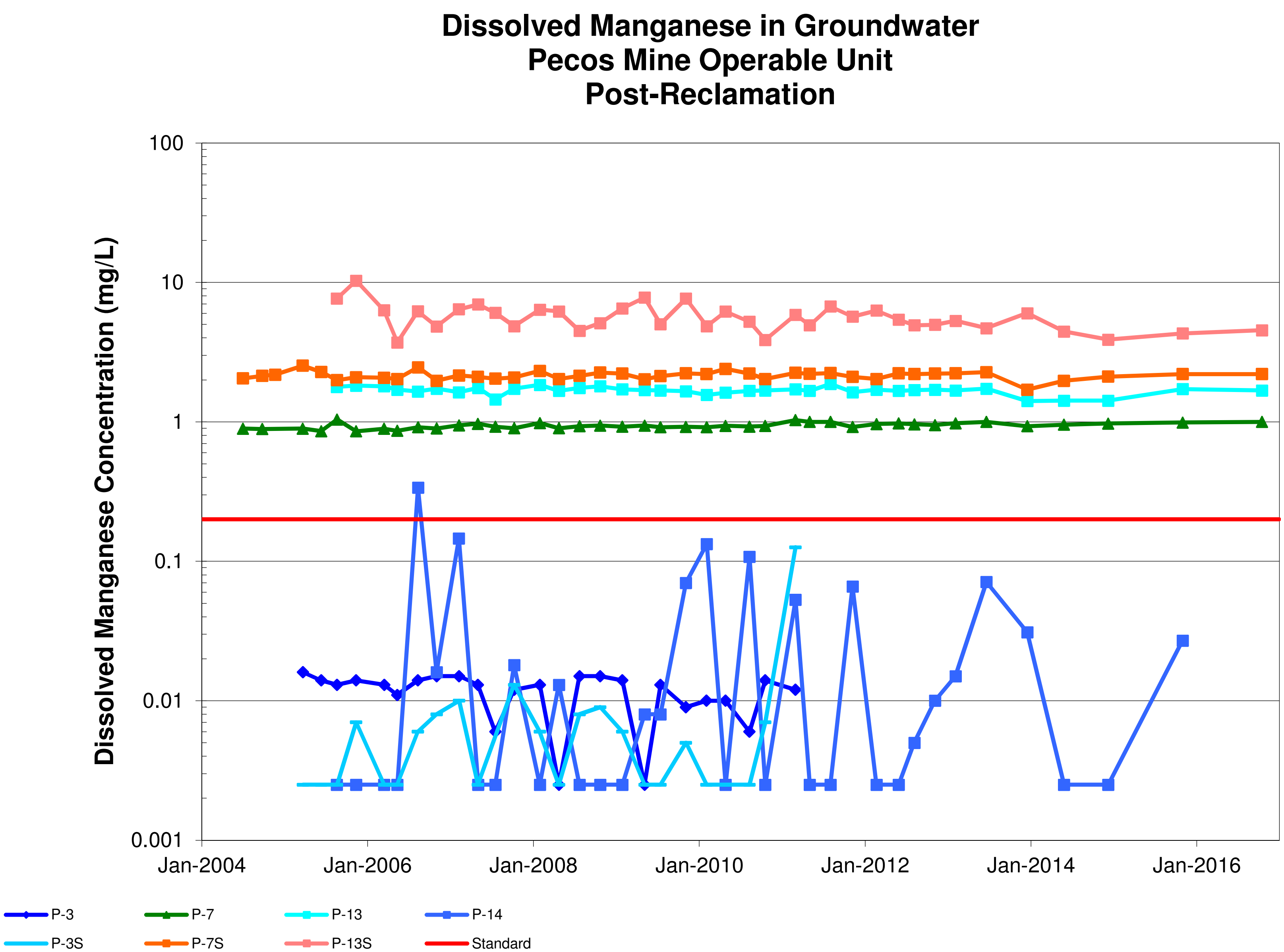
NMWQCC standard = 1.0 mg/L



Non-detect values plotted as one-half the method detect limit.
Samples collected using hydrasleeve methodology
during December 2013 through December 2014.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU GW_thru 4Q-16.xlsIron

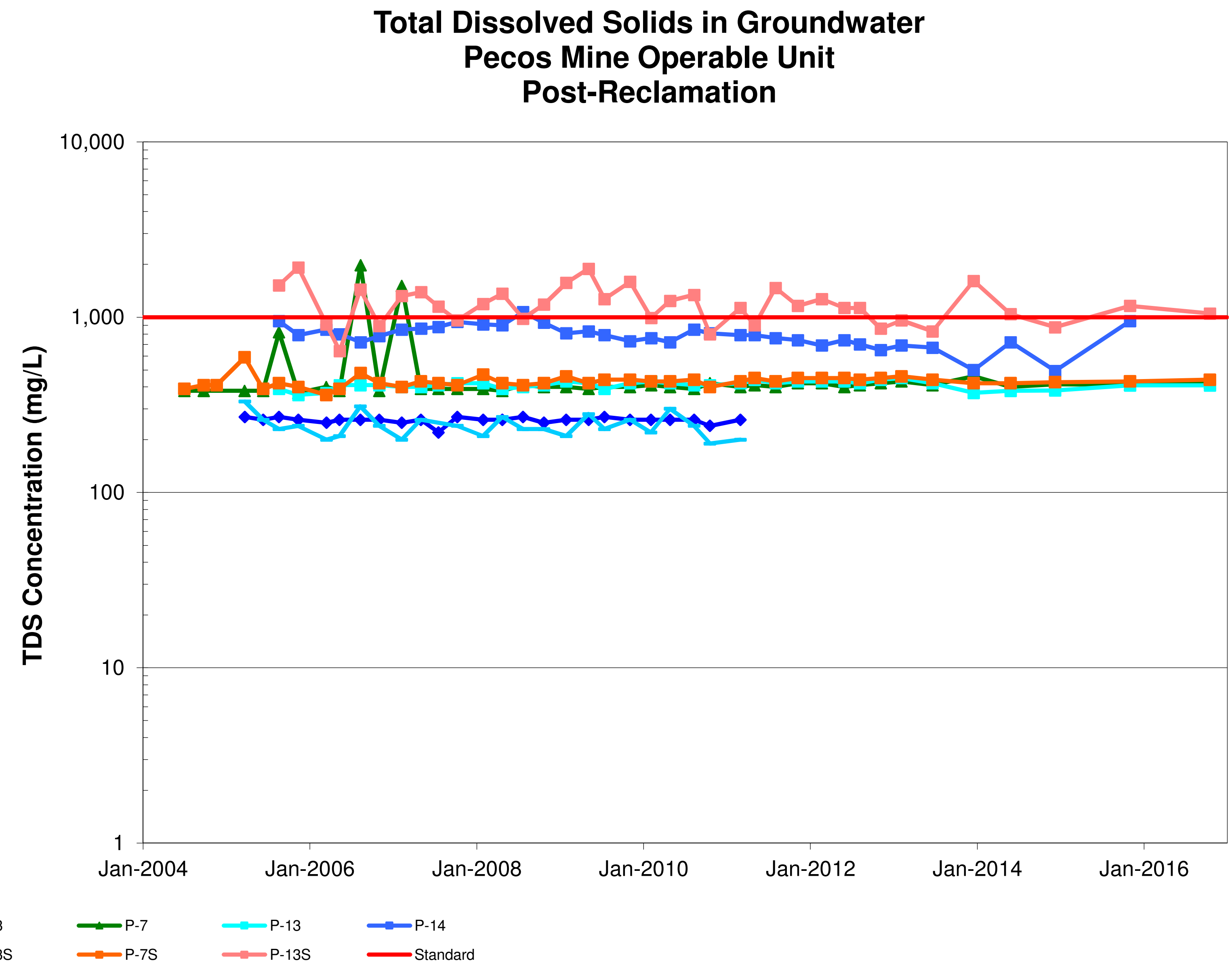
NMWQCC standard = 0.2 mg/L



Non-detect values plotted as one-half the method detect limit.
Samples collected using hydrasleeve methodology
during December 2013 through December 2014.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU GW_thru 4Q-16.xlsManganese

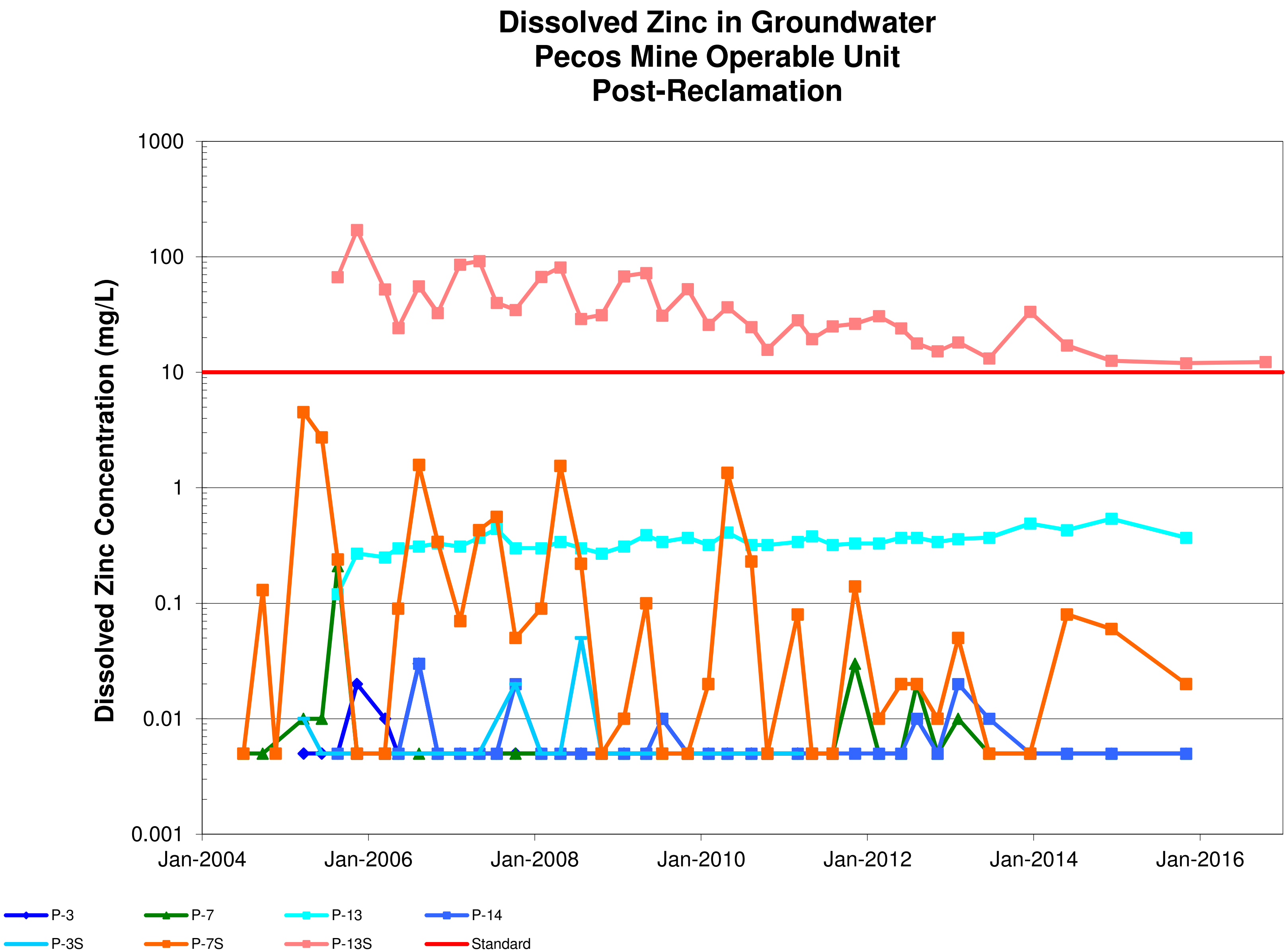
NMWQCC standard = 1,000 mg/L



Non-detect values plotted as one-half the method detect limit.
Samples collected using hydrasleeve methodology
during December 2013 through December 2014.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU GW_thru 4Q-16.xlsTDS

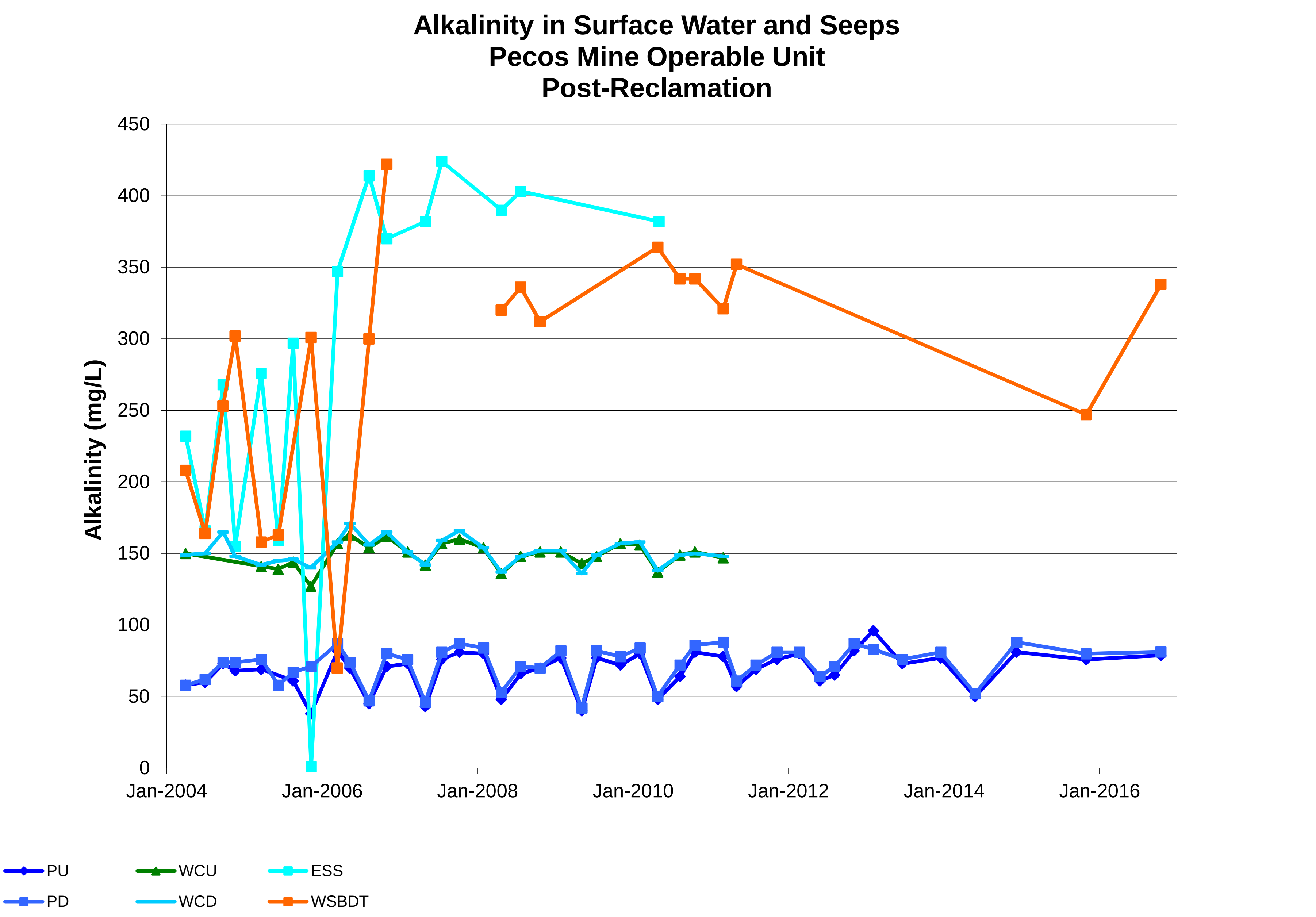
NMWQCC standard = 10 mg/L



Non-detect values plotted as one-half the method detect limit.
Samples collected using hydrasleeve methodology
during December 2013 through December 2014.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU GW_thru 4Q-16.xlsZinc

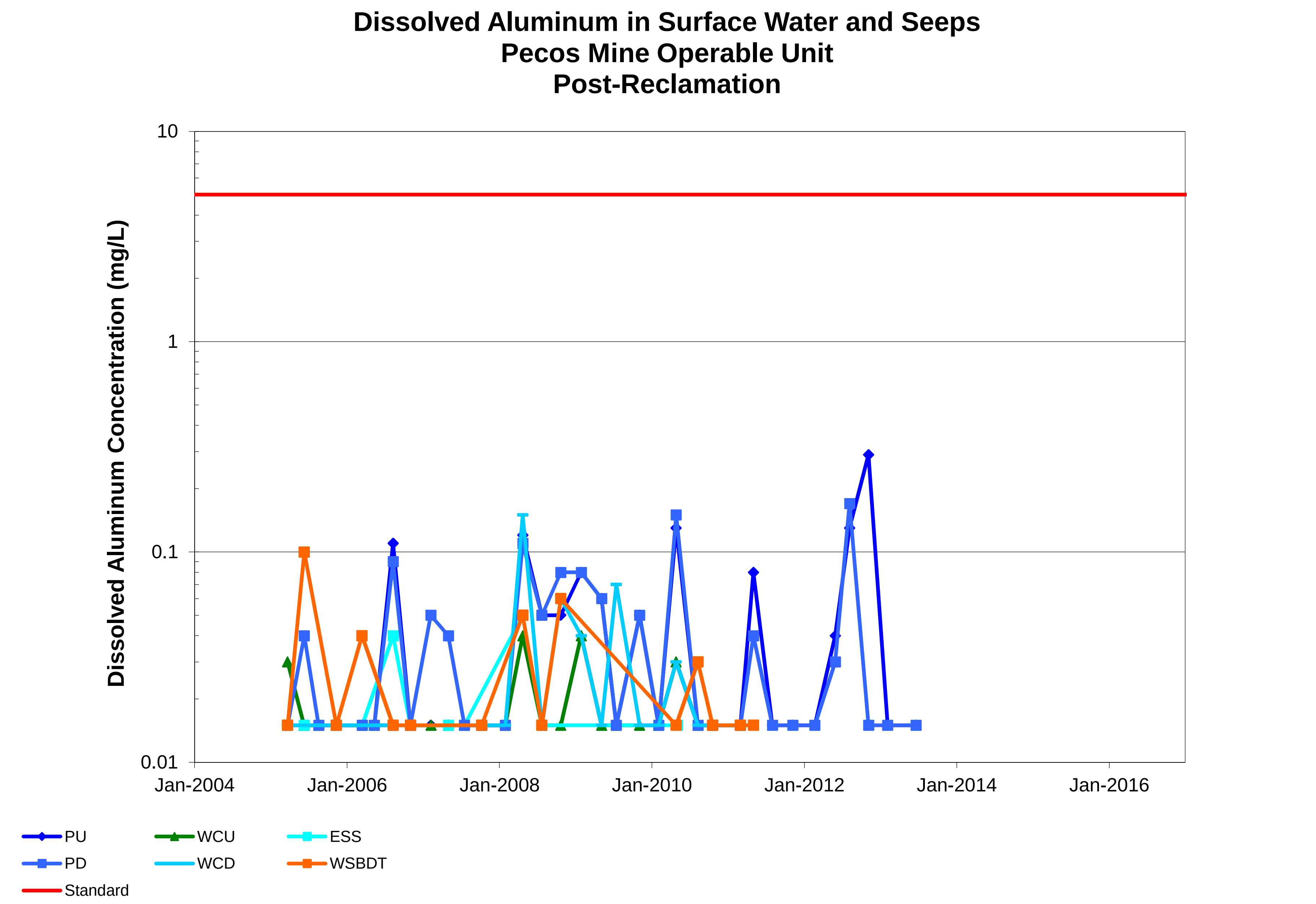
Surface Water



Non-detect values plotted as one-half the method detection limit.
There is no NMWQCC standard for alkalinity.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Alkalinity

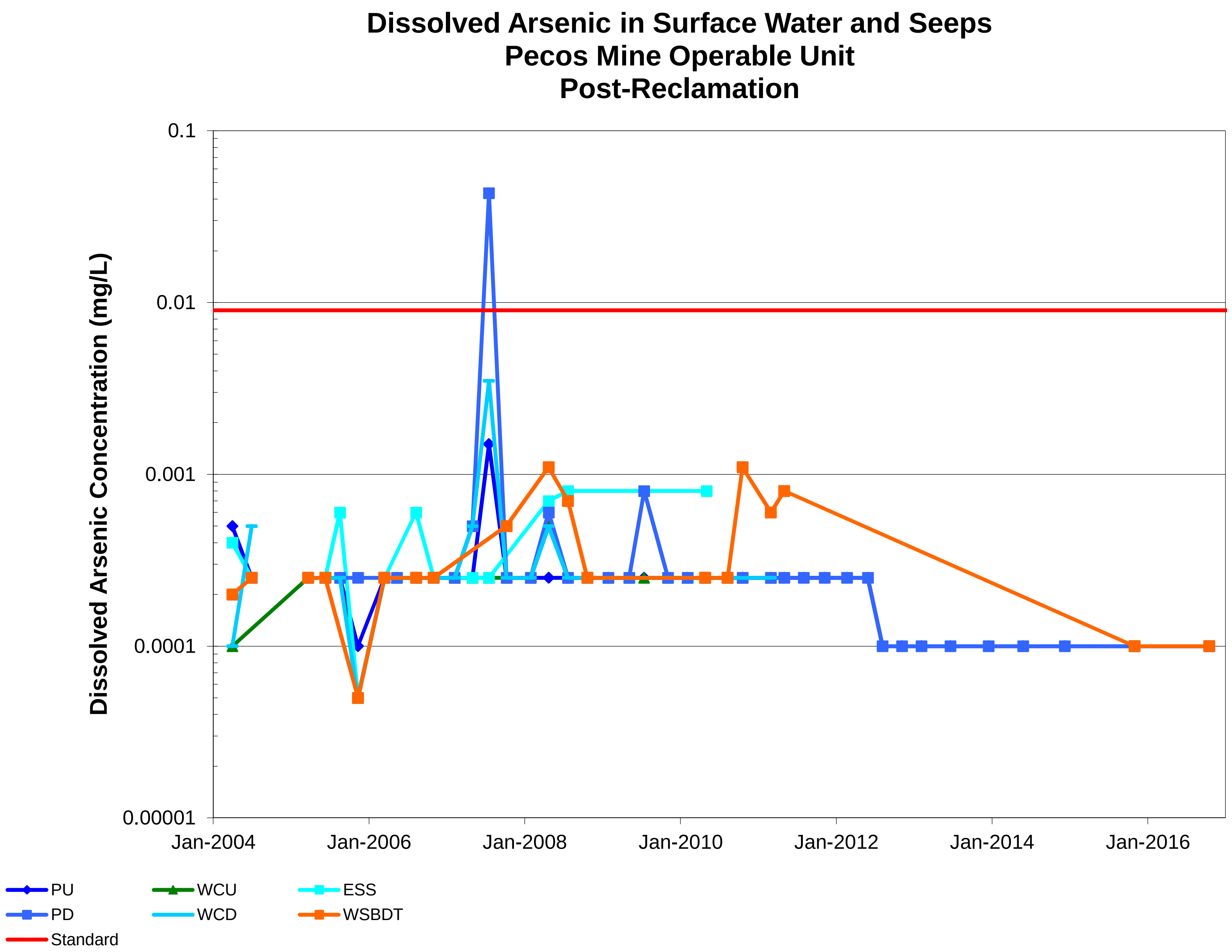
NMWQCC standard = 5 mg/L



S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Aluminum

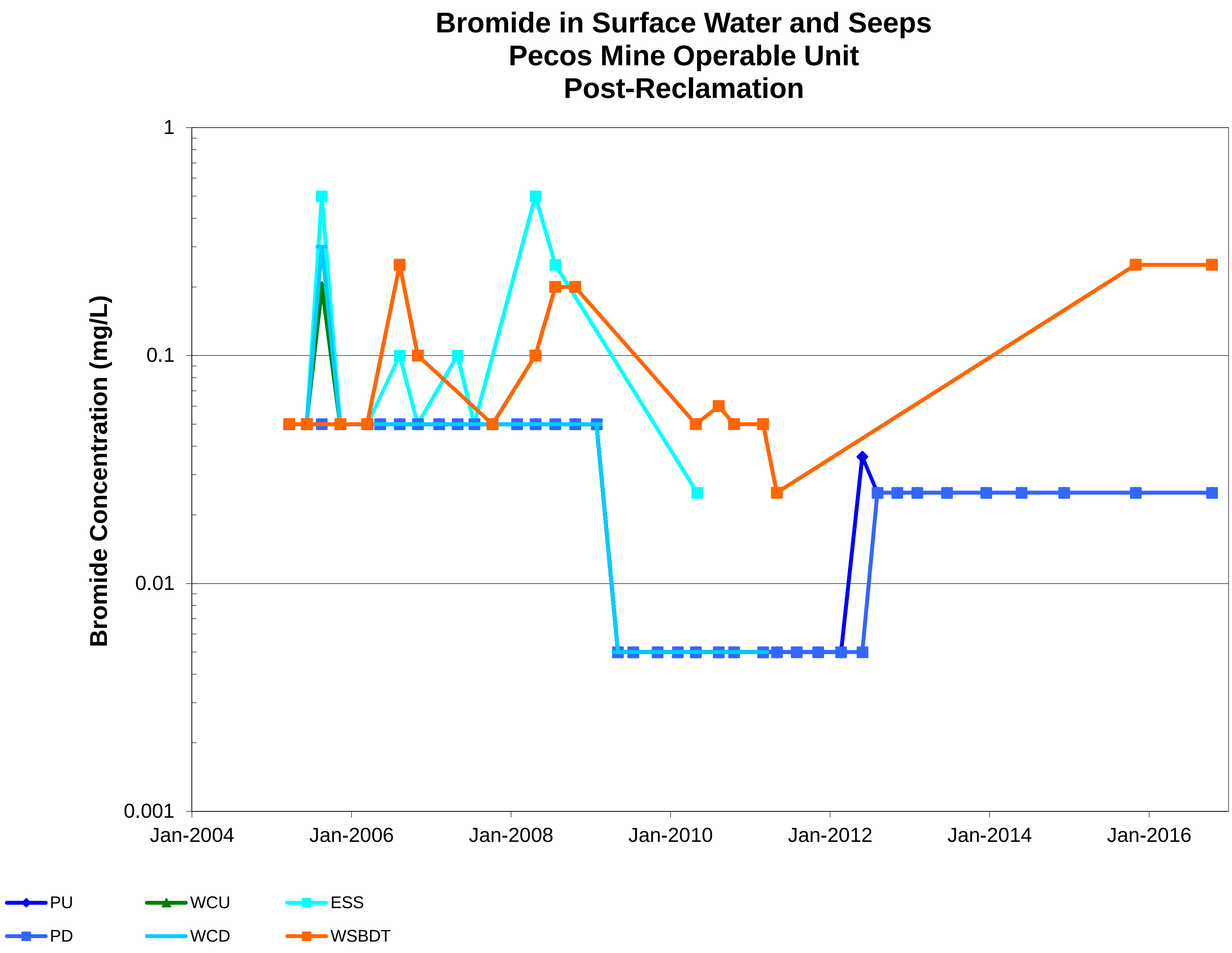
Non-detect values plotted as one-half the method detection limit.

NMWQCC standard = 0.009 mg/L



S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Arsenic

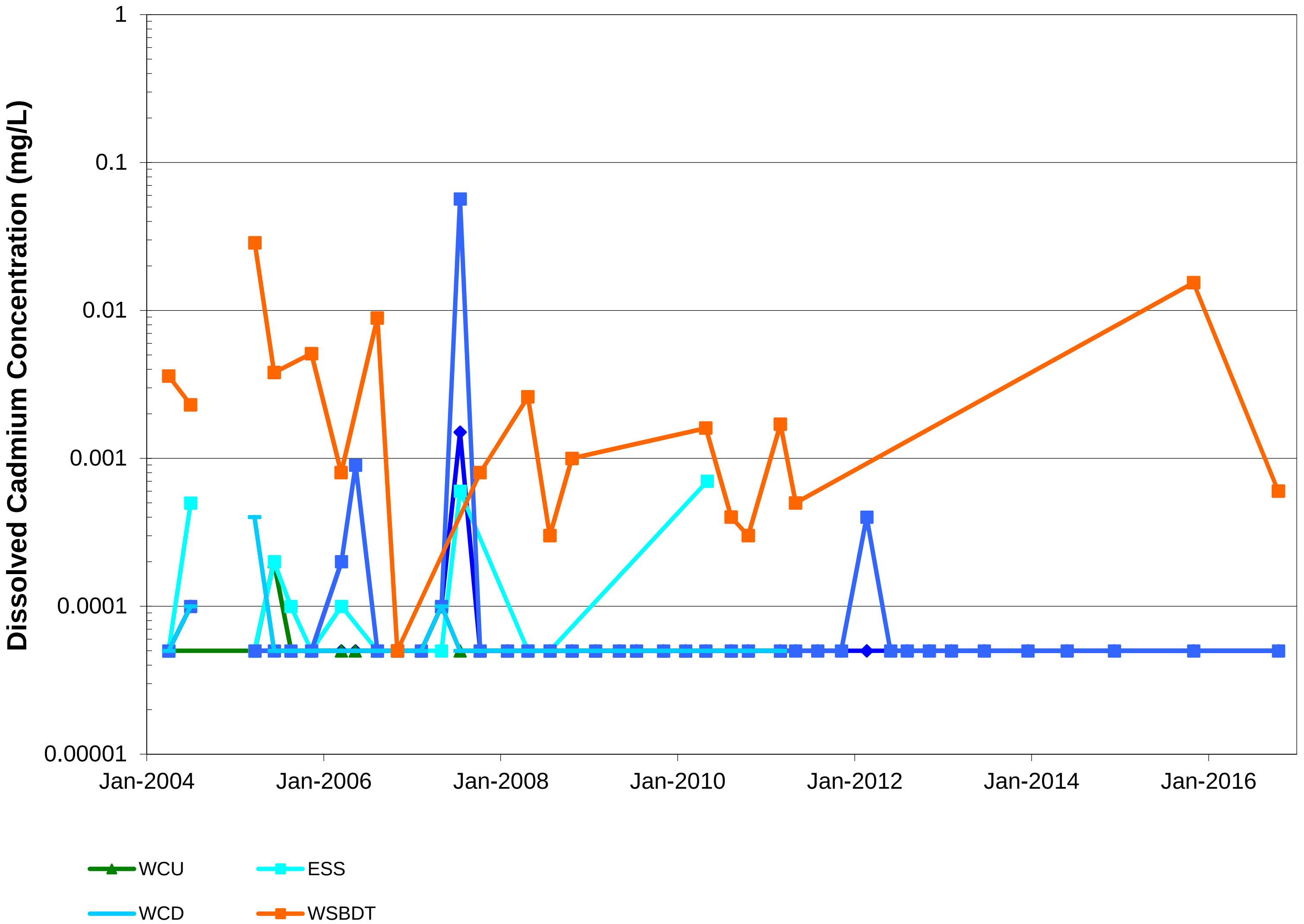
Non-detect values plotted as one-half the method detection limit.



Non-detect values plotted as one-half the method detection limit.
There is no NMWQCC standard for bromide.

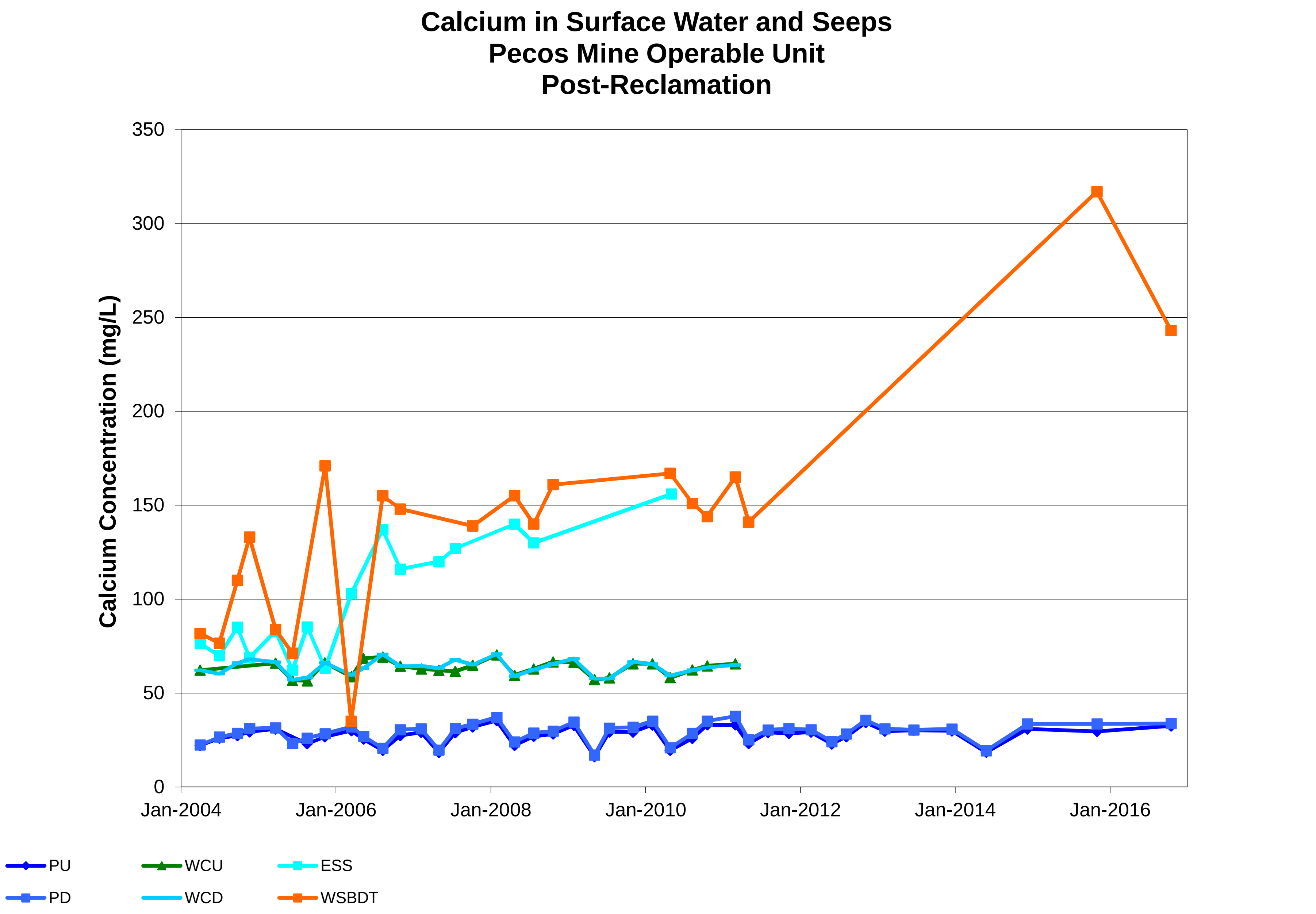
S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Bromide

Dissolved Cadmium in Surface Water and Seeps
Pecos Mine Operable Unit
Post-Reclamation



Non-detect values plotted as one-half the method detection limit.
NMWQCC standard for cadmium calculated using sample hardness measured at each location for each quarter.

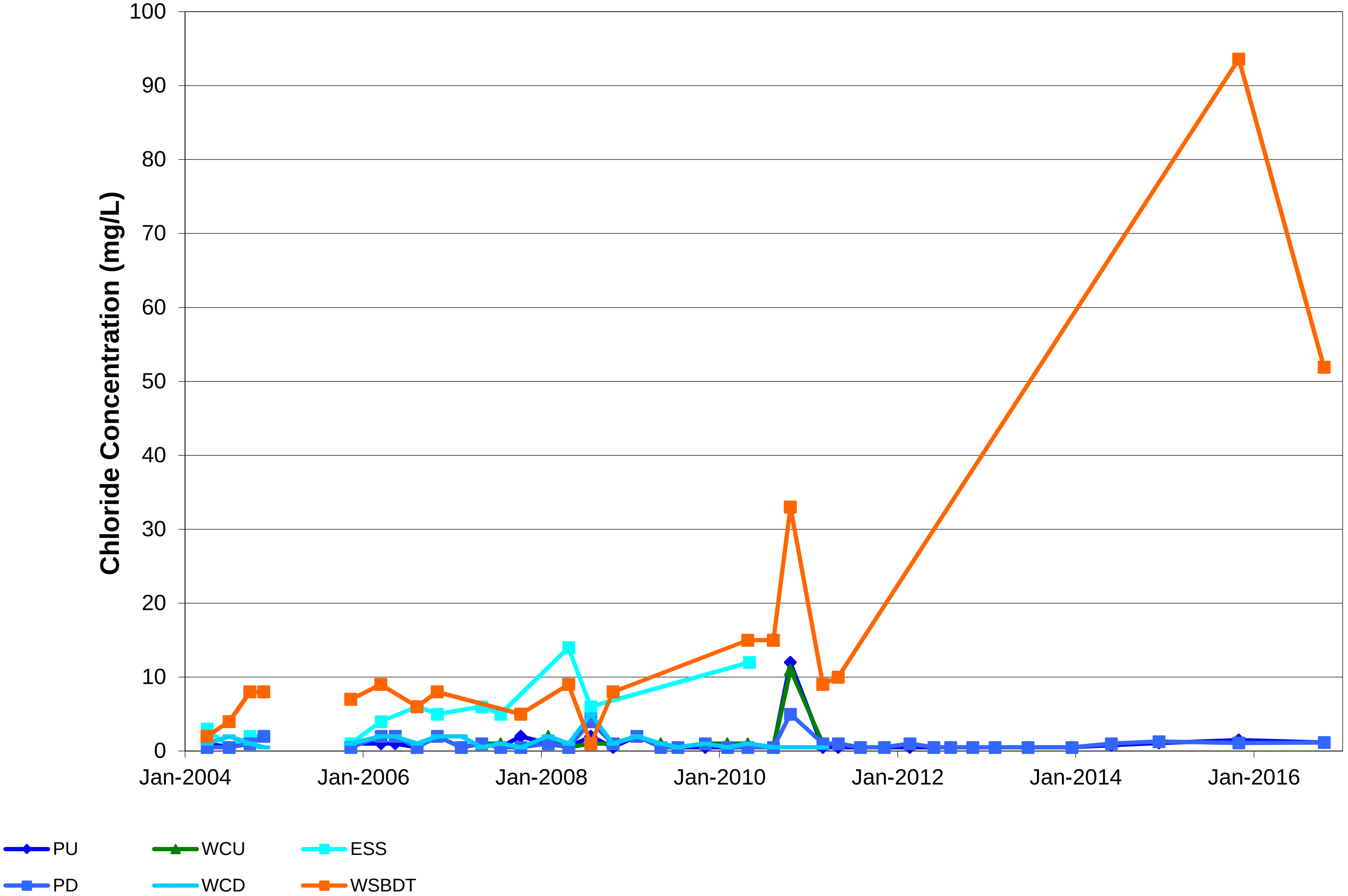
S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Cadmium



Non-detect values plotted as one-half the method detection limit.
There is no NMWQCC standard for calcium.

