Peabody Western Coal Company

April 1, 2008

Mr. John Tinger
U.S. Environmental Protection Agency
Region IX, CWA Standards and Permits
75 Hawthorne Street
San Francisco, CA 94105

RE: Interim Final Report on the Seepage Management Plan for NPDES Permit No. NN0022179

Dear Mr. Tinger:

Enclosed please find Peabody Western Coal Company's (PWCC) interim final report on the Seepage Management Plan for the Black Mesa Complex NPDES Permit No. NN0022179. The information contained in the enclosed report is provided in response to your September 9, 2007 email. The information was requested as a follow-up to a meeting held at PWCC's Black Mesa Complex on August 15, 2007 attended by representatives from the USEPA, OSM, Navajo Nation EPA, BIA, and PWCC to discuss the status of seeps below several NPDES ponds at the Complex.

The report includes summaries of inspections and flow measurements conducted at seep monitoring sites from 1999 through 2007, and comparisons of seep water quality data with water quality standards established by the NNEPA in 2004. The monitoring information and water quality standards comparisons are discussed on a pond by pond basis along with the purpose and status of each pond. These discussions provide the logic for plans and tentative time frames proposed by PWCC to remove several ponds and to install passive treatment systems downstream of two ponds with seeps that do not meet applicable standards. PWCC believes the NNEPA should consider variances at each site where the comparisons indicate seeps and naturally-occurring sources of water monitored on Black Mesa for decades do not meet standards established by the NNEPA. The standards for which variances may apply include those established for aluminum, TDS, and sulfate. No specific modifications to the Seepage Management Plan are proposed in the enclosed report. However, PWCC believes the summary information evaluated in the report and specific proposals developed to address problem seeps provide a solid basis for revising the Seepage Management Plan for continued implementation as part of the NPDES permit.

During the August 2007 meeting, you expressed interest in receiving photos of representative riparian vegetation in the vicinity of proposed permanent impoundments and at the vegetated area in the vicinity of seeps below Pond J7-DAM. In addition, your September 2007 email requested information on selenium uptake by plants and selenium deficiency in livestock within the Black Mesa leasehold. We are reviewing available digital photos to make sure we provide the proper location, vegetation types, and other pertinent information as a legend on each photo. We are also locating summary reports from 1996 and 1999 on livestock grazing and site-specific selenium standards within the Black Mesa leasehold. These reports summarize studies of selenium uptake by plants and selenium deficiency in livestock within the Black Mesa leasehold. Once we're finished with the photos and make copies of the reports, we'll send them to you in a follow up letter, hopefully within the next week or so.

Peabody Western Coal Company · P.O. Box 650 · Kayenta, Arizona 86033 · Telephone (520) 677-3201 · Fax (520) 677-3273

If you have any questions or need additional information please don't hesitate to call me at 928.677.5130, email me at gwendt@peabodyenergy.com, or write to me at the address below at your earliest convenience.

Respectfully,

Gary W. Wendt

Gary W. Wendt
Manager Environmental

GWW

Enclosure

C: w/enclosure

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file

Interim Final Report - Seepage Monitoring and Management Report

Peabody Western Coal Company NPDES Permit No. NN0022179

April 1, 2008

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Peabody Western Coal Company NPDES Permit No. NN0022179

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BACKGROUND

Peabody Western Coal Company's (PWCC) Black Mesa Complex (Black Mesa and Kayenta Mines) operates in compliance with NPDES Permit No. NN0022179. On January 31, 2001, the permit was reissued for a five-year term extending through January 31, 2006. PWCC reapplied for a five-year renewal on August 3, 2005 and to date this renewal has not been approved, but the permit term has been administratively extended. The permit includes language in Section A.5, which requires PWCC to implement the Seepage Management Plan (SMP) proposed on October 7, 1997, and subsequently revised in Appendix G of the 1999 Annual Seepage Monitoring and Management report submitted to the U.S. Environmental Protection Agency (USEPA) Region IX in April 2000. To date, eight annual seepage monitoring and management reports have been submitted to the USEPA and copies of each report were also distributed to the Office of Surface Mining (OSM), the Navajo Nation EPA and Hopi Tribe.

PURPOSE

The information contained in the following sections of this interim final report was requested via email by Mr. John Tinger of the USEPA on September 9, 2007. The request was made as a follow-up to a meeting held at PWCC's Black Mesa Complex on August 15, 2007 attended by representatives from the USEPA, OSM, Navajo Nation EPA, BIA, and PWCC to discuss the status of seeps below several NPDES ponds at the Complex. Information presented below includes summaries of inspections and flow measurements conducted at seep monitoring sites from 1999 through 2007. In addition, comparisons of seep water quality data with water quality standards established by the Navajo Nation EPA are provided. The monitoring information and water quality standards comparisons are discussed on a pond by pond basis along with the purpose and status of each pond. The purpose and status of each pond in combination with evaluations of monitoring data and standards comparisons provide the logic for plans and tentative time frames proposed by PWCC to remove several ponds and to install passive treatment systems downstream of two ponds with seeps that do not meet water quality standards. Comparisons of water quality standards with water quality data collected from background monitoring sites established at PWCC's leasehold indicate some standards have not been met in naturally-occurring sources of water on Black Mesa. In these instances, PWCC may pursue variances at each site below ponds that are either temporary and need to remain in place for the near future, or are proposed to remain as permanent structures where seep water quality does not meet the standard. For permanent ponds and temporary ponds that will be left in place for the near future where the information and water quality data collected show that the seep water quality meets applicable standards, PWCC proposes to discontinue inspections and monitoring.

INSPECTION SUMMARIES AND MONITORING DATA

Table 1 summarizes inspections conducted at seep monitoring sites on an annual basis. Table 2 summarizes the number of occurrences water was observed, the range of flows measured or estimated, and the total number of inspections conducted at each seep monitoring site from 1999 through 2007. This information is presented in a tabular format for reference purposes to support discussions provided on a pond by pond basis in subsequent sections of this report. More details of the information presented in Tables 1 and 2 can be found in previously submitted annual seepage monitoring and management reports which should be referenced as appropriate. The number of water quality samples column in Table 1 indicates the number of laboratory analyses run for either a reduced (nitrate, selenium, and iron only) or full suite of chemical parameters on water samples collected at each seep monitoring site listed. Typically, field water quality parameters including pH, electrical conductivity, salinity and temperature were collected at each seep monitoring site when either pooled or flowing water was found during inspections. All flow data in this report are provided in gallons per minute. Instances when no flowing water was present during an inspection yet a pool of water was available or hand-dug for collecting a water quality sample are indicated using the letter P. Water quality data associated with samples collected from very low flowing seeps, pooled water or where hand-digging was required in order to obtain a sample should be interpreted with caution as the sampling results may be biased. The respective annual report should be consulted for an explanation where Table 1 indicates an inspection was not conducted during a given year.

WATER QUALITY STANDARDS

In 1999 the Navajo Nation EPA developed a draft set of surface water quality standards, and these were formally adopted in 2004 (NNEPA, 1999; 2004). In 2006, the Navajo Nation received authority from the USEPA to administer certain Clean Water Act programs on lands within their jurisdiction and effectively approved the Navajo Nation's Surface Water Quality Standards under the Clean Water Act. PWCC used these water quality standards established for each designated use assigned to both Moenkopi Wash and Dinnebito Wash for comparing water quality data collected from the seep monitoring sites. These include standards established for the designated uses of Secondary Human Contact (ScHC), Aquatic Habitat (AqHbt), and Livestock and Wildlife Watering (L&W).

Standards assigned to the designated use of Agricultural Water Supply (AgWS) in Moenkopi Wash were not compared to seep water quality data. PWCC has investigated the possibility of past or present flood irrigation within and adjacent to the Black Mesa leasehold (PWCC, 1986). Results of these investigations yielded no evidence that flood irrigation is or has been practiced on the leasehold or in the immediate vicinity. Farm plots have been found, but rely solely on precipitation infiltration for crop growth. The flashy nature of surface-water runoff combined with high sediment loads and deeply incised active channels precludes the use of surface water on Black Mesa for flood irrigation.

In general, the comparisons of water quality data collected at seep monitoring sites with the standards identified above indicate a limited number of ponds have seeps that commonly exhibit water quality above or outside the range of a limited set of standards. These include standards established by the Navajo Nation EPA for pH, aluminum, total dissolved solids (TDS), and sulfate. PWCC believes aluminum, TDS and sulfate concentrations are well above the standards in various sources of naturally-occurring water on Black Mesa, and subsequent sections include supporting discussions and data. Infrequently, water quality at a very few seep monitoring sites have shown values greater than standards set for trace elements including cadmium, chromium, copper, and mercury. These, along with discussions of water quality data collected from seep monitoring sites below each NPDES pond and comparisons with water quality standards, are presented in the following sections.