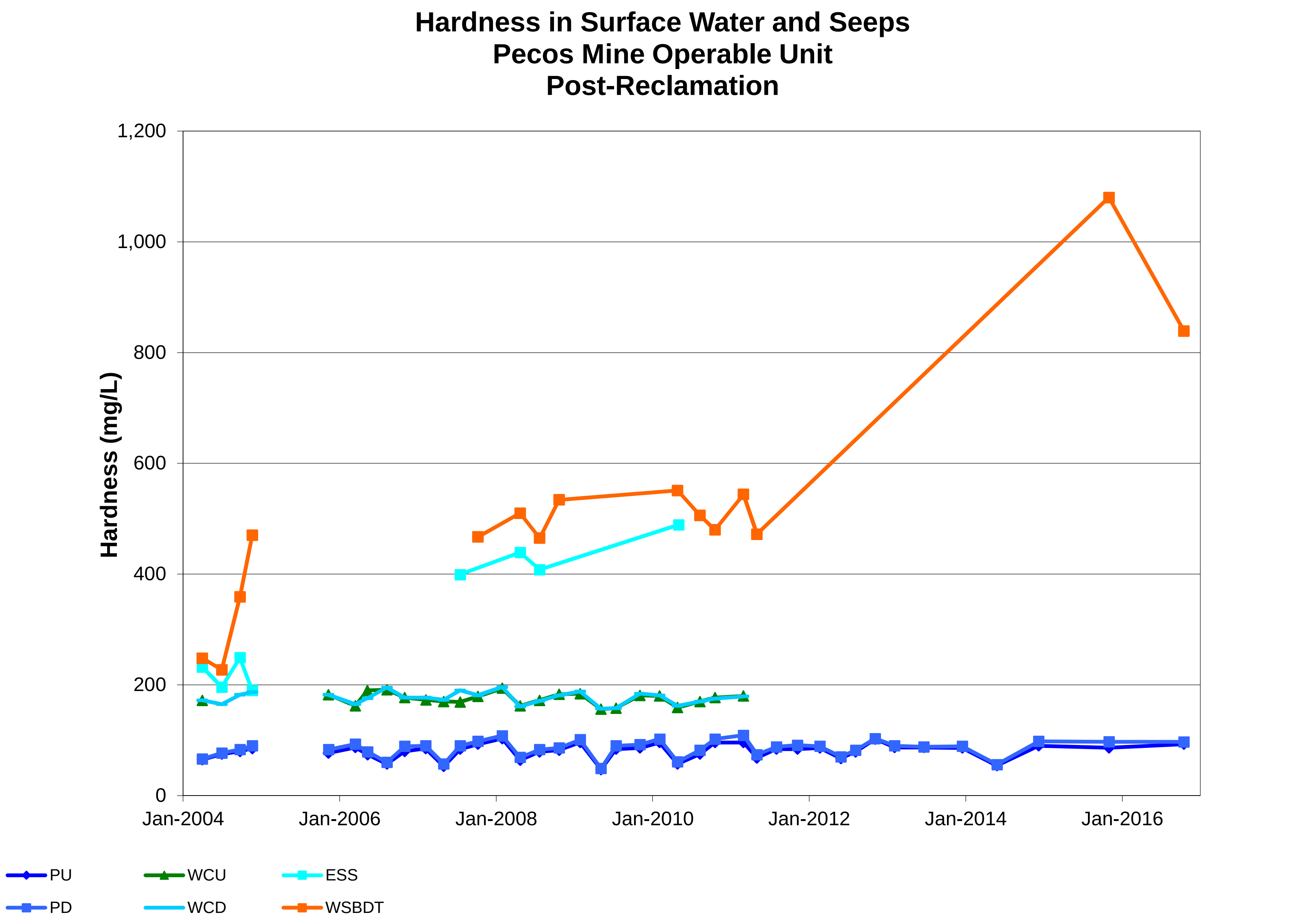
S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Calcium

Chloride in Surface Water and Seeps
Pecos Mine Operable Unit
Post-Reclamation



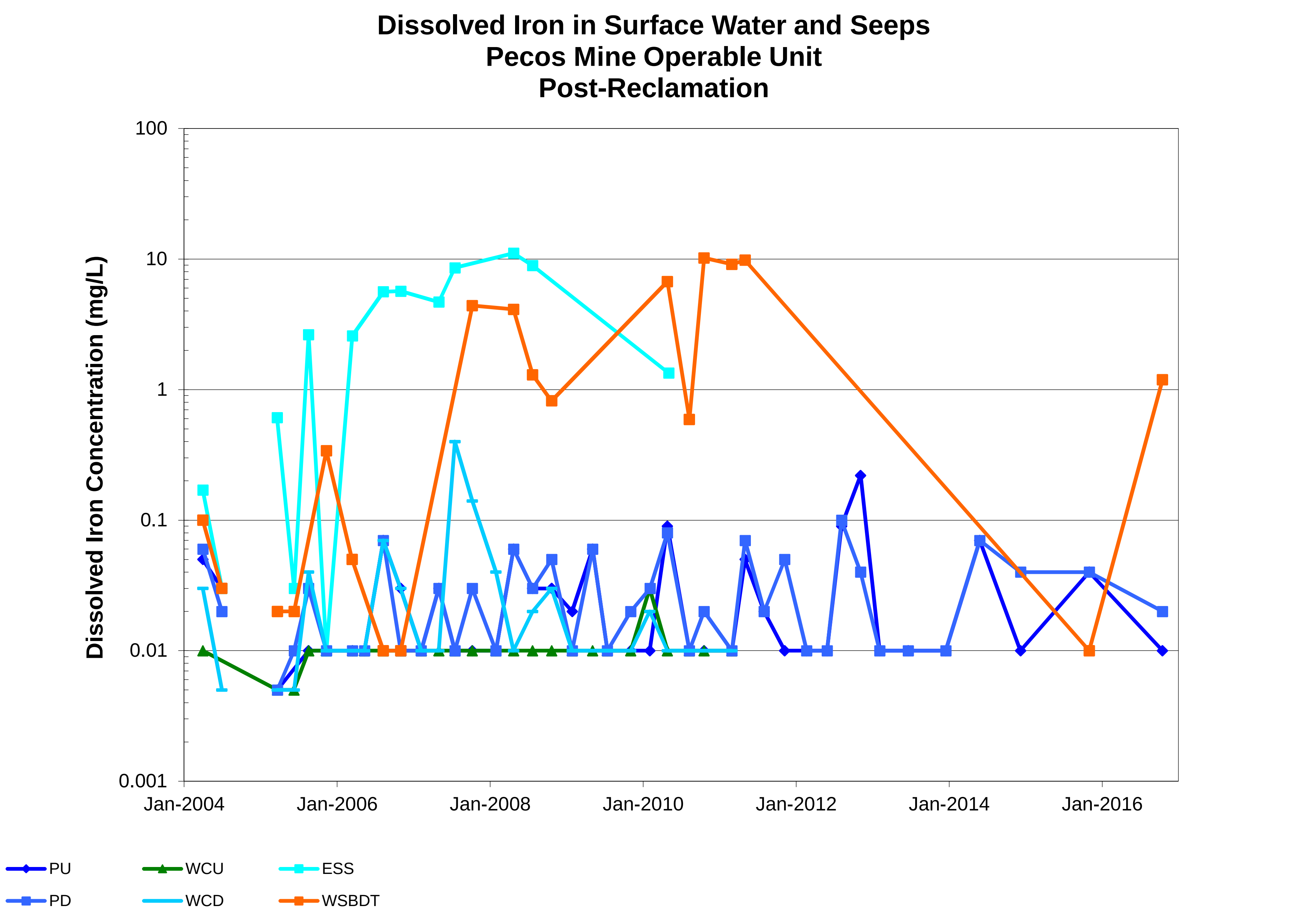
Non-detect values plotted as one-half the method detection limit.
There is no NMWQCC standard for chloride.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Chloride



S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Hardness

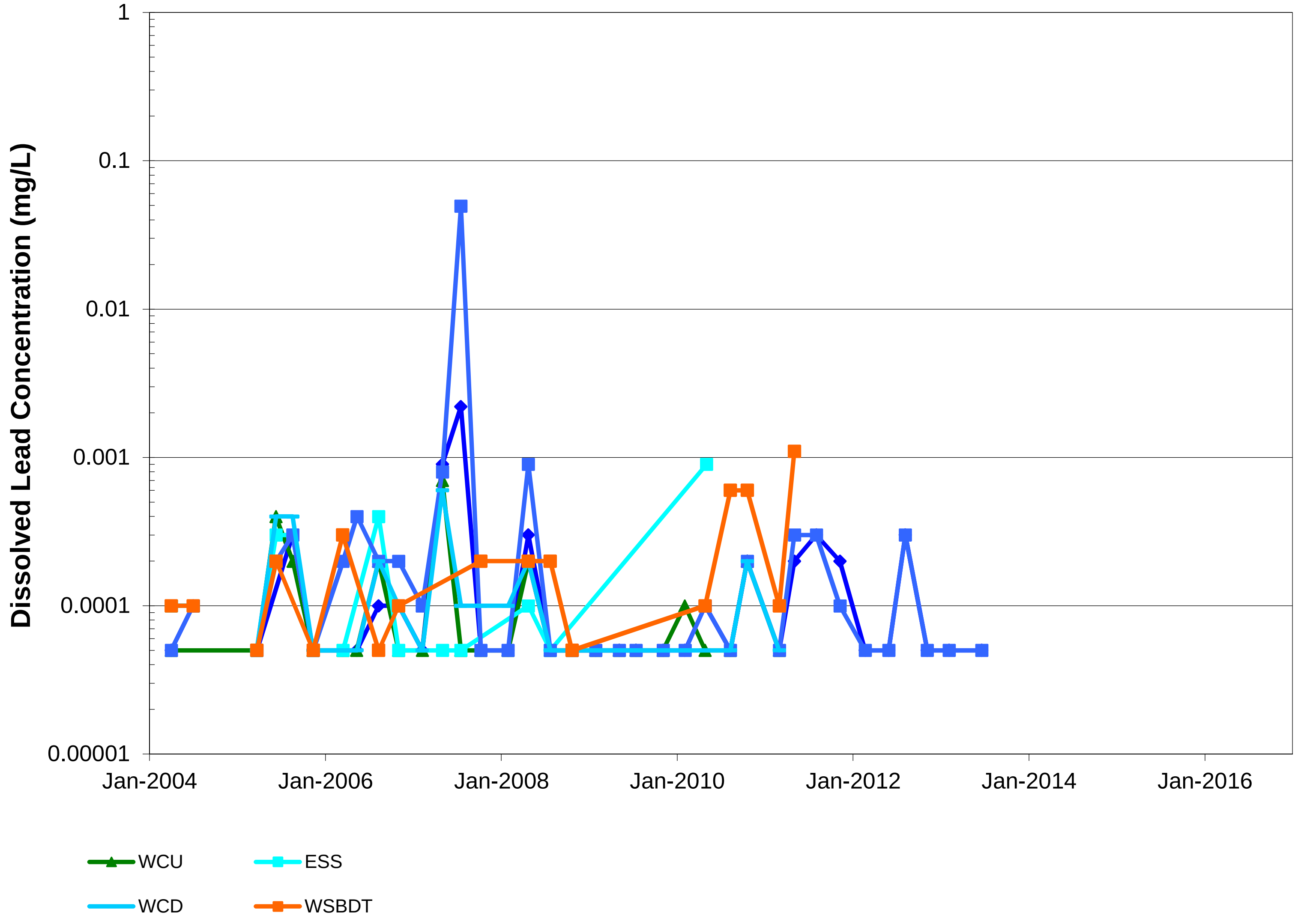
There is no NMWQCC standard for hardness.



Non-detect values plotted as one-half the method detection limit.
There is no NMWQCC standard for iron.

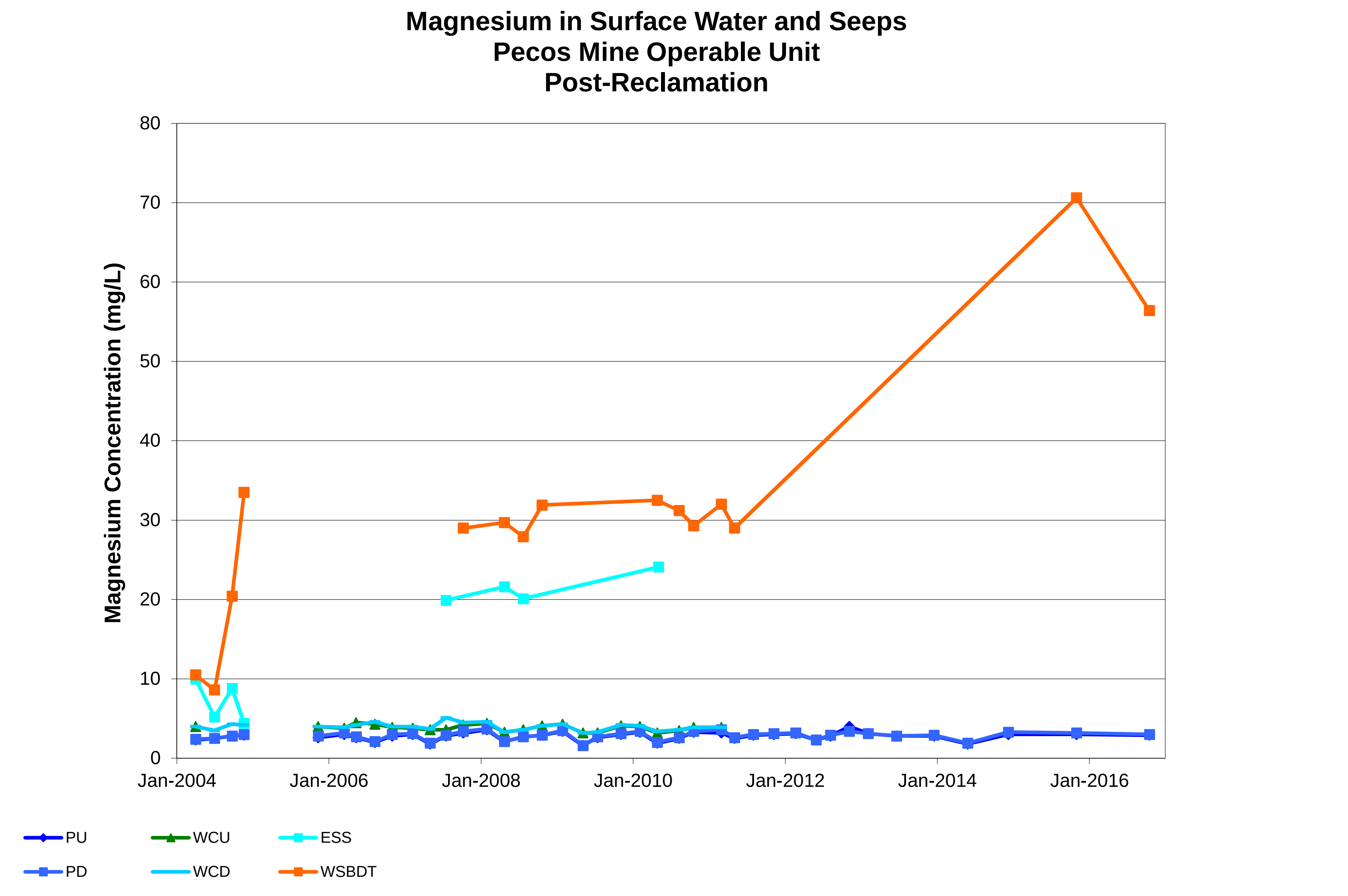
S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Iron

Dissolved Lead in Surface Water and Seeps
Pecos Mine Operable Unit
Post-Reclamation



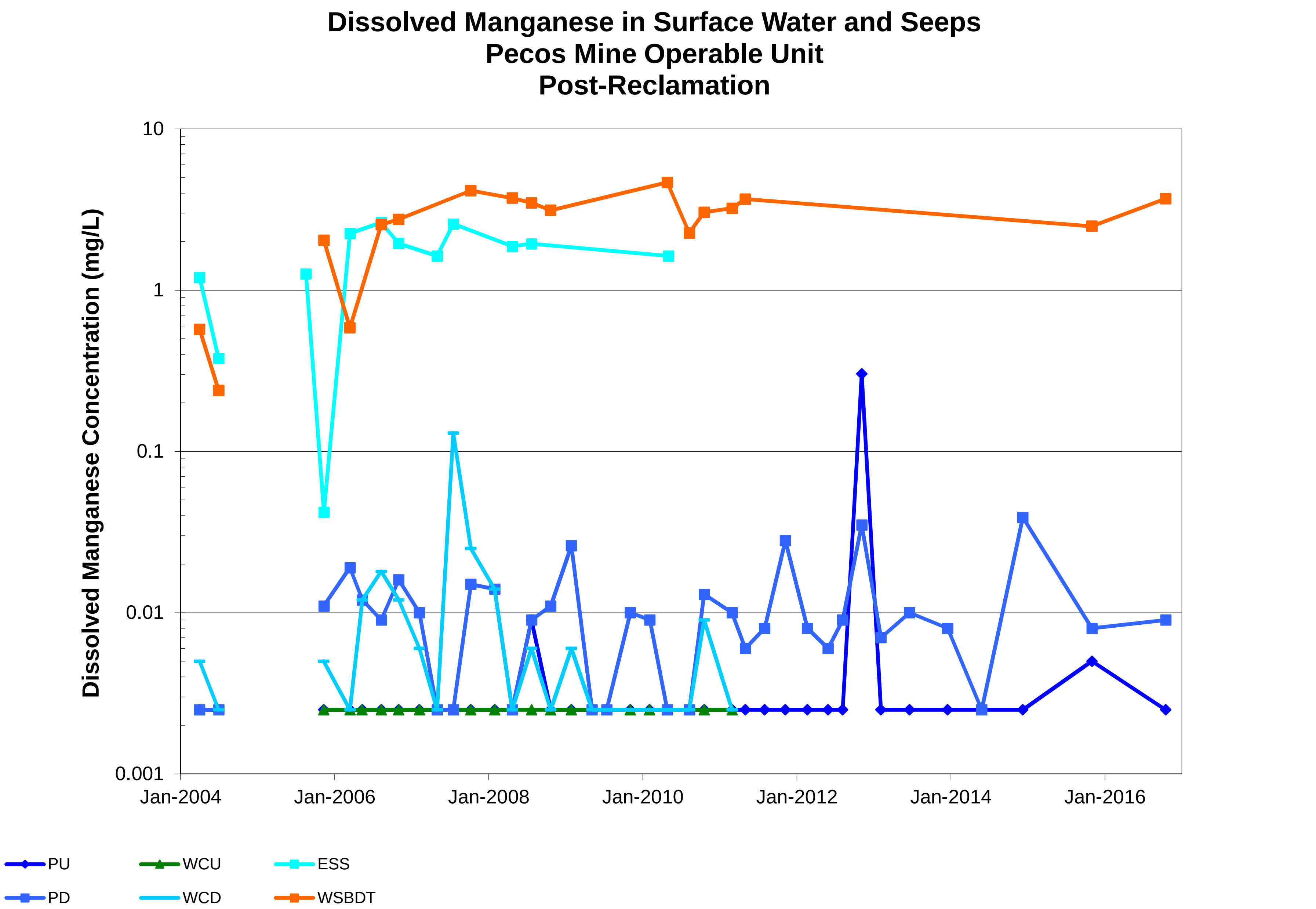
Non-detect values plotted as one-half the method detection limit.
NMWQCC standard for lead calculated using sample hardness measured at each location for each quarter.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Lead



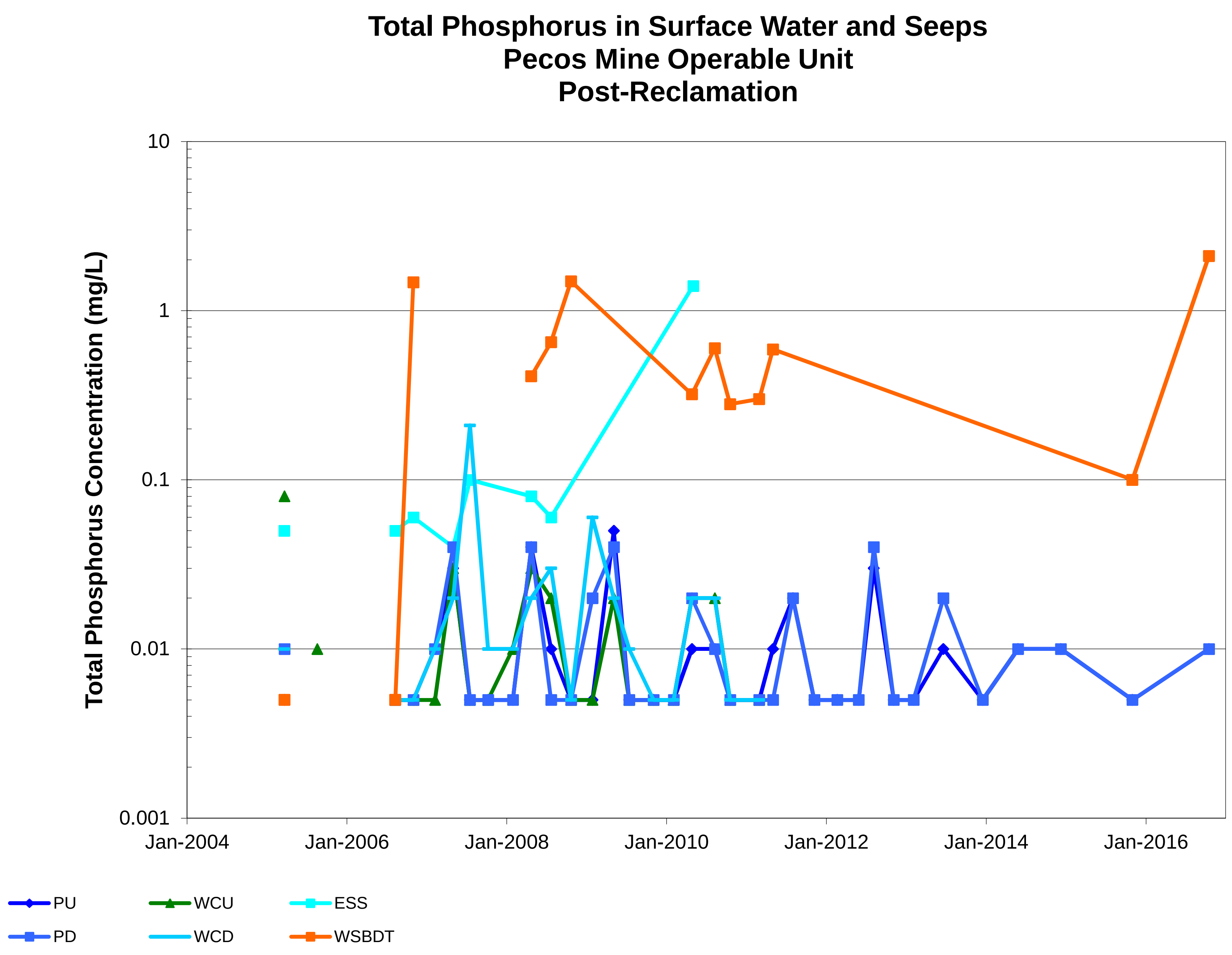
Non-detect values plotted as one-half the method detection limit.
There is no NMWQCC standard for magnesium.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Magnesium



Non-detect values plotted as one-half the method detection limit.
NMWQCC standard for manganses calculated using sample hardness measured at each location for each quarter.

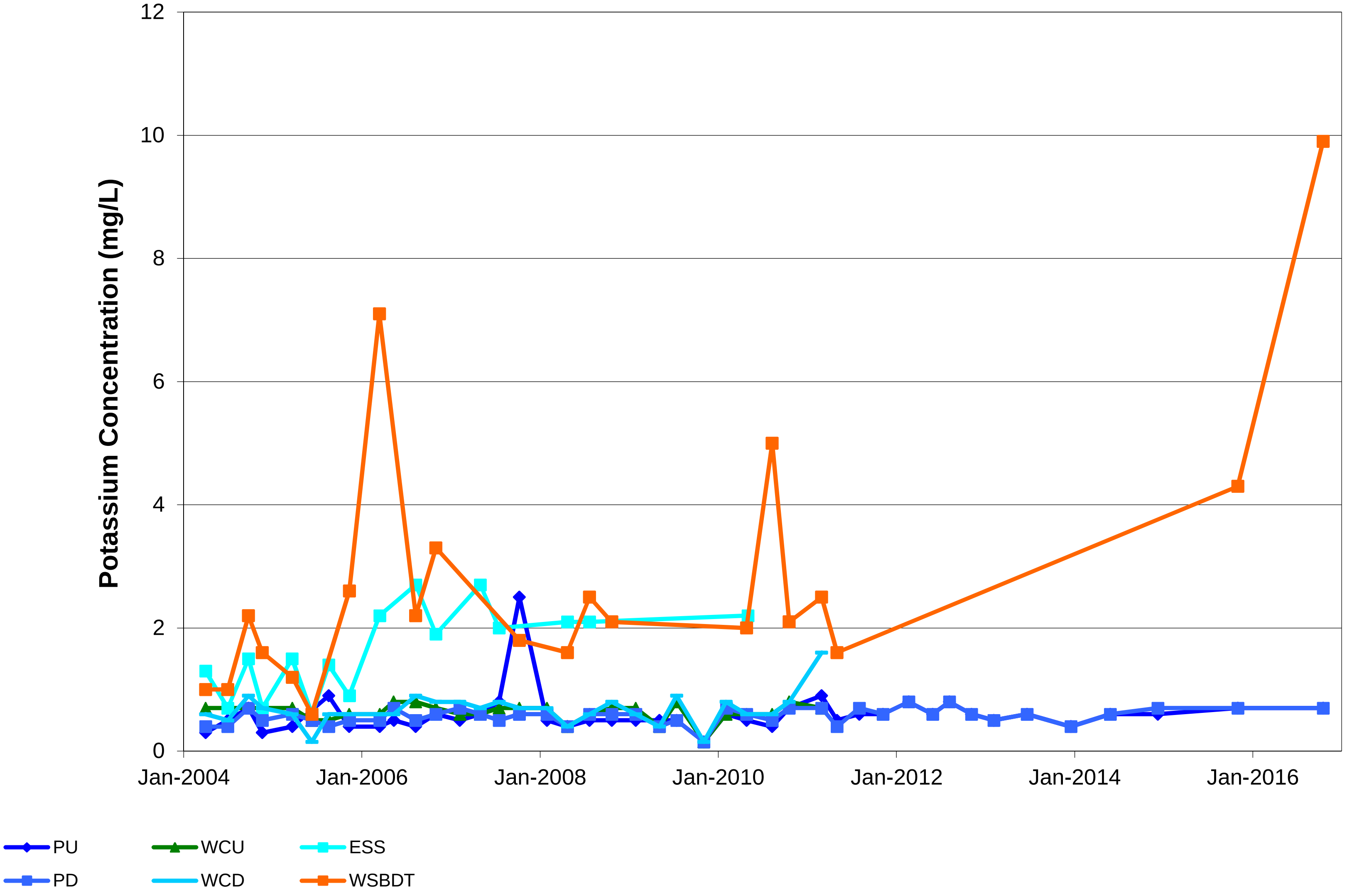
S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Manganese



Non-detect values plotted as one-half the method detection limit.
There is no NMWQCC standard for phosphorus.

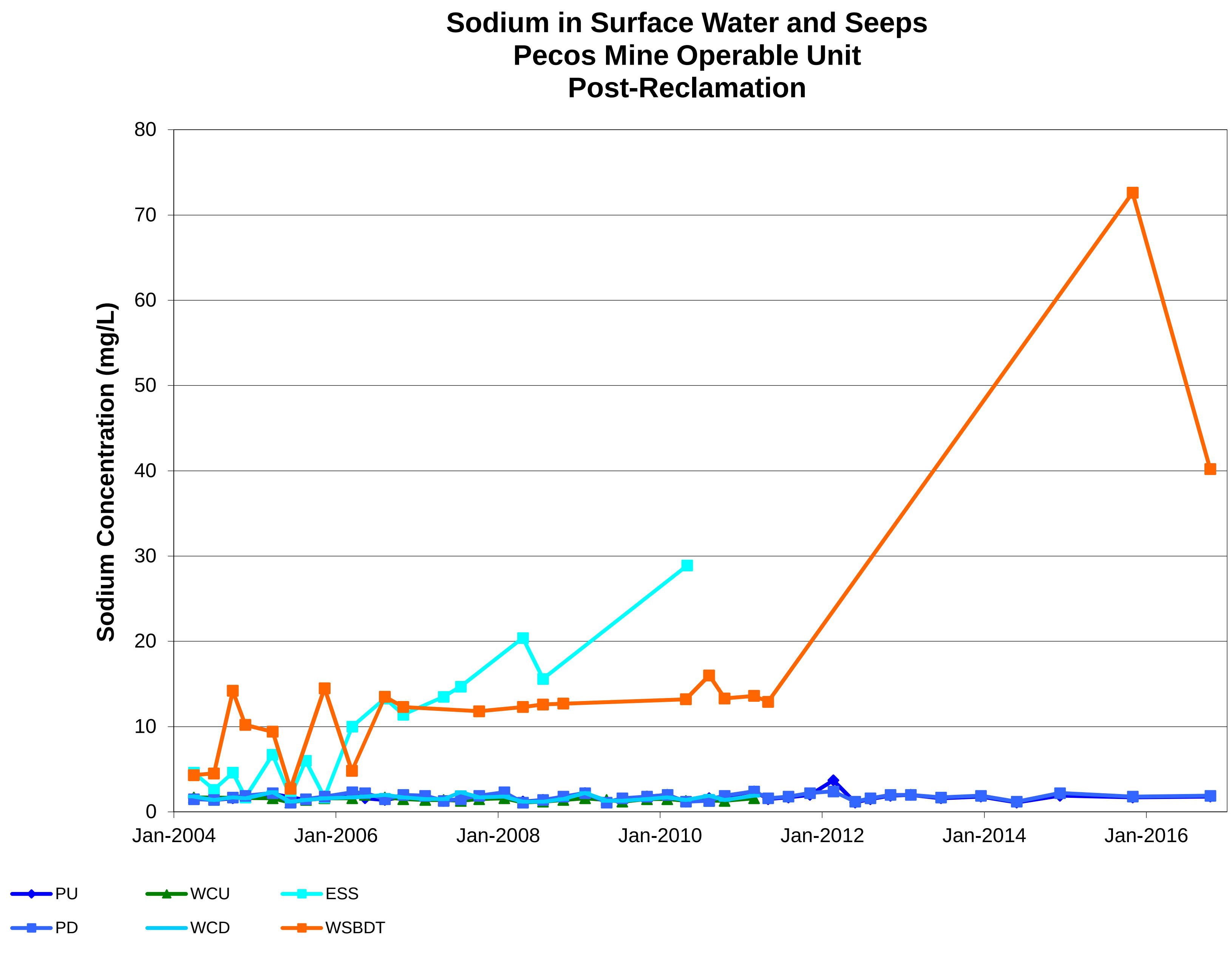
S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Phosphorus

Potassium in Surface Water and Seeps
Pecos Mine Operable Unit
Post-Reclamation



Non-detect values plotted as one-half the method detection limit.
There is no NMWQCC standard for potassium.

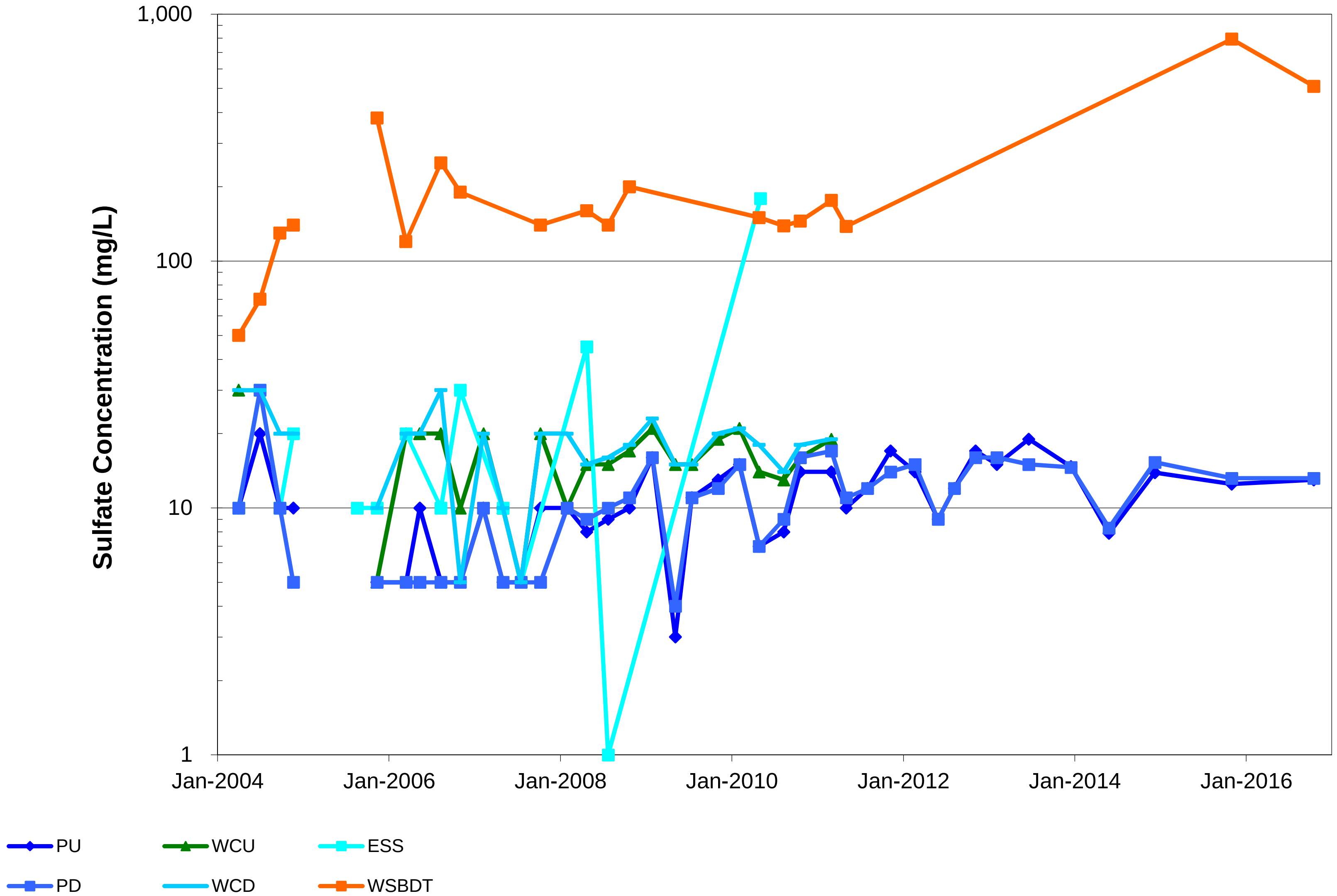
S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Potassium



Non-detect values plotted as one-half the method detection limit.
There is no NMWQCC standard for sodium.

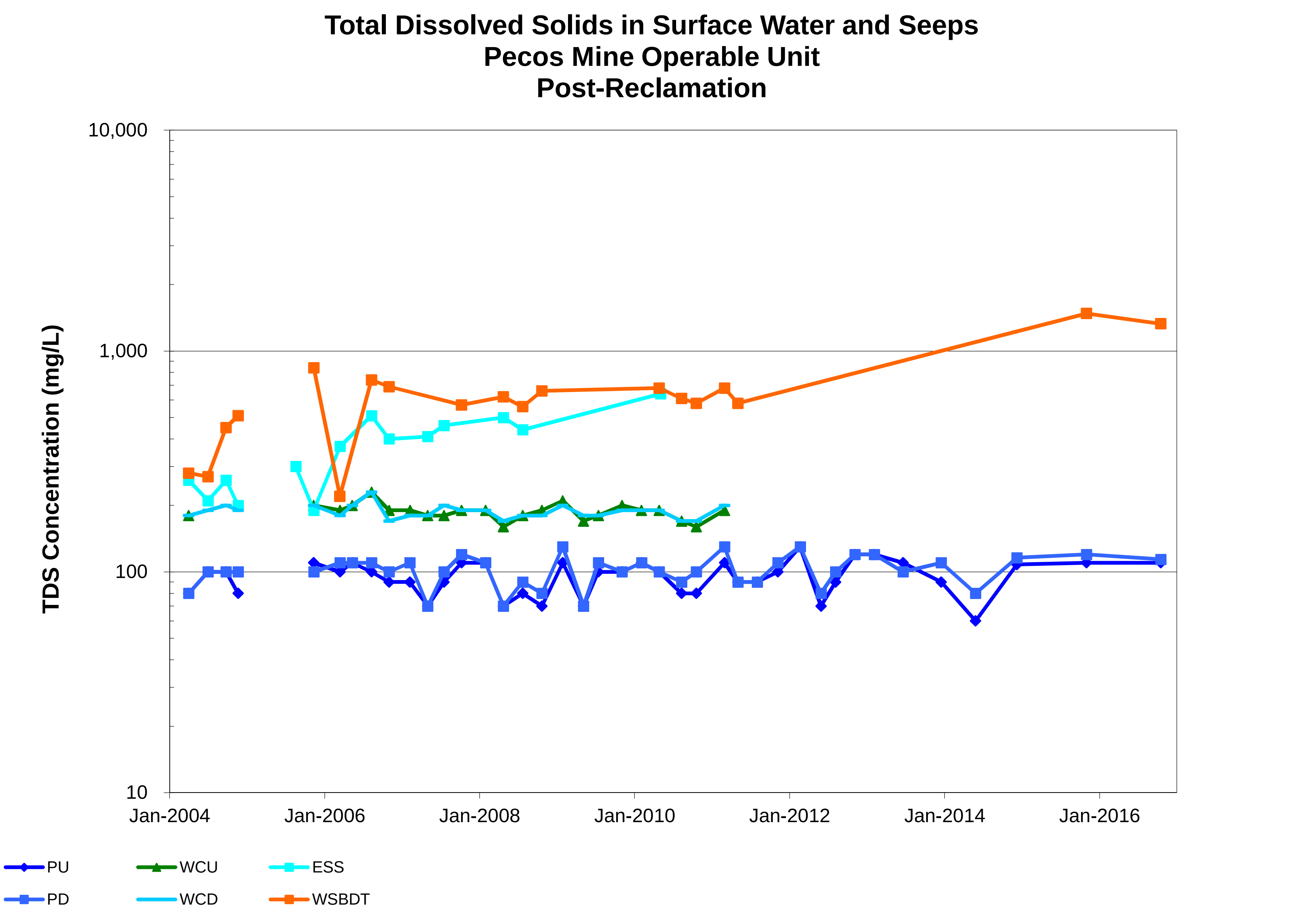
S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Sodium

Sulfate in Surface Water and Seeps
Pecos Mine Operable Unit
Post-Reclamation



Non-detect values plotted as one-half the method detection limit.
There is no NMWQCC standard for sulfate.

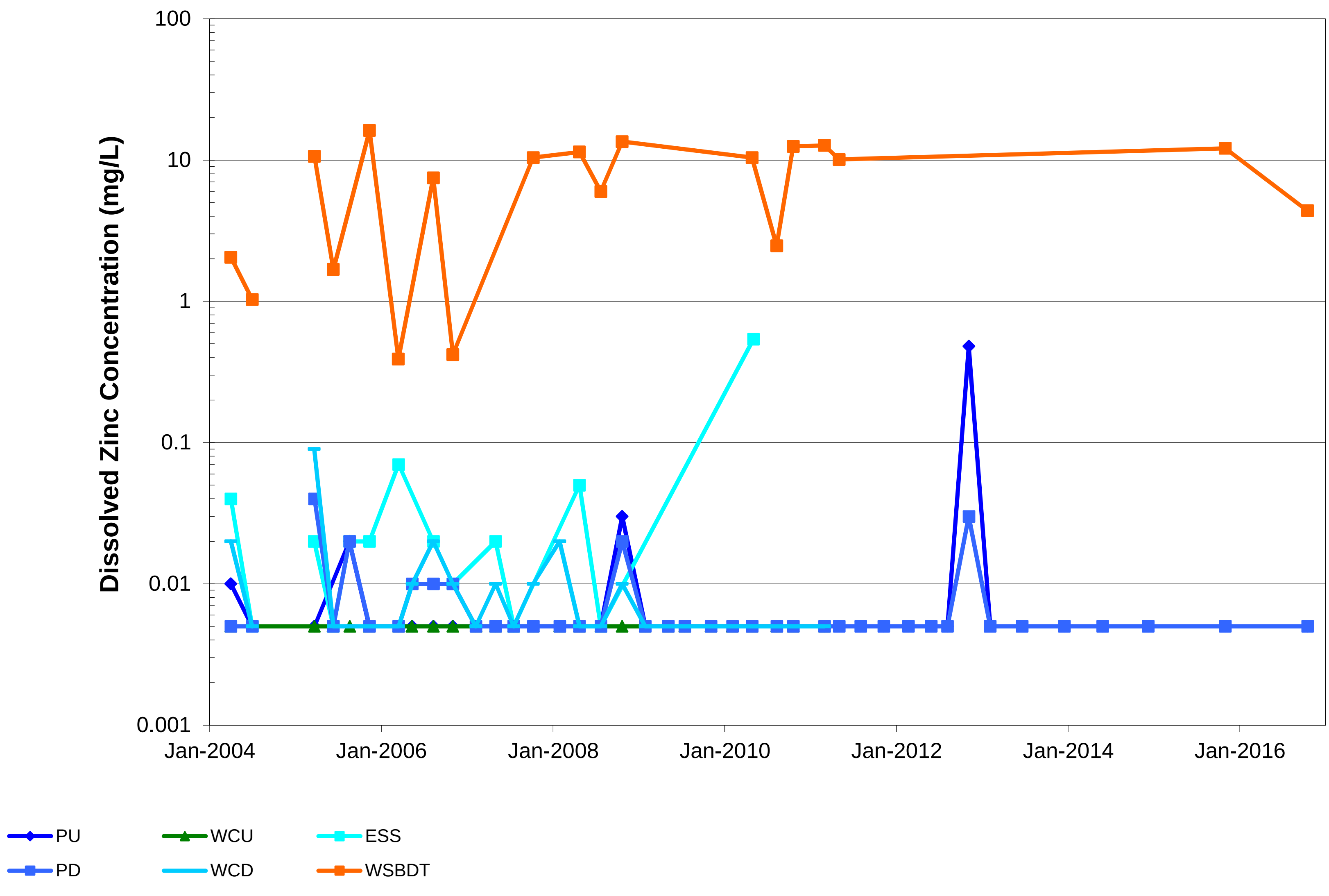
S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Sulfate



S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls TDS

There is no NMWQCC standard for total dissolved solids.

Dissolved Zinc in Surface Water and Seeps
Pecos Mine Operable Unit
Post-Reclamation



Non-detect values plotted as one-half the method detection limit.
NMWQCC standard for zinc calculated using sample hardness measured at each location for each quarter.

S:\Projects\ES06.0038_PMOU\Database\2016 Time-series plots\PMOU SW_thru 4Q-16.xls Zinc

Appendix B

Historical Analytical Results

Groundwater

PMOU historical analytical results for groundwater (mg/L)

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	F	Fe-dis	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Se-dis	SO4	TDS	Zn-dis
P-03	3/22/2005	<0.005		186	0.0007	0.046		<0.1	66.4	<0.0001		<0.01	<0.01	<0.0005	1.4	0.20	<0.0002	1.0		0.016		6.9	<0.01			<0.0001	<0.04	50	270	<0.01
P-03	6/10/2005	<0.005		193	0.0007	0.041		<0.1	63.4	0.0002		<0.01	<0.01	0.0050	1.5	0.18		1.2		0.014		7.8	<0.01			0.0003	<0.04	70	260	<0.01
P-03	8/19/2005	<0.01		192	0.0008	0.043		0.4	60.7	<0.0001		<0.01	<0.01	<0.0005	1.4	0.21		1.0		0.013		7.2	<0.01			0.0004	<0.001	40	270	<0.01
P-03	11/11/2005	<0.00005	<0.03	171	0.0006	0.040	0.03	<0.1	62.2	0.0018	1	<0.01	<0.01	<0.01	1.5	0.18	<0.0002	1.1		0.014	<0.01	7.1	<0.01	0.38		0.0001	<0.0001	20	260	0.02
P-03	3/15/2006	<0.00005	0.06	204	0.0007	0.041	0.01	<0.1	60.8	0.0001	2	<0.01	<0.01	<0.01	1.4	0.24		1.0		0.013	<0.01	7.1	<0.01	<0.02		0.0003	<0.0001	40	250	0.01
P-03	5/11/2006	<0.00005	<0.03	198	0.0006	0.044	0.02	<0.1	65.3	<0.0001	2	<0.01	<0.01	<0.01	1.4	0.20	<0.0002	1.1		0.011	<0.01	7.5	<0.01	<0.02		0.0003	<0.0001	40	260	<0.01
P-03	8/10/2006	<0.00005	<0.03	198	<0.0005	0.042	0.01	<0.1	63.7	<0.0001	1	<0.01	<0.01	<0.01	1.4	0.04	<0.0002	1.2		0.014	<0.01	7.1	<0.01	<0.02	<0.01	0.0001	<0.0001	40	260	0.03
P-03	11/1/2006	<0.00005	<0.03	214	<0.0005	0.043	0.02	<0.1	64.6	0.0006	2	<0.01	<0.01	<0.01	1.4	0.11	<0.0002	1.1		0.015	<0.01	7.2	<0.01	<0.02	<0.01	<0.0001	<0.0001	40	260	<0.01
P-03	2/8/2007	<0.00005	<0.03	194	0.0008	0.046	0.02	<0.1	66.2	<0.0001	1	<0.01	<0.01	<0.01	1.4	0.07	<0.0002	1.1		0.015	0.02	7.6	<0.01	0.03	0.01	0.0074	0.0015	40	250	<0.01
P-03	5/2/2007	<0.00005	<0.03	196	0.0007	0.046	0.02	<0.1	67.3	<0.0001	1	<0.01	<0.01	<0.01	1.2	0.22	<0.0002	1.3		0.013	<0.01	7.2	<0.01	<0.02	<0.01	<0.0001	<0.0001	40	260	<0.01
P-03	7/18/2007	<0.00005	<0.03	201	0.0008	0.041	0.02	<0.1	64.3	<0.0001	1	<0.01	<0.01	<0.0005	1.3	0.20	0.0004	0.9	16.6	0.006	<0.01	7.3	<0.01	0.09	0.02	<0.0001	<0.0001	40	220	<0.01
P-03	10/9/2007	<0.00005	<0.03	199	0.0007	0.041	0.02	<0.1	63.4	<0.0001	<1	<0.01	<0.01	0.0007	1.4	0.21	<0.0002	1.2	16.5	0.012	<0.01	7.2	<0.01	<0.02	<0.01	<0.0001	<0.0001	40	270	<0.01
P-03	1/30/2008	<0.00005	<0.03	197	0.0008	0.051	0.02	<0.1	65.9	<0.0001	2	<0.01	<0.01	0.0005	1.4	0.16	<0.0002	1.0	17.1	0.013	<0.01	7.4	<0.01	<0.02	<0.01	<0.0001	<0.0001	30	260	<0.01
P-03	4/23/2008	<0.0001	<0.03	192	0.0010	0.041	0.01	<0.2	67.0	<0.0001	1	<0.01	<0.01	<0.0005	1.3	0.08	<0.0002	0.8	17.3	<0.005	<0.01	7.1	<0.01	<0.02	<0.01	0.0001	<0.0001	38	260	<0.01
P-03	7/23/2008	<0.00005	<0.03	193	0.0006	0.045	0.02	<0.1	65.4	<0.0001	2	<0.01	<0.01	<0.0005	1.4	0.09	<0.0002	1.1	17.0	0.015	<0.01	7.3	<0.01	0.04	0.01	<0.0001	<0.0001	35	270	<0.01
P-03	10/22/2008	<0.00005	<0.03	190	0.0006	0.045	0.02	<0.1	66.2	<0.0001	1	<0.01	<0.01	<0.0005	1.4	0.23	<0.0002	1.1	17.0	0.015	0.01	7.4	<0.01	<0.02	<0.01	<0.0001	<0.0001	37	250	<0.01
P-03	1/28/2009	<0.00005	<0.03	192	0.0006	0.043	0.02	<0.1	64.8	<0.0001	2	<0.01	<0.01	<0.0005	1.9	0.17	<0.0002	1.1	16.9	0.014	<0.01	7.3	0.01	<0.02	<0.01	0.0005	<0.0001	35	260	<0.01
P-03	5/6/2009	<0.00005	<0.03	191	0.0008	0.043	0.02	<0.01	63.5	<0.0001	1	<0.01	<0.01	<0.0005	1.2	0.15	<0.0002	1.1	15.9	<0.005	<0.01	7.3	<0.01	<0.02	0.02	<0.0001	<0.0001	35	260	<0.01
P-03	7/15/2009	<0.00005	<0.03	200	0.0008	0.041	0.02	<0.01	65.5	<0.0001	<1	<0.01	<0.01	0.0013	1.2	0.18	<0.0002	1.0	17.0	0.013	<0.01	7.2	<0.01	<0.02	<0.01	<0.0001	<0.0001	39	270	0.01
P-03	11/4/2009	<0.00005	<0.03	194	0.0008	0.038	0.01	<0.01	63.4	<0.0001	1	<0.01	<0.01	<0.0005	1.3	0.20	<0.0002	0.8	16.4	0.009	<0.01	6.9	<0.01	<0.02	<0.01	<0.0001	<0.0001	37	260	<0.01
P-03	2/3/2010	<0.00005	<0.06	199	<0.0005	0.041	<0.02	<0.01	66.7	<0.0001	<1	<0.01	<0.01	0.0005	1.2	0.23	<0.0002	1.1	17.4	0.010	<0.01	6.9	<0.01	<0.02	<0.01	0.0001	<0.0001	34	260	<0.01
P-03	4/28/2010	<0.00005	<0.03	200	<0.0005	0.040	0.02	<0.01	63.9	<0.0001	1	<0.01	<0.01	<0.0005	1.3	0.18	<0.0002	1.2	16.4	0.010	<0.01	7.1	0.02	<0.02	0.01	0.0001	<0.0001	40	260	<0.01
P-03	8/11/2010	<0.00005	<0.03	196	0.0009	0.045	<0.01	<0.01	64.1	<0.0001	<1	<0.01	<0.01	<0.0005	1.3	0.14	<0.0002	0.7	16.3	0.006	<0.01	7.2	<0.01	0.42	<0.01	<0.0001	<0.0001	36	260	<0.01
P-03	10/20/2010	<0.00005	<0.03	193	0.0005	0.039	0.01	<0.01	65.7	<0.0001	<1	<0.01	<0.01	<0.0005	1.3	0.20	<0.0002	1.0	16.5	0.014	<0.01	7.0	<0.01	<0.02	<0.01	0.0002	<0.0001	38	240	<0.01
P-03	3/2/2011	<0.00005	<0.03	186	0.0005	0.040	0.01	<0.01	67.1	<0.0001	1	<0.01	<0.01	<0.0005	1.3	0.19	<0.0002	1.4	17.0	0.012	<0.01	7.8	<0.01	<0.02	<0.01	<0.0001	<0.0001	36	260	<0.01
P-03S	3/22/2005	<0.005		164	<0.0005	0.055		<0.1	105	0.0040		<0.01	<0.01	0.0009	<0.1	<0.01	<0.0002	1.0		<0.005		2.1	<0.01			<0.0001	<0.04	100	330	0.01
P-03S	6/10/2005	<0.005		175	<0.0005	0.043		<0.1	78.6	0.0018		<0.01	<0.01	0.0009	0.1	<0.01		0.9		<0.005		2.0	<0.01			0.0003	<0.04	40	260	<0.01
P-03S	8/19/2005	<0.01		188	<0.0005	0.044		<0.1	73.3	0.0004		<0.01	<0.01	0.0008	0.1	<0.02	<0.0002	1.0		<0.005		1.7	<0.01			0.0004	<0.001	30	230	<0.01
P-03S	11/11/2005	<0.00005	<0.03	188	<0.0001	0.042	0.01	<0.1	77.4	0.0004	1	<0.01	<0.01	<0.01	<0.1	<0.02	<0.0002	1.1		0.007	<0.01	1.5	<0.01	0.13		<0.0001	0.0002	30	240	<0.01
P-03S	3/15/2006	<0.00005	<0.03	171	<0.0005	0.034	<0.01	<0.1	66.0	0.0001	2	<0.01	<0.01	<0.01	<0.1	<0.02		0.7		<0.005	<0.01	1.4	<0.01	<0.02		<0.0001	0.0007	10	200	<0.01
P-03S	5/11/2006	<0.00005	0.05	164	<0.0005	0.039	<0.01	<0.1	72.1	0.0001	2	<0.01	<0.01	<0.01	<0.1	0.03	<0.0002	1.0		<0.005	<0.01	1.6	<0.01	<0.02		0.0004	0.0006	30	210	<0.01
P-03S	8/10/2006	<0.00005	<0.03	206	<0.0005	0.054	0.01	<0.1	89.5	0.0017	1	<0.01	<0.01	<0.01	0.2	<0.02	<0.0002	1.4		0.006	<0.01	2.0	<0.01	<0.02	0.45	0.0001	<0.0001	50	310	<0.01
P-03S	11/1/2006	<0.00005	0.06	201	<0.0005	0.047	0.01	<0.1	81.6	0.0002	2	<0.01	<0.01	<0.01	<0.1	0.05	<0.0002	1.0		0.008	<0.01	1.8	<0.01	0.04	0.69	0.0002	0.0002	30	240	<0.01
P-03S	2/8/2007	<0.00005	<0.03	166	<0.0005	0.039	0.01	<0.1	71.6	0.0002	1	<0.01	<0.01	<0.01	0.1	<0.02	<0.0002	0.8		0.010	<0.01	1.6	<0.01	0.05	0.21	0.0002	0.0005	20	200	<0.01
P-03S	5/2/2007	<0.00005	0.04	174	<0.0005	0.047	<0.01	<0.1	88.1	0.0003	1	<0.01	<0.01	<0.01	<0.1	<0.02	0.0002	1.4		<0.005	<0.01	1.9	<0.01	<0.02	0.14	<0.0001	<0.0001	50	260	<0.01
P-03S	7/18/2007																													
P-03S	10/9/2007	<0.00005	0.06	190	<0.0005	0.043	0.01	<0.1	76.1	0.0003	<1	<0.01	<0.01	0.0009	0.1	<0.02	<0.0002	1.2	4.4	0.013	<0.01	1.6	<0.01	0.12	0.1	<0.0001	0.0002	20	240	0.02
P-03S	1/30/2008	<0.00005	0.05	163	<0.0005	0.045	0.01	<0.1	72.6	0.0002	2	<0.01	<0.01	<0.0005	<0.1	<0.02	<0.0002	0.8	4.3	0.006	<0.01	1.3	<0.01	0.04	0.16	<0.0001	0.0006	20	210	<0.01
P-03S	4/23/2008	<0.00005	0.07	170	<0.0005	0.042	<0.01	<0.1	87.6	0.0002	1	<0.01	<0.01	0.0010	<0.1	<0.02	<0.0002	0.8	5.1	<0.005	<0.01	1.9	<0.01	0.12	0.22	0.0002	0.0001	56	270	<0.01
P-03S	7/23/2008	<0.00005	<0.03	181	<0.0005	0.045	0.01	<0.1	77.3	0.0002	2	<0.01	<0.01	0.0006	0.1	<0.02	<0.0002	0.9	4.4	0.008	<0.01	1.6	<0.01	0.02	0.22	<0.0001	0.0002	21	230	0.05
P-03S	10/22/2008	<0.00005	0.05	173	<0.0005	0.044	<0.01	<0.1	80.0	0.0003	1	<0.01	<0.01	0.0006	0.2	<0.02	0.0003	1.0	4.6	0.009	<0.01	1.6	<0.01	<0.02	0.10	<0.0001	0.0002	27	230	<0.01
P-03S	1/28/2009	<0.00005	0.04	168	<0.0005	0.036	<0.01	<0.1	72.5	0.0002	2	<0.01	<0.01	0.0013	0.1	0.04	<0.0002	0.7	4.3	0.006	<0.01	1.3	<0.01	0.06	0.14	0.0002	0.0004	30	210	<0.01
P-03S	5/6/2009	<0.00005	0.07	198	<0.0005	0.048	<0.01	<0.01	88.0	0.0005	1	<0.01	<0.01	0.0012	0.1	0.10	<0.0002	0.9	5.1	<0.005	<0.01	1.8	<0.01	0.03	0.26	0.0005	0.0006	52	280	<0.01
P-03S	7/15/2009	<0.00005	<0.03	185	<0.0005	0.042	0.01	<0.01	77.5	0.0002	<1	<0.01	<0.01	0.0011	0.1	<0.02	<0.0002	1.3	4.5	<0.005	<0.01	1.9	<0.01	0.03	0.20	<0.0001	0.0002	35	230	<0.01
P-03S	11/4/2009	<0.00005	0.07	178	<0.0005	0.038	<0.01	<0.01	80.6	0.0004	1	<0.01	<0.01	0.0014	0.1	0.10	<0.0002	0.7	4.6	0.005	<0.01	1.5	<0.01	<0.02	0.33	0.0006	0.0004	38	260	<0.01
P-03S	2/3/2010	<0.00005	0.08	168	<0.0005	0.034	<0.01	<0.01	73.6	0.0004	1	<0.01	<0.01	0.0011	0.1	0.07	<0.0002	1.0	4.2	<0.005	<0.01	1.4	<0.01	0.05	0.23	0.0004	0.0006	27	220	<0.01
P-03S	4/28/2010	<0.00005	<0.03	180	<0.0005	0.044	0.01	<0.01	93.6	0.0007	1	<0.01	<0.01	0.0047	<0.1	0.06	<0.0002	1.1	5.5	<0.005	<0.01	2.7	0.01	0.08	0.09	0.0002	0.0008	60	300	<0.01
P-03S	8/11/2010	<0.00005	<0.03	190	<0.0005	0.051	<0.01	<0.01	82.5	0.0009	<1	<0.01	<0.01	<0.0005	0.2	<0.02	<0.0002	0.8	4.6	<0.005	<0.01	1.6	<0.01	<0.02	0.16	0.0002	<0.0001	32	240	<0.01
P-03S	10/20/2010	<0.00005	<0.03	175	<0.0005	0.037	0.01	<0.01	72.7	0.0011	<1	<0.01	<0.01	0.0005	<0.1	<0.02	<0.0002	0.9	3.9	0.007	<0.01	1.4	<0.01	0.02	0.12	0.0002	0.0002	20	190	<0.01
P-03S	3/2/2011	<0.00005	0.09	155	<0.0005	0.036	<0.01	<0.01	68.4	0.0003	1	<0.01	<0.01	0.0009	0.1	0.09	<0.0002	1.0	4.0	0.126	<0.01	1.6	0.02	0.05	0.19	0.0004	0.0006	22	200	<0.01
P-07	6/30/2004			379	<0.0005				111	<0.0001	5			<0.0005		2.06		2.1	18.1	0.894		9.8				0.0002		10	380	<0.01
P-07	9/23/2004			395	<0.0005				110	<0.0001	3			<0.0005		1.88		1.9	18.0	0.890		9.4				<0.0001		<10	380	<0.01
P-07	3/21/2005	<0.005		337	<0.0005	3.310		<0.1	114	<0.0001		<0.01	<0.01	<0.0005	1.5	2.65	<0.0002	1.9		0.895		9.5	<0.01			<0.0001	<0.04	<10	380	0.01
P-07	6/10/2005	<0.005		363	<0.0005	3.150		<0.1	111	<0.0001		<0.01	<0.01	0.0007	1.8	3.18		2.0		0.858		9.4	<0.01			0.0003	<0.04	<10	380	0.01

Notes: Blank records were not analyzed. Samples collected using hydrasleeve methodology during December 2013 through December 2014.

PMOU historical analytical results for groundwater (mg/L)

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	F	Fe-dis	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Se-dis	SO4	TDS	Zn-dis
P-07	8/19/2005	<0.01		369	0.0010	2.620		2700	108	0.0027		<0.01	<0.01	0.0019	1.5	4.83		2.0		1.040		9.7	<0.01			0.0031	<0.001	<10	820	0.21
P-07	11/11/2005	<0.00005	<0.03	361	0.0002	2.990	0.02	<0.1	111	<0.0001	2	<0.01	<0.01	<0.01	1.7	2.99	<0.0002	1.9		0.857	<0.01	9.2	<0.01	<0.02		<0.0001	<0.0001	<10	370	<0.01
P-07	3/14/2006	<0.00005	<0.03	382	<0.0005	3.180	0.02	<0.1	110	<0.0001	3	<0.01	<0.01	<0.01	1.7	3.32		1.9		0.893	<0.01	9.7	<0.01	0.06		<0.0001	0.0003	<10	400	<0.01
P-07	5/11/2006	<0.00005	<0.03	392	<0.0005	3.420	0.02	<0.1	113	<0.0001	3	<0.01	<0.01	<0.01	1.6	3.29	<0.0002	2.0		0.864	<0.01	9.7	<0.01	<0.02		0.0002	<0.0001	<10	380	<0.01
P-07	8/11/2006	<0.00005	<0.03	371	<0.0005	3.260	0.02	<0.1	115	<0.0001	4	<0.01	<0.01	<0.01	1.6	3.43	<0.0002	2.1		0.916	<0.01	9.9	<0.01	0.02	<0.01	0.0001	<0.0001	<10	1980	<0.01
P-07	11/1/2006	<0.00005	<0.03	385	<0.0005	3.190	0.03	<0.1	114	<0.0001	3	<0.01	<0.01	<0.01	1.7	3.07	<0.0002	2.0		0.897	<0.01	9.7	<0.01	<0.02	0.02	0.0002	<0.0001	10	380	<0.01
P-07	2/8/2007	<0.00005	<0.03	367	<0.0005	3.270	0.03	<0.1	116	<0.0001	3	<0.01	<0.01	<0.01	1.7	2.89	0.0002	2.1		0.945	<0.01	10.2	<0.01	0.03	0.02	<0.0001	<0.0001	<10	1510	<0.01
P-07	5/2/2007	<0.00005	<0.03	368	<0.0005	3.600	0.02	<0.1	122	<0.0001	3	<0.01	<0.01	<0.01	1.5	3.27	<0.0002	2.3		0.970	<0.01	9.9	<0.01	<0.02	0.02	<0.0001	<0.0001	<10	390	<0.01
P-07	7/18/2007	<0.00005	<0.03	380	<0.0005	3.240	0.03	<0.1	113	<0.0001	3	<0.01	<0.01	<0.0005	1.7	3.27	0.0003	2.1	18.4	0.924	<0.01	9.9	<0.01	0.03	0.03	<0.0001	<0.0001	<10	390	<0.01
P-07	10/9/2007	<0.00005	<0.03	382	<0.0005	3.37	0.03	<0.1	113	<0.0001	3	<0.01	<0.01	0.0011	1.7	3.42	<0.0002	2	18.9	0.901	<0.01	10.2	<0.01	<0.02	<0.01	<0.0001	<0.0001	<10	390	<0.01
P-07	1/30/2008	<0.00005	<0.03	369	0.0005	3.580	0.03	<0.1	124	<0.0001	3	<0.01	<0.01	0.0010	1.7	3.77	<0.0002	2.2	20.3	0.981	<0.01	10.9	<0.01	<0.02	0.01	0.0002	<0.0001	<10	390	<0.01
P-07	4/23/2008	<0.00005	0.04	362	0.0009	3.340	<0.01	<0.2	115	<0.0001	3	<0.01	<0.01	0.0009	1.6	3.21	<0.0002	1.7	18.8	0.900	<0.01	9.8	<0.01	<0.02	<0.01	0.0002	<0.0001	<1	380	<0.01
P-07	7/23/2008	<0.00005	<0.03	403	0.0006	3.430	0.02	<0.1	116	<0.0001	4	<0.01	<0.01	0.0006	1.4	2.99	<0.0002	2.1	19.2	0.932	<0.01	21.7	<0.01	<0.02	1.16	<0.0001	<0.0001	<1	410	<0.01
P-07	10/22/2008	<0.00005	<0.03	361	<0.0005	3.470	0.02	<0.5	115	<0.0001	3	<0.01	<0.01	0.0006	1.5	3.54	<0.0002	2.1	18.9	0.942	0.01	10.3	<0.01	<0.02	0.02	<0.0001	<0.0001	<1	400	<0.01
P-07	1/28/2009	<0.00005	<0.03	357	<0.0005	3.240	0.02	<0.1	112	<0.0001	4	<0.01	<0.01	0.0006	0.2	3.44	<0.0002	2.0	18.5	0.924	<0.01	10.1	<0.01	0.04	0.02	<0.0001	<0.0001	6	400	<0.01
P-07	5/6/2009	<0.00005	<0.03	373	0.0006	3.370	0.02	<0.05	115	<0.0001	3	<0.01	<0.01	0.0013	1.5	3.36	<0.0002	2.0	18.3	0.942	<0.01	10.3	<0.01	0.03	0.05	<0.0001	<0.0001	<1	390	<0.01
P-07	7/15/2009	<0.00005	<0.03	383	0.0006	3.230	0.02	<0.01	116	<0.0001	3	<0.01	<0.01	<0.0005	1.6	3.61	<0.0002	2.2	18.6	0.916	<0.01	10.3	<0.01	<0.02	0.02	<0.0001	<0.0001	<1	400	<0.01
P-07	11/4/2009	<0.00005	<0.03	375	0.0007	3.240	0.02	<0.1	112	<0.0001	3	<0.01	<0.01	0.0008	1.6	3.48	<0.0002	1.5	18.5	0.922	<0.01	9.8	<0.01	<0.02	<0.01	0.0001	<0.0001	<1	400	<0.01
P-07	2/4/2010	<0.00005	<0.03	384	0.0007	2.960	<0.01	<0.05	121	<0.0001	3	<0.01	<0.01	0.0010	1.5	3.88	<0.0002	2.3	20.1	0.916	<0.01	9.9	<0.01	<0.02	<0.01	0.0001	<0.0001	<1	410	<0.01
P-07	4/28/2010	<0.00005	<0.03	385	<0.0005	3.310	0.01	<0.05	120	<0.0001	3	<0.01	<0.01	0.0011	1.6	3.77	<0.0002	2.0	19.4	0.938	<0.01	10.0	0.02	<0.02	0.01	<0.0001	<0.0001	<5	400	<0.01
P-07	8/11/2010	<0.00005	0.03	379	0.0009	3.620	0.02	<0.05	115	<0.0001	3	<0.01	<0.01	<0.0005	1.6	2.96	<0.0002	1.7	18.9	0.925	<0.01	10.6	<0.01	<0.02	0.02	<0.0001	<0.0001	<1	390	<0.01
P-07	10/20/2010	<0.00005	<0.03	376	0.0006	3.450	0.02	0.04	121	<0.0001	3	<0.01	<0.01	0.0006	1.6	3.72	<0.0002	2.1	19.4	0.935	<0.01	10.5	<0.01	0.06	0.03	0.0003	<0.0001	<1	420	<0.01
P-07	3/2/2011	<0.00005	<0.03	367	<0.0005	3.270	<0.01	<0.1	122	<0.0001	3	<0.01	<0.01	0.0005	1.7	4.13	<0.0002	2.3	19.6	1.030	<0.01	10.9	<0.01	<0.02	0.01	<0.0001	<0.0001	<5	400	<0.01
P-07	5/4/2011			367	<0.0005	3.210		<0.02	113	<0.0001	<5	0.01			1.6	3.93		1.9	18.4	1.000		10.5			0.01			<1	410	<0.01
P-07	8/3/2011			366	0.0005	3.460		<0.05	118	<0.0001	3	<0.01			1.7	3.83		2.2	19.6	1.000		10.4			0.02			<5	400	<0.01
P-07	11/9/2011			372	0.0007	3.280		<0.02	117	0.0002	3	<0.01			1.6	3.66		2.0	18.9	0.919		10.6			0.08			<1	420	0.03
P-07	2/22/2012			386	<0.0005	3.400		<0.05	113	<0.0001	3	<0.01			1.7	3.74		2.1	18.3	0.966		10.2			0.01			<10	420	<0.01
P-07	5/30/2012			384	0.0006	3.490		<0.02	114	<0.0001	3	<0.01			1.7	3.79		2.2	18.6	0.976		10.4			<0.01			<1	400	<0.01
P-07	8/7/2012			367	0.0005	3.530		<0.1	115	<0.0001	3	<0.01			1.6	3.61		2.2	18.6	0.961		10.3			<0.01			<1	410	0.02
P-07	11/6/2012			372	0.0006	3.460		<0.05	116	<0.0001	3	<0.01			1.7	3.79		2.1	18.5	0.948		10.3			0.02			<5	420	<0.01
P-07	2/5/2013			374	0.0008	3.450		<0.1	116	<0.0001	3	<0.01			1.7	3.84		2.1	18.9	0.978		10.6			0.01			<10	430	0.01
P-07	6/21/2013			392	0.0006	3.410		<0.1	116	<0.0001	2	<0.01			1.6	4.02		2.1	18.4	1.000		10.2			0.02			<5	410	<0.01
P-07	12/18/2013			395		3.990		<0.05	117	<0.0001		<0.01			1.65	3.79		2	18.4	0.931		10.5						<1	460	<0.01
P-07	5/29/2014			420		3.750		<0.1	119	<0.0001		<0.01			1.61	3.91		2.2	18.2	0.955		10.6						<1	400	<0.01
P-07	12/10/2014			424		3.950		<0.05	120	<0.0001		<0.01			1.66	4.03		2.1	18.5	0.973		10.3						1.38	414	<0.01
P-07	11/3/2015			406		3.410		<0.05	120	<0.0001		<0.01			1.56	4.07		2.1	18.5	0.989		10.4						<0.5	412	<0.01
P-07	10/18/2016					3.400									0.31	4.18				1.00									422	

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	F	Fe-dis	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Se-dis	SO4	TDS	Zn-dis
P-07S	6/30/2004			378	0.0021				118	<0.0001	3			<0.0005		7.29		2.1	17.8	2.050		10.1				0.0002		20	390	<0.01
P-07S	9/23/2004			397	0.0063				121	<0.0001	4			0.0007		5.94		2.0	18.1	2.140		10.1				0.0006		10	410	0.13
P-07S	11/19/2004			379	<0.005				129	<0.001	11			<0.0005		11.50		2.0	18.4	2.180		11.1				<0.001		<10	410	<0.01
P-07S	3/21/2005	<0.005		325	0.0104	0.315		0.2	163	<0.0001		<0.01	<0.01	<0.0005	1.2	8.76	<0.0002	2.5		2.530		17.7	<0.01			<0.0001	<0.04	150	590	4.53
P-07S	6/10/2005	<0.005		358	0.0026	0.473		<0.1	113	0.0003		<0.01	<0.01	0.0010	1.8	14.00		2.1		2.280		10.0	<0.01			0.0002	<0.04	<10	390	2.73
P-07S	8/19/2005	<0.01		383	0.0042	0.700		0.3	115	<0.0001		<0.01	<0.01	<0.0005	1.5	12.40		2.0		1.990		10.4	<0.01			0.0003	<0.001	<10	420	0.24
P-07S	11/11/2005	<0.00005	<0.03	434	0.0015	0.717	0.02	<0.1	125	<0.0001	5	<0.01	<0.01	<0.01	1.6	11.30	0.0003	2.2		2.090	<0.01	13.1	<0.01	<0.02		<0.0001	<0.0001	<10	400	<0.01
P-07S	3/14/2006	<0.00005	<0.03	399	0.0026	0.743	0.02	<0.1	114	<0.0001	5	<0.01	<0.01	<0.01	1.5	12.80		1.6		2.070	<0.01	9.4	<0.01	0.02		0.0002	0.0001	<10	360	<0.01
P-07S	5/11/2006	<0.00005	<0.03	385	0.0038	0.757	0.02	<1	119	<0.0001	3	<0.01	<0.01	<0.01	1.5	14.70	<0.0002	1.9		2.030	<0.01	10.0	<0.01	<0.02		0.0003	<0.0001	<10	390	0.09
P-07S	8/11/2006	<0.00005	<0.03	383	0.0106	0.526	0.03	<1	142	<0.0001	9	<0.01	<0.01	<0.01	1.6	16.80	<0.0002	2.5		2.460	<0.01	19.4	<0.01	0.03	0.28	<0.0001	<0.0001	40	480	1.58
P-07S	11/1/2006	<0.00005	<0.03	373	0.0098	0.616	0.03	<0.1	118	<0.0001	5	<0.01	<0.01	<0.01	1.6	11.70	<0.0002	2.0		1.970	<0.01	12.7	<0.01	<0.02	0.26	0.0001	<0.0001	10	420	0.34
P-07S	2/8/2007	<0.00005	<0.03	377	0.0042	0.728	0.02	<2	121	<0.0001	4	<0.01	<0.01	<0.01	1.5	13.60	<0.0002	1.9		2.150	<0.01	10.6	<0.01	0.03	0.08	<0.0001	<0.0001	<10	400	0.07
P-07S	5/2/2007	<0.00005	<0.03	378	0.0028	0.741	0.02	<0.5	123	<0.0001	4	<0.01	<0.01	<0.01	1.3	15.90	<0.0002	2.3		2.100	<0.01	10.5	<0.01	<0.02	0.04	<0.0001	<0.0001	<10	430	0.43
P-07S	7/18/2007	<0.00005	0.04	390	0.0038	0.637	0.03	<0.1	119	<0.0001	5	<0.01	<0.01	<0.0005	1.5	16.50	0.0003	2.2	18.3	2.040	<0.01	11.3	<0.01	0.04	0.09	<0.0001	<0.0001	<10	420	0.56
P-07S	10/9/2007	<0.00005	0.04	398	0.0032	0.703	0.03	<1	117	<0.0001	4	<0.01	<0.01	0.001	1.5	15.4	<0.0002	2.1	17.9	2.08	<0.01	11.1	<0.01	0.02	0.08	<0.0001	<0.0001	10	410	0.05
P-07S	1/30/2008	<0.00005	0.04	392	0.0011	0.779	0.02	<1	131	<0.0001	6	<0.01	<0.01	0.0007	1.4	15.20	<0.0002	2.1	19.9	2.320	<0.01	13.7	<0.01	0.07	0.06	<0.0001	<0.0001	30	470	0.09
P-07S	4/23/2008	<0.00005	0.05	345	0.0045	0.437	0.02	<1	121	<0.0001	4	<0.01	<0.01	0.0006	1.5	17.80	<0.0002	1.9	18.8	2.030	<0.01	11.0	<0.01	<0.02	0.08	0.0002	<0.0001	11	420	1.55
P-07S	7/23/2008	<0.00005	<0.03	372	0.0040	0.749	0.02	<1	122	<0.0001	4	<0.01	<0.01	<0.0005	1.4	15.90	<0.0002	2.0	18.9	2.140	<0.01	11.0	<0.01	<0.02	0.07	<0.0001	<0.0001	<1	410	0.22

Notes: Blank records were not analyzed. Samples collected using hydrasleeve methodology during December 2013 through December 2014.

PMOU historical analytical results for groundwater (mg/L)

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	F	Fe-dis	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Se-dis	SO4	TDS	Zn-dis
P-07S	10/22/2008	<0.00005	0.03	386	0.0031	0.798	0.02	<1	125	<0.0001	6	<0.01	<0.01	<0.0005	1.3	15.90	0.0003	2.2	19.0	2.260	0.01	11.8	<0.01	0.03	0.07	<0.0001	<0.0001	<1	420	<0.01
P-07S	1/28/2009	<0.00005	<0.03	374	0.0025	0.759	0.02	<0.5	125	<0.0001	11	<0.01	<0.01	0.0006	1.4	14.80	<0.0002	2.0	19.4	2.220	<0.01	11.6	<0.01	0.09	0.12	<0.0001	<0.0001	13	460	0.01
P-07S	5/6/2009	<0.00005	<0.03	378	0.0036	0.709	0.02	<0.05	124	<0.0001	5	<0.01	<0.01	0.0008	1.3	9.68	<0.0002	1.9	18.1	2.020	<0.01	13.4	<0.01	0.08	0.05	<0.0001	<0.0001	8	420	0.10
P-07S	7/15/2009	<0.00005	<0.03	400	0.0029	0.717	0.02	<0.2	123	<0.0001	<5	<0.01	<0.01	<0.0005	1.4	14.50	<0.0002	2.2	18.3	2.130	<0.01	12.4	<0.01	0.02	0.09	<0.0001	<0.0001	<3	440	<0.01
P-07S	11/4/2009	<0.00005	<0.03	394	0.0020	0.752	0.02	<0.2	121	<0.0001	6	<0.01	<0.01	<0.0005	1.4	13.90	<0.0002	1.7	18.5	2.230	<0.01	11.3	<0.01	<0.02	0.14	<0.0001	<0.0001	<5	440	<0.01
P-07S	2/3/2010	<0.00005	<0.03	397	0.0049	0.759	<0.01	<0.05	119	<0.0001	3	<0.01	<0.01	0.0009	1.3	13.10	<0.0002	2.2	17.9	2.200	<0.01	10.9	<0.01	<0.02	0.06	0.0002	<0.0001	<1	430	0.02
P-07S	4/28/2010	<0.00005	<0.03	387	0.0024	0.467	0.02	<0.1	124	<0.0001	5	<0.01	<0.01	0.0007	1.4	14.70	<0.0002	2.0	18.8	2.400	<0.01	11.0	0.03	<0.02	0.03	<0.0001	<0.0001	9	430	1.35
P-07S	8/11/2010	<0.00005	0.05	399	0.0041	0.786	0.02	<0.1	123	0.0001	<5	<0.01	<0.01	<0.0005	1.5	12.40	<0.0002	1.9	18.6	2.220	<0.01	12.8	<0.01	<0.02	0.11	0.0003	<0.0001	<5	440	0.23
P-07S	10/20/2010	<0.00005	<0.03	396	0.0033	0.720	0.02	<0.1	124	<0.0001	<10	<0.01	<0.01	<0.0005	1.5	14.00	<0.0002	1.9	18.4	2.030	<0.01	11.4	<0.01	<0.02	0.07	0.0002	<0.0001	<2	400	<0.01
P-07S	3/2/2011	<0.00005	<0.03	371	0.0022	0.750	0.01	<0.1	128	0.0001	4	<0.01	<0.01	<0.0005	1.4	13.50	<0.0002	2.3	19.4	2.250	<0.01	11.8	<0.01	<0.02	0.07	0.0002	<0.0001	<10	430	0.08
P-07S	5/4/2011			387	0.0011	0.778		<0.1	120	<0.0001	<5	<0.01			1.4	12.70		1.7	18.6	2.210		12.7			0.08			<5	450	<0.01
P-07S	8/3/2011			383	0.0036	0.782		<0.1	127	0.0001	5	<0.01			1.5	12.90		2.2	19.6	2.240		12.3			0.19			<2	430	<0.01
P-07S	11/9/2011			388	0.0077	0.766		<0.1	121	0.0004	<5	<0.01			1.5	12.80		2.0	18.4	2.100		10.9			0.40			<5	450	0.14
P-07S	2/22/2012			399	0.0075	0.729		<0.1	113	<0.0001	<5	<0.01			1.4	11.30		1.9	17.2	2.030		12.2			0.39			<10	450	0.01
P-07S	5/30/2012			397	0.0054	0.851		<0.1	125	0.0002	5	<0.01			1.4	11.50		2.2	18.8	2.230		12.8			0.41			<1	450	0.02
P-07S	8/7/2012			391	0.0036	0.790		<0.5	125	<0.0001	5	<0.01			1.5	12.90		2.3	18.6	2.200		13.1			0.14			<5	440	0.02
P-07S	11/6/2012			396	0.0083	0.833		<0.05	125	<0.0001	4	<0.01			1.5	11.10		2.1	18.6	2.220		11.8			0.14			<2	450	0.01
P-07S	2/5/2013			382	0.0054	0.810		<0.5	123	0.0002	4	<0.01			1.4	13.40		1.9	19.0	2.230		11.1			0.21			<10	460	0.05
P-07S	6/21/2013			389	0.0201	0.880		<0.05	124	<0.0001	3	<0.01			1.4	13.10		2.2	18.8	2.270		11.8			0.79			<5	440	<0.01
P-07S	12/18/2013			409		0.748		<0.05	125	<0.0001		<0.01			1.20	4.74		2.1	17.5	1.700		10.7						<1	420	<0.01
P-07S	5/29/2014			424		0.808		<0.1	129	0.0003		<0.01			1.19	8.25		2.2	18	1.970		11.9						1.6	420	0.08
P-07S	12/10/2014			422		0.816		0.092	127	0.0006		<0.01			1.32	10.40		2.2	18.1	2.110		11.3						<0.5	426	0.06
P-07S	11/3/2015			424		0.867		<0.05	129	<0.0001		<0.01			1.28	13.40		2.1	18.3	2.200		10.9						<0.5	430	0.02
P-07S	10/18/2016					0.858										14.60				2.200									440	