POND AND SEEP MONITORING EVALUATIONS AND MANAGEMENT PROPOSALS

Pond BM-A1

Pond BM-A1 is a temporary sediment pond located on an un-named tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from the shops and coal preparation areas at the Black Mesa Mine. Although mining operations have been temporarily suspended at the Black Mesa Mine, the pond is necessary should mining operations resume. Two seep monitoring locations have been established downstream of the pond, designated BM-A1-S1 and BM-A1-S2. In addition, a stream monitoring location in the channel below both BM-A1-S1 and BM-A1-S2 was established and designated BM-A1-SP1. BM-A1-SP1 is located just above a sheep pen constructed in the channel bed. BM-A1-S1 is the most distant seep monitoring location from the embankment, and data provided in Tables 1 and 2 shows that seep water at this location has ranged from non-flowing pools to 3.20 gallons per minute (gpm), and commonly occurs as small discharges that travel no more than fifty to one-hundred feet downstream before disappearing. Seep water at BM-A1-S2 has been observed less frequently ranging from non-flowing pools to 1.20 gpm, commonly occurs as either a damp spot or small pool less than six-inches in diameter, and only rarely exhibits flowing water that travels further than fifty feet downstream. Flows at BM-A1-SP1 have ranged from a trickle to 5.20 gpm, and when flowing, usually continue down channel through the sheep pen and beyond. At least 22 inspections of the area below Pond BM-A1 have occurred through 2007, resulting in the collection of 20 water quality samples at BM-A1-S1, 11 water quality samples at BM-A1-S2, and 6 samples at BM-A1-SP1. Pooled or flowing water at each site disappears during the summer months as temperature and evapotranspiration rates increase.

Table 3 presents an annual summary of water quality parameters and values at each seep monitoring site that have been higher or outside the range of water quality standards. Table 4 summarizes exceedences of NNEPA water quality standards that have occurred at seep monitoring sites from 1999 through 2007, including the standards associated with each designated use and the last year an exeedence was noted. Tables 3 and 4 show that pH measured at both seep monitoring sites below Pond BM-A1 has been well below the pH standard range. PWCC believes the low pH is a result of chemical reactions in the thin coal and carbonaceous shale that contribute water to the seeps below Pond BM-A1. Nitrate has been above the livestock standard in three samples collected at BM-A1-S1, two samples collected at the lower stream monitoring site BM-A1-SP1, and one sample collected at BM-A1-S2. PWCC believes these high values are a result of heavy livestock traffic in the vicinity due to the sheep pen.

Total recoverable aluminum concentrations measured at both seep monitoring sites and the downstream site BM-A1-SP1 have all been above the standards set for L&W and Aquatic Habitat. Peabody believes the high values measured at both seep monitoring sites are related in part to the low pH water. In addition, moderately high suspended solids were measured in all samples analyzed for total recoverable aluminum, and PWCC believes the acid digestion process involved with using the total recoverable analytical method on unfiltered samples that contain even moderate concentrations of suspended solids also contributed to the high aluminum values. The acid digestion breaks down the silts and clays that are typically composed of aluminum-rich minerals and releases aluminum into solution. The total analytical method used historically for laboratory analyses on trace elements in unfiltered samples collected at the Black Mesa Complex uses a similar rigorous acid digestion process. Appendix 1 to this report contains summaries of analytical results collected since 1986 for storm runoff and baseflow sampling at monitoring sites established in the main washes and at naturally occurring springs within the Black Mesa leasehold. The storm runoff and baseflow sampling data is representative of naturally occurring stream flows. A review of the data in Appendix 1 indicates total and total recoverable aluminum analyses of both storm runoff and springs on Black Mesa typically result in high values similar to or significantly greater than those measured in the seep monitoring sites below Pond BM-A1. Storm runoff in the main washes typically features low dissolved aluminum concentrations compared to total or total recoverable aluminum concentrations that can be orders of magnitude higher. At least one natural spring (NSPG162) showed both total and dissolved aluminum concentrations more than 40 mg/l higher than measured at monitoring sites below Pond BM-A1. Total or total recoverable aluminum concentrations in naturally-occurring storm runoff and baseflow have ranged between one or two orders of magnitudes higher than the values determined for monitoring sites below Pond BM-A1.

Both seep monitoring sites below Pond BM-A1 and the lower stream monitoring site BM-A1-SP1 have exhibited TDS and sulfate values above the L&W standards. Review of the data summaries provided in Appendix 1 shows many of the naturally occurring springs within the leasehold typically show much higher concentrations of both parameters, and it is not uncommon for stream baseflow to show similar concentrations well above the standards. Occasionally, storm runoff can also feature high TDS and sulfate concentrations above the standards. Appendix 1 also contains similar summaries of analytical results collected from monitoring wells constructed in the alluvium and Wepo formation upgradient of mining activities within the leasehold, and the data summaries are considered to be representative of naturally-occurring ground water. The data summaries provided in Appendix 1 show that both TDS and sulfate are ubiquitous in various sources of water within the leasehold, including groundwater that occurs in the alluvial deposits along the stream channels and in the Wepo formation.

Finally, one analysis for cadmium collected at BM-A1-S2 in March of 2000 was greater than the hardness-based Aquatic Habitat standard for this parameter. The analytical laboratory that provided the cadmium analysis reported the result with a "B" qualifier. This qualifier indicates the result was above the minimum detection limit (MDL) of the instrumentation but below the practical quantitation limit. Analytical results for trace elements reported with B qualifiers are considered semi-quantitative, and because of this, the cadmium value reported for BM-A1-S2 is inconclusive with respect to whether the seep met the cadmium Aquatic habitat standard. No other analyses for cadmium at any of the sites below Pond BM-A1 were above the MDL, so PWCC believes cadmium is not a problem below this pond.

As mentioned previously, PWCC will leave Pond BM-A1 in place for the near term. PWCC has investigated the potential for lining the pond to eliminate contributions from impounded water seeping through the embankment and pond bottom to downstream seeps, but is reluctant to line the pond bottom. When the mine is active, a considerable amount of water is used for dust control up stream of the pond. Lining the pond will undoubtedly result in a continuous discharge of water through the principal spillway. PWCC does not want to create a continuous discharge condition at pond BM-A1. Based on the above evaluation of the water quality data and other related information collected at the seep monitoring sites below Pond BM-A1, PWCC proposes to install a passive treatment system at the two sites to raise the pH of the seep water. This should also reduce concentrations of aluminum in the vicinity of the seeps by precipitation as pH levels rise. In June of 2001, PWCC sent a report to both the USEPA and OSM entitled "Passive Water Treatment Design for Low-pH Seeps BMA1-S1 and BMA1-S2". The report was prepared by Harding ESE of Grand Junction, Colorado at PWCC's request. The report presents details regarding review and analysis of data collected at the two seeps below Pond BM-A1, and the design of a passive treatment system to improve water quality at the seeps. Because the current extent of the disturbance for Pond BM-A1 is limited to the toe of the embankment, PWCC is currently in the process of seeking approval from the U.S. Army Corps of Engineers (USACOE) and NNEPA for expanding the channel disturbance area below Pond BM-A1 to include the areas proposed for the passive treatment systems under the NWP21 for the Black Mesa Complex. PWCC is optimistic approval will be granted by the USACOE, USEPA, and NNEPA during 2008, and is prepared to construct the system during 2008 once approval is received. The design report recommends monitoring at the outfalls of both systems for several years to ensure proper treatment. PWCC will continue to monitor the quality of treated seep water at the outfalls of both systems after installation to evaluate the system's effectiveness and to gather data to ensure compliance with the pH water quality standards.

In regards to marginally elevated levels of nitrate measured below BM-A1, PWCC maintains the source of this constituent is due to livestock traffic. PWCC has approached local residents in the vicinity of the pond with the idea of fencing the channel below Pond BM-A1 to prevent livestock access and reduce nitrate levels, but this idea has been met with continued resistance. As a result, PWCC does not propose any actions at this time for treating nitrate levels. Review of naturally-occurring water quality from various sources within the Black Mesa leasehold indicates high levels of aluminum, TDS, and sulfate do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. Because this temporary pond will be required for several years to come, PWCC believes a variance should be considered by the NNEPA for the elevated aluminum, TDS, and sulfate levels measured at seep monitoring sites BM-A1-S1 and BM-A1-S2 located downstream of Pond BM-A1.

Pond J2-A

Pond J2-A is a large MSHA impoundment located on Wild Ram Valley Wash, a tributary to Coal Mine Wash which, in turn, is tributary to Moenkopi Wash. PWCC proposes to leave the pond as a permanent impoundment for providing a source of water for livestock watering by the Navajo Nation. Pond J2-A provides treatment of disturbed area runoff from numerous areas within its watershed, largely composed of reclaimed mined lands. One seep monitoring location has been established downstream of the pond, designated J2-A-S1. Summary data provided in Tables 1 and 2 for J2-A-S1 show that water at this location has seldom been observed, as flowing water has only been found once at 15.6 gpm during the twenty-two inspections conducted below Pond J2-A through 2007. Only one water quality sample was collected from J2-A-S1, and the pH of the water (6.49 S.U.) was at the lower limit of the pH standard range (Tables 3 and 4). Laboratory analyses for all other water quality parameters were below or within the range of water quality standards.