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	F	Fe-dis	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Se-dis	SO4	TDS	Zn-dis
P-13	8/18/2005	<0.01		363	0.0147	0.359		0.3	97.4	<0.0001		<0.01	<0.01	0.0020	1.5	12.70		1.7		1.780		10.8	<0.01			0.0031	<0.001	<10	390	0.12
P-13	11/11/2005	<0.00005	<0.03	376	0.0194	0.400	0.03	<0.1	109	0.0003	2	<0.01	<0.01	<0.01	1.6	25.70	<0.0002	1.9		1.820	<0.01	9.6	<0.01	<0.02		<0.0001	<0.0001	<10	360	0.27
P-13	3/14/2006	<0.00005	<0.03	378	0.0162	0.312	0.02	<0.1	112	<0.0001	3	0.01	<0.01	<0.01	1.4	17.40		1.8		1.800	<0.01	10.0	<0.01	0.11		<0.0001	<0.0001	20	370	0.25
P-13	5/12/2006	<0.00005	<0.03	382	0.0193	0.428	<0.01	<1	105	<0.0001	4	<0.01	<0.01	<0.01	1.5	26.50	<0.0002	1.6		1.700	<0.01	9.7	<0.01	0.03		0.0003	<0.0001	20	410	0.30
P-13	8/10/2006	0.00012	<0.03	364	0.0139	0.448	0.02	<1	108	0.0001	4	<0.01	<0.01	<0.01	1.6	23.20	<0.0002	1.8		1.650	<0.01	10.0	<0.01	0.03	0.50	0.0003	<0.0001	<10	410	0.31
P-13	11/1/2006	<0.00005	<0.03	365	0.0171	0.461	0.03	<0.1	111	<0.0001	5	<0.01	<0.01	<0.01	1.7	28.20	<0.0002	1.8		1.730	<0.01	10.1	<0.01	<0.02	0.06	0.0002	<0.0001	<10	410	0.33
P-13	2/7/2007	<0.00005	<0.03	353	0.0108	0.411	0.03	<0.2	105	<0.0001	6	<0.01	<0.01	<0.01	1.6	21.10	<0.0002	1.6		1.630	<0.01	9.7	<0.01	<0.02	0.07	<0.0001	<0.0001	<10	400	0.31
P-13	5/3/2007	<0.00005	<0.03	357	0.0176	0.478	0.02	<0.5	113	0.0001	4	<0.01	<0.01	<0.01	1.4	29.80	<0.0002	2.0		1.750	<0.01	11.2	<0.01	<0.02	0.03	<0.0001	<0.0001	<10	400	0.37
P-13	7/18/2007	<0.00005	<0.03	365	0.0165	0.430	0.02	<0.1	108	0.0002	5	0.01	<0.01	<0.0005	1.5	22.20	0.0003	1.8	18.1	1.450	<0.01	10.0	<0.01	0.02	0.08	<0.0001	<0.0001	<10	410	0.44
P-13	10/9/2007	<0.00005	<0.03	369	0.0163	0.486	0.03	<2	112	<0.0001	4	<0.01	<0.01	<0.0005	1.6	30.3	<0.0002	1.8	19.1	1.73	<0.01	10.4	<0.01	<0.02	0.07	<0.0001	<0.0001	30	420	0.3
P-13	1/30/2008	<0.00005	<0.03	360	0.0184	0.528	0.02	<10	111	<0.0001	10	0.01	<0.01	<0.0005	1.5	32.20	<0.0002	1.9	18.8	1.840	<0.01	10.6	<0.01	<0.02	0.15	0.0001	<0.0001	<10	420	0.30
P-13	4/23/2008	<0.00005	0.05	349	0.0186	0.470	0.02	1	114	<0.0001	4	<0.01	<0.01	<0.0005	1.3	29.20	<0.0002	1.6	18.9	1.670	<0.01	10.2	<0.01	<0.02	0.03	0.0002	<0.0001	<1	390	0.34
P-13	7/23/2008	<0.00005	<0.03	351	0.0174	0.503	0.02	<2	112	<0.0001	3	<0.01	<0.01	<0.0005	1.4	31.00	<0.0002	1.7	19.2	1.750	<0.01	10.5	<0.01	<0.02	0.04	<0.0001	<0.0001	<10	400	0.30
P-13	10/22/2008	<0.00005	<0.03	353	0.0145	0.509	0.03	<1	114	0.0001	6	<0.01	<0.01	<0.0005	1.6	29.60	<0.0002	1.8	19.2	1.800	0.02	10.6	<0.01	0.02	0.07	<0.0001	<0.0001	20	410	0.27
P-13	1/28/2009	<0.00005	<0.03	344	0.0153	0.488	0.02	<1	112	<0.0001	10	0.01	<0.01	0.0005	<0.1	31.50	<0.0002	1.7	19.0	1.710	<0.01	10.6	<0.01	<0.02	0.07	<0.0001	<0.0001	14	430	0.31
P-13	5/6/2009	<0.00005	<0.03	347	0.0169	0.476	0.02	<0.1	106	<0.0001	6	<0.01	<0.01	0.0006	1.5	30.60	<0.0002	1.5	17.9	1.690	0.01	10.6	<0.01	0.04	0.03	<0.0001	<0.0001	<1	420	0.39
P-13	7/15/2009	<0.00005	<0.03	366	0.0160	0.478	0.02	<0.2	114	<0.0001	6	<0.01	<0.01	<0.0005	1.5	31.50	<0.0002	1.7	19.0	1.680	<0.01	10.5	<0.01	<0.02	0.04	<0.0001	<0.0001	<3	390	0.34
P-13	11/4/2009	<0.00005	<0.03	359	0.0147	0.463	0.02	<0.1	110	<0.0001	7	<0.01	<0.01	0.0006	1.6	30.90	<0.0002	1.1	19.1	1.660	0.02	10.4	<0.01	<0.02	0.04	0.0002	<0.0001	12	420	0.37
P-13	2/4/2010	<0.00005	<0.03	367	0.0164	0.439	<0.01	<0.2	110	<0.0001	4	<0.01	<0.01	0.0007	1.4	29.90	<0.0002	2.1	18.4	1.560	<0.01	10.5	<0.01	0.07	0.03	0.0001	<0.0001	<5	430	0.32
P-13	4/28/2010	<0.00005	<0.03	370	0.0194	0.463	0.03	<0.2	113	<0.0001	6	<0.01	<0.01	0.0006	1.5	31.40	<0.0002	1.7	19.1	1.620	<0.01	10.2	0.02	0.23	0.03	<0.0001	<0.0001	9	420	0.41
P-13	8/11/2010	<0.00005	0.05	364	0.0149	0.502	0.01	<0.2	109	<0.0001	<10	<0.01	<0.01	0.0007	1.5	29.40	<0.0002	1.6	18.4	1.670	<0.01	10.9	<0.01	<0.02	0.11	0.0003	<0.0001	<10	410	0.32
P-13	10/20/2010	<0.00005	<0.03	365	0.0140	0.461	0.02	<0.1	116	<0.0001	<10	0.01	<0.01	<0.0005	1.5	29.20	<0.0002	1.9	19.3	1.680	<0.01	10.7	<0.01	0.06	0.04	0.0003	<0.0001	1	410	0.32
P-13	3/2/2011	<0.00005	<0.03	350	0.0164	0.485	0.02	<0.2	116	<0.0001	<10	0.01	<0.01	<0.0005	1.6	32.30	<0.0002	1.8	19.4	1.710	<0.01	11.3	<0.01	<0.02	0.03	0.0001	<0.0001	<20	420	0.34
P-13	5/4/2011			352	0.0192	0.485		<0.2	109	<0.0001	<10	<0.01			1.5	31.00		1.6	18.4	1.670		10.9			0.03			<10	440	0.38
P-13	8/3/2011			352	0.0170	0.485		<0.2	115	<0.0001	5	<0.01			1.6	31.10		1.8	20.0	1.870		10.5			0.03			5	420	0.32
P-13	11/9/2011			359	0.0176	0.461		<0.2	109	<0.0001	6	<0.01			1.5	29.90		1.6	18.4	1.630		9.9			0.03			<5	430	0.33
P-13	2/22/2012			368	0.0206	0.492		<0.5	108	<0.0001	<10	<0.01			1.6	30.70		1.8	18.3	1.700		10.7			0.14			<10	430	0.33
P-13	5/30/2012			368	0.0198	0.487		<0.2	110	<0.0001	7	<0.01			1.6	29.50		1.9	18.7	1.670		10.6			0.02			<10	430	0.37
P-13	8/7/2012			355	0.0193	0.488		<1	110	0.0001	6	<0.01			1.5	29.90		2.1	18.6	1.690		10.8			0.02			<5	420	0.37
P-13	11/6/2012			382	0.0217	0.492		<0.5	112	<0.0001	3	0.01			1.5	31.60		1.8	18.5	1.700		10.6			0.03			<5	440	0.34
P-13	2/5/2013			371	0.0226	0.490		<0.5	113	<0.0001	5	<0.01			1.6	30.70		1.9	19.1	1.680		11.1			0.03			<2	450	0.36

Notes: Blank records were not analyzed. Samples collected using hydrasleeve methodology during December 2013 through December 2014.

PMOU historical analytical results for groundwater (mg/L)

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	F	Fe-dis	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Se-dis	SO4	TDS	Zn-dis
P-13	6/21/2013			356	0.0194	0.499		<0.25	110	<0.0001	<10	0.01			1.5	31.60		1.9	18.7	1.730		10.7			0.04			<5	420	0.37
P-13	12/18/2013			389	0.0247	0.511		<0.05	111	<0.0001		<0.01			1.57	32.10		1.8	18	1.410		10.9						<5	370	0.49
P-13	5/29/2014			385	0.0243	0.457		<0.1	112	<0.0001		<0.01			1.48	29.50		1.9	17.6	1.420		10.8						<1	380	0.43
P-13	12/10/2014			397	0.0212	0.520		<0.05	111	0.0003		<0.01			1.58	32.90		1.9	18.1	1.420		10.6						<0.5	382	0.54
P-13	11/3/2015			382	0.0235	0.504		<0.05	115	<0.0001		0.02			1.39	32.50		1.8	18.4	1.720		10.6						<0.5	408	0.37
P-13	10/18/2016															31.80				1.680									408	
P-13S	8/18/2005	<0.01		285	0.0038	0.145		<0.1	263	0.1990		0.10	<0.01	0.0043	2.2	6.45		2.4		7.660		17.5	0.03			0.0029	<0.001	780	1520	66.90
P-13S	11/11/2005	<0.0003	0.12	289	0.0029	0.088	0.03	<0.1	264	0.3800	2	0.18	<0.01	<0.05	2.6	5.93	0.0003	2.3		10.300	<0.05	22.3	0.07	<0.02		0.0098	<0.0005	1140	1920	171
P-13S	3/14/2006	<0.00005	0.05	300	0.0030	0.171	0.02	<0.5	170	0.1220	7	0.07	<0.01	<0.01	2.2	12.60		1.6		6.310	<0.01	12.4	0.02	0.02		0.0018	<0.0001	420	910	52.30
P-13S	5/12/2006	<0.00005	0.03	350	0.0027	0.440	<0.01	<0.2	130	0.0673	5	0.03	<0.01	<0.01	2.1	7.07	<0.0002	1.7		3.710	<0.01	10.7	<0.01	<0.02		0.0023	<0.0001	190	640	24.20
P-13S	8/10/2006	<0.00005	0.35	316	0.0031	0.116	0.03	<1	237	0.1490	21	0.07	<0.01	0.01	2.3	5.61	0.0004	2.5		6.210	0.01	22.1	0.02	0.02	1.06	0.0042	<0.0001	490	1440	55.70
P-13S	11/1/2006	<0.00005	0.03	327	0.0027	0.137	0.02	<0.5	184	0.0717	8	0.05	<0.01	<0.01	2.3	6.54	0.0003	1.9		4.840	0.01	13.1	0.01	<0.02	1.48	0.0019	<0.0001	390	890	32.70
P-13S	2/7/2007	<0.00005	0.11	273	0.0012	0.061	0.02	<1	239	0.1910	8	0.09	<0.01	0.06	2.1	1.49	<0.0002	1.5		6.420	<0.01	14.7	0.03	0.03	0.23	0.0010	<0.0001	690	1320	85.80
P-13S	5/3/2007	<0.00005	0.08	298	0.0022	0.107	0.03	<0.5	226	0.1620	20	0.11	<0.01	0.03	2.0	5.58	0.0002	2.1		6.950	<0.01	21.9	0.04	<0.02	0.42	0.0019	<0.0001	640	1390	91.90
P-13S	7/18/2007	<0.00005	0.03	320	0.0034	0.227	0.03	<0.1	222	0.0991	13	0.07	<0.01	0.0032	2.2	9.05	0.0003	2.3	57.8	6.060	<0.01	16.8	0.01	<0.02	0.42	0.0004	0.0001	510	1150	39.90
P-13S	10/9/2007	<0.00005	0.08	320	0.0027	0.099	0.03	<0.1	210	0.0839	9	0.06	<0.01	0.0122	2.1	5.37	0.0003	1.9	45.7	4.86	<0.01	14.1	0.01	<0.02	0.27	0.0053	<0.0001	440	960	34.7
P-13S	1/30/2008	<0.00005	0.08	289	0.0024	0.146	0.02	<0.5	242	0.1400	35	0.09	<0.01	0.0144	1.8	6.44	0.0007	1.8	65.3	6.380	0.01	22.0	0.02	0.03	2.17	0.0033	<0.0001	570	1190	67.10
P-13S	4/23/2008	<0.00005	0.29	279	0.0027	0.086	0.02	<0.2	230	0.1680	36	0.10	<0.01	0.0857	2.0	5.88	0.0005	1.7	75.1	6.200	<0.01	29.9	0.02	<0.02	1.02	0.0097	<0.0001	650	1360	81.20
P-13S	7/23/2008	<0.00005	0.05	321	0.0027	0.129	0.03	<0.5	212	0.0816	19	0.05	<0.01	0.0127	2.0	5.83	0.0003	2.0	43.3	4.500	<0.01	16.8	0.01	0.02	1.15	0.0039	0.0001	380	980	29.10
P-13S	10/22/2008	<0.00005	0.24	299	0.0023	0.092	0.02	<0.5	249	0.0660	27	0.06	<0.01	0.0234	2.0	4.31	0.0002	1.9	54.6	5.110	<0.01	20.7	0.01	<0.02	1.5	0.0059	0.0003	530	1180	31.40
P-13S	1/28/2009	0.00006	0.28	238	0.0014	0.054	0.02	<1	271	0.1210	68	0.11	<0.01	0.0697	1.6	3.03	<0.0002	1.7	75.6	6.520	<0.01	38.2	0.03	0.73	0.97	0.0071	0.0001	730	1570	67.90
P-13S	5/6/2009	<0.00005	<0.03	272	0.0016	0.034	0.02	<0.05	317	0.1570	68	0.13	<0.01	0.0838	1.8	2.49	0.0003	2.1	95.9	7.790	<0.01	49.1	0.03	0.03	0.39	0.0079	0.0001	1010	1890	72.50
P-13S	7/15/2009	<0.00005	0.04	328	0.0020	0.067	0.03	<0.1	255	0.0719	35	0.07	<0.01	0.0490	2.0	4.60	<0.0002	2.1	61.4	5.020	<0.01	27.8	0.02	<0.02	0.67	0.0045	0.0002	670	1270	31.00
P-13S	11/4/2009	<0.00005	<0.03	305	0.0025	0.074	0.02	<0.1	284	0.0955	43	0.10	<0.01	0.0484	1.9	6.36	<0.0002	1.7	89.7	7.650	<0.01	33.5	0.01	<0.02	0.44	0.0045	0.0002	760	1590	52.50
P-13S	2/4/2010	<0.00005	1.05	328	0.0022	0.074	<0.01	<0.05	199	0.0524	16	0.07	<0.01	0.1200	1.6	5.09	<0.0002	1.5	49.6	4.860	<0.01	17.0	0.02	<0.02	0.23	0.0310	0.0002	380	990	25.80
P-13S	4/28/2010	<0.00005	<0.03	296	0.0014	0.052	0.03	<0.1	243	0.0728	56	0.08	<0.01	0.0202	1.7	6.43	<0.0002	2.1	63.8	6.180	<0.01	36.0	0.02	0.54	0.14	0.0062	0.0002	580	1240	36.60
P-13S	8/11/2010	<0.00005	0.39	312	0.0020	0.072	0.03	<0.05	260	0.0587	47	0.06	<0.01	0.0611	1.9	4.51	<0.0002	2.6	64.1	5.230	<0.01	34.0	0.01	<0.02	0.09	0.0094	<0.0001	590	1340	24.70
P-13S	10/20/2010	<0.00005	0.16	326	0.0019	0.074	0.03	0.22	188	0.0374	13	0.05	<0.01	0.0280	1.8	4.45	<0.0002	1.9	38.3	3.870	<0.01	16.8	<0.01	<0.02	0.19	0.0032	<0.0001	280	800	15.70
P-13S	3/2/2011	<0.00005	<0.03	273	0.0005	0.033	<0.01	<0.1	243	0.0468	50	0.08	<0.01	0.0130	1.6	3.08	0.0003	2.6	57.1	5.870	<0.01	30.2	0.01	<0.02	0.32	0.0053	<0.0001	520	1130	28.30
P-13S	5/4/2011			331	0.0009	0.038		<0.05	183	0.0436	22	0.05			1.7	3.45		1.6	43.2	4.930		21.2			0.32			330	900	19.40
P-13S	8/3/2011			272	0.0009	0.052		<0.05	295	0.0665	51	0.06			1.8	1.35		2.7	71.2	6.720		37.7			0.25			750	1470	25.00
P-13S	11/9/2011			295	0.0008	0.033		<0.1	222	0.0527	34	0.06			1.5	3.73		1.9	58.2	5.680		26.2			0.20			580	1160	26.30
P-13S	2/22/2012			289	0.0109	0.031		<0.05	230	0.0596	63	0.08			1.5	5.00		1.9	66.7	6.290		34.8			0.56			520	1270	30.70
P-13S	5/30/2012			317	<0.0005	0.029		<0.05	220	0.0545	36	0.07			1.7	2.30		2.4	57.8	5.410		28.8			0.03			490	1130	24.00
P-13S	8/7/2012			307	0.0007	0.041		<0.25	219	0.0495	45	0.05			1.7	1.72		2.6	54.4	4.930		30.0			0.13			470	1130	17.80
P-13S	11/6/2012			310	0.0011	0.032		<0.25	179	0.0311	34	0.05			1.6	5.56		1.7	44.8	4.970		21.8			0.45			320	860	15.20
P-13S	2/5/2013			296	0.0006	0.025		<0.25	193	0.0353	69	0.06			1.5	5.53		1.6	49.7	5.300		31.3			0.18			350	960	18.20
P-13S	6/21/2013			325	0.0008	0.037		<0.25	180	0.0260	32	0.06			1.7	6.26		2.3	41.8	4.700		24.6			0.13			300	830	13.20
P-13S	12/18/2013			271		0.025		<0.5	297	0.0511		0.09			1.12	6.18		2.3	80.3	6.010		88						767	1610	33.40
P-13S	5/29/2014			347		0.034		<0.25	208	0.0325		0.05			1.59	6.99		2.2	48.2	4.450		42.4						402	1040	17.10
P-13S	12/10/2014			351		0.026		<0.25	187	0.0134		0.04			1.45	8.84		1.7	44	3.890		32.1						288	876	12.60
P-13S	11/3/2015			322		0.053		<0.25	220	0.0160		0.05			1.26	10.70		2.1	47.7	4.310		39.6						413	1160	12.0
P-13S	10/18/2016									0.0148		0.05			1.63	11.60				4.540									1050	12.30
P-14	8/18/2005	<0.01		130	<0.0005	0.061		8.6	207	<0.0001		<0.01	<0.01	<0.0005	0.2	<0.02		2.0		<0.005		8.9	<0.01			0.0016	0.002	490	950	<0.01
P-14	11/11/2005	<0.00005	<0.03	121	<0.0001	0.068	0.05	0.1	178	<0.0001	10	<0.01	<0.01	<0.01	<0.1	<0.02	0.0003	2.0		<0.005	<0.01	7.4	<0.01	2.78		0.0001	0.0015	420	790	<0.01
P-14	3/14/2006	<0.00005	<0.03	137	<0.0005	0.037	0.02	<0.5	200	<0.0001	11	<0.01	<0.01	<0.01	0.1	0.08		1.8		<0.005	<0.01	8.0	<0.01	1.94		<0.0001	0.0019	<10	850	<0.01
P-14	5/12/2006	<0.00005	<0.03	142	<0.0005	0.032	<0.02	<1	177	<0.0001	10	<0.01	0.01	<0.01	0.1	<0.02	<0.0002	1.7		<0.005	<0.02	7.4	<0.01	1.72		0.0001	0.0016	420	800	<0.01
P-14	8/11/2006	<0.00005	1.29	150	0.0012	0.085	0.02	<0.5	185	<0.0001	9	<0.01	<0.01	<0.01	0.3	1.31	<0.0002	2.4		0.337	<0.01	9.1	<0.01	1.65	0.83	0.0054	0.0014	430	720	0.03
P-14	11/2/2006	<0.00005	0.05	160	<0.0005	0.038	0.02	<0.5	183	<0.0001	10	<0.01	<0.01	<0.01	0.2	0.04	<0.0002	1.9		0.016	<0.01	7.9	<0.01	1.64	0.14	0.0002	0.0013	410	780	<0.01
P-14	2/7/2007	<0.00005	0.55	148	0.0010	0.065	0.02	<0.5	190	<0.0001	12	<0.01	<0.01	<0.01	0.2	0.53	<0.0002	1.9		0.146	<0.01	7.8	<0.01	1.79	0.69	0.0073	0.0014	450	850	<0.01
P-14	5/3/2007	<0.00005	<0.03	141	<0.0005	0.040	0.02	<0.5	202	<0.0001	12	<0.01	<0.01	<0.01	0.2	<0.02	<0.0002	2.1		<0.005	<0.01	8.8	<0.01	1.61	0.43	0.0001	0.0017	470	860	<0.01
P-14	7/18/2007	<0.00005	0.05	143	0.0005	0.039	0.02	0.1	190	<0.0001	10	<0.01	<0.01	0.0016	0.2	<0.02	0.0003	2.0	31.6	<0.005	<0.01	8.1	<0.01	1.77	0.23	0.0003	0.0016	430	880	<0.01
P-14	10/9/2007	<0.00005	0.09	137	0.0007	0.042	0.02	0.1	220	<0.0001	14	<0.01	<0.01	0.0015	0.2	0.06	<0.0002	2.1	37.7	0.018	<0.01	8.8	<0.01	1.99	0.15	0.0007	0.0016	530	940	0.02
P-14	1/30/2008	<0.00005	0.06	139	<0.0005	0.043	0.01	<0.1	209	<0.0001	12	<0.01	<0.01	0.0015	0.2	<0.02	<0.0002	2.0	35.1	<0.005	<0.01	8.3	<0.01	1.83	0.15	0.0002	0.0017	490	910	<0.01

Notes: Blank records were not analyzed. Samples collected using hydrasleeve methodology during December 2013 through December 2014.

PMOU historical analytical results for groundwater (mg/L)

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	F	Fe-dis	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Se-dis	SO4	TDS	Zn-dis
P-14	4/23/2008	<0.00005	0.17	134	0.0009	0.048	0.01	0.1	229	<0.0001	14	<0.01	<0.01	0.0014	0.3	0.03	<0.0002	2.0	38.7	0.013	<0.01	8.8	<0.01	1.72	0.18	0.0005	0.0010	510	900	<0.01
P-14	7/23/2008	<0.00005	<0.03	129	<0.0005	0.045	0.02	0.2	242	<0.0001	16	<0.01	<0.01	0.0012	0.2	<0.02	<0.0002	2.1	40.8	<0.005	<0.01	9.1	<0.01	2.21	0.10	<0.0001	0.0019	500	1070	<0.01
P-14	10/22/2008	<0.00005	0.07	128	0.0005	0.034	0.01	0.2	239	<0.0001	16	<0.01	<0.01	0.0015	0.2	0.02	<0.0002	2.1	39.6	<0.005	0.01	9.2	<0.01	1.96	0.23	<0.0001	0.0016	480	930	<0.01
P-14	1/28/2009	<0.00005	<0.03	132	<0.0005	0.031	0.02	0.1	191	<0.0001	15	<0.01	<0.01	0.0011	0.2	<0.02	<0.0002	1.9	31.8	<0.005	<0.01	8.0	0.01	1.72	0.12	<0.0001	0.0014	390	810	<0.01
P-14	5/6/2009	<0.00005	0.03	142	0.0006	0.031	0.02	0.07	188	<0.0001	13	<0.01	<0.01	0.0016	0.2	0.03	<0.0002	1.7	32.0	0.008	<0.01	8.2	<0.01	1.61	0.07	0.0004	0.0014	440	830	<0.01
P-14	7/15/2009	<0.00005	<0.03	150	0.0011	0.028	0.02	<0.1	184	<0.0001	12	<0.01	<0.01	0.0019	0.2	<0.02	<0.0002	1.9	30.4	0.008	<0.01	7.9	<0.01	1.47	0.13	<0.0001	0.0014	400	790	0.01
P-14	11/4/2009	<0.00005	0.19	151	0.0006	0.039	0.02	<0.05	171	<0.0001	12	<0.01	<0.01	0.0019	0.1	0.19	<0.0002	1.3	29.7	0.070	<0.01	7.4	<0.01	1.33	0.24	0.0021	0.0013	340	730	<0.01
P-14	2/4/2010	<0.00005	0.24	154	0.0005	0.043	<0.01	0.08	180	<0.0001	12	<0.01	<0.01	0.0022	0.2	0.25	<0.0002	2.1	30.4	0.133	<0.01	7.1	<0.01	1.36	0.25	0.0033	0.0013	370	760	<0.01
P-14	4/28/2010	<0.00005	0.05	156	<0.0005	0.029	0.02	0.7	179	<0.0001	10	<0.01	<0.01	0.0010	0.2	<0.02	<0.0002	1.9	29.8	<0.005	<0.01	7.6	<0.01	1.48	0.21	<0.0001	0.0014	350	720	<0.01
P-14	8/11/2010	<0.00005	0.31	146	0.0007	0.054	<0.01	0.10	189	<0.0001	14	<0.01	<0.01	0.0013	0.2	0.23	<0.0002	2.0	32.3	0.108	<0.01	8.5	<0.01	1.61	0.10	0.0028	0.0012	410	850	<0.01
P-14	10/20/2010	<0.00005	0.03	143	0.0009	0.029	0.01	0.5	204	<0.0001	13	<0.01	<0.01	0.0008	0.2	<0.02	<0.0002	2.0	33.8	<0.005	<0.01	8.1	<0.01	1.53	0.09	0.0003	0.0013	430	810	<0.01
P-14	3/2/2011	<0.00005	0.09	141	<0.0005	0.036	0.01	<0.1	198	<0.0001	14	<0.01	<0.01	0.0013	0.2	0.13	<0.0002	2.4	33.1	0.053	<0.01	9.4	<0.01	1.43	0.05	0.0015	0.0013	410	790	<0.01
P-14	5/4/2011			144	<0.0005	0.028		<0.05	177	<0.0001	12	<0.01			<0.1	<0.02		1.9	29.9	<0.005		8.3			0.09			410	790	<0.01
P-14	8/3/2011			149	<0.0005	0.030		0.14	182	<0.0001	13	<0.01			0.2	<0.02		1.9	30.9	<0.005		7.8			0.08			390	760	<0.01
P-14	11/9/2011			161	<0.0005	0.036		<0.05	171	<0.0001	13	<0.01			0.2	0.19		1.8	28.9	0.066		7.5			0.04			380	740	<0.01
P-14	2/22/2012			185	<0.0005	0.027		<0.05	151	<0.0001	11	<0.01			0.3	<0.02		1.8	25.6	<0.005		8.2			0.05			300	690	<0.01
P-14	5/30/2012			181	<0.0005	0.030		<0.05	175	<0.0001	13	<0.01			0.2	<0.02		2.0	29.5	<0.005		9.1			0.04			360	740	<0.01
P-14	8/7/2012			178	<0.0002	0.029		0.171	161	<0.0001	11	<0.01			0.2	0.03		2.0	27.3	0.005		9.5			0.04			310	700	0.01
P-14	11/6/2012			199	<0.0002	0.032		<0.25	155	<0.0001	10	<0.01			0.2	0.07		1.8	26.3	0.010		9.9			0.04			290	650	<0.01
P-14	2/5/2013			205	0.0002	0.032		<0.25	159	<0.0001	10	<0.01			0.3	0.07		1.9	27.5	0.015		10.5			0.06			300	690	0.02
P-14	6/21/2013			202	<0.0002	0.043		<0.25	149	<0.0001	8	0.02			0.3	0.22		1.9	25.7	0.071		10.3			0.07			250	670	0.01
P-14	12/18/2013			197				<0.5	145	<0.0001		<0.01			0.23	0.08		1.8	24.6	0.031		9.4						259	500	<0.01
P-14	5/29/2014			129				<0.25	139	<0.0001		<0.01			<0.25	<0.02		1.8	22.3	<0.005		6.9						275	720	<0.01
P-14	12/10/2014			171				<0.25	160	<0.0001		<0.01			<0.25	<0.02		1.9	26	<0.005		7.4						326	494	<0.01
P-14	11/3/2015			145				<0.25	211	<0.0001		<0.01			<0.25	0.08		2	34.1	0.027		8.3						481	950	<0.01

Notes: Blank records were not analyzed. Samples collected using hydrasleeve methodology during December 2013 through December 2014.

Surface Water

PMOU historical analytical results for surface water (mg/L)

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Be-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	Fe-dis	Hard	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Sb-dis	Se-dis	SO4	TDS	Tl-dis	Zn-dis
ESS	3/31/2004			232	0.0004					76.4	<0.0001	3			<0.0005	0.17	232		1.3	10.0	1.200		4.6				0.0001			10	260		0.04
ESS	6/30/2004			166	<0.0005					69.9	0.0005	<1			<0.0005	0.03	196	<0.0002	0.7	5.2	0.377		2.6				<0.0002			30	210		<0.01
ESS	9/23/2004			268						85.1		2					249	<0.0002	1.5	8.8			4.6							10	260		
ESS	11/19/2004			155						68.8		2					190	<0.0002	0.7	4.4			1.7							20	200		
ESS	3/21/2005	<0.005	<0.03	276	<0.0005	0.205		<0.002	<0.1	82.9	<0.0001		<0.01	<0.01	<0.01	0.61		<0.0002	1.5				6.7	<0.01	0.05	0.05	<0.0001	<0.02	<0.04			<0.2	0.02
ESS	6/10/2005	<0.005	<0.03	159	<0.0005	0.054		<0.002	<0.1	62.2	0.0002		<0.01	<0.01	<0.01	0.03		<0.0002	0.6				1.8	<0.01	0.07		0.0003	<0.02	<0.04			<0.2	<0.01
ESS	8/18/2005	<0.01		297	0.0006	0.193			0.5	85.3	0.0001		<0.01	<0.01	0.0006	2.64			1.4		1.260		6.0	<0.01			0.0003		<0.001	10	300		0.02
ESS	11/11/2005	<0.00005	<0.03	<2	<0.0001	0.041	0.02		<0.1	63.2	<0.0001	1	<0.01	0.02	<0.01	<0.02		<0.0002	0.9		0.042	<0.01	1.7	<0.01	0.45		<0.0001		0.0002	10	190		0.02
ESS	3/15/2006	<0.00005	<0.03	347	<0.0005	0.242	0.02		<0.1	103	0.0001	4	<0.01	<0.01	<0.01	2.58			2.2		2.250	<0.01	10.0	<0.01	<0.02		<0.0001		<0.0001	20	370		0.07
ESS	8/10/2006	0.00006	0.04	414	0.0006	0.536	0.04		<0.2	137	<0.0001	6	<0.01	<0.01	<0.01	5.62		<0.0002	2.7		2.630	<0.01	13.3	<0.01	<0.02	0.05	0.0004		<0.0001	10	510		0.02
ESS	11/1/2006	<0.00005	<0.03	370	<0.0005	0.297	0.02		<0.1	116	<0.0001	5	<0.01	<0.01	<0.01	5.68		<0.0002	1.9		1.950	<0.01	11.4	<0.01	<0.02	0.06	<0.0001		<0.0001	30	400		0.01
ESS	5/2/2007	<0.00005	<0.03	382	<0.0005	0.415	0.02		0.1	120	<0.0001	6	<0.01	<0.01	<0.01	4.69		<0.0002	2.7		1.630	<0.01	13.5	<0.01	<0.02	0.04	<0.0001		<0.0001	10	410		0.02
ESS	7/18/2007	<0.00005	<0.03	424	<0.0005	0.473	0.03	0.0001	<0.1	127	0.0006	5	<0.01	<0.01	0.0005	8.57	399	<0.0002	2.0	19.9	2.570	<0.01	14.7	<0.01	0.04	0.10	<0.0001	<0.0004	<0.0001	<10	460	0.0001	<0.01
ESS	4/23/2008	<0.00005	0.05	390	0.0007	0.517	0.02	<0.0001	<1	140	<0.0001	14	<0.01	<0.01	<0.0005	11.10	439	<0.0002	2.1	21.6	1.870	<0.01	20.4	<0.01	<0.02	0.08	0.0001	<0.0004	<0.0001	45	500	<0.0001	0.05
ESS	7/23/2008	<0.00005	<0.03	403	0.0008	0.581	0.03	<0.0001	<0.5	130	<0.0001	6	<0.01	<0.01	<0.0005	8.92	408	<0.0002	2.1	20.1	1.940	<0.01	15.6	<0.01	<0.02	0.06	<0.0001	<0.0004	<0.0001	1	440	<0.0001	<0.01
ESS	5/4/2010	<0.00005	<0.03	382	0.0008	0.071	0.02	<0.0001	<0.05	156	0.0007	12	<0.01	<0.01	0.0017	1.34	489	<0.0002	2.2	24.1	1.630	<0.01	28.9	<0.01	0.04	1.40	0.0009	<0.0004	0.0001	179	640	<0.0001	0.54
PD	3/31/2004			58	0.0002					22.4	<0.0001	<1			<0.0005	0.06	66		0.4	2.4	<0.005		1.5				<0.0001			10	80		<0.01
PD	6/30/2004			62	<0.0005					26.6	<0.0002	<1			<0.0005	0.02	77	<0.0002	0.4	2.5	<0.005		1.4				<0.0002			30	100		<0.01
PD	9/23/2004			74						28.6		1					83	<0.0002	0.7	2.8			1.7							10	100		
PD	11/19/2004			74						31.1		2					90	<0.0002	0.5	3.0			1.9							<10	100		
PD	3/22/2005	<0.005	<0.03	76	<0.0005	0.026		<0.002	<0.1	31.5	<0.0001		<0.01	<0.01	<0.01	<0.01		<0.0002	0.6				2.2	<0.01	27.0	0.01	<0.0001	<0.02	<0.04			<0.2	0.04
PD	6/10/2005	<0.005	0.04	58	<0.0005	0.017		<0.002	<0.1	23.1	<0.0001		<0.01	<0.01	<0.01	0.01		<0.0002	0.5				1.1	<0.01	<0.02		0.0002	<0.02	<0.04			<0.2	<0.01
PD	8/18/2005	<0.01	<0.03	67	<0.0005	0.023		<0.002	<0.1	26.0	<0.0001		<0.01	<0.01	<0.01	0.03		<0.0002	0.4				1.5	<0.01	0.12		0.0003	<0.02	<0.001			<0.0001	0.02
PD	11/11/2005	<0.00005	<0.03	71	<0.0005	0.022	<0.01	<0.0001	<0.1	28.4	<0.0001	<1	<0.01	<0.01	0.0008	<0.02	83	<0.0002	0.5	2.8	0.011	<0.01	1.8	<0.01			<0.0001	<0.0004	0.0002	<10	100	<0.0001	<0.01
PD	3/15/2006	<0.00005	<0.03	87	<0.0005	0.024	<0.01	<0.0001	<0.1	32.0	0.0002	2	<0.01	<0.01	0.0026	<0.02	93	<0.0002	0.5	3.2	0.019	<0.01	2.3	<0.01			0.0002	<0.0004	0.0003	<10	110	<0.0001	<0.01
PD	5/12/2006	<0.00005	<0.03	74	<0.0005	0.021	<0.01	<0.0001	<0.1	27.0	0.0009	2	<0.01	<0.01	0.0105	<0.02	79	<0.0002	0.7	2.7	0.012	<0.01	2.2	<0.01			0.0004	<0.0004	0.0002	<10	110	<0.0001	0.01
PD	8/10/2006	<0.00005	0.09	47	<0.0005	0.023	<0.01	<0.0001	<0.1	20.6	<0.0001	<1	<0.01	<0.01	<0.0005	0.07	60	<0.0002	0.5	2.1	0.009	<0.01	1.5	<0.01		<0.01	0.0002	<0.0004	<0.0001	<10	110	<0.0001	0.01
PD	11/1/2006	<0.00005	<0.03	80	<0.0005	0.021	<0.01	<0.0001	<0.1	30.5	<0.0001	2	<0.01	<0.01	0.0008	<0.02	89	<0.0002	0.6	3.0	0.016	<0.01	2.0	<0.01		<0.01	0.0002	<0.0004	0.0002	<10	100	<0.0001	0.01
PD	2/7/2007	<0.00005	0.05	76	<0.0005	0.023	<0.01	<0.0001	<0.1	31.0	<0.0001	<1	<0.01	<0.01	0.0007	<0.02	90	<0.0002	0.7	3.1	0.010	<0.01	1.9	<0.01		0.01	0.0001	<0.0004	0.0002	10	110	<0.0001	<0.01
PD	5/2/2007	<0.0001	0.04	46	<0.001	0.018	<0.01	<0.0002	<0.1	19.7	<0.0002	1	<0.01	<0.01	<0.001	0.03	57	<0.0002	0.6	1.9	<0.005	<0.01	1.3	<0.01		0.04	0.0008	<0.0008	<0.0002	<10	70	<0.0002	<0.01
PD	7/18/2007	0.00066	<0.03	81	0.0434	0.021	<0.01	0.0005	<0.1	31.1	0.0567	<1	<0.01	<0.01	<0.01	<0.02	90	0.0003	0.5	2.9	<0.005	<0.01	1.5	<0.01	0.03	<0.01	0.0495	0.0005	0.0026	<10	100	0.0004	<0.01
PD	10/9/2007	<0.00005	<0.03	87	<0.0005	0.026	<0.01	<0.0001	<0.1	33.5	<0.0001	<1	<0.01	<0.01	0.0006	0.03	98	<0.0002	0.6	3.4	0.015	<0.01	1.9	<0.01	<0.02	<0.01	<0.0001	<0.0004	0.0001	<10	120	<0.0001	<0.01
PD	1/30/2008	<0.00005	<0.03	84	<0.0005	0.035	0.01	<0.0001	<0.1	37.1	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	108	<0.0002	0.6	3.7	0.014	<0.01	2.3	<0.01	0.12	<0.01	<0.0001	<0.0004	0.0002	10	110	<0.0001	<0.01
PD	4/23/2008	<0.00005	0.11	53	0.0006	0.016	<0.01	<0.0001	<0.1	24.0	<0.0001	<1	<0.01	<0.01	0.0006	0.06	69	<0.0002	0.4	2.1	<0.005	<0.01	1.1	<0.01	0.31	0.04	0.0009	<0.0004	<0.0001	9	70	<0.0001	<0.01
PD	7/23/2008	<0.00005	0.05	71	<0.0005	0.025	<0.01	<0.0001	<0.1	28.8	<0.0001	4	<0.01	<0.01	<0.0005	0.03	83	<0.0002	0.6	2.7	0.009	<0.01	1.4	<0.01	<0.02	<0.01	<0.0001	<0.0004	0.0002	10	90	<0.0001	<0.01
PD	10/22/2008	<0.00005	0.08	70	<0.0005	0.025	<0.01	<0.0001	<0.1	29.7	<0.0001	1	<0.01	<0.01	0.0006	0.05	86	<0.0002	0.6	2.9	0.011	<0.01	1.8	<0.01	0.06	<0.01	<0.0001	<0.0004	<0.0001	11	80	<0.0001	0.02
PD	1/28/2009	<0.00005	0.08	82	<0.0005	0.027	<0.01	<0.0001	<0.1	34.6	<0.0001	2	<0.01	<0.01	0.0006	<0.02	101	<0.0002	0.6	3.5	0.026	<0.01	2.2	<0.01	0.15	0.02	<0.0001	<0.0004	0.0002	16	130	<0.0001	<0.01
PD	5/6/2009	<0.00005	0.06	42	<0.0005	0.018	<0.01	<0.0001	<0.01	17.0	<0.0001	<1	<0.01	<0.01	0.0012	0.06	49	<0.0002	0.4	1.6	<0.005	<0.01	1.1	<0.01	0.16	0.04	<0.0001	<0.0004	0.0002	4	70	<0.0001	<0.01
PD	7/15/2009	<0.00005	<0.03	82	0.0008	0.021	<0.01	<0.0001	<0.01	31.4	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	90	<0.0002	0.5	2.7	<0.005	<0.01	1.6	<0.01	<0.02	<0.01	<0.0001	<0.0004	0.0002	11	110	<0.0001	<0.01
PD	11/4/2009	<0.00005	0.05	78	<0.0005	0.018	<0.01	<0.0001	<0.01	31.8	<0.0001	1	<0.01	<0.01	<0.0005	0.02	92	<0.0002	<0.3	3.1	0.010	<0.01	1.8	<0.01	<0.02	<0.01	<0.0001	<0.0004	0.0002	12	100	<0.0001	<0.01
PD	2/4/2010	<0.00005	<0.03	84	<0.0005	0.020	<0.01	<0.0001	<0.01	35.1	<0.0001	<1	<0.01	<0.01	<0.0005	0.03	102	<0.0002	0.7	3.4	0.009	<0.01	2.0	<0.01	0.17	<0.01	<0.0001	<0.0004	0.0003	15	110	<0.0001	<0.01
PD	4/28/2010	<0.00005	0.15	50	<0.0005	0.016	<0.01	<0.0001	<0.01	20.9	<0.0001	<1	<0.01	<0.01	0.0005	0.08	61	<0.0002	0.6	2.0	<0.005	<0.01	1.2	0.02	0.12	0.02	0.0001	<0.0004	0.0002	7	100	<0.0001	<0.01
PD	8/11/2010	<0.00005	<0.03	72	<0.0005	0.018	<0.01	<0.0001	<0.01	28.6	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	82	<0.0002	0.5	2.6	<0.005	<0.01	1.3	<0.01	<0.02	0.01	<0.0001	<0.0004	0.0002	9	90	<0.0001	<0.01
PD	10/20/2010	<0.00005	<0.03	86	<0.0005	0.027	<0.01	<0.0001	<0.01	35.1	<0.0001	5	<0.01	<0.01	<0.0005	0.02	102	<0.0002	0.7	3.4	0.013	<0.01	1.9	<0.01	<0.02	<0.01	0.0002	<0.0004	0.0002	16	100	<0.0001	<0.01
PD	3/2/2011	<0.00005	<0.03	88	<0.0005	0.022	<0.01	<0.0001	<0.01	37.7	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	109	<0.0002	0.7	3.6	0.010	<0.01	2.4	<0.01	0.06	<0.01	<0.0001	<0.0004	0.0003	17	130	<0.0001	<0.01
PD	5/4/2011		0.04	61	<0.0005				<0.01	25.2	<0.0001	1				0.07	74		0.4	2.6	0.006		1.6			<0.01	0.0003			11	90		<0.01
PD	8/3/2011		<0.03	72	<0.0005				<0.01	30.4	<0.0001	<1				0.02	88		0.7	3.0	0.008		1.8			0.02	0.0003			12	90		<0.01
PD	11/9/2011		<0.03	81	<0.0005				<0.01	31.1	<0.0001	<1				0.05	91		0.6	3.1	0.028		2.2			<0.01	0.0001			14	110		<0.01
PD	2/22/2012		<0.03	81	<0.0005				<0.01	30.5	0.0004	1				<0.02	89		0.8	3.2	0.008		2.4			<0.01	<0.0001			15	130		<0.01
PD	5/30/2012		0.03	64	<0.0005				<0.01	24.2	<0.0001	<1				<0.02	70		0.6	2.3	0.006		1.2			<0.01	<0.0001			9	80		<0.01
PD	8/7/2012		0.17	71	<0.0002				<0.05	28.2	<0.0001	<1				0.10	82		0.8	2.9	0.009		1.6			0.04	0.0003			12	100		<0.01
PD	11/6/2012		<0.03	87	<0.0002				<0.05	35.6	<0.0001	<1				0.04	103		0.6	3.4	0.035		2.0			<0.01	<0.0001			16	120		0.03
PD	2/5/2013		<0.03	83	<0.0002				<0.05	31.0	<0.0001	<1				<0.02	90		0.5	3.1	0.007		2.0			<0.01	<0.0001			16	120		<0.01
PD	6/21/2013		<0.03	76	<0.0002				<0.05	30.4	<0.0001	<1				<0.02	88		0.6	2.8	0.010		1.7			0.02	<0.0001			15.0	100		<0.01
PD	12/18/2013			81	<0.0002				<0.05	30.9	<0.0001	<1				<0.02	89		0.4	2.9	0.008		1.9			<0.01				14.6	110		<0.01

Note: Blank records were not analyzed

PMOU historical analytical results for surface water (mg/L)

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Be-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	Fe-dis	Hard	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Sb-dis	Se-dis	SO4	TDS	Tl-dis	Zn-dis
PD	5/29/2014			52	<0.0002				<0.05	19.3	<0.0001	1				0.07	56		0.6	1.9	<0.005		1.2			0.01				8.3	80		<0.01
PD	12/10/2014			87.9	<0.0002				<0.05	33.6	<0.0001	1.3				0.04	98		0.7	3.3	0.039		2.2			0.01				15.3	116		<0.01
PD	11/3/2015			79.9	<0.0002				<0.05	33.6	<0.0001	1.1				0.04	97.1		0.7	3.2	0.008		1.8			<0.01				13.2	120		<0.01
PD	10/18/2016			81.2	<0.0002				<0.05	33.8	<0.0001	1.17				0.02	97		0.7	3	0.009		1.9			<0.02				13.2	114		<0.01
PU	3/31/2004			58	0.0005					22.1	<0.0001	1			<0.0005	0.05	65		0.3	2.3	<0.005		1.6				<0.0001			10	80		0.01
PU	6/30/2004			60	<0.0005					26.0	<0.0002	<1			<0.0005	0.03	75	<0.0002	0.5	2.5	<0.005		1.4				<0.0002			20	100		<0.01
PU	9/23/2004			73						27.4		1					80	<0.0002	0.7	2.8			1.6							10	100		
PU	11/19/2004			68						29.4		2					85	<0.0002	0.3	2.9			1.8							10	80		
PU	3/22/2005	<0.005	<0.03	69	<0.0005	0.024		<0.002	<0.1	30.9	<0.0001		<0.01	<0.01	<0.01	<0.01		<0.0002	0.4				2.1	<0.01	0.14	<0.01	<0.0001	<0.02	<0.04			<0.2	<0.01
PU	8/18/2005	<0.01	<0.03	61	<0.0005	0.021		<0.002	<0.1	23.0	<0.0001		<0.01	<0.01	<0.01	<0.02		<0.0002	0.9				1.4	<0.01	0.45		0.0003	<0.02	<0.001			<0.0001	0.02
PU	11/10/2005	<0.00005	<0.03	38	0.0001	0.021	<0.01	<0.0001	<0.1	26.7	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	77	<0.0002	0.4	2.6	<0.005	<0.01	1.8	<0.01			<0.0001	<0.0004	0.0002	<10	110	<0.0001	<0.01
PU	3/15/2006	<0.00005	<0.03	82	<0.0005	0.021	<0.01	<0.0001	<0.1	30.0	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	87	<0.0002	0.4	3.0	<0.005	<0.01	2.0	<0.01			<0.0001	<0.0004	0.0003	<10	100	<0.0001	<0.01
PU	5/12/2006	<0.00005	<0.03	70	<0.0005	0.020	<0.01	<0.0001	<0.1	25.5	<0.0001	1	<0.01	<0.01	0.0006	<0.02	74	<0.0002	0.5	2.6	<0.005	<0.01	1.6	<0.01			<0.0001	<0.0004	0.0002	10	110	<0.0001	<0.01
PU	8/10/2006	<0.00005	0.11	45	<0.0005	0.022	<0.01	<0.0001	<0.1	19.5	<0.0001	<1	<0.01	<0.01	0.0006	0.07	57	<0.0002	0.4	2.0	<0.005	<0.01	1.4	<0.01		<0.01	0.0001	<0.0004	<0.0001	<10	100	<0.0001	<0.01
PU	11/1/2006	<0.00005	<0.03	71	<0.0005	0.027	<0.01	<0.0001	<0.1	27.4	<0.0001	2	<0.01	<0.01	<0.0005	0.03	80	<0.0002	0.6	2.8	<0.005	<0.01	1.8	<0.01		<0.01	0.0001	<0.0004	<0.0001	<10	90	<0.0001	<0.01
PU	2/7/2007	<0.00005	<0.03	73	<0.0005	0.020	<0.01	<0.0001	<0.1	29.1	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	85	<0.0002	0.5	3.0	<0.005	<0.01	1.7	<0.01		0.01	<0.0001	<0.0004	0.0003	10	90	<0.0001	<0.01
PU	5/2/2007	<0.0001	<0.03	43	<0.0005	0.018	<0.01	<0.0002	<0.1	18.4	<0.0002	1	<0.01	<0.01	<0.0005	0.03	53	0.0003	0.6	1.8	<0.005	<0.01	1.3	<0.01		0.03	0.0009	<0.0008	<0.0002	<10	70	0.0003	<0.01
PU	7/18/2007	<0.00005	<0.03	76	0.0015	0.019	<0.01	<0.0001	<0.1	28.9	0.0015	<1	<0.01	<0.01	0.0061	<0.02	84	<0.0002	0.8	2.8	<0.005	<0.01	1.5	<0.01	0.05	<0.01	0.0022	<0.0004	0.0002	<10	90	0.0001	<0.01
PU	10/9/2007	0.00006	<0.03	81	<0.0005	0.024	<0.01	<0.0001	<0.1	32	<0.0001	2	<0.01	<0.01	0.0007	<0.02	93	<0.0002	2.5	3.2	<0.005	<0.01	1.8	<0.01	0.03	<0.01	<0.0001	<0.0004	0.0001	10	110	<0.0001	<0.01
PU	1/30/2008	<0.00005	<0.03	80	<0.0005	0.033	0.01	<0.0001	<0.1	35.4	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	103	<0.0002	0.5	3.6	<0.005	<0.01	2.1	<0.01	0.14	<0.01	<0.0001	<0.0004	0.0003	10	110	<0.0001	<0.01
PU	4/23/2008	<0.00005	0.12	48	<0.0005	0.016	<0.01	<0.0001	<0.1	22.1	<0.0001	<1	<0.01	<0.01	0.0005	0.06	64	<0.0002	0.4	2.1	<0.005	<0.01	1.2	<0.01	0.31	0.04	0.0003	<0.0004	<0.0001	8	70	<0.0001	<0.01
PU	7/23/2008	<0.00005	0.05	66	<0.0005	0.024	<0.01	<0.0001	<0.1	27.0	<0.0001	2	<0.01	<0.01	<0.0005	0.03	79	<0.0002	0.5	2.7	0.009	<0.01	1.4	<0.01	<0.02	0.01	<0.0001	<0.0004	0.0001	9	80	<0.0001	<0.01
PU	10/22/2008	<0.00005	0.05	70	<0.0005	0.024	<0.01	<0.0001	<0.1	28.2	<0.0001	<1	<0.01	<0.01	0.0005	0.03	82	<0.0002	0.5	2.9	<0.005	<0.01	1.7	<0.01	0.08	<0.01	<0.0001	<0.0004	<0.0001	10	70	<0.0001	0.03
PU	1/28/2009	<0.00005	0.08	77	<0.0005	0.025	<0.01	<0.0001	<0.1	32.8	<0.0001	2	<0.01	<0.01	0.0007	0.02	96	<0.0002	0.5	3.4	<0.005	<0.01	2.2	0.02	0.09	<0.01	<0.0001	<0.0004	0.0002	16	110	<0.0001	<0.01
PU	5/6/2009	<0.00005	0.06	40	<0.0005	0.017	<0.01	<0.0001	<0.01	16.2	<0.0001	<1	<0.01	<0.01	0.0015	0.06	47	<0.0002	0.5	1.6	<0.005	<0.01	1.2	<0.01	0.18	0.05	<0.0001	<0.0004	0.0002	3	70	<0.0001	<0.01
PU	7/15/2009	<0.00005	<0.03	77	<0.0005	0.020	<0.01	<0.0001	<0.01	29.3	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	84	<0.0002	0.5	2.6	<0.005	<0.01	1.5	<0.01	<0.02	<0.01	<0.0001	<0.0004	0.0001	11	100	<0.0001	<0.01
PU	11/4/2009	<0.00005	0.05	72	<0.0005	0.017	<0.01	<0.0001	<0.01	29.3	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	86	<0.0002	<0.3	3.0	<0.005	<0.01	1.8	<0.01	0.04	<0.01	<0.0001	<0.0004	0.0002	13	100	<0.0001	<0.01
PU	2/3/2010	<0.00005	<0.03	80	<0.0005	0.021	<0.01	<0.0001	<0.01	33.0	<0.0001	<1	<0.01	<0.01	0.0006	<0.02	96	<0.0002	0.6	3.3	<0.005	<0.01	2.0	<0.01	0.13	<0.01	<0.0001	<0.0004	0.0002	15	110	<0.0001	<0.01
PU	4/28/2010	<0.00005	0.13	48	<0.0005	0.016	<0.01	<0.0001	<0.01	19.5	<0.0001	<1	<0.01	<0.01	0.0006	0.09	57	<0.0002	0.5	1.9	<0.005	<0.01	1.2	<0.01	0.12	0.01	0.0001	<0.0004	0.0002	7	100	<0.0001	<0.01
PU	8/11/2010	<0.00005	<0.03	64	<0.0005	0.016	<0.01	<0.0001	<0.01	25.9	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	75	<0.0002	0.4	2.5	<0.005	<0.01	1.6	<0.01	<0.02	0.01	<0.0001	<0.0004	0.0002	8	80	<0.0001	<0.01
PU	10/20/2010	<0.00005	<0.03	81	<0.0005	0.037	0.01	<0.0001	<0.01	33.1	<0.0001	12	<0.01	<0.01	<0.0005	<0.02	96	<0.0002	0.7	3.3	<0.005	<0.01	1.8	<0.01	0.03	<0.01	0.0002	<0.0004	0.0002	14	80	<0.0001	<0.01
PU	3/2/2011	<0.00005	<0.03	78	<0.0005	0.020	<0.01	<0.0001	<0.01	33.1	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	96	<0.0002	0.9	3.2	<0.005	<0.01	2.4	<0.01	0.07	<0.01	<0.0001	<0.0004	0.0003	14	110	<0.0001	<0.01
PU	5/4/2011		0.08	57	<0.0005				<0.01	23.1	<0.0001	<1				0.05	68		0.5	2.5	<0.005		1.5			0.01	0.0002			10	90		<0.01
PU	8/3/2011		<0.03	69	<0.0005				<0.01	29.0	<0.0001	<1				0.02	84		0.6	2.9	<0.005		1.7			0.02	0.0003			12	90		<0.01
PU	11/9/2011		<0.03	76	<0.0005				<0.01	28.5	<0.0001	<1				<0.02	84		0.6	3.0	<0.005		2.0			<0.01	0.0002			17	100		<0.01
PU	2/22/2012		<0.03	80	<0.0005				<0.01	29.2	<0.0001	<1				<0.02	86		0.8	3.1	<0.005		3.7			<0.01	<0.0001			14	130		<0.01
PU	5/30/2012		0.04	61	<0.0005				0.036	22.9	<0.0001	<1				<0.02	67		0.6	2.3	<0.005		1.1			<0.01	<0.0001			9	70		<0.01
PU	8/7/2012		0.13	65	<0.0002				<0.05	26.8	<0.0001	<1				0.09	79		0.8	2.8	<0.005		1.5			0.03	0.0003			12	90		<0.01
PU	11/6/2012		0.29	82	<0.0002				<0.05	34.3	<0.0001	<1				0.22	102		0.6	4.0	0.303		1.9			<0.01	<0.0001			17	120		0.48
PU	2/5/2013		<0.03	96	<0.0002				<0.05	29.7	<0.0001	<1				<0.02	87		0.5	3.1	<0.005		2.0			<0.01	<0.0001			15	120		<0.01
PU	6/21/2013		<0.03	73	<0.0002				<0.05	30.2	<0.0001	<1				<0.02	87		0.6	2.8	<0.005		1.6			0.01	<0.0001			19.0	110		<0.01
PU	12/18/2013			77	<0.0002				<0.05	29.9	<0.0001	<1				<0.02	86		0.4	2.8	<0.005		1.8			<0.01				14.7	90		<0.01
PU	5/29/2014			50	<0.0002				<0.05	18.5	<0.0001	0.8				0.07	54		0.6	1.8	<0.005		1.1			0.01				7.9	60		<0.01
PU	12/10/2014			81.1	<0.0002				<0.05	30.9	<0.0001	1.1				<0.02	90		0.6	3	<0.005		1.9			0.01				13.9	108		<0.01
PU	11/3/2015			75.8	<0.0002				<0.05	29.6	<0.0001	1.5				0.04	86.3		0.7	3	0.005		1.7			<0.01				12.5	110		<0.01
PU	10/18/2016			78.8	<0.0002				<0.05	32.5	<0.0001	1.15				<0.02	93		0.7	2.9	<0.005		1.8			<0.02				13.0	110		<0.01
WCD	3/31/2004			149	0.0001					62.1	<0.0001	1			<0.0005	0.03	172		0.6	4.0	0.005		1.8				0.0001			30	180		0.02
WCD	6/30/2004			150	<0.001					60.3	<0.0002	2			<0.001	<0.01	165	<0.0002	0.5	3.5	<0.005		1.4				<0.0002			30	190		<0.01
WCD	9/23/2004			165						65.9		1					182	<0.0002	0.9	4.3			1.7							20	200		
WCD	11/19/2004			148						68.0		<1					187	<0.0002	0.7	4.2			1.6							20	190		
WCD	3/21/2005	<0.005	<0.03	142	<0.0005	0.036		<0.002	<0.1	66.5	0.0004		<0.01	<0.01	<0.01	<0.01		<0.0002	0.6				2.3	<0.01	0.05	0.01	<0.0001	<0.02	<0.04			<0.2	0.09
WCD	6/10/2005	<0.005	<0.03	145	<0.0005	0.027		<0.002	<0.1	57.1	<0.0001		<0.01	<0.01	<0.01	<0.01		<0.0002	<0.3				1.2	<0.01	<0.02		0.0004	<0.02	<0.04			<0.2	<0.01
WCD	8/18/2005	<0.01	<0.03	146	<0.0005	0.039		<0.002	0.3	58.2	<0.0001		<0.01	<0.01	<0.01	0.04		<0.0002	0.6				1.4	<0.01	0.05		0.0004	<0.02	<0.001			<0.0001	<0.01
WCD	11/10/2005	<0.00005	<0.03	140	<0.0001	0.036	<0.01	<0.0001	<0.1	66.2	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	182	<0.0002	0.6	4.0	0.005	<0.01	1.6	<0.01			<0.0001	<0.0004	0.0003	10	200	<0.0001	<0.01

Note: Blank records were not analyzed

PMOU historical analytical results for surface water (mg/L)

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Be-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	Fe-dis	Hard	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Sb-dis	Se-dis	SO4	TDS	Tl-dis	Zn-dis
WCD	3/15/2006	<0.00005	<0.03	158	<0.0005	0.033	<0.01	<0.0001	<0.1	59.7	<0.0001	2	<0.01	<0.01	0.0009	<0.02	165	<0.0002	0.6	3.9	<0.005	<0.01	1.7	<0.01			<0.0001	<0.0004	0.0006	20	180	<0.0001	<0.01
WCD	5/12/2006	<0.00005	<0.03	171	<0.0005	0.039	<0.01	<0.0001	<0.1	63.3	<0.0001	2	<0.01	<0.01	0.0010	<0.02	176	<0.0002	0.6	4.2	0.012	<0.01	1.8	<0.01			<0.0001	<0.0004	0.0004	20	200	<0.0001	0.01
WCD	8/10/2006	<0.00005	<0.03	156	<0.0005	0.048	0.01	<0.0001	<0.1	70.6	<0.0001	1	<0.01	<0.01	0.0013	0.07	195	<0.0002	0.9	4.6	0.018	<0.01	2.0	<0.01		<0.01	0.0002	<0.0004	<0.0001	30	230	<0.0001	0.02
WCD	11/1/2006	<0.00005	<0.03	165	<0.0005	0.042	0.01	<0.0001	<0.1	64.3	<0.0001	2	<0.01	<0.01	0.0006	0.03	177	<0.0002	0.8	4.0	0.012	<0.01	1.7	<0.01		<0.01	0.0001	<0.0004	0.0002	<10	170	<0.0001	0.01
WCD	2/7/2007	<0.00005	<0.03	151	<0.0005	0.038	<0.01	<0.0001	<0.1	64.4	<0.0001	2	<0.01	<0.01	<0.0005	<0.02	177	<0.0002	0.8	4.0	0.006	<0.01	1.5	<0.01		0.01	<0.0001	<0.0004	0.0005	20	180	<0.0001	<0.01
WCD	5/2/2007	<0.0001	<0.03	142	<0.001	0.034	0.01	<0.0002	<0.1	63.3	<0.0002	<1	<0.01	<0.01	<0.001	<0.02	173	<0.0002	0.7	3.7	<0.005	<0.01	1.5	<0.01		0.02	0.0006	<0.0008	<0.0002	10	180	<0.0002	0.01
WCD	7/18/2007	<0.00005	<0.03	159	0.0035	0.117	0.01	<0.0001	<0.1	67.7	<0.0001	1	<0.01	<0.01	0.0010	0.40	190	0.0002	0.8	5.1	0.130	<0.01	2.3	<0.01	0.03	0.21	0.0001	0.0010	0.0018	<10	200	<0.0001	<0.01
WCD	10/9/2007	0.00021	<0.03	166	<0.0005	0.054	<0.01	<0.0001	<0.1	65.2	<0.0001	<1	<0.01	<0.01	0.0007	0.14	181	<0.0002	0.7	4.5	0.025	<0.01	1.7	<0.01	<0.02	0.01	0.0001	<0.0004	0.0002	20	190	0.0001	0.01
WCD	1/30/2008	<0.00005	<0.03	154	<0.0005	0.053	0.02	<0.0001	<0.1	70.8	<0.0001	2	<0.01	<0.01	0.0005	0.04	196	<0.0002	0.7	4.6	0.014	<0.01	1.8	<0.01	0.13	0.01	0.0001	<0.0004	0.0005	20	190	<0.0001	0.02
WCD	4/23/2008	<0.00005	0.15	137	0.0005	0.027	<0.01	<0.0001	<0.1	59.0	<0.0001	1	<0.01	<0.01	0.0006	<0.02	161	<0.0002	0.4	3.3	<0.005	<0.01	1.2	<0.01	0.04	0.02	0.0002	<0.0004	<0.0001	15	170	<0.0001	<0.01
WCD	7/23/2008	<0.00005	<0.03	148	<0.0005	0.034	<0.01	<0.0001	<0.1	62.4	<0.0001	5	<0.01	<0.01	<0.0005	0.02	171	<0.0002	0.6	3.6	0.006	<0.01	1.2	<0.01	0.09	0.03	<0.0001	<0.0004	0.0004	16	180	<0.0001	<0.01
WCD	10/22/2008	<0.00005	0.06	152	<0.0005	0.035	<0.01	<0.0001	<0.1	65.5	<0.0001	1	<0.01	<0.01	<0.0005	0.03	181	<0.0002	0.8	4.1	<0.005	<0.01	1.5	<0.01	<0.02	<0.01	<0.0001	<0.0004	0.0002	18	180	<0.0001	0.01
WCD	1/28/2009	<0.00005	0.04	152	<0.0005	0.036	<0.01	<0.0001	<0.1	68.3	<0.0001	2	<0.01	<0.01	0.0006	<0.02	188	<0.0002	0.6	4.3	0.006	<0.01	2.2	<0.01	0.14	0.06	<0.0001	<0.0004	0.0005	23	200	<0.0001	<0.01
WCD	5/6/2009	<0.00005	<0.03	136	<0.0005	0.030	<0.01	<0.0001	<0.01	57.7	<0.0001	1	<0.01	<0.01	0.0006	<0.02	157	<0.0002	0.4	3.2	<0.005	0.01	1.3	<0.01	0.12	0.02	<0.0001	<0.0004	0.0005	15	180	<0.0001	<0.01
WCD	7/15/2009	<0.00005	0.07	149	<0.0005	0.029	<0.01	<0.0001	<0.01	57.7	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	158	<0.0002	0.9	3.3	<0.005	<0.01	1.3	<0.01	0.05	0.01	<0.0001	<0.0004	0.0002	15	180	<0.0001	<0.01
WCD	11/4/2009	<0.00005	<0.03	157	<0.0005	0.029	<0.01	<0.0001	<0.01	66.6	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	184	<0.0002	<0.3	4.2	<0.005	<0.01	1.5	<0.01	<0.02	<0.01	<0.0001	<0.0004	0.0003	20	190	<0.0001	<0.01
WCD	2/3/2010	<0.00005	<0.03	158	<0.0005	0.035	<0.01	<0.0001	<0.01	65.5	<0.0001	<1	<0.01	<0.01	<0.0005	0.02	181	<0.0002	0.8	4.1	<0.005	0.01	1.7	<0.01	0.12	<0.01	<0.0001	<0.0004	0.0004	21	190	<0.0001	<0.01
WCD	4/28/2010	<0.00005	0.03	138	<0.0005	0.026	0.01	<0.0001	<0.01	59.3	<0.0001	1	<0.01	<0.01	0.0006	<0.02	162	<0.0002	0.6	3.4	<0.005	<0.01	1.4	<0.01	<0.02	0.02	<0.0001	<0.0004	0.0005	18	190	<0.0001	<0.01
WCD	8/11/2010	<0.00005	<0.03	149	<0.0005	0.027	<0.01	<0.0001	<0.01	62.2	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	170	<0.0002	0.6	3.6	<0.005	<0.01	1.9	<0.01	0.02	0.02	<0.0001	<0.0004	0.0004	14	170	<0.0001	<0.01
WCD	10/20/2010	<0.00005	<0.03	150	<0.0005	0.037	0.01	<0.0001	<0.01	63.6	<0.0001	<1	<0.01	0.01	<0.0005	<0.02	175	<0.0002	0.8	3.9	0.009	<0.01	1.4	<0.01	<0.02	<0.01	0.0002	<0.0004	0.0003	18	170	<0.0001	<0.01
WCD	3/2/2011	<0.00005	<0.03	148	<0.0005	0.034	0.01	<0.0001	<0.01	65.0	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	179	<0.0002	1.6	3.9	<0.005	<0.01	1.9	<0.01	0.08	<0.01	<0.0001	<0.0004	0.0005	19	200	<0.0001	<0.01
WCU	3/31/2004			150	0.0001					62.2	<0.0001	<1			<0.0005	0.01	172		0.7	4.0	<0.005		1.7				<0.0001			30	180		<0.01
WCU	3/22/2005	<0.005	0.03	141	<0.0005	0.034		<0.002	<0.1	65.9	<0.0001		<0.01	<0.01	<0.01	<0.01		<0.0002	0.7				1.6	<0.01	0.13	0.08	<0.0001	<0.02	<0.04			<0.2	<0.01
WCU	6/9/2005	<0.005	<0.03	139	<0.0005	0.026		<0.002	<0.1	56.8	0.0002		<0.01	<0.01	<0.01	<0.01		<0.0002	0.5				1.1	<0.01	0.08		0.0004	<0.02	<0.04			<0.2	<0.01
WCU	8/19/2005	<0.01	<0.03	144	<0.0005	0.033		<0.002	0.2	56.5	<0.0001		<0.01	<0.01	<0.01	<0.02		<0.0002	0.5				1.4	<0.01	0.06	0.01	0.0002	<0.0004	<0.001			<0.0001	<0.01
WCU	11/10/2005	<0.00005	<0.03	127	<0.0001	0.035	<0.01	<0.0001	<0.1	66.1	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	182	<0.0002	0.6	4.0	<0.005	<0.01	1.6	<0.01			<0.0001	<0.0004	0.0003	<10	200	<0.0001	<0.01
WCU	3/15/2006	<0.00005	<0.03	157	<0.0005	0.032	<0.01	<0.0001	<0.1	58.7	<0.0001	2	<0.01	<0.01	<0.0005	<0.02	162	<0.0002	0.6	3.8	<0.005	<0.01	1.6	<0.01			<0.0001	<0.0004	0.0005	20	190	<0.0001	<0.01
WCU	5/11/2006	<0.00005	<0.03	163	<0.0005	0.037	0.01	<0.0001	<0.1	68.5	<0.0001	2	<0.01	<0.01	<0.0005	<0.02	190	<0.0002	0.8	4.5	<0.005	<0.01	2.0	<0.01			<0.0001	<0.0004	0.0005	20	200	<0.0001	<0.01
WCU	8/10/2006	<0.00005	<0.03	154	<0.0005	0.040	0.01	<0.0001	<0.1	69.2	<0.0001	<1	<0.01	<0.01	0.0005	<0.02	191	<0.0002	0.8	4.3	<0.005	<0.01	1.7	<0.01		<0.01	0.0002	<0.0004	<0.0001	20	230	<0.0001	<0.01
WCU	11/1/2006	<0.00005	<0.03	162	<0.0005	0.034	0.01	<0.0001	<0.1	64.3	<0.0001	2	<0.01	<0.01	<0.0005	<0.02	177	<0.0002	0.7	3.9	<0.005	<0.01	1.5	<0.01		<0.01	<0.0001	<0.0004	0.0003	10	190	<0.0001	<0.01
WCU	2/8/2007	<0.00005	<0.03	151	<0.0005	0.034	<0.01	<0.0001	<0.1	62.9	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	173	<0.0002	0.6	3.8	<0.005	<0.01	1.4	<0.01		<0.01	<0.0001	<0.0004	0.0004	20	190	<0.0001	<0.01
WCU	5/2/2007	<0.0001	<0.03	142	<0.0005	0.031	<0.01	<0.0002	<0.1	62.1	<0.0002	1	<0.01	<0.01	<0.0005	<0.02	170	<0.0002	0.6	3.6	<0.005	<0.01	1.4	<0.01		0.03	0.0007	<0.0008	<0.0002	10	180	<0.0002	<0.01
WCU	7/18/2007	<0.00005	<0.03	157	<0.0005	0.031	0.01	<0.0001	<0.1	61.6	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	169	0.0003	0.7	3.6	<0.005	<0.01	1.3	<0.01	0.04	<0.01	<0.0001	<0.0004	<0.0001	<10	180	<0.0001	<0.01
WCU	10/9/2007	0.00011	<0.03	160	<0.0005	0.036	<0.01	<0.0001	<0.1	64.8	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	179	<0.0002	0.7	4.2	<0.005	<0.01	1.5	<0.01	<0.02	<0.01	<0.0001	<0.0004	0.0002	20	190	<0.0001	<0.01
WCU	1/30/2008	<0.00005	<0.03	154	<0.0005	0.044	0.01	<0.0001	<0.1	70.3	<0.0001	2	<0.01	<0.01	0.0006	<0.02	194	<0.0002	0.7	4.4	<0.005	<0.01	1.6	<0.01	0.12	0.01	<0.0001	<0.0004	0.0005	10	190	<0.0001	<0.01
WCU	4/23/2008	<0.00005	0.04	136	0.0005	0.025	0.01	<0.0001	<0.1	59.5	<0.0001	<1	<0.01	<0.01	0.0007	<0.02	162	<0.0002	0.4	3.3	<0.005	<0.01	1.1	<0.01	0.04	0.03	0.0002	<0.0004	<0.0001	15	160	<0.0001	<0.01
WCU	7/23/2008	<0.00005	<0.03	148	<0.0005	0.033	0.02	<0.0001	<0.1	62.9	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	172	<0.0002	0.6	3.6	<0.005	<0.01	1.2	<0.01	0.09	0.02	<0.0001	<0.0004	0.0003	15	180	<0.0001	<0.01
WCU	10/22/2008	<0.00005	<0.03	151	<0.0005	0.035	<0.01	<0.0001	<0.1	66.6	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	183	<0.0002	0.7	4.1	<0.005	<0.01	1.4	<0.01	0.08	<0.01	<0.0001	<0.0004	0.0002	17	190	<0.0001	<0.01
WCU	1/28/2009	<0.00005	0.04	151	<0.0005	0.034	<0.01	<0.0001	<0.1	66.5	<0.0001	2	<0.01	<0.01	<0.0005	<0.02	184	<0.0002	0.7	4.3	<0.005	<0.01	1.6	<0.01	0.11	<0.01	<0.0001	<0.0004	0.0005	21	210	<0.0001	<0.01
WCU	5/6/2009	<0.00005	<0.03	143	<0.0005	0.030	<0.01	<0.0001	<0.01	57.2	<0.0001	1	<0.01	<0.01	0.0018	<0.02	156	<0.0002	0.4	3.2	<0.005	<0.01	1.4	<0.01	0.12	0.02	<0.0001	<0.0004	0.0005	15	170	<0.0001	<0.01
WCU	7/15/2009	<0.00005	<0.03	148	<0.0005	0.031	0.01	<0.0001	<0.01	58.1	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	158	<0.0002	0.8	3.2	<0.005	0.01	1.2	<0.01	0.05	<0.01	<0.0001	<0.0004	0.0002	15	180	<0.0001	<0.01
WCU	11/4/2009	<0.00005	<0.03	157	<0.0005	0.030	<0.01	<0.0001	<0.01	65.6	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	181	<0.0002	<0.3	4.1	<0.005	<0.01	1.5	<0.01	<0.02	<0.01	<0.0001	<0.0004	0.0003	19	200	<0.0001	<0.01
WCU	2/3/2010	<0.00005	<0.03	156	<0.0005	0.031	<0.01	<0.0001	<0.01	65.6	<0.0001	1	<0.01	<0.01	<0.0005	0.03	180	<0.0002	0.6	4.0	<0.005	<0.01	1.5	<0.01	0.10	<0.01	0.0001	<0.0004	0.0004	21	190	0.0001	<0.01
WCU	4/28/2010	<0.00005	0.03	137	<0.0005	0.025	0.01	<0.0001	<0.01	58.2	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	159	<0.0002	0.6	3.2	<0.005	<0.01	1.3	<0.01	0.04	0.02	<0.0001	<0.0004	0.0005	14	190	<0.0001	<0.01
WCU	8/11/2010	<0.00005	<0.03	149	<0.0005	0.026	<0.01	<0.0001	<0.01	62.3	<0.0001	<1	<0.01	<0.01	<0.0005	<0.02	170	<0.0002	0.6	3.5	<0.005	<0.01	1.3	<0.01	0.03	0.02	<0.0001	<0.0004	0.0004	13	170	<0.0001	<0.01
WCU	10/20/2010	<0.00005	<0.03	151	<0.0005	0.033	0.01	<0.0001	<0.01	64.5	<0.0001	11	<0.01	0.01	<0.0005	<0.02	177	<0.0002	0.8	3.9	<0.005	<0.01	1.3	<0.01	<0.02	<0.01	0.0002	<0.0004	0.0003	16	160	<0.0001	<0.01
WCU	3/2/2011	<0.00005	<0.03	147	<0.0005	0.031	<0.01	<0.0001	<0.01	65.6	<0.0001	1	<0.01	<0.01	<0.0005	<0.02	180	<0.0002	0.7	3.9	<0.005	<0.01	1.6	<0.01	0.08	<0.01	<0.0001	<0.0004	0.0005	19	190	<0.0001	<0.01
WSBDT	3/31/2004			208	0.0002					81.8	0.0036	2			<0.0005	0.10	248		1.0	10.5	0.572		4.3				0.0001			50	280		2.05
WSBDT	6/30/2004			164	<0.0005					76.5	0.0023	4			0.0008	0.03	227	<0.0002	1.0	8.6	0.239		4.5				<0.0002			70	270		1.03
WSBDT	9/23/2004			253						110		8					359	<0.0002	2.2	20.4			14.2							130	450		
WSBDT	11/19/2004			302						133		8					470	<0.0002	1.6	33.5			10.2							140	510		
WSBDT	3/22/2005	<0.005	<0.03	158	<0.0005	0.073		<0.002	<0.1	83.8	0.0287		<0.01	<0.01	<0.01	0.02		<0.0002	1.2				9.4	<0.01	0.06	<0.01	<0.0001	<0.02	<0.04			<0.2	10.60
WSBDT	6/10/2005	<0.005	0.10	163	<0.0005	0.053		<0.002	<0.1	71.2	0.0038		<0.01	<0.01	<0.01	0.02			0.6				2.7	<0.01	<0.02		0.0002	<0.02	<0.04			<0.2	1.68
WSBDT	11/11/2005	<0.00005	<0.03	301	<0.0001	0.056	0.02		<0.1	171	0.0051	7	<0.01	<0.01	<0.01	0.34		<0.0002	2.6		2.040	<0.01	14.5	<0.01	0.39		<0.0001		<0.0001	380	840		16.20

Note: Blank records were not analyzed

PMOU historical analytical results for surface water (mg/L)

Location	Date	Ag-dis	Al-dis	Alk	As-dis	Ba-dis	B-dis	Be-dis	Br	Ca-dis	Cd-dis	Cl	Co-dis	Cr-dis	Cu-dis	Fe-dis	Hard	Hg	K-dis	Mg-dis	Mn-dis	Mo-dis	Na-dis	Ni-dis	No3no2n	P	Pb-dis	Sb-dis	Se-dis	SO4	TDS	Tl-dis	Zn-dis
WSBDT	3/14/2006	<0.00005	0.04	70	<0.0005	0.037	0.01		<0.1	35.0	0.0008	9	<0.01	<0.01	<0.01	0.05			7.1		0.584	<0.01	4.8	<0.01	0.31		0.0003		0.0001	120	220		0.39
WSBDT	8/10/2006	<0.00005	<0.03	300	<0.0005	0.140	0.05		<0.5	155	0.0089	6	<0.01	<0.01	<0.01	<0.02		<0.0002	2.2		2.550	<0.01	13.5	<0.01	<0.02	<0.01	<0.0001		<0.0001	250	740		7.49
WSBDT	11/1/2006	<0.00005	<0.03	422	<0.0005	0.092	0.03		<0.2	148	<0.0001	8	<0.01	<0.01	<0.01	<0.02		<0.0002	3.3		2.750	<0.01	12.3	<0.01	0.05	1.47	0.0001		<0.0001	190	690		0.42
WSBDT	10/9/2007	<0.00005	<0.03		0.0005	0.209	0.02	<0.0001	<0.1	139	0.0008	5	0.02	<0.01	0.0009	4.4	467		1.8	29	4.14	<0.01	11.8	<0.01			0.0002	<0.0004	<0.0001	140	570	<0.0001	10.4
WSBDT	4/23/2008	<0.00005	0.05	320	0.0011	0.133	0.02	<0.0001	<0.2	155	0.0026	9	0.02	<0.01	0.0011	4.12	510	<0.0002	1.6	29.7	3.730	<0.01	12.3	<0.01	0.07	0.41	0.0002	<0.0004	<0.0001	160	620	<0.0001	11.40
WSBDT	7/23/2008	<0.00005	<0.03	336	0.0007	0.288	0.03	<0.0001	0.2	140	0.0003	1	0.02	<0.01	0.0007	1.30	465	<0.0002	2.5	27.9	3.480	<0.01	12.6	<0.01	<0.02	0.65	0.0002	<0.0004	<0.0001	140	560	<0.0001	5.99
WSBDT	10/22/2008	<0.00005	0.06	312	<0.0005	0.083	0.02	<0.0001	0.2	161	0.0010	8	0.02	<0.01	0.0012	0.82	534	<0.0002	2.1	31.9	3.130	<0.01	12.7	<0.01	<0.02	1.49	<0.0001	<0.0004	<0.0001	200	660	<0.0001	13.50
WSBDT	4/28/2010	<0.00005	<0.03	364	<0.0005	0.103	0.03	<0.0001	<0.1	167	0.0016	15	0.03	<0.01	0.0010	6.72	551	<0.0002	2.0	32.5	4.660	<0.01	13.2	0.02	0.06	0.32	0.0001	<0.0004	<0.0001	150	680	<0.0001	10.40
WSBDT	8/11/2010	<0.00005	0.03	342	<0.0005	0.344	0.04	<0.0001	0.06	151	0.0004	15	0.02	<0.01	0.0025	0.59	506	<0.0002	5.0	31.2	2.260	<0.01	16.0	<0.01	<0.02	0.60	0.0006	<0.0004	<0.0001	139	610	<0.0001	2.47
WSBDT	10/20/2010	<0.00005	<0.03	342	0.0011	0.096	0.03	<0.0001	<0.1	144	0.0003	33	0.01	<0.01	0.0007	10.20	480	<0.0002	2.1	29.3	3.040	0.01	13.3	<0.01	0.02	0.28	0.0006	<0.0004	<0.0001	145	580	<0.0001	12.50
WSBDT	3/2/2011	<0.00005	<0.03	321	0.0006	0.091	0.01	<0.0001	<0.1	165	0.0017	9	0.02	<0.01	0.0011	9.13	544	<0.0002	2.5	32.0	3.220	<0.01	13.6	<0.01	<0.02	0.30	0.0001	<0.0004	<0.0001	176	680	<0.0001	12.70
WSBDT	5/4/2011		<0.03	352	0.0008				<0.05	141	0.0005	10				9.80	472		1.6	29.0	3.670		12.9			0.59	0.0011			138	580		10.10
WSBDT	11/3/2015			247	<0.0002				<0.5	317	0.0154	93.6				<0.02	1080		4.3	70.6	2.490		72.6			0.10				792	1480		12.10
WSBDT	10/18/2016			338	<0.0002				<0.5	243	0.0006	51.9				1.19	839		9.9	56.4	3.690		40.2			2.1				510	1330		4.38

Note: Blank records were not analyzed

Appendix C

Field Notes

Fourth Quarter 2016

11/5/15 BS/N.B./CJ

12:25 Arrive onsite with DBS+A, FMI, Westland & NMED
Beth Salvas, Neil Blandford, Chad Johannesen
Alicia Voss, David Cerasale
Kurt Vollbrecht, David Mayerson
Walk around on Waste Rock pile to Willow creek, checking reclamation and vegitation

Drive to southern edge of reclamation and view from Highway

13:55 offsite

10/18/16 EB/AC

1010 Onsite at PMOU, sampling site Pecos upstream.

1012 Calibrate YSI

pre	post	param.	comment
3.79	4.00	pH 4.0	
6.95	7.00	pH 7.0	
10.25	10.00	pH 10.0	
1330	1413	sp C	17.77°C
80.6	75.8	DO	576.1 mmHg

10:15 Tailgate safety meeting discuss cold/sun/wind and slips + trips.

16:15 offsite

10/18/16 EB/AL
10:20 Location ID: Pecos upstream
Sample ID: PUSW416DS
Sample time: 1025
Sample method: grab

Field parameters
pH = 7.60
T = 5.78°C
SpC = 178 µS/cm
DO = 10.60 mg/L
Turbidity = 2.42 NTU

3 photos taken.