Due to the infrequent observations of seep water below the pond during twenty-two inspections covering an eight-year period, and because the analytical results indicate compliance with water quality standards, PWCC proposes to discontinue seep inspections and monitoring below Pond J2-A.

Pond J3-D

Pond J3-D is a sediment pond located on an un-named tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from a coal haul road. PWCC has proposed leaving Pond J3-D as a permanent impoundment to serve as a livestock watering source for the Navajo Nation. Two seepage monitoring sites have been established downstream of the pond, designated J3-D-S1 and J3-D-S2. Summary data provided in Tables 1 and 2 indicate seep water at both sites was infrequently found, but has been observed at J3-D-S2 nine of the seventeen inspections conducted. Seep water at J3-D-S1 was not found from 1999 through 2004, and from 2005 through 2007 mostly occurred as a small pool, although flows as high as 1.50 gpm were noted.

At J3-D-S2, seep water also mostly occurred as a small pool, and when flowing did not exceed 0.63 gpm. Three water samples were collected at J3-D-S1, and seven water samples were collected at J3-D-S2.

Data summarized in Tables 3 and 4 shows that recent water quality analyses for chloride at both seep sampling locations below Pond J3-D are well above the L&W standard of 600 mg/l. PWCC attributes the high chloride values at both seeps to local geologic conditions and evaporation in the alluvium below Pond J3-D. Recent TDS analyses are also above the L&W standard for TDS at both sampling locations. One of two mercury analyses for J3-D-S1 was detected at the laboratory minimum detection limit (0.2 ug/l) and reported with a B qualifier rendering this result as only semi-quantitative. PWCC believes this result is inconclusive with regard to seep water below Pond J3-D meeting the Wildlife and Chronic Aquatic standards for mercury of 0.012 ug/l. One sample collected at J3-D-S1 in 2007 showed a sulfate value slightly above the L&W standard of 1000 mg/l. The one sample collected at J3-D-S2 in 2007 showed an aluminum concentration slightly above 0.5 mg/l, which is higher than both the L&W and chronic Aquatic Habitat standards.

The summaries of analytical results for unaffected alluvial wells contained in Appendix 1 indicates there are some locations in alluvial deposits within the leasehold that have featured naturally-occurring high levels of chloride above the L&W standard, but not at the levels measured recently below Pond J3-D. PWCC believes the high chloride levels measured at the two seeps below Pond J3-D are related to local geologic conditions and evaporation, and future runoff events in the channel below the pond where the seeps are located will serve to flush and dilute chloride to acceptable levels with time. As discussed for the seeps below Pond BM-A1, a review of naturally-occurring water quality from various sources within the Black Mesa leasehold as provided in Appendix 1 indicate high levels of aluminum, TDS, and sulfate do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. The seeps monitored below J3-D flow infrequently and are typically only small pools, and water quality here may be more representative of shallow groundwater. Because Pond J3-D is proposed as a permanent pond for the Navajo Nation, and the seeps flow so infrequently at low rates, PWCC believes a variance should be considered by the NNEPA for the elevated aluminum, TDS, and sulfate levels measured at seep monitoring sites J3-D-S1 and J3-D-S2.

<u>Pond J3-E</u>

Pond J3-E is a sediment pond located on an un-named tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from a shop area associated with maintaining reclamation equipment. PWCC has proposed leaving Pond J3-E as a permanent impoundment to serve as a livestock watering source for the Navajo Nation. Two seepage monitoring sites have been established downstream of the pond, designated J3-E-S1 and J3-E-S2. Summary data provided in Tables 1 and 2 indicate seep water was observed at both sites more than fifty percent of the inspections conducted at both sites. At least seventeen inspections were conducted below Pond J3-E through 2007. Typically more pooled or flowing water was found at J3-E-S1 than J3-E-S2. Seep water observed at J3-E-S1 ranged from non-flowing pools to 1.90 gpm, and at J3-E-S2 from non-flowing pools to 0.63 gpm. Ten water samples have been collected at J3-E-S1, and four water samples have been collected at J3-E-S2.

Table 3 and 4 show that out of the five samples collected at J3-E-S2, only one showed an aluminum concentration slightly above the chronic Aquatic Habitat standard. Of the ten samples collected at J3-E-S1, only two showed pH values lower than the range established for the pH standard, and one of those was only slightly lower. Two samples out of ten collected at J3-E-S1 exhibited TDS and sulfate concentrations just slightly above the L&W standards. The seep monitoring activities conducted below Pond J3-E for eight years shows the seep water quality meets almost all of the water quality standards except for those few excursions noted above. PWCC proposes to discontinue seep inspections and monitoring below Pond J3-E.

Pond J7-A

Pond J7-A is a temporary sediment pond located on an un-named tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from a reclaimed mining area. A portion of the area above Pond J7-A was recently disturbed to provide a location where a large dragline was dismantled, and final reclamation of this area has only recently been initiated but is scheduled for completion during 2008. After two years following completion of final reclamation of the recently disturbed area, this temporary sediment pond will be eligible for removal under OSM rules and USEPA effluent limitation guidelines at 40 CFR Part 434 for Subpart H - Western Alkaline Coal Mining. PWCC anticipates this to occur in 2011. One seep monitoring site has been established downstream of the pond, designated J7-A-S1. Summary data provided in Tables 1 and 2 indicate observations of seep water at this site occurred frequently as flowing water during 12 of the sixteen inspections conducted below Pond J7-A through 2007. Seep water at J7-A-S1 ranged from non-flowing pools to 2.70 gpm, and ten water samples have been collected mostly when the seep was flowing.

Tables 3 and 4 show that eight of the ten samples collected at J7-A-S1 met all applicable water quality standards. One sample collected in 1999, and another collected in 2007 exhibited concentrations of chloride, TDS, and sulfate above the standards set for L&W. The chloride levels are comparable to or slightly above high levels measured at unaffected alluvial wells 29 and 98/98R as shown in Appendix 1. The TDS and sulfate levels measured at J7-A-S1 are within the maximum values of both parameters measured at other naturally-occurring sources (springs, storm runoff, and baseflow) of water monitored within the leasehold (Appendix 1). The 1999 sample also yielded a cadmium value greater than the hardness-based Aquatic Habitat standard for this parameter. The cadmium value was reported with a B qualifier, and PWCC considers this analysis to be inconclusive with respect to whether the seep below Pond J7-A met the cadmium Aquatic Habitat standard. No other analysis for cadmium at this site has been above the MDL, so PWCC believes cadmium is not a problem below this pond. PWCC believes a variance should be considered by the NNEPA for the elevated TDS and sulfate levels measured at J7-A-S1 downstream of Pond J7-A until PWCC can secure approval from the USEPA and OSM for removing the embankment, anticipated in 2011.

Pond J7-CD

Pond J7-CD is a temporary sediment pond located on an un-named tributary to Sagebrush Wash, which eventually flows into Moenkopi Wash. This pond provides treatment of disturbed area runoff from a small portion of reclaimed mining area within its largely undisturbed watershed. This temporary sediment pond has been approved by OSM for removal, and is also eligible for removal under the USEPA effluent limitation guidelines at 40 CFR Part 434 for Subpart H - Western Alkaline Coal Mining. One seep monitoring site was established downstream of the pond beginning in 2002, designated J7-CD-S1. Summary data provided in Tables 1 and 2 indicate seep water at this site occurred infrequently at relatively low rates (less than 1 gpm) during eight of the twenty-two inspections conducted below Pond J7-CD. Observations of seep water at J7-CD-S1 ranged from non-flowing pools to 1.30 gpm, and seven water samples have been collected.

Tables 3 and 4 show that three water quality analyses for aluminum were above the chronic Aquatic Habitat standard of 0.087 mg/l, and two were above the L&W standard of 0.50 mg/l. The sample collected in 2002 also exhibited concentrations of both TDS and sulfate above the L&W standards. In addition, the chromium analysis for the 2002 sample was above the aquatic habitat standards. The chromium analysis for the 2002 sample was reported by the laboratory with a B qualifier, and PWCC considers this analysis to be inconclusive with respect to whether the seep below Pond J7-CD met the chromium Aquatic Habitat standard. PWCC has initiated modeling work in support of an application to the OSM and USEPA to remove the embankment at Pond J7-CD that will be submitted during the second quarter of 2008. Upon approval of the application, PWCC plans to remove the embankment during the latter portion of 2008. Removing the embankment would eliminate the seep as runoff will no longer be impounded to provide a source of water for the seep monitored at J7-CD-S1.

Pond J7-DAM

Pond J7-DAM is a large MSHA impoundment located on Red Peak Valley Wash which is tributary to Moenkopi Wash. This impoundment is the largest sediment control structure within the PWCC leasehold and in 1973 was the first one built. PWCC proposes to leave the pond as a permanent impoundment for providing a source of water for livestock watering by the Navajo Nation. Pond J7-DAM provides treatment of disturbed area runoff from numerous areas within its watershed, including reclaimed mined lands and a portion of the shops and coal preparation areas at the Black Mesa Mine. Several seep monitoring locations have been established downstream of the pond, and these are designated J7-DAM-S1, J7-DAM-S1A, J7-DAM-S2, J7-DAM-S3, J7-DAM-S3A, and J7-DAM-S5. Summary data provided in Tables 1 and 2 for all of the seep monitoring sites except J7-DAM-S2 show that water at these monitoring locations was frequently observed, and was always observed at sites J7-DAM-S3A and J7-DAM-S5. At least twenty-one inspections occurred below Pond J7-DAM during the eight-year monitoring period. Flowing water measured at the seep monitoring sites ranged from non-flowing pools at most sites to 10.8 gpm at J7-DAM-S5. J7-DAM-S5 is the most distant of all the sites from the toe of the embankment, and discharges from the upstream seeps coalesce at this location. Eighteen samples were collected at J7-DAM-S5, sixteen samples were collected at both J7-DAM-S1 and J7-DAM-S3A, thirteen samples were collected at J7-DAM-S1A, and eight samples were collected at J7-DAM-S3. Seepage monitoring site J7-DAM-S2 did not flow or feature pooled water during the entire monitoring period, so no samples were collected at this site.

Table 3 presents a yearly summary of water quality parameters and values at the seep monitoring sites below Pond J7-DAM that have been above or outside of the range of water quality standards. Table 3 shows that elevated levels of TDS and sulfate above the L&W standards have occurred at all seep monitoring sites below J7-DAM. The mercury analyses for the 1999 sample collected at J7-DAM-S5 was detected at the minimum detection limit for this trace element (0.2 ug/l) and reported with a B qualifier rendering this result as only semi-quantitative. PWCC believes this result is inconclusive with regard to seep water below Pond J7-DAM meeting the Wildlife and Chronic Aquatic standards for mercury of 0.012 ug/l. One sample collected at J7-DAM-S1A in 2005 showed an aluminum value above the standards for L&W and Aquatic Habitat, but no other analyses for aluminum from samples collected at J7-DAM-S1A or any other seep monitoring site were above the standards. Two pH values measured at J7-DAM-S3A in 2000 and 2001 were just slightly below the pH standard range.

In the mid-1980's, PWCC planted vegetation to create an artificial wetland for wildlife to take advantage of the seepage below Pond J7-DAM. Cattails, willows, and other species were planted in the vicinity of the seeps and along the channel bed below the embankment toe down to the present location of J7-DAM-S5. This area was fenced off in 1999 to control livestock from accessing the area and destroying the vegetation. Today, the vegetation seeded years ago provides treatment of water from the seeps as it flows downstream to J7-DAM-S5. A review of the data shown in Tables 3 and 4 indicate this treatment of the seep water by the vegetation has been successful and has improved water quality over time. Samples collected at J7-DAM-S5 have met all water quality standards for the last three years, and shown only one elevated TDS analysis above the standards in the last five years. Because the current extent of the disturbance for Pond J7-DAM is limited to the toe of the embankment, PWCC is currently in the process of seeking approval from the USACOE and NNEPA for expanding the channel disturbance area below Pond J7-DAM under the NWP21 for the Black Mesa Complex to include the area seeded with wetland vegetation in the vicinity of the seeps down to the location of J7-DAM-S5. PWCC is optimistic approval of this existing and functional passive treatment system will be granted by the USACOE, USEPA, and NNEPA during 2008. PWCC proposes to continue collecting flow measurements and water quality samples at the downstream site J7-DAM-S5 on an annual basis to insure compliance with water quality standards, and to periodically monitor the health of the vegetation within the area to insure adequate treatment is still occurring.

Pond J7-JR

Pond J7-JR is a large MSHA impoundment located on Red Peak Valley Wash which is tributary to Moenkopi Wash. This impoundment is upstream of Pond J7-DAM. PWCC proposes to leave the pond as a permanent impoundment for providing a source of water for livestock watering by the Navajo Nation. Pond J7-JR provides treatment of disturbed area runoff from active mining and reclaimed mined lands. One seep monitoring location was established downstream of the pond in 2003, designated J7-JR-S1. Summary data provided in Tables 1 and 2 for J7-JR-S1 show that water at this location was infrequently found, usually in pools or at very low rates. Flows greater than a trickle (less than 0.01 gpm) have not been observed. More than sixty inspections have been made below Pond J7-JR for the purposes of inspecting for seepage and for checking the integrity of this large MSHA embankment. Seven water quality samples were collected from J7-JR-S1, all of which were collected from a very small pool or hand dug cistern.

Data provided in Tables 3 and 4 show that since 2003, five samples collected at J7-JR-S1 had analyses for TDS and sulfate above the standards for L&W. In addition, two samples collected in 2004 and 2007 exhibited elevated aluminum concentrations above the L&W and Aquatic Habitat standards. As discussed previously, a review of naturally-occurring water quality from various sources within the Black Mesa leasehold provided in Appendix 1 indicate high levels of aluminum, TDS, and sulfate do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. The copper analysis for the 2004 sample was reported by the laboratory with a B qualifier, and PWCC considers this analysis to be inconclusive with respect to whether the seep below Pond J7-JR met the copper hardness-based Aquatic Habitat standard. Because Pond J7-JR is proposed as a permanent impoundment for the Navajo Nation, and because the water at the seep has been found in either very small pools or flowing at such low rates, PWCC believes a variance should be considered by the NNEPA for the elevated aluminum, TDS, and sulfate levels measured at seep monitoring site J7-JR-S1.

Pond J16-A

Pond J16-A is a large MSHA impoundment located on an un-named tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from reclaimed mined lands and both shop and coal preparation areas associated with the Kayenta Mine. PWCC proposes to leave the pond as a permanent impoundment for providing a source of water for livestock watering by the Navajo

Nation. One seep monitoring location has been established downstream of the pond, designated J16-A-S1. Summary data provided in Tables 1 and 2 for J16-A-S1 show that seep water at this location was frequently observed and ranged from non-flowing pools to 0.5 gpm. More than seventy inspections have been made below Pond J16-A for the purposes of seepage monitoring and for checking the integrity of this large MSHA embankment. Sixteen water quality samples were collected from J16-A-S1.

Summary data provided in Tables 3 and 4 show that five analyses for TDS and four analyses for sulfate in samples collected at J16-A-S1 have been above the L&W standards. The copper analysis for the 2002 sample was reported by the laboratory with a B qualifier, and PWCC considers this analysis to be inconclusive with respect to whether the seep below Pond J16-A met the copper hardness-based Aquatic Habitat standard. No other water quality parameters were analyzed at levels above or outside of the range of water quality standards. As discussed for other seeps below several ponds, a review of naturally-occurring water quality from various sources within the Black Mesa leasehold as provided in Appendix 1 indicate high levels of TDS and sulfate do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. Because Pond J16-A is proposed as a permanent impoundment for the Navajo Nation, PWCC believes a variance should be considered by the NNEPA for the elevated TDS and sulfate levels measured at seep monitoring site J16-A-S1.

Pond J16-E

Pond J16-E is a temporary sediment pond located on an un-named tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from reclaimed mining areas and a small portion of undisturbed land. This temporary sediment pond is eligible for removal under OSM rules and under the USEPA effluent limitation guidelines at 40 CFR Part 434 for Subpart H - Western Alkaline Coal Mining. Two seep monitoring sites have been established downstream of the pond. J16-E-S1 is located on one side of the J16-E pond embankment that forms a portion of the adjacent and downstream Pond J16-D, and discharges from J16-E-S1 flow directly into Pond J16-D. J16-E-S2 is located about midway down the J16-E pond embankment on the small tributary to Moenkopi Wash. Summary data provided in Tables 1 and 2 indicate seep water at J16-E-S1 ranging from non-flowing pools to 1.0 gpm has been observed seventeen times out of fifty-one inspections conducted. In contrast, flowing water at J16-E-S2, which flows towards Moenkopi Wash, has been observed on only three occasions and at extremely low rates not exceeding 0.1 gpm during forty-nine inspections conducted. Three samples have been collected at J16-E-S1, and only one sample has been collected at J16-E-S2.