10/18/16 EB/AL

Well ID: P-7S
DTW = 9.32 TD = 16.45 ft btoc
Purge Vol (3cV): (16.45 − 9.32) ½ = 3.56
Purge Method: Ded Poly bailer
Sample ID: P7SMW416DS
Sample time: 1115

Field Parameters:

Time	Vol (gal)	pH	T(°c)	SpC (mS/cm)	Comments
1100	init	6.59	13.15	750	DO = 1.50 mg/L
1103	1.5	6.74	12.32	766	Slightly cloudy
1105	2.75	6.87	12.36	768	"
1110	3.75	6.84	13.09	764	"

Turbidity = 25.8 NTU

10/18/16 AL/EB

1120 Well ID: P-7

DTW: 7.45 TD = ~~16.45~~ ~~95.35~~ 95.35

purge vol (3CV) = (~~16.45~~ 95.35 − 7.45) ½ = ~~4.5~~ 43.95

purge method: Dedicated poly bailer

Sample ID: P7SMW416DS

Sample time: 1210

Field Parameters

Time	Vol (gal)	pH	T (°C)	SpC (µS/cm)	Comments
1120	Init	7.15	13.18	695	DO = 0.83 mg/l
1133	10	6.87	11.57	708	Slight trash odor
1142	20	6.80	11.43	702	"
1151	30	6.88	11.53	702	"
1200	40	6.98	11.00	703	"
1204	44	6.81	10.76	703	"

Turbidity (final) = 5.31 NTU

10/18/16 EB/AL

13:00 Well ID: P-13S

DTW = 6.30 TD = 13.5 ft btoc

Purge Vol (3CV) = (13.5 − 6.30) × ½ = 3.6 gal

Purge method = Ded Poly bailer

Sample ID: P13SMW416DS

Sample time: 13:45

Field Data:

Time	Vol (gal)	pH	T (°C)	SpC (µS/cm)	Comment
13:28	Int	6.71	11.62	1582	DO = 0.88 mg/L
13:32	1.25	6.76	11.77	1605	Cloudy, slight odor
13:36	2.5	6.75	11.84	1475	"
13:40	3.75	6.74	12.43	1557	"
13:45	collect sample				

Turbidity = 203 NTU

13:55 collect sample duplicate DUI-P416DS

10/18/16 EB/AL

Well ID: P-13

DTW = 4.02 ft btoc TD = 32.13

Purge Vol(3cv) = (32.13 - 4.02) x ½ = 14.06 gal

Purge Method = Ded Poly bailer

Sample ID: P13MW416DS

Sample time: 1350

Field Parameters:

~~DTW = emz TD =~~

~~Purge Vol(3cv) =~~

~~Purge Method: Ded Poly bailer~~

time	Vol (gal)	pH	T(°C)	SpC (mS/cm)	Comments
13:15	Int	6.92	13.37	662	DO = 0.93 mg/L
13:25	5.0	6.85	11.09	751	clear, Strong odor
13:35	10.0	6.90	11.10	769	"
1345	14.0	6.92	11.45	767	"

1350 collect sample

Turbidity = 11.3 NTU

10/18/16 EB/AL

Location ID: Pecos Downstream

Sample ID = PDSW416DS

Sample time = 14:20

Sample method = grab

Field Parameters:

pH = ~~8.07~~ 8.35

T°C = ~~9.60~~ 9.61

SpC (µS/cm) = 181

DO (mg/L) = 9.73

Turbidity = 2.21 NTU

photos taken

16:30 collect Duplicate DU2-P416DS

10/18/16 GB/AC

Location ID: White seep
Sample ID: WSBDTSW41605
Sample time: 1450
Sample method: peristaltic pump from ponded water
Flow est: < 1/4 L/min (trickle)
Field parameters
pH = 7.22
T (°C) = 19.48
SpC (µS/cm) = 1633
DO (mg/L) = 3.60
Turbidity (NTU) = 730

Photos taken

10/18/16 GB/AC

1530 Location ID: Explosive Shed Seep
Sample ID: No sample
Sample time: NA
Sample method: NA

No flow. Damp soil under vegetation cover.
Photo taken.

10/18/16 EB/AC

Location ID: Equipment blank
Sample ID: EB1-P416DS
Sample time: 1540
Sample method: PVC bailer

Field parameters:

pH = 8.45
Temp (°C) = 17.45
SpC (µS/cm) = 3
DO (mg/L) = 6.43
Turbidity (NTU) = 0.35

10/18/16 EB/AC

Location ID: Field blank
Sample ID: FB1-P416DS
Sample time: 1550
Sample method: PVC bailer

Field parameters:

pH = 8.55
Temp (°C) = 17.93
SpC (µS/cm) = 3
DO (mg/L) = ~~7~~ 6.83
Turbidity (NTU) = 0.71

Appendix D

Laboratory Analytical Reports

Fourth Quarter 2016

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Analytical Report

November 07, 2016

Report to:	Bill to:
Beth Salvas	Beth Salvas
Daniel B. Stephens & Associates	Daniel B. Stephens & Associates
6020 Academy NE	6020 Academy Suite 100
Suite 100	
Albuquerque, NM 87109	Albuquerque, NM 87109

cc: Elizabeth Bastien

Project ID: 021757/ES06.0038.15P4
ACZ Project ID: L33706

Beth Salvas:

Enclosed are the analytical results for sample(s) submitted to ACZ Laboratories, Inc. (ACZ) on October 21, 2016. This project has been assigned to ACZ's project number, L33706. Please reference this number in all future inquiries.

All analyses were performed according to ACZ's Quality Assurance Plan. The enclosed results relate only to the samples received under L33706. Each section of this report has been reviewed and approved by the appropriate Laboratory Supervisor, or a qualified substitute.

Except as noted, the test results for the methods and parameters listed on ACZ's current NELAC certificate letter (#ACZ) meet all requirements of NELAC.

This report shall be used or copied only in its entirety. ACZ is not responsible for the consequences arising from the use of a partial report.

All samples and sub-samples associated with this project will be disposed of after February 05, 2017. If the samples are determined to be hazardous, additional charges apply for disposal (typically $11/sample). If you would like the samples to be held longer than ACZ's stated policy or to be returned, please contact your Project Manager or Customer Service Representative for further details and associated costs. ACZ retains analytical raw data reports for ten years.

If you have any questions or other needs, please contact your Project Manager.

Max Janicek

Max Janicek has reviewed and approved this report.

Daniel B. Stephens & Associates

Project ID:	021757/ES06.0038.15P4	ACZ Sample ID:	***L33706-01***
Sample ID:	DU2-P416DS	Date Sampled:	*10/18/16 14:30*
		Date Received:	*10/21/16*
		Sample Matrix:	*Surface Water*

Inorganic Prep

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Phosphorus, total	M365.1 - Auto Ascorbic Acid Digestion								10/27/16 15:01	bce

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Arsenic, dissolved	M200.8 ICP-MS	1		U		mg/L	0.0002	0.001	10/27/16 20:40	msh
Cadmium, dissolved	M200.8 ICP-MS	1		U		mg/L	0.0001	0.0005	10/27/16 20:40	msh
Calcium, dissolved	M200.7 ICP	1	32.8			mg/L	0.1	0.5	10/26/16 20:45	gss
Iron, dissolved	M200.7 ICP	1	0.03	B		mg/L	0.02	0.05	10/26/16 20:45	gss
Magnesium, dissolved	M200.7 ICP	1	2.9		*	mg/L	0.2	1	10/26/16 20:45	gss
Manganese, dissolved	M200.7 ICP	1	0.009	B	*	mg/L	0.005	0.03	10/26/16 20:45	gss
Potassium, dissolved	M200.7 ICP	1	0.7	B		mg/L	0.2	1	10/26/16 20:45	gss
Sodium, dissolved	M200.7 ICP	1	1.8			mg/L	0.2	1	10/26/16 20:45	gss
Zinc, dissolved	M200.7 ICP	1		U		mg/L	0.01	0.05	10/26/16 20:45	gss

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Alkalinity as CaCO3	SM2320B - Titration									
Bicarbonate as CaCO3		1	80.2			mg/L	2	20	10/26/16 0:00	abd
Carbonate as CaCO3		1		U		mg/L	2	20	10/26/16 0:00	abd
Hydroxide as CaCO3		1		U		mg/L	2	20	10/26/16 0:00	abd
Total Alkalinity		1	81.7			mg/L	2	20	10/26/16 0:00	abd
Bromide	M300.0 - Ion Chromatography	1		U	*	mg/L	0.05	0.25	11/01/16 17:07	bsu
Cation-Anion Balance	Calculation									
Cation-Anion Balance			2.6			%			11/07/16 0:00	calc
Sum of Anions			1.9			meq/L			11/07/16 0:00	calc
Sum of Cations			2			meq/L			11/07/16 0:00	calc
Chloride	M300.0 - Ion Chromatography	1	1.16	B	*	mg/L	0.5	2.5	11/01/16 17:07	bsu
Hardness as CaCO3 (dissolved)	SM2340B - Calculation		94			mg/L	0.2	5	11/07/16 0:00	calc
Phosphorus, total	M365.1 - Auto Ascorbic Acid (digest)	1		U	*	mg/L	0.02	0.05	10/31/16 15:20	bsu
Residue, Filterable (TDS) @180C	SM2540C	1	116			mg/L	10	20	10/22/16 11:58	emk
Sulfate	M300.0 - Ion Chromatography	1	12.9			mg/L	0.5	2.5	11/01/16 17:07	bsu
TDS (calculated)	Calculation		101			mg/L			11/07/16 0:00	calc
TDS (ratio - measured/calculated)	Calculation		1.15						11/07/16 0:00	calc

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

Daniel B. Stephens & Associates

Project ID: 021757/ES06.0038.15P4
Sample ID: PDSW416DS

ACZ Sample ID: ***L33706-02***
Date Sampled: *10/18/16 14:20*
Date Received: *10/21/16*
Sample Matrix: *Surface Water*

Inorganic Prep

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Phosphorus, total	M365.1 - Auto Ascorbic Acid Digestion								10/27/16 15:27	bce

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Arsenic, dissolved	M200.8 ICP-MS	1		U		mg/L	0.0002	0.001	10/27/16 20:41	msh
Cadmium, dissolved	M200.8 ICP-MS	1		U		mg/L	0.0001	0.0005	10/27/16 20:41	msh
Calcium, dissolved	M200.7 ICP	1	33.8			mg/L	0.1	0.5	10/26/16 20:48	gss
Iron, dissolved	M200.7 ICP	1	0.02	B		mg/L	0.02	0.05	10/26/16 20:48	gss
Magnesium, dissolved	M200.7 ICP	1	3		*	mg/L	0.2	1	10/26/16 20:48	gss
Manganese, dissolved	M200.7 ICP	1	0.009	B	*	mg/L	0.005	0.03	10/26/16 20:48	gss
Potassium, dissolved	M200.7 ICP	1	0.7	B		mg/L	0.2	1	10/26/16 20:48	gss
Sodium, dissolved	M200.7 ICP	1	1.9			mg/L	0.2	1	10/26/16 20:48	gss
Zinc, dissolved	M200.7 ICP	1		U		mg/L	0.01	0.05	10/26/16 20:48	gss

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Alkalinity as CaCO3	SM2320B - Titration									
Bicarbonate as CaCO3		1	79.6			mg/L	2	20	10/26/16 0:00	abd
Carbonate as CaCO3		1		U		mg/L	2	20	10/26/16 0:00	abd
Hydroxide as CaCO3		1		U		mg/L	2	20	10/26/16 0:00	abd
Total Alkalinity		1	81.2			mg/L	2	20	10/26/16 0:00	abd
Bromide	M300.0 - Ion Chromatography	1		U	*	mg/L	0.05	0.25	11/01/16 18:19	bsu
Cation-Anion Balance	Calculation									
Cation-Anion Balance			2.6			%			11/07/16 0:00	calc
Sum of Anions			1.9			meq/L			11/07/16 0:00	calc
Sum of Cations			2.0			meq/L			11/07/16 0:00	calc
Chloride	M300.0 - Ion Chromatography	1	1.17	B	*	mg/L	0.5	2.5	11/01/16 18:19	bsu
Hardness as CaCO3 (dissolved)	SM2340B - Calculation		97			mg/L	0.2	5	11/07/16 0:00	calc
Phosphorus, total	M365.1 - Auto Ascorbic Acid (digest)	1		U	*	mg/L	0.02	0.05	10/31/16 15:23	bsu
Residue, Filterable (TDS) @180C	SM2540C	1	114		*	mg/L	10	20	10/22/16 12:04	emk
Sulfate	M300.0 - Ion Chromatography	1	13.2			mg/L	0.5	2.5	11/01/16 18:19	bsu
TDS (calculated)	Calculation		102			mg/L			11/07/16 0:00	calc
TDS (ratio - measured/calculated)	Calculation		1.12						11/07/16 0:00	calc

REPIN.02.06.05.01

** Please refer to Qualifier Reports for details.*

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

Daniel B. Stephens & Associates

Project ID:	021757/ES06.0038.15P4	ACZ Sample ID:	***L33706-03***
Sample ID:	PUSW416DS	Date Sampled:	*10/18/16 10:25*
		Date Received:	*10/21/16*
		Sample Matrix:	*Surface Water*

Inorganic Prep

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Phosphorus, total	M365.1 - Auto Ascorbic Acid Digestion								10/27/16 15:40	bce

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Arsenic, dissolved	M200.8 ICP-MS	1		U		mg/L	0.0002	0.001	10/27/16 20:47	msh
Cadmium, dissolved	M200.8 ICP-MS	1		U		mg/L	0.0001	0.0005	10/27/16 20:47	msh
Calcium, dissolved	M200.7 ICP	1	32.5			mg/L	0.1	0.5	10/26/16 20:51	gss
Iron, dissolved	M200.7 ICP	1		U		mg/L	0.02	0.05	10/26/16 20:51	gss
Magnesium, dissolved	M200.7 ICP	1	2.9		*	mg/L	0.2	1	10/26/16 20:51	gss
Manganese, dissolved	M200.7 ICP	1		U	*	mg/L	0.005	0.03	10/26/16 20:51	gss
Potassium, dissolved	M200.7 ICP	1	0.7	B		mg/L	0.2	1	10/26/16 20:51	gss
Sodium, dissolved	M200.7 ICP	1	1.8			mg/L	0.2	1	10/26/16 20:51	gss
Zinc, dissolved	M200.7 ICP	1		U		mg/L	0.01	0.05	10/26/16 20:51	gss

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Alkalinity as CaCO3	SM2320B - Titration									
Bicarbonate as CaCO3		1	78.2			mg/L	2	20	10/26/16 0:00	abd
Carbonate as CaCO3		1		U		mg/L	2	20	10/26/16 0:00	abd
Hydroxide as CaCO3		1		U		mg/L	2	20	10/26/16 0:00	abd
Total Alkalinity		1	78.8			mg/L	2	20	10/26/16 0:00	abd
Bromide	M300.0 - Ion Chromatography	1		U	*	mg/L	0.05	0.25	11/01/16 18:55	bsu
Cation-Anion Balance	Calculation									
Cation-Anion Balance			2.6			%			11/07/16 0:00	calc
Sum of Anions			1.9			meq/L			11/07/16 0:00	calc
Sum of Cations			2			meq/L			11/07/16 0:00	calc
Chloride	M300.0 - Ion Chromatography	1	1.15	B	*	mg/L	0.5	2.5	11/01/16 18:55	bsu
Hardness as CaCO3 (dissolved)	SM2340B - Calculation		93			mg/L	0.2	5	11/07/16 0:00	calc
Phosphorus, total	M365.1 - Auto Ascorbic Acid (digest)	1		U	*	mg/L	0.02	0.05	10/31/16 15:24	bsu
Residue, Filterable (TDS) @180C	SM2540C	1	110		*	mg/L	10	20	10/22/16 12:06	emk
Sulfate	M300.0 - Ion Chromatography	1	13.0			mg/L	0.5	2.5	11/01/16 18:55	bsu
TDS (calculated)	Calculation		99.8			mg/L			11/07/16 0:00	calc
TDS (ratio - measured/calculated)	Calculation		1.10						11/07/16 0:00	calc

** Please refer to Qualifier Reports for details.*

Daniel B. Stephens & Associates

Project ID: 021757/ES06.0038.15P4
Sample ID: WSBDTSW416DS

ACZ Sample ID: ***L33706-04***
Date Sampled: *10/18/16 14:50*
Date Received: *10/21/16*
Sample Matrix: *Surface Water*

Inorganic Prep

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Phosphorus, total	M365.1 - Auto Ascorbic Acid Digestion				*				10/27/16 15:54	bce

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Arsenic, dissolved	M200.8 ICP-MS	1		U		mg/L	0.0002	0.001	10/28/16 15:25	enb
Cadmium, dissolved	M200.8 ICP-MS	1	0.0006			mg/L	0.0001	0.0005	10/28/16 15:25	enb
Calcium, dissolved	M200.7 ICP	1	243			mg/L	0.1	0.5	10/26/16 20:54	gss
Iron, dissolved	M200.7 ICP	1	1.19			mg/L	0.02	0.05	10/26/16 20:54	gss
Magnesium, dissolved	M200.7 ICP	1	56.4		*	mg/L	0.2	1	10/26/16 20:54	gss
Manganese, dissolved	M200.7 ICP	1	3.690		*	mg/L	0.005	0.03	10/26/16 20:54	gss
Potassium, dissolved	M200.7 ICP	1	9.9			mg/L	0.2	1	10/26/16 20:54	gss
Sodium, dissolved	M200.7 ICP	1	40.2			mg/L	0.2	1	10/26/16 20:54	gss
Zinc, dissolved	M200.7 ICP	1	4.38			mg/L	0.01	0.05	10/26/16 20:54	gss

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Alkalinity as CaCO3	SM2320B - Titration									
Bicarbonate as CaCO3		1	338			mg/L	2	20	10/26/16 0:00	abd
Carbonate as CaCO3		1		U		mg/L	2	20	10/26/16 0:00	abd
Hydroxide as CaCO3		1		U		mg/L	2	20	10/26/16 0:00	abd
Total Alkalinity		1	338		*	mg/L	2	20	10/26/16 0:00	abd
Bromide	M300.0 - Ion Chromatography	10		U	*	mg/L	0.5	2.5	11/01/16 19:13	bsu
Cation-Anion Balance	Calculation									
Cation-Anion Balance			0.0			%			11/07/16 0:00	calc
Sum of Anions			19			meq/L			11/07/16 0:00	calc
Sum of Cations			19			meq/L			11/07/16 0:00	calc
Chloride	M300.0 - Ion Chromatography	10	51.9		*	mg/L	5	25	11/01/16 19:13	bsu
Hardness as CaCO3 (dissolved)	SM2340B - Calculation		839			mg/L	0.2	5	11/07/16 0:00	calc
Phosphorus, total	M365.1 - Auto Ascorbic Acid (digest)	25	2.1		*	mg/L	0.5	1	10/31/16 15:27	bsu
Residue, Filterable (TDS) @180C	SM2540C	5	1330		*	mg/L	50	100	10/22/16 12:09	emk
Sulfate	M300.0 - Ion Chromatography	10	510			mg/L	5	25	11/01/16 19:13	bsu
TDS (calculated)	Calculation		1130			mg/L			11/07/16 0:00	calc
TDS (ratio - measured/calculated)	Calculation		1.18						11/07/16 0:00	calc

Report Header Explanations

Batch	A distinct set of samples analyzed at a specific time
Found	Value of the QC Type of interest
Limit	Upper limit for RPD, in %.
Lower	Lower Recovery Limit, in % (except for LCSS, mg/Kg)
MDL	Method Detection Limit. Same as Minimum Reporting Limit unless omitted or equal to the PQL (see comment #5). Allows for instrument and annual fluctuations.
PCN/SCN	A number assigned to reagents/standards to trace to the manufacturer's certificate of analysis
PQL	Practical Quantitation Limit. Synonymous with the EPA term "minimum level".
QC	True Value of the Control Sample or the amount added to the Spike
Rec	Recovered amount of the true value or spike added, in % (except for LCSS, mg/Kg)
RPD	Relative Percent Difference, calculation used for Duplicate QC Types
Upper	Upper Recovery Limit, in % (except for LCSS, mg/Kg)
Sample	Value of the Sample of interest

QC Sample Types

AS	Analytical Spike (Post Digestion)	*LCSWD*	Laboratory Control Sample - Water Duplicate
ASD	Analytical Spike (Post Digestion) Duplicate	*LFB*	Laboratory Fortified Blank
CCB	Continuing Calibration Blank	*LFM*	Laboratory Fortified Matrix
CCV	Continuing Calibration Verification standard	*LFMD*	Laboratory Fortified Matrix Duplicate
DUP	Sample Duplicate	*LRB*	Laboratory Reagent Blank
ICB	Initial Calibration Blank	*MS*	Matrix Spike
ICV	Initial Calibration Verification standard	*MSD*	Matrix Spike Duplicate
ICSAB	Inter-element Correction Standard - A plus B solutions	*PBS*	Prep Blank - Soil
LCSS	Laboratory Control Sample - Soil	*PBW*	Prep Blank - Water
LCSSD	Laboratory Control Sample - Soil Duplicate	*PQV*	Practical Quantitation Verification standard
LCSW	Laboratory Control Sample - Water	*SDL*	Serial Dilution

QC Sample Type Explanations

Blanks	Verifies that there is no or minimal contamination in the prep method or calibration procedure.
Control Samples	Verifies the accuracy of the method, including the prep procedure.
Duplicates	Verifies the precision of the instrument and/or method.
Spikes/Fortified Matrix	Determines sample matrix interferences, if any.
Standard	Verifies the validity of the calibration.

ACZ Qualifiers (Qual)

B	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
L	Target analyte response was below the laboratory defined negative threshold.
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

Method References

(1) EPA 600/4-83-020. Methods for Chemical Analysis of Water and Wastes, March 1983.
(2) EPA 600/R-93-100. Methods for the Determination of Inorganic Substances in Environmental Samples, August 1993.
(3) EPA 600/R-94-111. Methods for the Determination of Metals in Environmental Samples - Supplement I, May 1994.
(4) EPA SW-846. Test Methods for Evaluating Solid Waste.
(5) Standard Methods for the Examination of Water and Wastewater.

Comments

(1) QC results calculated from raw data. Results may vary slightly if the rounded values are used in the calculations.
(2) Soil, Sludge, and Plant matrices for Inorganic analyses are reported on a dry weight basis.
(3) Animal matrices for Inorganic analyses are reported on an "as received" basis.
(4) An asterisk in the "XQ" column indicates there is an extended qualifier and/or certification qualifier associated with the result.
(5) If the MDL equals the PQL or the MDL column is omitted, the PQL is the reporting limit.

For a complete list of ACZ's Extended Qualifiers, please click: http://www.acz.com/public/extquallist.pdf

Daniel B. Stephens & Associates

ACZ Project ID: ***L33706***

Alkalinity as CaCO3 SM2320B - Titration

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412167													
WG412167PBW1	PBW	10/26/16 16:10				U	mg/L		-20	20			
WG412167LCSW3	LCSW	10/26/16 16:27	WC161018-9	820.0001		769	mg/L	94	90	110			
L33715-01DUP	DUP	10/26/16 19:24			107	106	mg/L				1	20	
WG412167LCSW6	LCSW	10/26/16 19:41	WC161018-9	820.0001		789	mg/L	96	90	110			
WG412167PBW2	PBW	10/26/16 19:48				U	mg/L		-20	20			
WG412167LCSW9	LCSW	10/26/16 22:10	WC161018-9	820.0001		799	mg/L	97	90	110			
WG412167PBW3	PBW	10/26/16 22:17				U	mg/L		-20	20			
WG412167LCSW12	LCSW	10/27/16 1:08	WC161018-9	820.0001		774	mg/L	94	90	110			
WG412167PBW4	PBW	10/27/16 1:15				U	mg/L		-20	20			

Arsenic, dissolved M200.8 ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412272													
WG412272ICV	ICV	10/27/16 20:07	MS160920-1	.05		.05241	mg/L	105	90	110			
WG412272ICB	ICB	10/27/16 20:09				U	mg/L		-0.0006	0.0006			
WG412272LFB	LFB	10/27/16 20:11	MS160928-2	.0501		.05094	mg/L	102	85	115			
L33706-02AS	AS	10/27/16 20:43	MS160928-2	.0501	U	.05041	mg/L	101	70	130			
L33706-02ASD	ASD	10/27/16 20:45	MS160928-2	.0501	U	.04944	mg/L	99	70	130	2	20	
WG412343													
WG412343ICV	ICV	10/28/16 14:14	MS160920-1	.05		.05207	mg/L	104	90	110			
WG412343ICB	ICB	10/28/16 14:17				U	mg/L		-0.0006	0.0006			
WG412343LFB	LFB	10/28/16 14:20	MS160928-2	.0501		.04981	mg/L	99	85	115			
L33705-06AS	AS	10/28/16 15:18	MS160928-2	2.505	U	2.715	mg/L	108	70	130			
L33705-06ASD	ASD	10/28/16 15:22	MS160928-2	2.505	U	2.689	mg/L	107	70	130	1	20	

Bromide M300.0 - Ion Chromatography

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG410689													
WG410689ICV	ICV	09/29/16 7:13	WI160818-1	4.004		3.87	mg/L	97	90	110			
WG410689ICB	ICB	09/29/16 7:31				U	mg/L		-0.05	0.05			
WG412498													
WG412498LFB1	LFB	11/01/16 15:02	WI160802-5	1.5		1.48	mg/L	99	90	110			
L33706-01DUP	DUP	11/01/16 17:25			U	U	mg/L				0	20	RA
L33706-02AS	AS	11/01/16 18:37	WI160802-5	1.5	U	1.31	mg/L	87	90	110			M2
WG412498LFB2	LFB	11/02/16 2:05	WI160802-5	1.5		1.47	mg/L	98	90	110			

Daniel B. Stephens & Associates ACZ Project ID: **L33706**

Cadmium, dissolved M200.8 ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412272													
WG412272ICV	ICV	10/27/16 20:07	MS160920-1	.05		.05014	mg/L	100	90	110			
WG412272ICB	ICB	10/27/16 20:09				U	mg/L		-0.0003	0.0003			
WG412272LFB	LFB	10/27/16 20:11	MS160928-2	.05005		.04719	mg/L	94	85	115			
L33706-02AS	AS	10/27/16 20:43	MS160928-2	.05005	U	.04642	mg/L	93	70	130			
L33706-02ASD	ASD	10/27/16 20:45	MS160928-2	.05005	U	.04724	mg/L	94	70	130	2	20	
WG412343													
WG412343ICV	ICV	10/28/16 14:14	MS160920-1	.05		.04887	mg/L	98	90	110			
WG412343ICB	ICB	10/28/16 14:17				U	mg/L		-0.0003	0.0003			
WG412343LFB	LFB	10/28/16 14:20	MS160928-2	.05005		.04629	mg/L	92	85	115			
L33705-06AS	AS	10/28/16 15:18	MS160928-2	2.5025	U	2.4405	mg/L	98	70	130			
L33705-06ASD	ASD	10/28/16 15:22	MS160928-2	2.5025	U	2.4695	mg/L	99	70	130	1	20	

Calcium, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412158													
WG412158ICV	ICV	10/26/16 19:11	II161007-2	100		101.05	mg/L	101	95	105			
WG412158ICB	ICB	10/26/16 19:17				U	mg/L		-0.3	0.3			
WG412158LFB	LFB	10/26/16 19:29	II160929-3	67.98044		69.4	mg/L	102	85	115			
L33705-06AS	AS	10/26/16 20:27	II160929-3	67.98044	209	270.6	mg/L	91	85	115			
L33705-06ASD	ASD	10/26/16 20:30	II160929-3	67.98044	209	267.2	mg/L	86	85	115	1	20	

Chloride M300.0 - Ion Chromatography

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG410689													
WG410689ICV	ICV	09/29/16 7:13	WI160818-1	20.02		18.9	mg/L	94	90	110			
WG410689ICB	ICB	09/29/16 7:31				U	mg/L		-0.5	0.5			
WG412498													
WG412498LFB1	LFB	11/01/16 15:02	WI160802-5	30		29.6	mg/L	99	90	110			
L33706-01DUP	DUP	11/01/16 17:25			1.16	1.16	mg/L				0	20	RA
L33706-02AS	AS	11/01/16 18:37	WI160802-5	30	1.17	30.2	mg/L	97	90	110			
WG412498LFB2	LFB	11/02/16 2:05	WI160802-5	30		29.7	mg/L	99	90	110			

Iron, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412158													
WG412158ICV	ICV	10/26/16 19:11	II161007-2	2		2.001	mg/L	100	95	105			
WG412158ICB	ICB	10/26/16 19:17				U	mg/L		-0.06	0.06			
WG412158LFB	LFB	10/26/16 19:29	II160929-3	1.0017		.983	mg/L	98	85	115			
L33705-06AS	AS	10/26/16 20:27	II160929-3	1.0017	.11	1.09	mg/L	99	85	115			
L33705-06ASD	ASD	10/26/16 20:30	II160929-3	1.0017	.11	1.064	mg/L	96	85	115	2	20	

Daniel B. Stephens & Associates ACZ Project ID: ***L33706***

Magnesium, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412158													
WG412158ICV	ICV	10/26/16 19:11	II161007-2	100		99.9	mg/L	100	95	105			
WG412158ICB	ICB	10/26/16 19:17				U	mg/L		-0.6	0.6			
WG412158LFB	LFB	10/26/16 19:29	II160929-3	50.01136		46.1	mg/L	92	85	115			
L33705-06AS	AS	10/26/16 20:27	II160929-3	50.01136	78.3	121.6	mg/L	87	85	115			
L33705-06ASD	ASD	10/26/16 20:30	II160929-3	50.01136	78.3	120.5	mg/L	84	85	115	1	20	MA

Manganese, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412158													
WG412158ICV	ICV	10/26/16 19:11	II161007-2	2		1.9512	mg/L	98	95	105			
WG412158ICB	ICB	10/26/16 19:17				U	mg/L		-0.015	0.015			
WG412158LFB	LFB	10/26/16 19:29	II160929-3	.5		.4938	mg/L	99	85	115			
L33705-06AS	AS	10/26/16 20:27	II160929-3	.5	4.89	5.165	mg/L	55	85	115			M3
L33705-06ASD	ASD	10/26/16 20:30	II160929-3	.5	4.89	5.104	mg/L	43	85	115	1	20	M3

Phosphorus, total M365.1 - Auto Ascorbic Acid (digest)

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412437													
WG412437ICV	ICV	10/31/16 14:00	WI160908-3	.65228		.645	mg/L	99	90	110			
WG412437ICB	ICB	10/31/16 14:03				U	mg/L		-0.02	0.02			
WG412441													
WG412213LRB	LRB	10/31/16 15:00				U	mg/L		-0.02	0.02			
WG412213LFB	LFB	10/31/16 15:01	WI161021-2	.5		.496	mg/L	99	90	110			
L33701-02LFM	LFM	10/31/16 15:19	WI161021-2	.5	U	.51	mg/L	102	90	110			
L33706-01DUP	DUP	10/31/16 15:22			U	U	mg/L				0	20	RA

Potassium, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412158													
WG412158ICV	ICV	10/26/16 19:11	II161007-2	20		20.16	mg/L	101	95	105			
WG412158ICB	ICB	10/26/16 19:17				U	mg/L		-0.6	0.6			
WG412158LFB	LFB	10/26/16 19:29	II160929-3	99.96112		99.54	mg/L	100	85	115			
L33705-06AS	AS	10/26/16 20:27	II160929-3	99.96112	4.3	108.7	mg/L	104	85	115			
L33705-06ASD	ASD	10/26/16 20:30	II160929-3	99.96112	4.3	107.3	mg/L	103	85	115	1	20	

Residue, Filterable (TDS) @180C SM2540C

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG411965													
WG411965PBW	PBW	10/22/16 11:30				U	mg/L		-20	20			
WG411965LCSW	LCSW	10/22/16 11:32	PCN51577	260		260	mg/L	100	80	120			
L33706-01DUP	DUP	10/22/16 12:01			116	116	mg/L				0	10	
L33708-07DUP	DUP	10/22/16 12:30			U	U	mg/L				0	10	RA

Daniel B. Stephens & Associates ACZ Project ID: ***L33706***

Sodium, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412158													
WG412158ICV	ICV	10/26/16 19:11	II161007-2	100		100.55	mg/L	101	95	105			
WG412158ICB	ICB	10/26/16 19:17				U	mg/L		-0.6	0.6			
WG412158LFB	LFB	10/26/16 19:29	II160929-3	100.007		98.77	mg/L	99	85	115			
L33705-06AS	AS	10/26/16 20:27	II160929-3	100.007	4.2	107.4	mg/L	103	85	115			
L33705-06ASD	ASD	10/26/16 20:30	II160929-3	100.007	4.2	106.5	mg/L	102	85	115	1	20	

Sulfate M300.0 - Ion Chromatography

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG410689													
WG410689ICV	ICV	09/29/16 7:13	WI160818-1	50		48.7	mg/L	97	90	110			
WG410689ICB	ICB	09/29/16 7:31				U	mg/L		-0.5	0.5			
WG412498													
WG412498LFB1	LFB	11/01/16 15:02	WI160802-5	30		29.6	mg/L	99	90	110			
L33706-01DUP	DUP	11/01/16 17:25			12.9	12.8	mg/L				1	20	
L33706-02AS	AS	11/01/16 18:37	WI160802-5	30	13.2	42	mg/L	96	90	110			
WG412498LFB2	LFB	11/02/16 2:05	WI160802-5	30		29.7	mg/L	99	90	110			

Zinc, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412158													
WG412158ICV	ICV	10/26/16 19:11	II161007-2	2		1.972	mg/L	99	95	105			
WG412158ICB	ICB	10/26/16 19:17				U	mg/L		-0.03	0.03			
WG412158LFB	LFB	10/26/16 19:29	II160929-3	.4995		.507	mg/L	102	85	115			
L33705-06AS	AS	10/26/16 20:27	II160929-3	.4995	.9	1.374	mg/L	95	85	115			
L33705-06ASD	ASD	10/26/16 20:30	II160929-3	.4995	.9	1.368	mg/L	94	85	115	0	20	

ACZ ID	WORKNUM	PARAMETER	METHOD	QUAL	DESCRIPTION
L33706-01	WG412158	Magnesium, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
		Manganese, dissolved	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG412498	Bromide	M300.0 - Ion Chromatography	M2	Matrix spike recovery was low, the recovery of the associated control sample (LCS or LFB) was acceptable.
			M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
		Chloride	M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG412441	Phosphorus, total	M365.1 - Auto Ascorbic Acid (digest)	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
L33706-02	WG412158	Magnesium, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
		Manganese, dissolved	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG412498	Bromide	M300.0 - Ion Chromatography	M2	Matrix spike recovery was low, the recovery of the associated control sample (LCS or LFB) was acceptable.
			M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
		Chloride	M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG412441	Phosphorus, total	M365.1 - Auto Ascorbic Acid (digest)	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG411965	Residue, Filterable (TDS) @180C	SM2540C	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
L33706-03	WG412158	Magnesium, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
		Manganese, dissolved	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG412498	Bromide	M300.0 - Ion Chromatography	M2	Matrix spike recovery was low, the recovery of the associated control sample (LCS or LFB) was acceptable.
			M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
		Chloride	M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG412441	Phosphorus, total	M365.1 - Auto Ascorbic Acid (digest)	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG411965	Residue, Filterable (TDS) @180C	SM2540C	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).

Daniel B. Stephens & Associates

ACZ Project ID: ***L33706***

ACZ ID	WORKNUM	PARAMETER	METHOD	QUAL	DESCRIPTION
L33706-04	WG412213	Phosphorus, total	M365.1 - Auto Ascorbic Acid Digestion	DF	Sample required dilution due to high sediment.
	WG412158	Magnesium, dissolved	M200.7 ICP	MA	Recovery for either the spike or spike duplicate was outside of the acceptance limits; the RPD was within the acceptance limits.
		Manganese, dissolved	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG412498	Bromide	M300.0 - Ion Chromatography	DC	Sample required dilution. Non-target analyte exceeded calibration range.
			M300.0 - Ion Chromatography	M2	Matrix spike recovery was low, the recovery of the associated control sample (LCS or LFB) was acceptable.
			M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
		Chloride	M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG412441	Phosphorus, total	M365.1 - Auto Ascorbic Acid (digest)	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG411965	Residue, Filterable (TDS) @180C	SM2540C	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG412167	Total Alkalinity	SM2320B - Titration	ZW	Method deviation. The sample was centrifuged prior to analysis due to high solid content.

Daniel B. Stephens & Associates ACZ Project ID: ***L33706***

No certification qualifiers associated with this analysis

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Daniel B. Stephens & Associates
021757/ES06.0038.15P4

ACZ Project ID:	L33706
Date Received:	10/21/2016 10:06
Received By:	pjs
Date Printed:	10/21/2016

Receipt Verification

	YES	NO	NA
1) Is a foreign soil permit included for applicable samples?			X
2) Is the Chain of Custody form or other directive shipping papers present?	X		
3) Does this project require special handling procedures such as CLP protocol?			X
4) Are any samples NRC licensable material?		X	
5) If samples are received past hold time, proceed with requested short hold time analyses?	X		
6) Is the Chain of Custody form complete and accurate?	X		
7) Were any changes made to the Chain of Custody form prior to ACZ receiving the samples?	X		

A change was made in the Date:Time Line 1 section prior to ACZ custody.

Samples/Containers

	YES	NO	NA
8) Are all containers intact and with no leaks?	X		
9) Are all labels on containers and are they intact and legible?	X		
10) Do the sample labels and Chain of Custody form match for Sample ID, Date, and Time?	X		
11) For preserved bottle types, was the pH checked and within limits? [1]	X		
12) Is there sufficient sample volume to perform all requested work?	X		
13) Is the custody seal intact on all containers?			X
14) Are samples that require zero headspace acceptable?			X
15) Are all sample containers appropriate for analytical requirements?	X		
16) Is there an Hg-1631 trip blank present?			X
17) Is there a VOA trip blank present?			X
18) Were all samples received within hold time?	X		

Chain of Custody Related Remarks

Client Contact Remarks

Shipping Containers

Cooler Id	Temp(°C)	Temp Criteria(°C)	Rad(µR/Hr)	Custody Seal Intact?
4245	5.1	<=6.0	14	Yes

Was ice present in the shipment container(s)?

Yes - Wet ice was present in the shipment container(s).

Client must contact an ACZ Project Manager if analysis should not proceed for samples received outside of their thermal preservation acceptance criteria.

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Daniel B. Stephens & Associates
021757/ES06.0038.15P4

ACZ Project ID:	L33706
Date Received:	10/21/2016 10:06
Received By:	pjs
Date Printed:	10/21/2016

[1] The preservation of the following bottle types is not checked at sample receipt: Orange (oil and grease), Purple (total cyanide), Pink (dissolved cyanide), Brown (arsenic speciation), Sterile (fecal coliform), EDTA (sulfite), HCl preserved vial (organics), Na2S2O3 preserved vial (organics), and HG-1631 (total/dissolved mercury by method 1631).

ACZ Laboratories, Inc. L33706

2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

CHAIN of CUSTODY

Report to:

Name: Beth Salvas

Company: Daniel B Stephens +Assoc

E-mail:

Address: 6020 Academy Rd NE Ste 100 Albuquerque, NM 87109

Telephone: 505-822-9400

Copy of Report to:

Name: Elizabeth Bastien

Company: Daniel B Stephens

E-mail: ebastien@dbstephens.com

Telephone: 505-822-9400

Invoice to:

Name: Beth Salvas

Company: DBSA

E-mail: bsalvas@dbstephens.com

Address: 6020 Academy Ste 100 ABQ, NM 87109

Telephone: 505-822-9400

If sample(s) received past holding time (HT), or if insufficient HT remains to complete analysis before expiration, shall ACZ proceed with requested short HT analyses? YES [ ] NO [ ]

If "NO" then ACZ will contact client for further instruction. If neither "YES" nor "NO" is indicated, ACZ will proceed with the requested analyses, even if HT is expired, and data will be qualified

Are samples for SDWA Compliance Monitoring? Yes [ ] No [X]

If yes, please include state forms. Results will be reported to PQL for Colorado.

Sampler's Name: E. Bastien **Sampler's Site Information** **State** NM **Zip code** ______ **Time Zone** MTN

***Sampler's Signature:** Elizabeth Bastien *I attest to the authenticity and validity of this sample. I understand that intentionally mislabeling the time/date/location or tampering with the sample in anyway, is considered fraud and punishable by State Law.

PROJECT INFORMATION

Quote #: PMOU-SW-2016

PO#: 021757 / ES06.0038.15 P4

Reporting state for compliance testing: NM

Check box if samples include NRC licensed material? NO

ANALYSES REQUESTED *(attach list or use quote number)*

SAMPLE IDENTIFICATION	DATE:TIME	Matrix	# of Containers	Raw BackUp	Dissolved Metals	Dissolved Anions	Total Phosphorous				
DU2-P416DS	10/18/16 14:30	SW	4	X	X	X	X				
PDSW416DS	10/18/16 14:20	SW	4	X	X	X	X				
PUSW416DS	10/18/16 10:25	SW	4	X	X	X	X				
WSBDTSW416DS	10/18/16 14:50	SW	4	X	X	X	X				

Matrix: SW (Surface Water) · GW (Ground Water) · WW (Waste Water) · DW (Drinking Water) · SL (Sludge) · SO (Soil) · OL (Oil) · Other (Specify)

REMARKS

Please see attached analyte list

Please refer to ACZ's terms & conditions located on the reverse side of this COC.