Data from site J16-E-S1 was not included in Tables 3 and 4, as discharges from this seep monitoring site flow into the adjacent and downstream Pond J16-D. Data provided in Tables 3 and 4 for J16-E-S2 show that the one sample collected at this site exhibited a pH value well below the pH standard range, and also exhibited high levels of aluminum, TDS, and sulfate well above the standards. Field investigations of the source of water to Pond J16-E and a review of historical aerial photographs strongly indicate the presence of a spring upstream of Pond J16-E that existed prior to constructing the pond and commencing mining activities in the vicinity. PWCC believes the natural spring contributes to the poor water quality monitored at both seep monitoring sites J16-E-S1 and J16-E-S2. PWCC has initiated modeling work in support of an application to the OSM and USEPA to remove the embankment at Pond J16-E that will be submitted during the second quarter of 2008. Upon approval of the application, PWCC plans to remove the embankment during the latter portion of 2008. Removing the embankment would eliminate the seep as runoff will no longer be impounded to provide a source of water for the seeps monitored at J16-E-S2, and at J16-E-S1. PWCC also plans to seed the area along the channel above and in the vicinity of Pond J16-E with vegetation that will provide treatment of the spring water after the embankment is removed.

Pond J16-L

Pond J16-L is a large MSHA impoundment located on Reed Valley Wash, which is tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from active mining, reclaimed mined lands, and both shop and coal preparation areas associated with the Kayenta Mine. PWCC proposes to leave the pond as a permanent impoundment for providing a source of water for livestock watering by the Navajo Nation. One seep monitoring location has been established on the downstream portion of the pond embankment in the corrugated metal pipe that serves as the principal spillway, designated J16-L-CMP. Summary data provided in Tables 1 and 2 for J16-L-CMP show that water has not been observed during 65 inspections conducted at this site since 2003 for the purposes of seepage monitoring and for checking the integrity of this large MSHA embankment. No water quality samples have been collected from J16-L-CMP. PWCC proposes to discontinue seep inspections and monitoring at this location.

Pond J19-D

Pond J19-D is a relatively new temporary sediment pond located on an un-named tributary to Red Peak Valley Wash, which is tributary to Moenkopi Wash, and will continue to provide treatment of disturbed area runoff from an active mining area for many years. One seep monitoring site was established downstream of the pond beginning in 2005, designated J19-D-S1. Summary data provided in Tables 1 and 2 indicate seep water observed at this site occurred frequently on seven of the fourteen inspections conducted below Pond J19-D since 2005. Seep water at this site has ranged from non-flowing pools to 2.50 gpm, and four water samples have been collected from flowing water at the seep.

Summary data provided in Tables 3 and 4 show that three of the four samples collected at J19-D-S1 had elevated levels of TDS and sulfate above the L&W water quality standards. One mercury analyses for J19-D-S1 collected in 2006 was detected at the minimum detection limit for this trace element (0.2 ug/l) and reported with a B qualifier rendering this result as only semi-quantitative. PWCC believes this result is inconclusive with regard to seep water below Pond J19-D meeting the Wildlife and Chronic Aquatic standards for mercury of 0.012 ug/l. No other parameters in the four samples collected to date had water quality parameter concentrations above or outside the range of water quality standards. The TDS and sulfate levels measured at J19-D-S1 are within the maximum values of both parameters measured at other naturally-occurring sources (springs, storm runoff, and baseflow) of water monitored within the leasehold (Appendix 1). PWCC proposes to continue inspections and seep monitoring below Pond J19-D, and believes a variance should be considered by the NNEPA for the elevated TDS and sulfate levels measured at the seep monitoring site located downstream of Pond J19-D.

Pond J21-C

Pond J21-C is a moderately-sized temporary sediment pond located on an un-named tributary to Dinnebito Wash, and provides treatment of disturbed area runoff from reclaimed mining areas and a small portion of active mining areas. PWCC proposes to leave the pond as a permanent impoundment for providing a source of water for livestock watering by the Navajo Nation. One seep monitoring site was established in 2004 on the downstream portion of the pond embankment in the corrugated metal pipe that serves as the principal spillway, designated J21-C-CMP. Summary data provided in Tables 1 and 2 indicate seep water at J21-C-CMP ranged from non-flowing pools to 0.5 gpm during fifteen of the twenty-four inspections conducted. Seven samples have been collected at J21-C-CMP since 2004.

Data provided in Tables 3 and 4 for J21-C-CMP show that samples collected at this site in 2007 exhibited aluminum values higher than the L&W and Aquatic Habitat water quality standards. As discussed previously, a review of naturally-occurring water quality from various sources within the Black Mesa leasehold provided in Appendix 1 indicate high levels of aluminum do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. No other parameters in the seven samples collected to date had water quality parameter concentrations above or outside the range of water quality standards. Because Pond J21-C is proposed as a permanent impoundment for the Navajo Nation, PWCC believes a variance should be considered by the NNEPA for the elevated aluminum levels measured at seep monitoring site J21-C.

Pond J27-A

Pond J27-A is a temporary sediment pond located on an un-named tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from a coal haul road near the Black Mesa Mine. Two seepage monitoring sites have been established downstream of the pond, designated J27-A-S1 and J27-A-S2. Summary data provided in Tables 1 and 2 indicate seep water at both sites was observed frequently at about fifty percent of the time inspections occurred, and at least 22 inspections were conducted below Pond J27-A. Seep water observed ranged from non-flowing pools to 7.5 gpm at J27-A-S1, and from non-flowing pools to 3.7 gpm at J27-A-S2. Eight water samples have been collected at J27-A-S1, and six water samples have been collected at J27-A-S2. Most of the water quality samples were collected from flowing water.

Summary data provided in Tables 3 and 4 shows that water quality analyses for the eight samples collected at J27-A-S1 were below or within the range of water quality standards. One sample out of six collected at J27-A-S2 featured elevated chloride and TDS concentrations above the water quality standards set for both constituents. No other parameters analyzed in samples collected at J27-A-S2 were above or outside the range of water quality samples. Similar to the seep below Pond J7-A, the high chloride level is comparable to or slightly above high levels measured at unaffected alluvial wells 29 and 98/98R as shown in Appendix 1. PWCC believes local geologic conditions and evaporation have contributed to the elevated chloride below Pond J27-A, and future runoff events in the channel below the pond where the seeps are located will serve to flush and dilute chloride to acceptable levels with time. A review of naturally-occurring water quality from various sources within the Black Mesa leasehold provided in Appendix 1 indicate high levels of TDS do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. Because mining operations at the Black Mesa Mine may resume in the future, Pond J27-A will need to remain in place. Because Pond J27-A will remain for the foreseeable future, PWCC believes a variance should be considered by the NNEPA for the elevated TDS levels measured at seep monitoring site J27-A.

Pond J27-B

Pond J27-B was a temporary sediment pond located on an un-named tributary to Moenkopi Wash, and provided treatment of disturbed area runoff from a reclaimed mining area. The pond was removed in 1999. One seepage monitoring site was established downstream of the pond, designated J27-B-S1. Summary data provided in Tables 1 and 2 indicate the seep was inspected only once in 1999, no water was found, and no samples were collected. New pond J27-RC was constructed in the same un-named tributary above Pond J27-B in 1999, and seep monitoring below this pond is discussed in the following section.

Pond J27-RC

Pond J27-RC is a relatively new permanent impoundment located on an un-named tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from reclaimed mining areas immediately above the pond as well as a source of livestock drinking water for the Navajo Nation. Two seep monitoring sites were established downstream of the pond beginning in 2000, designated J27-RC-S1 and J27-RC-S2. Summary data provided in Tables 1 and 2 indicate seep water at both sites was observed infrequently about fifty percent of the time inspections were conducted. At least nineteen inspections were conducted below Pond J27-RC since 2000. Seep water observed at J27-RC-S1 ranged from non-flowing pools to 2.00 gpm, and ranged from non-flowing pools to 3.0 gpm at J27-RC-S2. Ten water samples have been collected at J27-RC-S1, and four water samples have been collected at J27-RC-S2.

Summary data provided in Tables 3 and 4 show that only one of the ten samples collected at J27-RC-S1 had elevated levels of TDS and sulfate above the L&W water quality standards. A review of naturally-occurring water quality from various sources within the Black Mesa leasehold provided in Appendix 1 indicate high levels of TDS and sulfate do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. No other samples collected at J27-RC-S1 had water quality parameter concentrations that were above or outside of the range of water quality standards. All of the four samples collected at J27-RC-S2 met water quality standards. Because J27-RC is a proposed permanent impoundment, PWCC believes a variance should be considered by the NNEPA for the elevated TDS and sulfate levels measured at seep monitoring site J27-RC-S1 until a pending application for OSM termination of jurisdiction for the reclaimed areas above Pond J27-RC is approved.

Pond N6-C

Pond N6-C is a temporary sediment pond located on an un-named tributary to Moenkopi Wash. This pond provides treatment of disturbed area runoff from a small portion of reclaimed mining area within its largely undisturbed watershed. This temporary sediment pond is eligible for removal under OSM rules and under the USEPA effluent limitation guidelines at 40 CFR Part 434 for Subpart H - Western Alkaline Coal Mining. One seep monitoring site has been established downstream of the pond, designated N6-C-S1. Summary data provided in Tables 1 and 2 indicate seep water observed at this site occurred infrequently during only three of the eleven inspections conducted below Pond N6-C through 2007. When seep water was found, the flow rate was estimated at a trace. One water sample has been collected.

Data provided in Table 3 and 4 shows that the one sample collected at N6-C-S1 in 2007 exhibited concentrations of both TDS and sulfate above the L&W standards. PWCC has initiated modeling work in support of an application to the OSM and USEPA to remove the embankment at Pond N6-C that will be submitted during the second quarter of 2008. Upon approval of the application, PWCC plans to remove the embankment during the latter portion of 2008. Removing the embankment should eliminate the seep as runoff will no longer be impounded to provide a source of water for the seep monitored at N6-C-S1.

Pond N6-F

Pond N6-F is a temporary sediment pond located on an un-named tributary to Moenkopi Wash. This pond provides treatment of disturbed area runoff from a relatively small reclaimed mining area. This temporary sediment pond is eligible for removal under OSM rules and under the USEPA effluent limitation guidelines at 40 CFR Part 434 for Subpart H - Western Alkaline Coal Mining. One seep monitoring site has been established downstream of the pond, designated N6-F-S1. Summary data provided in Tables 1 and 2 indicate seep water observed at this site occurred frequently during eighteen of the thirty-eight inspections conducted below Pond N6-F. When seep water was found, the flow rate ranged from non-flowing pools to 5.6 gpm. Fourteen water samples have been collected at N6-F-S1.

Data in Tables 3 and 4 show that pH values were commonly well below the pH range set for the standard. Three analyses for aluminum yielded concentrations several orders of magnitude higher than the L&W and Aquatic Habitat standards for this constituent. Samples collected at N6-F-S1 in 2000 and in 2007 exhibited concentrations of both TDS and sulfate above the L&W standards. PWCC has initiated modeling work in support of an application to the OSM and USEPA to remove the embankment at Pond N6-F that will be submitted during the second quarter of 2008. Upon approval of the application, PWCC plans to remove the embankment during the latter portion of 2008. Removing the embankment should eliminate the seep as runoff will no longer be impounded to provide a source of water for the seep monitored at N6-F-S1.

Pond N14-B

Pond N14-B is a temporary sediment pond located on an un-named tributary to Moenkopi Wash. This pond will continue to provide treatment of disturbed area runoff from a coal conveyor transfer station associated with the Kayenta Mine for many years. Three seep monitoring sites have been established downstream of the pond, designated N14-B-S1, N14-B-S1A, and N14-B-S2. Summary data provided in Tables 1 and 2 indicate seep water observed at sites N14-B-S1 and N14-B-S2 occurred frequently during inspections conducted below Pond N14-B through 2007. Flow rates observed at N14-B-S1 ranged from non-flowing pools to 2.0 gpm, and flow rates observed at N14-B-S2 ranged from non-flowing pools to 3.0 gpm. No flowing water is ever observed at site N14-B-S1A. Eleven water samples were collected at N14-B-S1, three water samples were collected at N14-B-S1A, and seven water samples were collected at N14-B-S2.

Summary data provided in Tables 3 and 4 shows that four of the eleven samples collected at N14-B-S1 exhibited concentrations of sulfate above the L&W standard, and five of the eleven samples collected at N14-B-S1 exhibited concentrations of TDS above the L&W standard. One sample collected at N14-B-S1 yielded an aluminum concentration just slightly above the chronic Aquatic Habitat standard, but well below the acute Aquatic habitat standard and the L&W standard for this constituent. The mercury analysis for one of the two 1999 samples collected at N14-B-S1 was detected at the minimum detection limit for this trace element (0.2 ug/l) and reported with a B qualifier rendering this result as only semi-quantitative. PWCC believes this result is inconclusive with regard to seep water below Pond N14-B meeting the Wildlife and Chronic Aquatic standards for mercury of 0.012 ug/l. One pH value measured in 1999 at N14-B-S1 was slightly below the pH range set for the standard. Two of the seven samples collected at N14-B-S2 exhibited concentrations of both TDS and sulfate above the L&W standards. All samples collected at site N14-B-S1A met the water quality standards. A review of naturally-occurring water quality from various sources within the Black Mesa leasehold provided in Appendix 1 indicate high levels of aluminum, TDS and sulfate do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. Because mining operations at the Kayenta Mine are ongoing, Pond N14-B will remain in place. PWCC believes a variance should be considered by the NNEPA for the elevated aluminum, TDS and sulfate levels measured at seep monitoring site N14-B-S1, and for the elevated levels of TDS and sulfate measured at seep monitoring site N14-B-S2.

Pond N14-F

Pond N14-F is a large MSHA impoundment located on an un-named tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from reclaimed mined lands. PWCC proposes to leave the pond as a permanent impoundment for providing a source of water for livestock watering by the Navajo Nation. The mined lands that drain into Pond N14-F have been reclaimed for more than 5 years, and will soon be eligible for final bond release under OSM rules. PWCC is planning to apply for final bond release for these areas sometime in 2011. Once OSM approves final bond release, Pond N14-F will be a permanent structure for providing livestock drinking water in the N14 area for the Navajo Nation, and will be eligible for removal from the NPDES permit. One seep monitoring location was established in 2003 downstream of the pond, designated N14-F-S1. Summary data provided in Tables 1 and 2 for N14-F-S1 shows that seep water at this location was only observed once at a rate of 1.5 gpm during fifty-four inspections conducted below the embankment for the purposes of seepage monitoring and for checking the integrity of this large MSHA embankment. One water quality sample was collected from the flowing seep at N14-F-S1.

Data in Table 3 and 4 shows that analyses for TDS and sulfate in the one sample collected at N14-F-S1 were above the L&W standards. No other water quality parameters were analyzed at levels above or outside of the range of water quality standards. A review of naturally-occurring water quality from various sources within the Black Mesa leasehold provided in Appendix 1 indicate high levels of TDS and sulfate do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. Because Pond N14-F is proposed as a permanent impoundment for the Navajo Nation, PWCC believes a variance should be considered by the NNEPA for the elevated TDS and sulfate levels measured at seep monitoring site N14-F-S1 until final bond release for the reclaimed areas above the pond is granted by OSM.

Pond N14-H

Pond N14-H is a large MSHA impoundment located on an un-named tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from reclaimed mined lands. PWCC proposes to leave the pond as a permanent impoundment for providing a source of water for livestock watering by the Navajo Nation. The mined lands that drain into Pond N14-H have been reclaimed for more than 5 years, and will soon be eligible for final bond release under OSM rules. PWCC is planning to apply for final bond release for these areas sometime in 2011. Once OSM approves final bond release, Pond N14-H will be a permanent structure for providing livestock drinking water in the N14 area for the Navajo Nation, and will be eligible for removal from the NPDES permit. One seep monitoring location was established in 2003 downstream of the pond, designated N14-H-S1. Summary data provided in Tables 1 and 2 for N14-H-S1 shows that seep water at this location was only observed twice at rates of 0.25-2.5 gpm during fifty-five inspections conducted below the embankment for the purposes of seepage monitoring and for checking the integrity of this large MSHA embankment. One water quality sample was collected from the flowing seep at N14-H-S1.

Summary data in Tables 3 and 4 shows that analyses for sulfate in the one sample collected at N14-H-S1 was above the L&W standard. No other water quality parameters were analyzed at levels above or outside of the range of water quality standards. A review of naturally-occurring water quality from various sources within the Black Mesa leasehold as provided in Appendix 1 indicate high levels of sulfate do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. Because Pond N14-H is proposed as a permanent impoundment for the Navajo Nation, PWCC believes a variance should be considered by the NNEPA for the elevated sulfate level measured at seep monitoring site N14-H-S1 until final bond release for the reclaimed areas above the pond is granted by OSM.

Pond N14-P

Pond N14-P is a temporary sediment pond located on an un-named tributary to Moenkopi Wash. This pond provides treatment of disturbed area runoff from a coal conveyor transfer station associated with the Kayenta Mine. One seep monitoring site was established downstream of the pond in 2005, designated N14-P-S1. Summary data provided in Tables 1 and 2 indicate seep water at site N14-P-S1 was observed only twice during the five inspections conducted in 2005, and no seep water was found at this site during the eight inspections conducted in 2006 and 2007. Seep water observed at N14-P-S1 in 2005 was observed twice at very low rates of 0.1-0.2 gpm. One water sample was collected from N14-P-S1 when the seep was flowing.