RELINQUISHED BY:	DATE:TIME	RECEIVED BY:	DATE:TIME
Elizabeth Bastien	10/20/16 14:30	[signature]	10/21/16 1000

L33706 Chain of Custody

PMOU-SW-2016 Sample IDs and Requested Analyses

Constituent	CMP Detection Limit (mg/L)	ACZ Sample Analyses				
		ESSSW416DS	PDSW416DS	PUSW416DS	WSBDTSW416DS	DU2-P416DS
Aluminum	0.03	~~green dot~~	not analyzed	not analyzed	not analyzed	not analyzed
Arsenic	0.0005	~~green dot~~	green dot	green dot	green dot	green dot
Cadmium	0.0001	~~green dot~~	green dot	green dot	green dot	green dot
Chloride	1	~~white dot~~	white dot	white dot	white dot	white dot
Iron	0.02	~~green dot~~	green dot	green dot	green dot	green dot
Lead	0.0001	~~green dot~~	not analyzed	not analyzed	not analyzed	not analyzed
Manganese	0.005	~~green dot~~	green dot	green dot	green dot	green dot
Sulfate	10	~~white dot~~	white dot	white dot	white dot	white dot
TDS	10	~~white dot~~	white dot	white dot	white dot	white dot
Zinc	0.01	~~green dot~~	green dot	green dot	green dot	green dot
Alkalinity	2	~~no dot~~	no dot	no dot	no dot	no dot
Bromide	0.1	~~white dot~~	white dot	white dot	white dot	white dot
Calcium	0.2	~~green dot~~	green dot	green dot	green dot	green dot
Hardness	calculation	~~green dot~~	green dot	green dot	green dot	green dot
Magnesium	0.2	~~green dot~~	green dot	green dot	green dot	green dot
Phosphorus (total)	0.01	~~yellow dot~~	yellow dot	yellow dot	yellow dot	yellow dot
Potassium	0.3	~~green dot~~	green dot	green dot	green dot	green dot
Sodium	0.3	~~green dot~~	green dot	green dot	green dot	green dot
		Dry - Not sampled				

ACZ Laboratories, Inc.
2773 Downhill Drive   Steamboat Springs, CO 80487   (800) 334-5493

Analytical Report

November 07, 2016

Report to:	Bill to:
Beth Salvas	Beth Salvas
Daniel B. Stephens & Associates	Daniel B. Stephens & Associates
6020 Academy NE	6020 Academy Suite 100
Suite 100	
Albuquerque, NM 87109	Albuquerque, NM 87109

cc: Elizabeth Bastien

Project ID: 021757/ES06.0038.15P4
ACZ Project ID: L33708

Beth Salvas:

Enclosed are the analytical results for sample(s) submitted to ACZ Laboratories, Inc. (ACZ) on October 21, 2016. This project has been assigned to ACZ's project number, L33708. Please reference this number in all future inquiries.

All analyses were performed according to ACZ's Quality Assurance Plan. The enclosed results relate only to the samples received under L33708. Each section of this report has been reviewed and approved by the appropriate Laboratory Supervisor, or a qualified substitute.

Except as noted, the test results for the methods and parameters listed on ACZ's current NELAC certificate letter (#ACZ) meet all requirements of NELAC.

This report shall be used or copied only in its entirety. ACZ is not responsible for the consequences arising from the use of a partial report.

All samples and sub-samples associated with this project will be disposed of after February 05, 2017. If the samples are determined to be hazardous, additional charges apply for disposal (typically $11/sample). If you would like the samples to be held longer than ACZ's stated policy or to be returned, please contact your Project Manager or Customer Service Representative for further details and associated costs. ACZ retains analytical raw data reports for ten years.

If you have any questions or other needs, please contact your Project Manager.

Max Janicek

Max Janicek has reviewed and approved this report.

ACCREDITED IN ACCORDANCE WITH nelac

ACIL

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

Daniel B. Stephens & Associates

Project ID: 021757/ES06.0038.15P4
Sample ID: P7SMW416DS

ACZ Sample ID: ***L33708-01***
Date Sampled: *10/18/16 11:15*
Date Received: *10/21/16*
Sample Matrix: *Ground Water*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Barium, dissolved	M200.7 ICP	1	0.858			mg/L	0.003	0.02	10/26/16 21:58	aeb
Iron, dissolved	M200.7 ICP	1	14.60		*	mg/L	0.02	0.05	10/26/16 21:58	aeb
Manganese, dissolved	M200.7 ICP	1	2.200		*	mg/L	0.005	0.03	10/26/16 21:58	aeb

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Residue, Filterable (TDS) @180C	SM2540C	1	440		*	mg/L	10	20	10/22/16 12:11	emk

REPIN.02.06.05.01

** Please refer to Qualifier Reports for details.*

Daniel B. Stephens & Associates

Project ID: 021757/ES06.0038.15P4
Sample ID: DU1-P416DS

ACZ Sample ID: ***L33708-02***
Date Sampled: *10/18/16 13:55*
Date Received: *10/21/16*
Sample Matrix: *Ground Water*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Cadmium, dissolved	M200.8 ICP-MS	1	0.0146			mg/L	0.0001	0.0005	10/28/16 15:34	enb
Cobalt, dissolved	M200.7 ICP	1	0.04	B		mg/L	0.01	0.05	10/26/16 22:14	aeb
Iron, dissolved	M200.7 ICP	1	11.60		*	mg/L	0.02	0.05	10/26/16 22:14	aeb
Manganese, dissolved	M200.7 ICP	1	4.550		*	mg/L	0.005	0.03	10/26/16 22:14	aeb
Zinc, dissolved	M200.7 ICP	1	12.30			mg/L	0.01	0.05	10/26/16 22:14	aeb

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Fluoride	M300.0 - Ion Chromatography	5	1.63		*	mg/L	0.25	1.25	11/02/16 17:37	bsu
Residue, Filterable (TDS) @180C	SM2540C	2	1070		*	mg/L	20	40	10/22/16 12:14	emk

ACZ Laboratories, Inc.

2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

Daniel B. Stephens & Associates

Project ID: 021757/ES06.0038.15P4

Sample ID: P13MW416DS

ACZ Sample ID: ***L33708-03***

Date Sampled: *10/18/16 13:50*

Date Received: *10/21/16*

Sample Matrix: *Ground Water*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Iron, dissolved	M200.7 ICP	1	31.80		*	mg/L	0.02	0.05	10/26/16 22:17	aeb
Manganese, dissolved	M200.7 ICP	1	1.680		*	mg/L	0.005	0.03	10/26/16 22:17	aeb

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Residue, Filterable (TDS) @180C	SM2540C	2	408		*	mg/L	20	40	10/22/16 12:17	emk

Daniel B. Stephens & Associates

Project ID: 021757/ES06.0038.15P4
Sample ID: P13SMW416DS

ACZ Sample ID: ***L33708-04***
Date Sampled: *10/18/16 13:45*
Date Received: *10/21/16*
Sample Matrix: *Ground Water*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Cadmium, dissolved	M200.8 ICP-MS	1	0.0148			mg/L	0.0001	0.0005	10/28/16 15:37	enb
Cobalt, dissolved	M200.7 ICP	1	0.05			mg/L	0.01	0.05	10/26/16 22:20	aeb
Iron, dissolved	M200.7 ICP	1	11.60			mg/L	0.02	0.05	10/26/16 22:20	aeb
Manganese, dissolved	M200.7 ICP	1	4.540			mg/L	0.005	0.03	10/26/16 22:20	aeb
Zinc, dissolved	M200.7 ICP	1	12.30			mg/L	0.01	0.05	10/26/16 22:20	aeb

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Fluoride	M300.0 - Ion Chromatography	5	1.63		*	mg/L	0.25	1.25	11/02/16 17:55	bsu
Residue, Filterable (TDS) @180C	SM2540C	1	1050		*	mg/L	10	20	10/22/16 12:19	emk

Daniel B. Stephens & Associates

Project ID: 021757/ES06.0038.15P4
Sample ID: P7MW416DS

ACZ Sample ID: ***L33708-05***
Date Sampled: *10/18/16 12:10*
Date Received: *10/21/16*
Sample Matrix: *Ground Water*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Barium, dissolved	M200.7 ICP	1	3.400			mg/L	0.003	0.02	10/26/16 22:23	aeb
Iron, dissolved	M200.7 ICP	1	4.18			mg/L	0.02	0.05	10/26/16 22:23	aeb
Manganese, dissolved	M200.7 ICP	1	1.00			mg/L	0.005	0.03	10/26/16 22:23	aeb

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Fluoride	M300.0 - Ion Chromatography	1	0.31		*	mg/L	0.05	0.25	11/02/16 0:00	bsu
Residue, Filterable (TDS) @180C	SM2540C	1	422		*	mg/L	10	20	10/22/16 12:22	emk

** Please refer to Qualifier Reports for details.*

Daniel B. Stephens & Associates

Project ID: 021757/ES06.0038.15P4
Sample ID: EB1-P416DS

ACZ Sample ID: ***L33708-06***
Date Sampled: *10/18/16 15:40*
Date Received: *10/21/16*
Sample Matrix: *Ground Water*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Barium, dissolved	M200.7 ICP	1	0.004	B		mg/L	0.003	0.02	10/26/16 22:26	aeb
Cadmium, dissolved	M200.8 ICP-MS	1		U		mg/L	0.0001	0.0005	10/28/16 15:41	enb
Cobalt, dissolved	M200.7 ICP	1		U		mg/L	0.01	0.05	10/26/16 22:26	aeb
Iron, dissolved	M200.7 ICP	1		U		mg/L	0.02	0.05	10/26/16 22:26	aeb
Manganese, dissolved	M200.7 ICP	1		U		mg/L	0.005	0.03	10/26/16 22:26	aeb
Zinc, dissolved	M200.7 ICP	1		U		mg/L	0.01	0.05	10/26/16 22:26	aeb

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Fluoride	M300.0 - Ion Chromatography	1		U	*	mg/L	0.05	0.25	11/02/16 0:17	bsu
Residue, Filterable (TDS) @180C	SM2540C	1		U	*	mg/L	10	20	10/22/16 12:24	emk

Inorganic Analytical Results

Daniel B. Stephens & Associates

Project ID:	021757/ES06.0038.15P4	ACZ Sample ID:	***L33708-07***
Sample ID:	FB1-P416DS	Date Sampled:	*10/18/16 15:50*
		Date Received:	*10/21/16*
		Sample Matrix:	*Ground Water*

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Barium, dissolved	M200.7 ICP	1		U		mg/L	0.003	0.02	10/26/16 22:30	aeb
Cadmium, dissolved	M200.8 ICP-MS	1		U		mg/L	0.0001	0.0005	10/28/16 15:44	enb
Cobalt, dissolved	M200.7 ICP	1		U		mg/L	0.01	0.05	10/26/16 22:30	aeb
Iron, dissolved	M200.7 ICP	1		U		mg/L	0.02	0.05	10/26/16 22:30	aeb
Manganese, dissolved	M200.7 ICP	1		U		mg/L	0.005	0.03	10/26/16 22:30	aeb
Zinc, dissolved	M200.7 ICP	1		U		mg/L	0.01	0.05	10/26/16 22:30	aeb

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Fluoride	M300.0 - Ion Chromatography	1		U	*	mg/L	0.05	0.25	11/02/16 0:35	bsu
Residue, Filterable (TDS) @180C	SM2540C	1		U	*	mg/L	10	20	10/22/16 12:27	emk

** Please refer to Qualifier Reports for details.*

Report Header Explanations

Batch	A distinct set of samples analyzed at a specific time
Found	Value of the QC Type of interest
Limit	Upper limit for RPD, in %.
Lower	Lower Recovery Limit, in % (except for LCSS, mg/Kg)
MDL	Method Detection Limit. Same as Minimum Reporting Limit unless omitted or equal to the PQL (see comment #5). Allows for instrument and annual fluctuations.
PCN/SCN	A number assigned to reagents/standards to trace to the manufacturer's certificate of analysis
PQL	Practical Quantitation Limit. Synonymous with the EPA term "minimum level".
QC	True Value of the Control Sample or the amount added to the Spike
Rec	Recovered amount of the true value or spike added, in % (except for LCSS, mg/Kg)
RPD	Relative Percent Difference, calculation used for Duplicate QC Types
Upper	Upper Recovery Limit, in % (except for LCSS, mg/Kg)
Sample	Value of the Sample of interest

QC Sample Types

AS	Analytical Spike (Post Digestion)	*LCSWD*	Laboratory Control Sample - Water Duplicate
ASD	Analytical Spike (Post Digestion) Duplicate	*LFB*	Laboratory Fortified Blank
CCB	Continuing Calibration Blank	*LFM*	Laboratory Fortified Matrix
CCV	Continuing Calibration Verification standard	*LFMD*	Laboratory Fortified Matrix Duplicate
DUP	Sample Duplicate	*LRB*	Laboratory Reagent Blank
ICB	Initial Calibration Blank	*MS*	Matrix Spike
ICV	Initial Calibration Verification standard	*MSD*	Matrix Spike Duplicate
ICSAB	Inter-element Correction Standard - A plus B solutions	*PBS*	Prep Blank - Soil
LCSS	Laboratory Control Sample - Soil	*PBW*	Prep Blank - Water
LCSSD	Laboratory Control Sample - Soil Duplicate	*PQV*	Practical Quantitation Verification standard
LCSW	Laboratory Control Sample - Water	*SDL*	Serial Dilution

QC Sample Type Explanations

Blanks	Verifies that there is no or minimal contamination in the prep method or calibration procedure.
Control Samples	Verifies the accuracy of the method, including the prep procedure.
Duplicates	Verifies the precision of the instrument and/or method.
Spikes/Fortified Matrix	Determines sample matrix interferences, if any.
Standard	Verifies the validity of the calibration.

ACZ Qualifiers (Qual)

B	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
L	Target analyte response was below the laboratory defined negative threshold.
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

Method References

(1) EPA 600/4-83-020. Methods for Chemical Analysis of Water and Wastes, March 1983.
(2) EPA 600/R-93-100. Methods for the Determination of Inorganic Substances in Environmental Samples, August 1993.
(3) EPA 600/R-94-111. Methods for the Determination of Metals in Environmental Samples - Supplement I, May 1994.
(4) EPA SW-846. Test Methods for Evaluating Solid Waste.
(5) Standard Methods for the Examination of Water and Wastewater.

Comments

(1) QC results calculated from raw data. Results may vary slightly if the rounded values are used in the calculations.
(2) Soil, Sludge, and Plant matrices for Inorganic analyses are reported on a dry weight basis.
(3) Animal matrices for Inorganic analyses are reported on an "as received" basis.
(4) An asterisk in the "XQ" column indicates there is an extended qualifier and/or certification qualifier associated with the result.
(5) If the MDL equals the PQL or the MDL column is omitted, the PQL is the reporting limit.

For a complete list of ACZ's Extended Qualifiers, please click: http://www.acz.com/public/extquallist.pdf

Daniel B. Stephens & Associates

ACZ Project ID: ***L33708***

Barium, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412169													
WG412169ICV	ICV	10/26/16 21:14	II161007-2	2		1.9902	mg/L	100	95	105			
WG412169ICB	ICB	10/26/16 21:20				.0032	mg/L		-0.009	0.009			
WG412169LFB	LFB	10/26/16 21:33	II160929-3	.5005		.5051	mg/L	101	85	115			
L33708-01AS	AS	10/26/16 22:01	II160929-3	.5005	.858	1.313	mg/L	91	85	115			
L33708-01ASD	ASD	10/26/16 22:11	II160929-3	.5005	.858	1.345	mg/L	97	85	115	2	20	
L33720-01AS	AS	10/26/16 22:49	II160929-3	.5005	.01	.5181	mg/L	102	85	115			
L33720-01ASD	ASD	10/26/16 22:52	II160929-3	.5005	.01	.5175	mg/L	101	85	115	0	20	

Cadmium, dissolved M200.8 ICP-MS

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412343													
WG412343ICV	ICV	10/28/16 14:14	MS160920-1	.05		.04887	mg/L	98	90	110			
WG412343ICB	ICB	10/28/16 14:17				U	mg/L		-0.0003	0.0003			
WG412343LFB	LFB	10/28/16 14:20	MS160928-2	.05005		.04629	mg/L	92	85	115			
L33705-06AS	AS	10/28/16 15:18	MS160928-2	2.5025	U	2.4405	mg/L	98	70	130			
L33705-06ASD	ASD	10/28/16 15:22	MS160928-2	2.5025	U	2.4695	mg/L	99	70	130	1	20	

Cobalt, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412169													
WG412169ICV	ICV	10/26/16 21:14	II161007-2	2.002		1.923	mg/L	96	95	105			
WG412169ICB	ICB	10/26/16 21:20				U	mg/L		-0.03	0.03			
WG412169LFB	LFB	10/26/16 21:33	II160929-3	.5015		.501	mg/L	100	85	115			
L33708-01AS	AS	10/26/16 22:01	II160929-3	.5015	U	.485	mg/L	97	85	115			
L33708-01ASD	ASD	10/26/16 22:11	II160929-3	.5015	U	.494	mg/L	99	85	115	2	20	
L33720-01AS	AS	10/26/16 22:49	II160929-3	.5015	U	.491	mg/L	98	85	115			
L33720-01ASD	ASD	10/26/16 22:52	II160929-3	.5015	U	.506	mg/L	101	85	115	3	20	

Fluoride M300.0 - Ion Chromatography

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG410689													
WG410689ICV	ICV	09/29/16 7:13	WI160818-1	3.996		3.82	mg/L	96	90	110			
WG410689ICB	ICB	09/29/16 7:31				U	mg/L		-0.05	0.05			
WG412498													
WG412498LFB1	LFB	11/01/16 15:02	WI160802-5	1.5		1.53	mg/L	102	90	110			
L33707-08DUP	DUP	11/01/16 22:12			U	U	mg/L				0	20	RA
WG412498LFB2	LFB	11/02/16 2:05	WI160802-5	1.5		1.52	mg/L	101	90	110			
L33707-09AS	AS	11/02/16 17:19	WI160802-5	30	1.56	31.4	mg/L	99	90	110			

Daniel B. Stephens & Associates ACZ Project ID: ***L33708***

Iron, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412169													
WG412169ICV	ICV	10/26/16 21:14	II161007-2	2		1.981	mg/L	99	95	105			
WG412169ICB	ICB	10/26/16 21:20				U	mg/L		-0.06	0.06			
WG412169LFB	LFB	10/26/16 21:33	II160929-3	1.0017		1.029	mg/L	103	85	115			
L33708-01AS	AS	10/26/16 22:01	II160929-3	1.0017	14.6	14.68	mg/L	8	85	115			M3
L33708-01ASD	ASD	10/26/16 22:11	II160929-3	1.0017	14.6	14.96	mg/L	36	85	115	2	20	M3
L33720-01AS	AS	10/26/16 22:49	II160929-3	1.0017	U	1.006	mg/L	100	85	115			
L33720-01ASD	ASD	10/26/16 22:52	II160929-3	1.0017	U	1.005	mg/L	100	85	115	0	20	

Manganese, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412169													
WG412169ICV	ICV	10/26/16 21:14	II161007-2	2		1.948	mg/L	97	95	105			
WG412169ICB	ICB	10/26/16 21:20				U	mg/L		-0.015	0.015			
WG412169LFB	LFB	10/26/16 21:33	II160929-3	.5		.5132	mg/L	103	85	115			
L33708-01AS	AS	10/26/16 22:01	II160929-3	.5	2.2	2.569	mg/L	74	85	115			M3
L33708-01ASD	ASD	10/26/16 22:11	II160929-3	.5	2.2	2.624	mg/L	85	85	115	2	20	
L33720-01AS	AS	10/26/16 22:49	II160929-3	.5	U	.5106	mg/L	102	85	115			
L33720-01ASD	ASD	10/26/16 22:52	II160929-3	.5	U	.5121	mg/L	102	85	115	0	20	

Residue, Filterable (TDS) @180C SM2540C

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG411965													
WG411965PBW	PBW	10/22/16 11:30				U	mg/L		-20	20			
WG411965LCSW	LCSW	10/22/16 11:32	PCN51577	260		260	mg/L	100	80	120			
L33708-07DUP	DUP	10/22/16 12:30			U	U	mg/L				0	10	RA

Zinc, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec	Lower	Upper	RPD	Limit	Qual
WG412169													
WG412169ICV	ICV	10/26/16 21:14	II161007-2	2		2.004	mg/L	100	95	105			
WG412169ICB	ICB	10/26/16 21:20				U	mg/L		-0.03	0.03			
WG412169LFB	LFB	10/26/16 21:33	II160929-3	.4995		.542	mg/L	109	85	115			
L33708-01AS	AS	10/26/16 22:01	II160929-3	.4995	U	.512	mg/L	103	85	115			
L33708-01ASD	ASD	10/26/16 22:11	II160929-3	.4995	U	.536	mg/L	107	85	115	5	20	
L33720-01AS	AS	10/26/16 22:49	II160929-3	.4995	U	.533	mg/L	107	85	115			
L33720-01ASD	ASD	10/26/16 22:52	II160929-3	.4995	U	.557	mg/L	112	85	115	4	20	

Daniel B. Stephens & Associates ACZ Project ID: ***L33708***

ACZ ID	WORKNUM	PARAMETER	METHOD	QUAL	DESCRIPTION
L33708-01	WG412169	Iron, dissolved	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Manganese, dissolved	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG411965	Residue, Filterable (TDS) @180C	SM2540C	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
L33708-02	WG412169	Iron, dissolved	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Manganese, dissolved	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG412498	Fluoride	M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG411965	Residue, Filterable (TDS) @180C	SM2540C	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
L33708-03	WG412169	Iron, dissolved	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
		Manganese, dissolved	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG411965	Residue, Filterable (TDS) @180C	SM2540C	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
L33708-04	WG412498	Fluoride	M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG411965	Residue, Filterable (TDS) @180C	SM2540C	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
L33708-05	WG412498	Fluoride	M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG411965	Residue, Filterable (TDS) @180C	SM2540C	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
L33708-06	WG412498	Fluoride	M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG411965	Residue, Filterable (TDS) @180C	SM2540C	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
L33708-07	WG412498	Fluoride	M300.0 - Ion Chromatography	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG411965	Residue, Filterable (TDS) @180C	SM2540C	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).

No certification qualifiers associated with this analysis

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

Daniel B. Stephens & Associates
021757/ES06.0038.15P4

ACZ Project ID:	L33708
Date Received:	10/21/2016 10:06
Received By:	pjs
Date Printed:	10/21/2016

Receipt Verification

	YES	NO	NA
1) Is a foreign soil permit included for applicable samples?			X
2) Is the Chain of Custody form or other directive shipping papers present?	X		
3) Does this project require special handling procedures such as CLP protocol?			X
4) Are any samples NRC licensable material?		X	
5) If samples are received past hold time, proceed with requested short hold time analyses?	X		
6) Is the Chain of Custody form complete and accurate?	X		
7) Were any changes made to the Chain of Custody form prior to ACZ receiving the samples?	X		

A change was made in the ID Line 1 and Analyses Requested section prior to ACZ custody.

Samples/Containers

	YES	NO	NA
8) Are all containers intact and with no leaks?	X		
9) Are all labels on containers and are they intact and legible?	X		
10) Do the sample labels and Chain of Custody form match for Sample ID, Date, and Time?	X		
11) For preserved bottle types, was the pH checked and within limits? [1]	X		
12) Is there sufficient sample volume to perform all requested work?	X		
13) Is the custody seal intact on all containers?			X
14) Are samples that require zero headspace acceptable?			X
15) Are all sample containers appropriate for analytical requirements?	X		
16) Is there an Hg-1631 trip blank present?			X
17) Is there a VOA trip blank present?			X
18) Were all samples received within hold time?	X		

Chain of Custody Related Remarks

Client Contact Remarks

Shipping Containers

Cooler Id	Temp(°C)	Temp Criteria(°C)	Rad(µR/Hr)	Custody Seal Intact?
4073	0.3	<=6.0	15	Yes
4245	5.1	<=6.0	14	Yes

Was ice present in the shipment container(s)?

Yes - Wet ice was present in the shipment container(s).

Client must contact an ACZ Project Manager if analysis should not proceed for samples received outside of their thermal preservation acceptance criteria.

Daniel B. Stephens & Associates
021757/ES06.0038.15P4

ACZ Project ID:	L33708
Date Received:	10/21/2016 10:06
Received By:	pjs
Date Printed:	10/21/2016

[1] The preservation of the following bottle types is not checked at sample receipt: Orange (oil and grease), Purple (total cyanide), Pink (dissolved cyanide), Brown (arsenic speciation), Sterile (fecal coliform), EDTA (sulfite), HCl preserved vial (organics), Na2S2O3 preserved vial (organics), and HG-1631 (total/dissolved mercury by method 1631).

ACZ Laboratories, Inc. L33708

2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

CHAIN of CUSTODY

Report to:

Name: Beth Salvas	Address: 6020 Academy Ste 100
Company: Daniel B Stephens + Assoc	Albuquerque, NM 87109
E-mail: Bsalvas@dbstephens.com	Telephone: 505-822-9400

Copy of Report to:

Name: Elizabeth Bastien	E-mail: ebastien@dbstephens.com
Company: Daniel B Stephens + Assoc	Telephone: 505-822-9400

Invoice to:

Name: Beth Salvas	Address: 6020 academy st 100
Company: DBSA	ABQ, NM 87109
E-mail: bsalvas@dbstephens.com	Telephone: 505-822-9400

If sample(s) received past holding time (HT), or if insufficient HT remains to complete analysis before expiration, shall ACZ proceed with requested short HT analyses? YES [ ] NO [ ]

If "NO" then ACZ will contact client for further instruction. If neither "YES" nor "NO" is indicated, ACZ will proceed with the requested analyses, even if HT is expired, and data will be qualified

Are samples for SDWA Compliance Monitoring? Yes [ ] No [X]

If yes, please include state forms. Results will be reported to PQL for Colorado.

Sampler's Name: E. Bastien **Sampler's Site Information** **State** NM **Zip code** ______ **Time Zone** MTN

***Sampler's Signature:** Elizabeth Bastien

*I attest to the authenticity and validity of this sample. I understand that intentionally mislabeling the time/date/location or tampering with the sample in anyway, is considered fraud and punishable by State Law.

PROJECT INFORMATION

Quote #: PMOU-GW-2016

PO#: 021757 / ES06.0038.15 P4

Reporting state for compliance testing: NM

Check box if samples include NRC licensed material? NO

ANALYSES REQUESTED *(attach list or use quote number)*

SAMPLE IDENTIFICATION	DATE:TIME	Matrix	# of Containers	Rad Backup	Dissolved Metals	Dissolved Anions	Total EMB 7				
~~P7SMW~~ P7SMW416DS	10/18/16 11:15	GW	2	X	X						
DU1-P416DS	10/18/16 13:55	GW	3	X	X	X					
P13MW416DS	10/18/16 13:50	GW	2	X	X						
P13SMW416DS	10/18/16 13:45	GW	3	X	X	X					
P7MW416DS	10/18/16 12:10	GW	3	X	X	X					
EB1-P416DS	10/18/16 15:40	GW	3	X	X	X					
FB1-P416DS	10/18/16 15:50	GW	3	X	X	X					

Matrix: SW (Surface Water) · GW (Ground Water) · WW (Waste Water) · DW (Drinking Water) · SL (Sludge) · SO (Soil) · OL (Oil) · Other (Specify)

REMARKS

Please see attached analyte list

Please refer to ACZ's terms & conditions located on the reverse side of this COC.

RELINQUISHED BY:	DATE:TIME	RECEIVED BY:	DATE:TIME
Elizabeth Bastien	10/20/16 14:00		

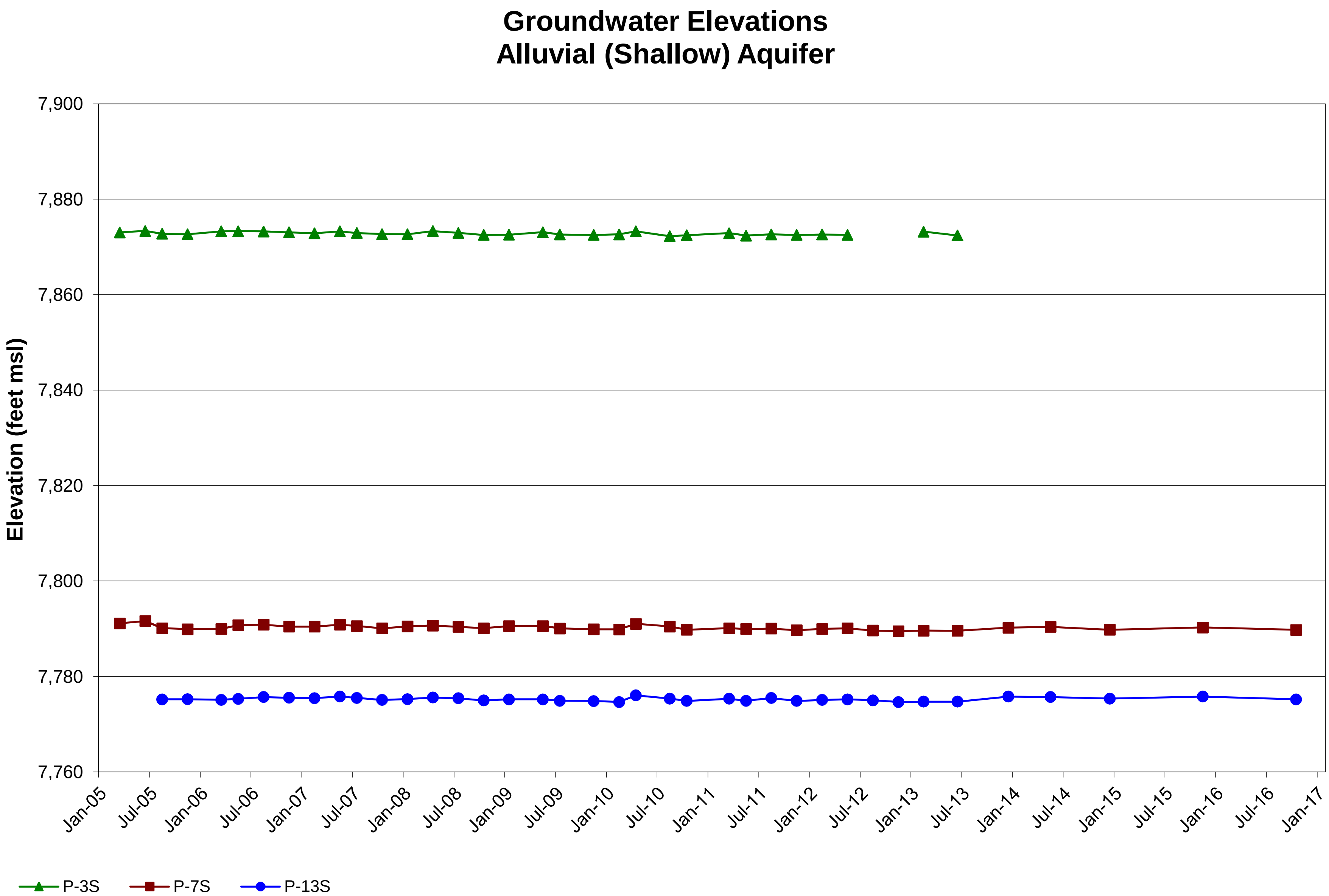
L33708 Chain of Custody

PMOU-GW-2016 Sample IDs and Requested Analyses

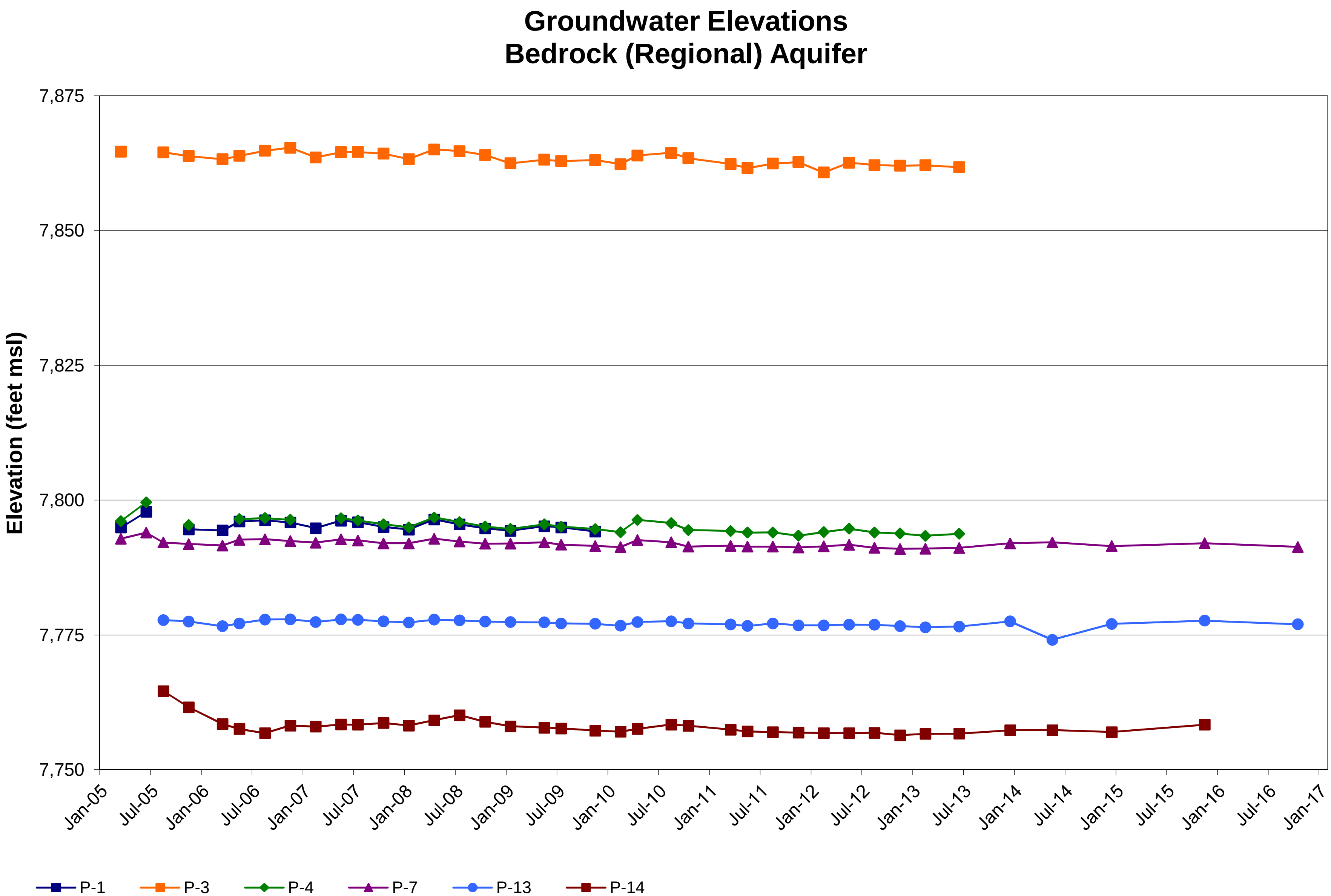
Constituent	CMP Detection Limit (mg/L)	ACZ Sample Analyses						
		P7MW416DS	P7SMW416DS	P13MW416DS	P13SMW416DS	DU1-P416DS	FB1-P416DS	EB1-P416DS
Barium	0.003	green dot	green dot	not analyzed	not analyzed	not analyzed	green dot	green dot
Cadmium	0.001	not analyzed	not analyzed	not analyzed	green dot	green dot	green dot	green dot
Cobalt	0.01	not analyzed	not analyzed	not analyzed	green dot	green dot	green dot	green dot
Fluoride	0.1	white dot	not analyzed	not analyzed	white dot	white dot	white dot	white dot
Iron	0.02	green dot	green dot	green dot	green dot	green dot	green dot	green dot
Manganese	0.005	green dot	green dot	green dot	green dot	green dot	green dot	green dot
TDS	10	not analyzed	not analyzed	not analyzed	white dot	white dot	white dot	white dot
Zinc	0.01	not analyzed	not analyzed	not analyzed	green dot	green dot	green dot	green dot

Appendix E

Hydrographs



P:_ES06-038\16-AnnlRpt.N-17\PMOU Appx E_Hydrographs.xlsAlluvial Aquifer



P:_ES06-038\16-AnnlRpt.N-17\PMOU Appx E_Hydrographs.xlsRegional Aquifer

Appendix C

NMDGF Groundwater Monitoring Data

NMDGF Willow Creek Campground Groundwater Monitoring Data (mg/L)

Well ID	Analytes	Aluminum, dissolved	Aluminum, total	Arsenic, dissolved	Arsenic, total	Barium, dissolved	Barium, total	Boron, dissolved	Cadmium, dissolved	Cadmium, total	Calcium, dissolved	Calcium, total	Chromium, dissolved	Chromium, total	Cobalt, dissolved	Cobalt, total	Copper, dissolved	Copper, total	Iron, dissolved	Iron, total
	Section 20.6.2.3103 NMAC Standard	**5**	**NA**	**0.1**	**NA**	**1**	**NA**	**0.75**	**0.01**	**NA**	**NA**	**NA**	**0.05**	**NA**	**0.05**	**NA**	**1**	**NA**	**1**	**NA**
WCMW1	10/7/1998	3.17	77.3	0.01	0.25	0.177	0.654	-	0.0004	0.002	94.3	112	0.0057	0.126	**0.05**	0.33	0.033	0.456	**5.22**	103
	2/10/1999	U	141	0.009	0.046	0.108	1.14	-	U	0.003	88.7	125	0.0024	0.356	0.03	0.55	0.003	1.58	0.29	210
	5/27/1999	0.07	108	U	0.024	0.099	0.928	-	U	0.0015	104	136	0.0006	0.224	0.01	0.32	0.005	1.39	0.1	154
	8/18/1999	0.08	151	0.0087	0.04	0.131	1.35	-	0.0003	0.002	86.7	145	0.00052	0.39703	0.02	0.51	0.0021	1.3153	0.84	218
	11/16/1999	0.1	123	0.0126	0.03	0.148	1.12	-	U	0.0048	73.3	115	0.0003	0.308	**0.06**	0.71	0.0011	1.27	0.36	210
	2/23/2000	0.03	21.5	0.0034	0.0006	0.099	0.239	-	U	0.0009	68.7	70.7	U	0.0356	0.03	0.09	0.0006	0.136	0.13	28.8
	6/1/2000	0.15	117	U	0.021	0.097	1.04	-	U	0.0036	68.1	110	0.001	0.205	0.01	0.59	U	1.5	0.77	184
	8/1/2000	0.12	11	0.0072	0.025	0.147	0.102	-	0.0001	0.0042	96.7	10.9	0.0006	0.338	**0.06**	0.09	0.0014	2.44	0.86	17.9
	2/28/2017	-	-	-	-	-	-	-	-	-	51	-	-	-	**0.057**	-	-	-	-	-
	2/28/2017 (dup)	-	-	-	-	-	-	-	-	-	54	-	-	-	0.037	-	-	-	-	-
	4/18/2017	0.023	-	<0.020	-	0.087	-	0.064	<0.0020	-	61	-	<0.0060	-	0.013	-	<0.0060	-	0.27	-
	4/18/2017 (dup)	<0.020	-	<0.020	-	0.085	-	0.065	<0.0020	-	60	-	<0.0060	-	0.017	-	<0.0060	-	0.28	-
	8/7/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	0.040	-	-	-	-	-
	8/7/2017 (dup)	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.079**	-	-	-	-	-
	11/8/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.099**	-	-	-	-	-
	11/8/2017 (dup)	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.120**	-	-	-	-	-
WCMW2A	2/10/1999	0.09	17.5	0.017	0.026	0.058	0.223	-	U	0.0037	34.5	49.7	0.0012	0.0402	0.01	0.07	U	0.117	0.23	29.2
	5/27/1999	0.17	7.18	0.005	0.011	0.046	0.092	-	U	0.0006	34.7	39.6	0.0005	0.0115	0.01	0.02	0.003	0.051	0.31	9.9
	8/18/1999	0.06	12.8	0.0219	0.03	0.05	0.133	-	0.0001	0.002	33.5	40	0.00037	0.019	U	0.04	0.0011	0.07	0.14	16.4
	11/16/1999	U	9.63	0.0206	U	0.054	0.143	-	0.0002	0.0011	33.7	39.8	0.0002	U	0.01	0.05	0.001	U	0.23	13.6
	2/23/2000	U	1.98	0.005	0.018	0.044	0.075	-	U	0.002	34.7	33.5	U	0.005	U	0.03	U	0.021	0.06	4.21
	6/1/2000	0.06	12.7	0.006	0.036	0.048	0.2	-	U	0.0057	31	39.2	0.0008	0.0242	0.01	0.12	U	0.114	0.12	22.2
	8/1/2000	0.06	6.32	0.0125	0.027	0.05	0.122	-	0.0007	0.0039	34.2	38.3	0.0005	0.0134	0.01	0.05	0.0008	0.047	0.14	10.7
	2/28/2017	-	-	-	-	-	-	-	-	-	38	-	-	-	0.015	-	-	-	-	-
	4/18/2017	<0.020		<0.020		0.036		<0.040	<0.0020	-	36	-	<0.0060	-	<0.0060	-	<0.0060	-	0.024	-
	8/7/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0098	-	-	-	-	-
	11/08/2017	-	-	-	-	-	-	-	-	-	-	-	-	-	0.011	-	-	-	-	-
WCMW2B	10/7/1998	0.16	13.8	U	0.004	0.36	0.19	-	U	U	34.4	37.4	0.0005	0.0214	U	0.09	0.005	0.122	0.17	19.7
	2/10/1999	0.12	132	U	0.008	0.03	1.91	-	U	U	34.4	83	0.0011	0.548	U	1.07	0.003	0.306	0.08	222
	5/27/1999	0.28	83	U	0.019	0.033	0.998	-	U	0.0029	34.6	64.9	0.0005	0.155	U	0.26	0.004	0.749	0.15	125
	8/18/1999	0.03	61.8	U	0.02	0.041	0.76	-	0.0002	U	40.3	67	0.00028	0.09065	U	0.24	0.0027	0.4494	0.03	92.3
	11/16/1999	0.05	10.7	U	U	0.033	0.152	-	0.0002	0.0007	35.3	39.5	0.0003	0.0205	U	0.05	0.0015	0.085	0.04	17.8
	2/23/2000	0.04	7.87	U	U	0.027	0.109	-	U	U	34.8	36.6	0.0002	0.013	U	0.05	0.003	0.078	0.02	12.7
	6/1/2000	0.09	0.52	U	U	0.019	0.022	-	U	U	13.1	11.9	0.0006	0.0007	U	U	0.0012	0.001	0.09	0.3
	8/1/2000	0.17	52.9	U	0.007	0.038	0.91	-	0.0002	0.0028	37.9	60	0.0006	0.0828	U	0.4	0.0022	0.889	0.09	92.6
	4/18/2017	<0.020	-	<0.020	-	0.027	-	<0.040	<0.0020	-	29	-	<0.0060	-	<0.0060	-	<0.0060	-	0.038	-