Data in Tables 3 and 4 shows that the sample collected at N14-P-S1 exhibited concentrations of TDS and sulfate above the L&W standards. The sample collected in 2005 at N14-P-S1 also yielded aluminum concentrations above the L&W and both chronic and acute Aquatic Habitat standards for this constituent, and a low pH (5.3 S.U.) below the pH standard range. The 2005 sample also yielded a cadmium value greater than the hardness-based Aquatic Habitat standard for this parameter. The cadmium value was reported with a B qualifier, and PWCC considers this analytical result to be semi-quantitative and inconclusive with respect to whether the seep below Pond N14-P-S1 met the cadmium Aquatic Habitat standard. A review of naturally-occurring water quality from various sources within the Black Mesa leasehold provided in Appendix 1 indicate high levels of aluminum, TDS and sulfate do occur at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. Because mining operations at the Kayenta Mine are ongoing, Pond N14-P will remain in place. PWCC believes a variance should be considered by the NNEPA for the elevated aluminum, TDS and sulfate levels measured at seep monitoring site N14-P-S1. Due to the low rate and infrequent occurrence of seep water at N14-P-S1, PWCC does not believe pH is a problem. However, PWCC proposes to continue seep inspections and monitoring below Pond N14-P since the seep was found relatively recently.

Pond WW-9

Pond WW-9 is a temporary sediment pond located on an un-named tributary to Yucca Flat Wash, which is tributary to Moenkopi Wash, and provides treatment of disturbed area runoff from a production well facility and occasional discharges from the production well for maintenance purposes. One seep monitoring site has been established downstream of the pond, designated WW-9-S1. Summary data provided in Tables 1 and 2 indicate seep water observed at this site occurred during twelve of the twenty-nine inspections conducted below Pond WW-9 through 2007. Seep water rates at this site have ranged from non-flowing pools to 5.20 gpm. Eight water samples have been collected from flowing water at seep monitoring site WW-9-S1.

Data in Tables 3 and 4 shows that seven of the eight samples collected at WW-9-S1 have met water quality standards. One of the two samples collected in 2007 exhibited concentrations of

TDS and sulfate above the L&W standards, and an aluminum concentration above the L&W and chronic Aquatic Habitat standards for this constituent. Since Pond WW-9 will remain in place for the foreseeable future, PWCC believes a variance should be considered by the NNEPA for the elevated aluminum, TDS and sulfate levels measured recently at WW-9-S1.

SUMMARY REMARKS

The discussions are based on eight years of inspections, flow measurements, and water quality data collected as part of monitoring activities conducted below NPDES ponds in accordance with the Seepage Management Plan. The evaluations of seep water quality collected from 1999 through 2007 at seep monitoring sites indicate analytical results for a few trace metals including cadmium, chromium, copper, and mercury were above the water quality standards, but in all cases, the results were reported by the laboratory with B qualifiers that render the results as semi-quantitative. PWCC considers the results to be inconclusive with respect to meeting water quality standards. Since few detections of each element were found, PWCC does not believe any of the seeps below the NPDES ponds on Black Mesa exhibit problematic concentrations of cadmium, chromium, copper and mercury. High chloride levels have been found at seeps below Ponds J3-D, J7-A, and J27-A, and PWCC believes these occurrences are related to local geology and climate, as several of the values are similar to concentrations measured in naturally-occurring water quality in a few sources monitored within the Black Mesa leasehold. Chloride is a standard established for L&W only, and PWCC maintains future runoff events in the vicinity of those few seeps that showed high chloride levels will provide dilution of chloride and eventually reduce the concentration. Many ponds have seeps that have shown elevated levels of aluminum, TDS and sulfate. PWCC has provided information in this interim final report to demonstrate that naturally-occurring water quality from various sources within the Black Mesa leasehold commonly exhibit high levels of aluminum, TDS and sulfate at either similar or greater concentrations than the standards set for these by the Navajo Nation EPA. PWCC believes it is appropriate to seek variances for those seep monitoring sites that show levels above the standards set for these constituents. Treatment of seep water that features aluminum, TDS and sulfate values higher than the NNEPA standards but well within concentrations typically exhibited by naturally-occurring waters within the Black Mesa leasehold will likely not be effective considering these constituents are ubiquitous in the natural environment on Black Mesa.

Low pH values have been measured consistently at seep monitoring sites below Ponds BM-A1, J16-E, and N6-F, and PWCC has developed specific plans to address the low pH seeps below these three ponds. Infrequently, pH values have been measured at sites below a few other ponds slightly below the pH standard range, such as at J2-A, J3-E, J7-DAM, N14-B, and N14-P. The infrequent and typically slight excursions of the pH standard range a these sites are not considered to be problematic, although the one recent occurrence at the infrequent seepage below N14-P warrants further monitoring as proposed.

PWCC has investigated several options for eliminating seeps below NPDES ponds on Black Mesa above and beyond those management activities that are presently included in the Seepage Management Plan and implemented at select locations, including installing liners and passive treatment systems. In addition, PWCC has evaluated whether some of the NPDES ponds that are proposed as permanent can be replaced with other temporary ponds. Installing pond liners may create more problematic compliance conditions such as continuous discharges. Passive treatment systems may have merit for large and persistent seepage areas, but these are not prevalent below most of the NPDES ponds that have shown high levels of aluminum, TDS, and sulfate. Replacing permanent ponds with other ponds may not be feasible in many locations, as these ponds were originally proposed and agreed upon with the Navajo Nation in consideration of their desires for distributing post-mining water sources across the leasehold, and replacement sources in the vicinity may not be available.

PWCC has proposed specific plans in this interim final report to move forward managing seeps below the ponds at the Black Mesa Complex. In the near term, PWCC plans to seek approval from the USACOE, USEPA, and NNEPA for an existing and functional passive treatment system below Pond J7-DAM, and for installing a passive treatment system below Pond BM-A1. In addition, PWCC plans to remove the embankment and eliminate Ponds J7-CD, N6-C, N6-F, and J16-E during 2008, and another pond J7-A in 2011 under both OSM and USEPA rules as mentioned in the report. Pond J27-RC may soon be eligible for removal from the NPDES permit once OSM grants approval for an application for terminating jurisdiction that is pending for the reclaimed area above the pond, and both Ponds N14-F and N14-H may soon be eligible for removal from the NPDES permit once OSM grants approval for a final bond release application PWCC plans to submit in 2011.

Besides the specific management and regulatory proposals presented in this interim final report, PWCC also maintains existing management activities that have been proposed or implemented at select locations in prior years still have merit. PWCC will continue to dewater ponds to reduce the source of water to downstream seeps as practicable and fence areas below ponds to prevent livestock access. PWCC believes placing rock riprap over a small area at seeps that occur infrequently and as small pools or very low discharges is an appropriate seep management practice, and will also consider planting vegetation as a passive treatment system for large seeping areas below ponds that may develop in the future below existing and new NPDES ponds. PWCC proposes to monitor at the most downstream locations of the passive treatment systems planned below Pond BM-A1 and the existing vegetation treatment system below Pond J7-DAM. In addition, PWCC believes there is merit in continuing seep monitoring below some ponds, including Pond N14-P. However, PWCC maintains information presented in this report justifies discontinuing monitoring activities at other ponds, such as Ponds J2-A and J16-E, because monitoring has shown few problems with the seeps meeting water quality standards. PWCC will pursue discontinued monitoring below ponds that are either proposed as permanent or are temporary and will remain in place for the foreseeable future if variances for aluminum, TDS and sulfate are approved by the NNEPA. PWCC is prepared to revise the Seep Management Plan to reflect the proposals presented in this report upon approval by the USEPA and NNEPA.

REFERENCES

PWCC (Peabody Western Coal Company), 1986. "Chapter 17, Protection of the Hydrologic Balance" Volume 11, Mining and Reclamation Plan – Black Mesa and Kayenta Mines.

NNEPA (Navajo Nation Environmental Protection Agency), 1994-2004. "Navajo Nation Surface Water Quality Standards." Navajo Nation Environmental Protection Agency, Water Quality program, Window Rock, Arizona. [This document may be viewed at: http://www.navajonationepa.org]