Notes:
U = non-detection
- = not reported, not tested
HT = holding time missed
NA = no applicable standard

NMDGF Willow Creek Campground Groundwater Monitoring Data (mg/L)

Well ID	Analytes	Lead, dissolved	Lead, total	Magnesium, dissolved	Magnesium, total	Manganese, dissolved	Manganese, total	Mercury, dissolved	Mercury, total	Molybdenum, dissolved	Molybdenum, total	Nickel, dissolved	Nickel, total	Potassium, dissolved	Potassium, total	Selenium, dissolved	Selenium, total	Silica, dissolved
	Section 20.6.2.3103 NMAC Standard	**0.05**	**NA**	**NA**	**NA**	**0.2**	**NA**	**NA**	**0.002**	**1**	**NA**	**0.2**	**NA**	**NA**	**NA**	**0.05**	**NA**	**NA**
WCMW1	10/7/1998	0.0048	0.0564	14.5	37.3	**0.844**	1.8	U	U	0.05	0.11	0.01	0.12	2.8	13.1	U	0.002	-
	2/10/1999	U	0.128	13.4	63	**0.622**	2.82	U	U	0.05	0.12	0.02	0.31	2	22	U	0.003	-
	5/27/1999	0.0002	0.105	12.8	49.4	**0.369**	1.99	U	U	U	0.03	U	0.21	1.3	11.9	0.003	0.002	-
	8/18/1999	0.0003	0.142	13	64	**0.746**	3.38	U	U	0.04	0.07	U	0.31	2.2	21	U	0.001	-
	11/16/1999	0.001	0.0856	13	62.2	**0.718**	2.93	U	U	0.08	0.15	0.03	0.36	3	23.3	U	0.003	-
	2/23/2000	0.0013	0.0166	12.9	18.8	**0.711**	1.04	U	U	0.05	0.04	0.01	0.05	2.1	4.9	U	U	-
	6/1/2000	U	0.106	12.5	56	**0.841**	2.89	U	U	0.03	0.07	U	0.34	2.1	19.9	U	U	-
	8/1/2000	0.0001	0.145	13.4	5.2	**0.731**	0.252	U	U	0.03	U	0.03	0.04	2	2.2	U	U	-
	2/28/2017	-	-	9.1	-	**0.36**	-	-	-	-	-	-	-	1.3	-	-	-	24
	2/28/2017 (dup)	-	-	8.8	-	**0.25**	-	-	-	-	-	-	-	1.2	-	-	-	24
	4/18/2017	<0.0050	-	9.2	-	**0.22**	-	-	<0.00020	0.019		<0.010	-	1.0	-	-	-	26
	4/18/2017 (dup)	<0.0050	-	9.2	-	**0.23**	-	-	<0.00020	0.019		<0.010	-	1.1	-	-	-	24
	8/7/2017	-	-	-	-	**0.35**	-	-	-	-	-	-	-	-	-	-	-	-
	8/7/2017 (dup)	-	-	-	-	**0.42**	-	-	-	-	-	-	-	-	-	-	-	-
	11/8/2017	-	-	-	-	**0.44**	-	-	-	-	-	-	-	-	-	-	-	-
	11/8/2017 (dup)	-	-	-	-	**0.46**	-	-	-	-	-	-	-	-	-	-	-	-
WCMW2A	2/10/1999	0.0005	0.0698	4.6	8.8	**0.41**	0.877	U	U	U	U	U	0.04	1.2	3.7	U	0.002	-
	5/27/1999	0.0005	0.0191	3.9	5.6	0.182	0.216	U	U	U	U	U	0.02	0.8	1.8	U	U	-
	8/18/1999	0.0003	0.034	4.3	6.2	**0.211**	0.421	U	U	U	U	U	0.02	1.2	2.2	U	U	-
	11/16/1999	0.0003	0.0271	4.4	6.3	**0.298**	0.516	U	U	0.03	0.02	U	0.02	1.1	2.6	U	U	-
	2/23/2000	U	0.008	4.3	4.5	0.093	0.502	U	U	U	U	U	0.02	1.1	1.2	U	U	-
	6/1/2000	0.0007	0.0504	3.7	6.8	0.187	1.37	U	U	U	U	U	0.04	1.2	3	U	U	-
	8/1/2000	0.0002	0.0208	4.1	5.8	**0.286**	0.735	U	U	U	U	U	0.02	1.3	2.2	U	U	-
	2/28/2017	-	-	3.6	-	0.087	-	-	-	-	-	-	-	1.0	-	-	-	14
	4/18/2017	<0.0050	-	3.5	-	0.049	-	-	<0.00020	<0.0080	-	<0.010	-	<1.0	-	-	-	13
	8/7/2017	-	-	-	-	0.160	-	-	-	-	-	-	-	-	-	-	-	-
	11/08/2017	-	-	-	-	0.086	-	-	-	-	-	-	-	-	-	-	-	-
WCMW2B	10/7/1998	0.0011	0.0143	3.2	6.1	**0.251**	1.37	U	U	U	0.01	U	0.04	0.6	2.4	U	0.001	-
	2/10/1999	U	0.0328	3.1	40	0.131	12.9	U	0.0005	U	U	U	0.45	0.5	0.17	U	0.004	-
	5/27/1999	0.0002	0.144	2.9	24.2	0.026	5.52	U	0.0006	U	U	U	0.21	0.4	8.7	0.001	0.001	-
	8/18/1999	0.0002	0.094	3.7	19	0.113	3.43	U	0.0004	U	U	U	0.15	0.4	9	U	U	-
	11/16/1999	U	0.0107	3.4	6.1	0.105	0.728	U	U	0.01	U	U	0.03	0.5	2	U	U	-
	2/23/2000	U	0.007	3.4	5.4	0.055	0.542	U	U	U	U	U	0.03	0.4	1.5	U	U	-
	6/1/2000	0.0001	0.0022	1.3	1.5	0.018	0.007	U	U	U	U	U	U	0.6	0.7	U	U	-
	8/1/2000	0.0001	0.0947	3.5	21	**0.461**	5.39	U	U	U	U	U	0.2	0.6	8	U	U	-
	4/18/2017	<0.0050	-	2.8	-	0.082	-	-	<0.00020	<0.0080	-	<0.010	-	<1.0	-	-	-	7.8

Notes:
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NMDGF Willow Creek Campground Groundwater Monitoring Data (mg/L)

Well ID	Analytes	Silver, dissolved	Silver, total	Sodium, dissolved	Sodium, total	Zinc, dissolved	Zinc, total	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Total Alkalinity	Chloride	Fluoride	Hardness as caco3	Nitrate as N, dissolved	Nitrate/Nitrite as N, dissolved	Nitrite as N, dissolved	Residual, Filterable (TDS)	Sulfate
	Section 20.6.2.3103 NMAC Standard	**0.05**	**NA**	**NA**	**NA**	**10**	**NA**	**NA**	**NA**	**NA**	**NA**	**250**	**1.6**	**NA**	**10**	**10**	**NA**	**1000**	**600**
WCMW1	10/7/1998	U	0.0005	61.8	64.5	0.06	0.79	-	U	U	381	18	**3.4**	295	0.07	0.09	0.02	450	15
	2/10/1999	U	0.0011	51.2	55	U	1.75	304	U	U	304	16	**2.9**	277	0.05	0.05	U	410	25.7
	5/27/1999	U	0.0007	47.8	49.2	0.01	1.39	348	U	U	348	10	**3**	313	U	U	U	420	28.2
	8/18/1999	U	0.002	58.6	61	U	1.94	348	U	U	348	10	**3.3**	270	0.16	0.2	0.4	420	15.2
	11/16/1999	U	0.0009	57.3	61.6	0.01	2.07	322	U	U	322	7	**3.6**	237	0.11	0.11	U	380	21.7
	2/23/2000	U	0.0002	52	51	U	0.23	315	U	U	315	7	**3.9**	225	0.02	0.02	U	350	8.8
	6/1/2000	U	0.0007	56.4	60	0.01	1.79	305	U	U	305	5	**4**	222	0.03	0.03	U	350	U
	8/1/2000	U	0.0008	56.6	5	0.02	0.22	369	U	U	369	7	**2.4**	297	HT	HT	HT	460	33
	2/28/2017	-	-	51	-	-	-	233.9	<2.000	-	233.9	6.9	**4.9**	-	-	<0.10	-	280	27
	2/28/2017 (dup)	-	-	50	-	-	-	235.5	<2.000	-	235.5	7.1	**4.8**	-	-	0.18	-	280	28
	4/18/2017	<0.0050	-	52	-	<0.020	-	267	<2.000	-	267	7.7	**4.7**	-	<0.10	-	-	335	26
	4/18/2017 (dup)	<0.0050	-	51	-	<0.020	-	269.3	<2.000	-	269.3	7.6	**4.6**	-	<0.10	-	-	345	25
	8/7/2017	-	-	-	-	-	-	-	-	-	-	-	**5.7**	-	-	-	-	-	-
	8/7/2017 (dup)	-	-	-	-	-	-	-	-	-	-	-	**5.9**	-	-	-	-	-	-
	11/8/2017	-	-	-	-	-	-	-	-	-	-	-	**4.9**	-	-	-	-	-	-
	11/8/2017 (dup)	-	-	-	-	-	-	-	-	-	-	-	**4.8**	-	-	-	-	-	-
WCMW2A	2/10/1999	U	U	25.9	25.8	U	0.39	133	U	U	133	3	**2.2**	105	U	U	U	190	18.8
	5/27/1999	U	U	20.7	20.4	0.01	0.14	125	U	U	125	2	**1.8**	103	0.03	0.03	U	160	16.8
	8/18/1999	U	U	25.7	23.8	U	0.24	132	U	U	132	2	**1.9**	101	0.05	0.05	U	170	7.6
	11/16/1999	U	U	28.1	28.6	0.02	0.19	158	U	U	158	2	**2.2**	102	0.16	0.16	U	180	19.9
	2/23/2000	U	U	20.9	19	0.02	0.08	122	U	U	122	2	**1.6**	104	0.04	0.04	U	160	21.7
	6/1/2000	U	0.0002	24.4	25	0.02	0.3	119	U	U	119	2	**2.4**	93	0.03	0.03	U	160	11
	8/1/2000	U	U	21.9	22	0.03	0.16	122	U	U	122	3	**2.1**	102	HT	HT	HT	180	21
	2/28/2017	-	-	16	-	-	-	114.9	<2.000	-	114.9	2.4	**1.7**	-	-	<0.10	-	168	23
	4/18/2017	<0.0050	-	14	-	0.028	-	121	<2.000	-	121	2.3	1.5	-	<0.10	-	-	166	19
	8/7/2017	-	-	-	-	-	-	-	-	-	-	-	**2.0**	-	-	-	-	-	-
	11/08/2017	-	-	-	-	-	-	-	-	-	-	-	**1.7**	-	-	-	-	-	-
WCMW2B	10/7/1998	U	U	5.7	6	0.02	0.16	95	U	U	95	U	0.5	99	0.1	0.1	U	130	10
	2/10/1999	U	U	6	10	0.02	1.95	90	U	U	90	1	0.5	99	U	U	U	130	14
	5/27/1999	U	0.0011	5	6.1	0.01	0.93	88	U	U	88	2	0.5	98	U	U	U	110	17.2
	8/18/1999	0.00008	U	5.8	7	U	0.79	117	U	U	117	U	0.5	116	U	U	U	150	8.1
	11/16/1999	U	0.0002	5.7	6.1	0.02	0.14	88	U	U	88	U	0.6	102	0.08	0.08	U	140	12.4
	2/23/2000	U	U	6.6	7	0.01	0.12	103	U	U	165	U	0.7	101	U	U	U	130	14.8
	6/1/2000	U	U	1.1	U	0.02	U	31	U	U	31	U	0.2	38	0.11	0.11	U	60	2
	8/1/2000	U	0.0005	5.8	U	0.02	0.9	102	U	U	102	1	0.7	109	HT	HT	HT	140	18
	4/18/2017	<0.0050	-	2.8	-	<0.020	-	85.32	<2.000	-	85.32	1.0	0.4	-	<0.10	-	-	106	11

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NMDGF Willow Creek Campground Groundwater Monitoring Data (mg/L)

Well ID	Analytes	Aluminum, dissolved	Aluminum, total	Arsenic, dissolved	Arsenic, total	Barium, dissolved	Barium, total	Boron, dissolved	Cadmium, dissolved	Cadmium, total	Calcium, dissolved	Calcium, total	Chromium, dissolved	Chromium, total	Cobalt, dissolved	Cobalt, total	Copper, dissolved	Copper, total	Iron, dissolved	Iron, total
	Section 20.6.2.3103 NMAC Standard	5	NA	0.1	NA	1	NA	0.75	0.01	NA	NA	NA	0.05	NA	0.05	NA	1	NA	1	NA
WCMW2	10/7/1998	0.15	19.9	U	0.019	0.074	0.216	-	U	0.0039	71.9	22.4	0.0011	0.167	U	0.02	0.003	0.289	0.93	28.6
	2/10/1999	0.14	345	U	0.06	0.047	4.6	-	U	0.016	59.6	297	0.0015	0.85	U	0.54	0.003	1.65	0.09	482
	5/27/1999	0.2	63.1	U	0.011	0.034	0.75	-	U	0.0021	39	64	0.001	0.111	U	0.05	0.002	0.182	0.11	84
	8/18/1999	0.78	140	U	0.02	0.042	1.6	-	U	0.005	41.8	107	0.00091	0.32453	U	0.27	0.0034	0.5341	0.31	210
	11/16/1999	U	62.8	U	0.012	0.048	0.707	-	0.0003	0.0042	54.8	82	0.0001	0.115	U	0.09	0.0017	0.269	U	94.7
	2/23/2000	0.4	50.5	U	U	0.039	0.614	-	0.0003	U	49.9	67	0.0014	0.11	U	0.1	0.0009	0.2	0.11	72.7
	6/1/2000	0.71	90.1	U	0.013	0.033	1.15	-	U	0.0053	33.9	76	0.0015	0.211	U	0.16	0.003	0.529	0.29	122
	8/1/2000	0.15	25.9	U	0.005	0.049	0.34	-	U	0.0019	51.9	49	0.0006	0.0585	U	U	0.0016	0.161	0.06	34.7
	2/28/2017	-	-	-	-	-	-	-	-	-	36	-	-	-	<0.0060	-	-	-	-	-
	4/18/2017	0.11	-	<0.020	-	0.022	-	<0.040	<0.0020	-	30	-	<0.0060	-	<0.0060	-	<0.0060	-	0.056	-
WCMW1B	2/10/1999	-	50.6	-	0.019	-	0.64	-	-	0.004	-	59	-	0.075	-	0.21	-	0.63	-	94.8
	5/27/1999	0.08	85.6	U	0.04	0.036	1.23	-	U	0.002	39.7	75.9	U	0.146	U	0.16	0.003	0.7	0.06	144
	8/18/1999	0.36	41.7	U	0.03	0.037	0.77	-	U	U	42.4	66	0.00059	0.0833	U	0.17	0.0032	0.481	0.18	71.6
	11/16/1999	0.09	3.56	U	0.002	0.035	0.054	-	0.0001	0.0002	40.7	41.4	0.0007	0.0045	U	U	0.0034	0.035	0.12	5.24
	2/23/2000	0.25	14.9	U	U	0.031	0.179	-	U	0.002	40.3	42.3	0.0009	0.018	U	0.03	0.005	0.14	0.16	24.5
	6/1/2000	0.44	47.8	U	0.016	0.036	0.56	-	U	0.0056	37.9	52	0.0014	0.0766	U	0.13	0.012	0.529	0.26	80.2
	2/28/2017	-	-	-	-	-	-	-	-	-	35	-	-	-	<0.0060	-	-	-	-	-
	4/18/2017	<0.020	-	<0.020	-	0.021	-	<0.040	<0.0020	-	27	-	<0.0060	-	<0.0060	-	<0.0060	-	<0.020	-
WCMW1A	5/27/1999	0.15	10.4	U	0.1	0.045	0.195	-	U	0.001	43.7	47.4	U	0.0188	U	U	0.003	0.054	0.11	15.7
	6/1/2000	0.06	0.31	U	U	0.018	0.019	-	U	0.0003	13.4	12.3	0.0014	0.0007	U	U	0.0011	0.001	0.08	0.28
	4/18/2017	0.049	-	<0.020	-	0.029	-	<0.040	<0.0020	-	34	-	<0.0060	-	<0.0060	-	<0.0060	-	0.18	-

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NMDGF Willow Creek Campground Groundwater Monitoring Data (mg/L)

Well ID	Analytes	Lead, dissolved	Lead, total	Magnesium, dissolved	Magnesium, total	Manganese, dissolved	Manganese, total	Mercury, dissolved	Mercury, total	Molybdenum, dissolved	Molybdenum, total	Nickel, dissolved	Nickel, total	Potassium, dissolved	Potassium, total	Selenium, dissolved	Selenium, total	Silica, dissolved
	Section 20.6.2.3103 NMAC Standard	**0.05**	**NA**	**NA**	**NA**	**0.2**	**NA**	**NA**	**0.002**	**1**	**NA**	**0.2**	**NA**	**NA**	**NA**	**0.05**	**NA**	**NA**
WCMW2	10/7/1998	0.0007	0.272	6.1	5.3	**1.36**	1.14	U	U	U	U	U	0.03	1.9	3.9	U	0.006	-
	2/10/1999	U	1.31	4.7	90	**0.288**	22.9	U	0.0013	U	U	U	0.68	1.4	50	U	0.007	-
	5/27/1999	0.0003	0.207	2.8	16.4	0.008	2.76	U	U	U	U	U	0.09	1.3	9.5	U	0.001	-
	8/18/1999	0.0005	0.42	3.5	36	0.062	8.09	U	0.0005	U	0.01	U	0.31	1.4	22	U	0.002	-
	11/16/1999	0.002	0.161	4.5	18.6	0.075	3.86	U	0.0002	U	U	U	0.11	1.3	10.3	U	0.002	-
	2/23/2000	U	0.15	4.2	15.5	0.027	3.84	U	U	U	U	U	0.11	1.1	8.2	U	U	-
	6/1/2000	0.0019	0.347	2.8	25	U	7.35	U	U	U	U	U	0.21	1.3	16	U	U	-
	8/1/2000	0.0002	0.107	4.1	9	0.013	2.02	U	U	U	U	U	0.07	1.4	6	U	U	-
	2/28/2017	-	-	2.9	-	0.015	-	-	-	-	-	-	-	<1.0	-	-	-	7.3
	4/18/2017	<0.0050	-	2.5	-	0.0034	-	-	<0.00020	<0.0080	-	<0.010	-	<1.0	-	-	-	7.4
WCMW1B	2/10/1999	-	0.063	-	16	-	6.38	-	U	-	U	-	0.19	-	9	-	0.002	-
	5/27/1999	U	0.154	3.3	25.2	0.008	7.29	U	U	U	U	U	0.24	0.8	11.4	U	0.001	-
	8/18/1999	0.0001	0.081	3.9	18	-	5.83	U	U	U	U	U	0.22	1	9	U	U	-
	11/16/1999	0.0002	0.0031	3.6	4.2	0.008	0.192	U	U	U	U	U	0.01	0.9	1.4	U	U	-
	2/23/2000	0.0004	0.013	3.6	6.8	0.021	1.09	U	U	U	U	U	0.04	0.9	3.1	U	U	-
	6/1/2000	0.0009	0.0609	3.3	14	0.007	4.15	U	U	U	U	U	0.16	1.5	9	U	U	-
	2/28/2017	-	-	3.1	-	0.0026	-	-	-	-	-	-	-	<1.0	-	-	-	6.2
	4/18/2017	<0.0050	-	2.5	-	<0.0020	-	-	<0.00020	<0.0080	-	<0.010	-	<1.0	-	-	-	6.6
WCMW1A	5/27/1999	U	0.0608	3.1	5.4	0.151	0.769	U	U	U	U	U	0.02	0.7	2.2	U	U	-
	6/1/2000	0.0002	0.0003	1.4	1.4	U	U	U	U	U	U	U	U	0.5	0.5	U	U	-
	4/18/2017	<0.0050	-	2.7	-	0.12	-	-	<0.00020	<0.0080	-	<0.010	-	<1.0	-	-	-	7.4

Notes:
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NMDGF Willow Creek Campground Groundwater Monitoring Data (mg/L)

Well ID	Analytes	Silver, dissolved	Silver, total	Sodium, dissolved	Sodium, total	Zinc, dissolved	Zinc, total	Bicarbonate as $CaCO_3$	Carbonate as $CaCO_3$	Hydroxide as $CaCO_3$	Total Alkalinity	Chloride	Fluoride	Hardness as caco3	Nitrate as N, dissolved	Nitrate/Nitrite as N, dissolved	Nitrite as N, dissolved	Residual, Filterable (TDS)	Sulfate
	Section 20.6.2.3103 NMAC Standard	**0.05**	**NA**	**NA**	**NA**	**10**	**NA**	**NA**	**NA**	**NA**	**NA**	**250**	**1.6**	**NA**	**10**	**10**	**NA**	**1000**	**600**
WCMW2	10/7/1998	U	0.0011	2.7	0.7	U	0.17	204	U	U	204	U	0.3	205	0.1	0.1	U	240	19
	2/10/1999	U	0.005	1.9	6	U	3.5	155	U	U	155	2	0.2	168	0.09	0.09	U	200	18.5
	5/27/1999	U	0.0008	1.8	2.2	U	0.63	95	U	U	95	1	0.2	109	0.04	0.04	U	130	8.7
	8/18/1999	U	0.003	1.8	3	U	1.4	118	U	U	118	U	0.2	119	0.02	0.02	U	130	8.6
	11/16/1999	U	0.0006	2	2.7	U	0.6	155	U	U	155	U	0.2	155	0.06	0.06	U	180	13.7
	2/23/2000	U	U	2.1	2	U	0.53	125	U	U	125	U	0.3	142	0.29	0.29	U	160	17.5
	6/1/2000	U	0.0011	1.8	U	0.01	0.96	89	U	U	89	U	0.3	96	0.3	0.3	U	130	4
	8/1/2000	U	U	2.4	U	0.02	0.22	127	U	U	127	1	0.2	147	HT	HT	HT	170	17
	2/28/2017	-	-	1.7	-	-	-	91.52	<2.000	-	91.52	1.1	0.16	-	-	0.16	-	125	14
	4/18/2017	<0.0050	-	1.7	-	<0.020	-	83.16	<2.000	-	83.16	0.72	0.18	-	0.13	0.16	-	116	9.4
WCMW1B	2/10/1999	-	U	-	5	-	0.69	111	U	U	111	3	0.3	-	0.15	0.15	U	-	15.8
	5/27/1999	U	U	3	4.8	U	1.06	98	U	U	98	1	0.2	113	0.1	0.1	U	150	13.5
	8/18/1999	U	0.001	2.2	4	U	0.78	111	U	U	111	U	0.2	122	U	U	U	150	10.9
	11/16/1999	U	U	2.3	2.4	U	0.04	100	U	U	100	U	0.2	117	0.19	0.19	U	150	13.1
	2/23/2000	U	U	2.7	3	U	0.18	103	U	U	380	2	0.2	116	0.3	0.3	U	140	16.6
	6/1/2000	U	0.0003	2.8	U	0.01	0.6	99	U	U	99	1	0.2	108	0.22	0.22	U	130	7
	2/28/2017	-	-	1.8	-	-	-	87.80	<2.000	-	87.80	1.1	0.16	-	-	0.27	-	270	14
	4/18/2017	<0.0050	-	1.7	-	<0.020	-	75.32	<2.000	-	75.32	0.79	0.17	-	0.22	-	-	102	9.0
WCMW1A	5/27/1999	U	0.0003	8.4	8.8	0.01	0.28	106	0	0	106	1	0.4	122	0.24	0.24	U	160	25.1
	6/1/2000	U	U	1	U	0.01	U	31	U	U	31	U	0.5	39	0.03	0.03	U	60	2
	4/18/2017	<0.0050	-	2.8	-	<0.020	-	94.48	<2.000		94.48	0.92	0.31		0.20	-	-	145	11

Notes:
U = non-detection
- = not reported, not tested
HT = holding time missed
NA = no applicable standard

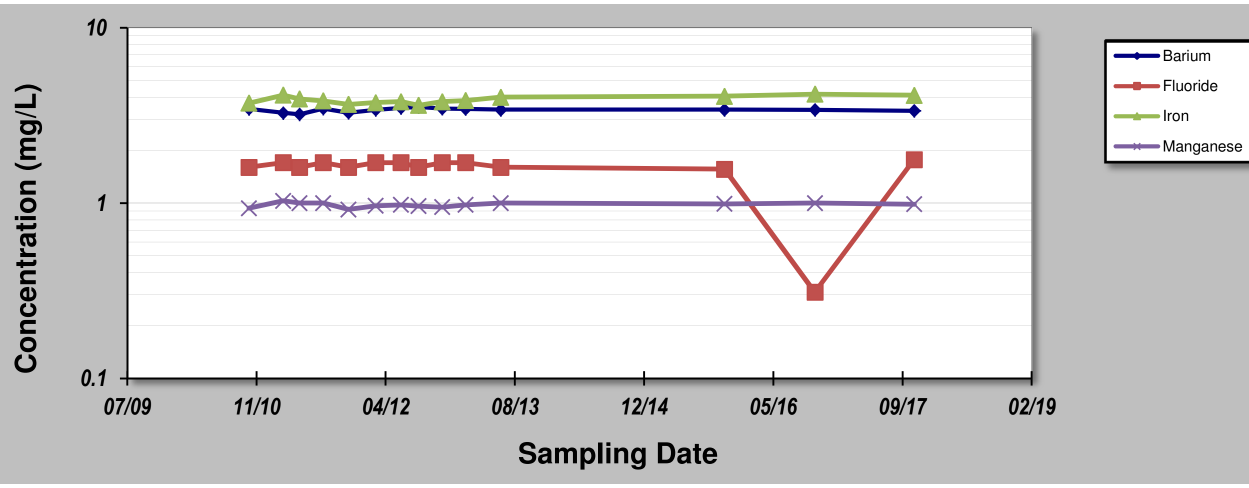
Appendix D

Mann-Kendall Statistical Evaluations

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	12-Feb-18	Job ID:	ES06.0038
Facility Name:	PMOU deep aquifer well P-7	Constituent:	See column heading
Conducted By:	A. Lewis and B. Salvas	Concentration Units:	mg/L

Sampling Point ID:		Barium	Fluoride	Iron	Manganese			
Sampling Event	Sampling Date	SEE COLUMN HEADING CONCENTRATION (mg/L)						
1	10/20/2010	3.450	1.6	3.72	0.935			
2	3/2/2011	3.270	1.7	4.13	1.030			
3	5/4/2011	3.210	1.6	3.93	1.000			
4	8/3/2011	3.460	1.7	3.83	1.000			
5	11/9/2011	3.280	1.6	3.66	0.919			
6	2/22/2012	3.400	1.7	3.74	0.966			
7	5/30/2012	3.490	1.7	3.79	0.976			
8	8/7/2012	3.530	1.6	3.61	0.961			
9	11/6/2012	3.460	1.7	3.79	0.948			
10	2/5/2013	3.450	1.7	3.84	0.978			
11	6/21/2013	3.410	1.6	4.02	1.000			
12	11/3/2015	3.410	1.56	4.07	0.989			
13	10/18/2016	3.400	0.31	4.18	1.00			
14	11/7/2017	3.360	1.77	4.12	0.984			
15								
16								
17								
18								
19								
20								
Coefficient of Variation:		0.03	0.23	0.05	0.03			
Mann-Kendall Statistic (S):		1	-6	32	9			
Confidence Factor:		50.0%	60.6%	95.5%	66.6%			
Concentration Trend:		No Trend	Stable	Increasing	No Trend			



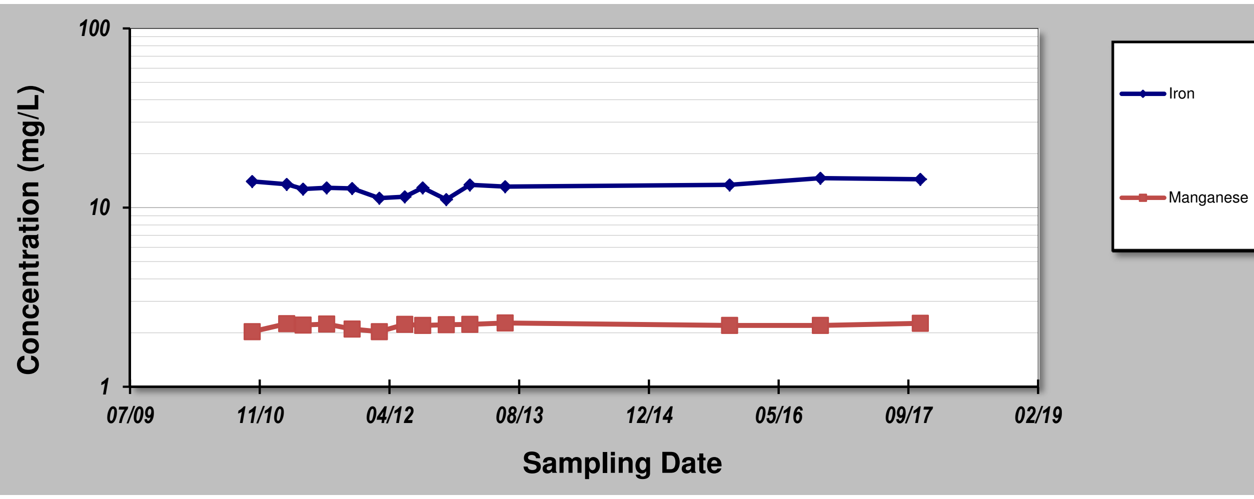
Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	12-Feb-18	Job ID:	ES06.0038
Facility Name:	PMOU shallow aquifer well P-7S	Constituent:	See column heading
Conducted By:	A. Lewis and B. Salvas	Concentration Units:	mg/L

	Sampling Point ID:	Iron	Manganese					
Sampling Event	Sampling Date	SEE COLUMN HEADING CONCENTRATION (mg/L)						
1	10/20/2010	14.00	2.030					
2	3/2/2011	13.50	2.250					
3	5/4/2011	12.70	2.210					
4	8/3/2011	12.90	2.240					
5	11/9/2011	12.80	2.100					
6	2/22/2012	11.30	2.030					
7	5/30/2012	11.50	2.230					
8	8/7/2012	12.90	2.200					
9	11/6/2012	11.10	2.220					
10	2/5/2013	13.40	2.230					
11	6/21/2013	13.10	2.270					
12	11/3/2015	13.40	2.200					
13	10/18/2016	14.60	2.200					
14	11/7/2017	14.40	2.260					
15								
16								
17								
18								
19								
20								
Coefficient of Variation:		0.08	0.04					
Mann-Kendall Statistic (S):		17	16					
Confidence Factor:		80.6%	79.1%					
Concentration Trend:		No Trend	No Trend					

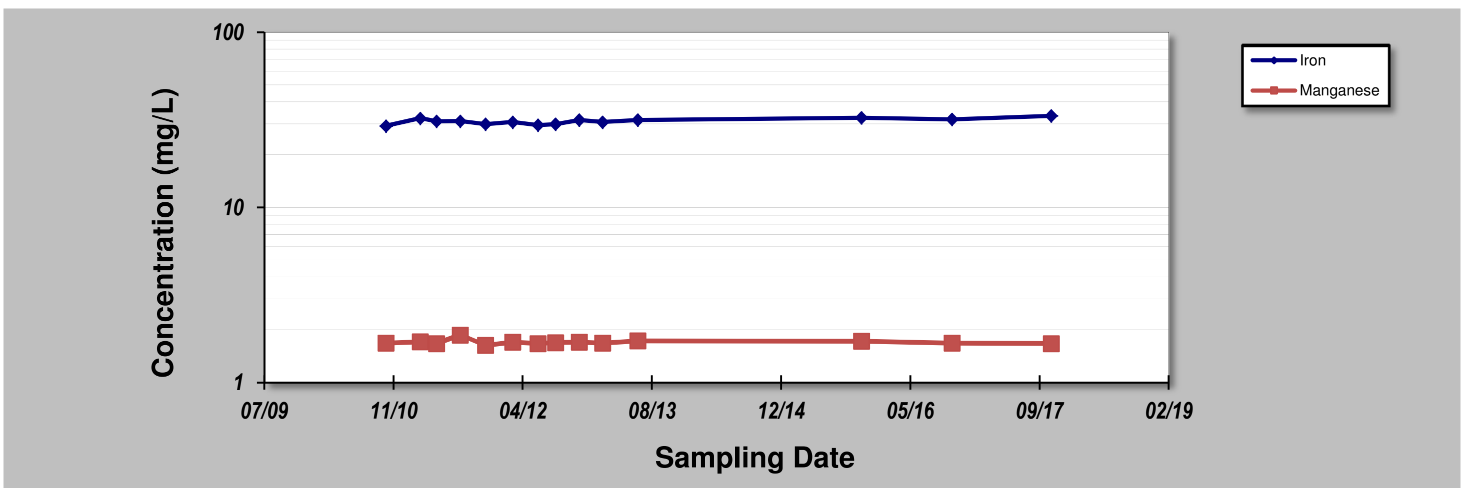


Notes:
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 12-Feb-18
Facility Name: PMOU deep aquifer well P-13
Conducted By: A. Lewis and B. Salvas
Job ID: ES06.0038
Constituent: See column heading
Concentration Units: mg/L

Sampling Point ID:		Iron	Manganese					
Sampling Event	Sampling Date	SEE COLUMN HEADING CONCENTRATION (mg/L)						
1	10/20/2010	29.20	1.680					
2	3/2/2011	32.30	1.710					
3	5/4/2011	31.00	1.670					
4	8/3/2011	31.10	1.870					
5	11/9/2011	29.90	1.630					
6	2/22/2012	30.70	1.700					
7	5/30/2012	29.50	1.670					
8	8/7/2012	29.90	1.690					
9	11/6/2012	31.60	1.700					
10	2/5/2013	30.70	1.680					
11	6/21/2013	31.60	1.730					
12	11/3/2015	32.50	1.720					
13	10/18/2016	31.80	1.680					
14	11/7/2017	33.30	1.670					
15								
16								
17								
18								
19								
20								
Coefficient of Variation:		0.04	0.03					
Mann-Kendall Statistic (S):		38	0					
Confidence Factor:		97.9%	47.8%					
Concentration Trend:		Increasing	Stable					

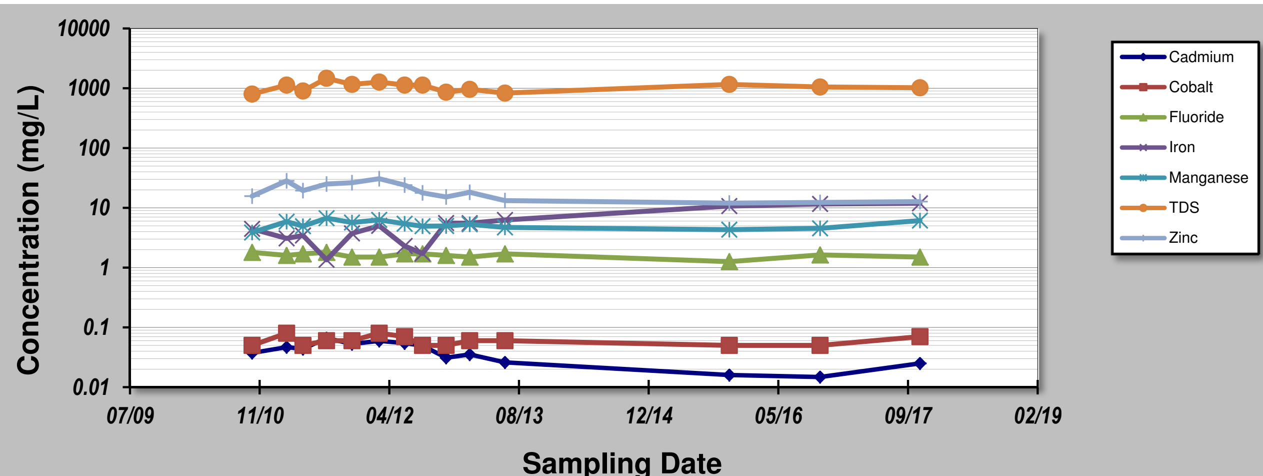


Notes:
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	12-Feb-18	Job ID:	ES06.0038
Facility Name:	PMOU shallow aquifer well P-13S	Constituent:	See column heading
Conducted By:	A. Lewis and B. Salvas	Concentration Units:	mg/L

Sampling Point ID:		Cadmium	Cobalt	Fluoride	Iron	Manganese	TDS	Zinc
Sampling Event	Sampling Date	SEE COLUMN HEADING CONCENTRATION (mg/L)						
1	10/20/2010	0.0374	0.05	1.8	4.45	3.870	800	15.70
2	3/2/2011	0.0468	0.08	1.6	3.08	5.870	1130	28.30
3	5/4/2011	0.0436	0.05	1.7	3.45	4.930	900	19.40
4	8/3/2011	0.0665	0.06	1.8	1.35	6.720	1470	25.00
5	11/9/2011	0.0527	0.06	1.5	3.73	5.680	1160	26.30
6	2/22/2012	0.0596	0.08	1.5	5.00	6.290	1270	30.70
7	5/30/2012	0.0545	0.07	1.7	2.30	5.410	1130	24.00
8	8/7/2012	0.0495	0.05	1.7	1.72	4.930	1130	17.80
9	11/6/2012	0.0311	0.05	1.6	5.56	4.970	860	15.20
10	2/5/2013	0.0353	0.06	1.5	5.53	5.300	960	18.20
11	6/21/2013	0.0260	0.06	1.7	6.26	4.700	830	13.20
12	11/3/2015	0.0160	0.05	1.26	10.70	4.310	1160	12.0
13	10/18/2016	0.0148	0.05	1.63	11.60	4.540	1050	12.30
14	11/7/2017	0.0250	0.07	1.5	11.90	6.120	1020	12.70
15								
16								
17								
18								
19								
20								
Coefficient of Variation:		0.40	0.18	0.09	0.65	0.15	0.17	0.33
Mann-Kendall Statistic (S):		-47	-6	-31	55	-18	-9	-49
Confidence Factor:		99.5%	60.6%	95.0%	99.9%	82.1%	66.6%	99.7%
Concentration Trend:		Decreasing	Stable	Prob. Decreasing	Increasing	Stable	Stable	Decreasing



Notes:

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3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.