Interim Final Report - Seepage Monitoring and Management Report

April 1, 2008

Tables 1-4

Table 1

Summary of Seepage Inspections and Monitoring Results, 1999-2000

Pond Site ID	Seep Site ID	1999				2000			
		# Insp's	# Observed Flows	Range of Flows	# WQ Samples	# Insp's	# Observed Flows	Range of Flows	# WQ Samples
BM-A1	-S1	4	2	0.1-0.4	3	4	2	0.1-2.3	3
	-S2	---	---	---	---	5	4	0.1-0.2	3
	-SP1	1	1	0.5	1	3	2	0.1-2.2	2
J2-A	-S1	2	0	---	0	2	0	---	0
J3-D	-S1	2	0	---	0	2	0	---	0
	-S2	1	1	0.05	1	2	0	---	0
J3-E	-S1	2	1	0.1	1	2	0	P	2
	-S2	1	1	0.1	1	2	0	---	0
J7-A	-S1	2	2	0.16	1	3	1	0.24	1
J7-CD	-S1	---	---	---	---	---	---	---	---
J7-DAM	-S1	2	1	0.1	1	2	1	P, <0.1	2
	-S1A	1	1	0.04	1	2	1	P, 0.02	2
	-S2	2	0	---	0	1	0	---	0
	-S3	1	1	0.32	1	1	0	---	0
	-S3A	---	---	---	---	2	2	0.1	2
	-S5	2	2	0.43-5.3	2	2	2	3.96-4.23	2
J7-JR	-S1	---	---	---	---	---	---	---	---
J16-A	-S1	3	2	0.07-0.15	2	11	3	Tr-0.1	1
J16-E	-S1	3	1	1	1	6	3	0.02-0.25	1
	-S2	---	---	---	---	---	---	---	---
J16-L	-CMP	---	---	---	---	---	---	---	---
J19-D	-S1	---	---	---	---	---	---	---	---
J21-C	-CMP	---	---	---	---	---	---	---	---
J27-A	-S1	2	0	P	1	2	0	P	1
	-S2	2	2	1.1	1	3	2	P, 0.5	2
J27-B	-S1	1	0	---	0	Monitoring site replaced by J27-RC			
J27-RC	-S1	3	0	P	1	3	0	P	2
	-S2	3	2	1.0	1	2	1	0.1	1
N6-C	-S1	---	---	---	---	4	0	---	0
N6-F	-S1	4	0	P	2	2	0	P	1
N14-B	-S1	5	5	Tr-0.68	4	5	2	Tr-0.026	1
	-S1A	---	---	---	---	---	---	---	---
	-S2	3	3	0.04-1.16	2	5	2	0.04-0.38	0
N14-F	-S1	---	---	---	---	---	---	---	---
N14-H	-S1	---	---	---	---	---	---	---	---
N14-P	-S1	---	---	---	---	---	---	---	---
WW-9	-S1	2	0	---	0	2	0	---	0

Notes:

P Non-flowing sample collected from hand-dug cistern or pool.

Tr Flow rate is a trickle, or less than 0.01 gpm

All flow values are in gallons per minute (GPM)

(rev. 4/1/08)

Table 1 (cont.)

Summary of Seepage Inspections and Monitoring Results, 2001-2002

Pond Site ID	Seep Site ID	2001				2002			
		# Insp's	# Observed Flows	Range of Flows	# WQ Samples	# Insp's	# Observed Flows	Range of Flows	# WQ Samples
BM-A1	-S1	2	0	P	2	2	1	P-0.63	2
	-S2	2	0	P	1	2	1	<0.1	1
	-SP1	2	0	---	0	2	1	1.06	1
J2-A	-S1	1	0	---	0	1	0	---	0
J3-D	-S1	1	0	---	0	1	0	---	0
	-S2	1	0	---	0	1	1	0.013	1
J3-E	-S1	1	0	P	1	1	1	0.9	1
	-S2	1	0	---	0	1	0	---	0
J7-A	-S1	1	0	---	0	1	0	P	1
J7-CD	-S1	---	---	---	---	1	1	0.01	1
J7-DAM	-S1	2	1	P, <0.1	2	2	1	P, <0.1	2
	-S1A	2	2	0.01-0.03	2	2	1	P, <0.1	2
	-S2	Not Inspected in 2001				1	0	---	0
	-S3					1	0	---	0
	-S3A	2	2	< 0.1	2	2	2	< 0.1	2
	-S5	2	2	1.6-2.64	2	2	2	3.6-10.8	2
J7-JR	-S1	---	---	---	---	---	---	---	---
J16-A	-S1	2	2	0.25-0.3	2	2	2	0.08-0.33	2
J16-E	-S1	Not Inspected in 2001				1	1	0.25	0
	-S2					Not inspected in 2002			
J16-L	-CMP	---	---	---	---	---	---	---	---
J19-D	-S1	---	---	---	---	---	---	---	---
J21-C	-CMP	---	---	---	---	---	---	---	---
J27-A	-S1	1	0	---	0	1	0	P	1
	-S2	1	0	---	0	1	0	---	0
J27-B	-S1	Monitoring site replaced by J27-RC				Monitoring site replaced by J27-RC			
J27-RC	-S1	1	0	P	1	1	0	P	1
	-S2	1	0	---	0	1	0	---	0
N6-C	-S1	Not inspected in 2001				1	0	P	0
N6-F	-S1	2	0	---	0	2	1	4.04	1
N14-B	-S1	1	1	0.01	1	1	1	0.2	1
	-S1A	---	---	---	---	---	---	---	---
	-S2	1	0	---	0	1	0	---	0
N14-F	-S1	---	---	---	---	---	---	---	---
N14-H	-S1	---	---	---	---	---	---	---	---
N14-P	-S1	---	---	---	---	---	---	---	---
WW-9	-S1	1	0	---	0	1	1	3.0	1

Notes:

P Non-flowing sample collected from hand-dug cistern or pool.

Tr Flow rate is a trickle, or less than 0.01 gpm

All flow values are in gallons per minute (GPM)

(rev. 4/1/08)

Table 1 (cont.)

Summary of Seepage Inspections and Monitoring Results, 2003-2004

Pond Site ID	Seep Site ID	2003 # Insp's	2003 # Observed Flows	2003 Range of Flows	2003 # WQ Samples	2004 # Insp's	2004 # Observed Flows	2004 Range of Flows	2004 # WQ Samples
BM-A1	-S1	2	1	P, 3.2	2	2	2	0.08-1.4	2
	-S2	1	1	0.46	1	2	1	1.2	1
	-SP1	1	1	5.2	1	Not inspected in 2004			
J2-A	-S1	1	1	15.6	1	2	0	---	0
J3-D	-S1	1	0	---	0	1	0	---	0
	-S2	1	1	0.26	1	1	0	P	1
J3-E	-S1	1	0	P	1	2	1	< 0.1	1
	-S2	1	0	---	0	1	1	0.5	1
J7-A	-S1	1	1	2.7	1	3	3	2.3	2
J7-CD	-S1	1	1	1.3	1	2	1	0.1	1
J7-DAM	-S1	2	0	P	2	3	1	0.1	2
	-S1A	2	0	P	2	3	2	0.45	1
	-S2	1	0	---	0	Not inspected in 2004			
	-S3	1	0	---	0	3	0	P	2
	-S3A	2	2	< 0.1	2	2	2	< 0.1	2
	-S5	2	2	1.66-3.28	2	3	3	3.8-5.0	2
J7-JR	-S1	1	0	P	1	21	1	P	1
J16-A	-S1	1	1	0.5	0	16	7	Tr-0.3	2
J16-E	-S1	1	1	0.23	1	9	7	1.0	0
	-S2	1	1	0.05	1	12	2	0.1	0
J16-L	-CMP	14	0	---	0	13	0	---	0
J19-D	-S1	---	---	---	---	---	---	---	---
J21-C	-CMP	---	---	---	---	2	2	Tr	1
J27-A	-S1	1	1	5.3	1	2	1	7.5	1
	-S2	Not inspected in 2003				Not inspected in 2004			
J27-B	-S1	Monitoring site replaced by J27-RC				Monitoring site replaced by J27-RC			
J27-RC	-S1	1	0	P	1	3	2	2.0	1
	-S2	1	0	---	0	2	1	3.0	1
N6-C	-S1	Not inspected in 2003				Not inspected in 2004			
N6-F	-S1	2	2	0.19-5.6	2	5	5	0.2-3.0	2
N14-B	-S1	1	1	2.0	0	5	3	0.1	0
	-S1A	---	---	---	---	4	0	P	2
	-S2	1	1	3.0	0	4	3	0.5	2
N14-F	-S1	1	1	1.5	1	15	0	---	0
N14-H	-S1	1	1	2.5	1	16	0	---	0
N14-P	-S1	---	---	---	---	---	---	---	---
WW-9	-S1	1	1	5.2	1	1	0	---	0

Notes:

P Non-flowing sample collected from hand-dug cistern or pool.

Tr Flow rate is a trickle, or less than 0.01 gpm

All flow values are in gallons per minute (GPM)

(rev. 4/1/08)

Table 1 (cont.)

Summary of Seepage Inspections and Monitoring Results, 2005-2006

Pond Site ID	Seep Site ID	2005 # Insp's	2005 # Observed Flows	2005 Range of Flows	2005 # WQ Samples	2006 # Insp's	2006 # Observed Flows	2006 Range of Flows	2006 # WQ Samples
BM-A1	-S1	2	2	0.5-0.9	2	2	2	0.1-0.8	2
	-S2	2	2	0.13	2	3	1	P, < 0.1	2
	-SP1	2	1	0.9	1	2	1	1.0	0
J2-A	-S1	5	0	---	0	4	0	---	0
J3-D	-S1	5	2	0.2	1	3	1	< 0.1	0
	-S2	4	2	0.04	1	3	1	0.1	1
J3-E	-S1	6	6	1.9	1	1	1	0.16	1
	-S2	6	6	< 0.01	1	1	1	0.16	1
J7-A	-S1	2	2	0.8-1.1	2	1	1	0.5	1
J7-CD	-S1	8	2	0.5	1	4	2	0.5-0.8	2
J7-DAM	-S1	2	2	1.5-3.0	2	2	2	0.04-0.8	2
	-S1A	3	3	0.01-0.25	2	2	2	< 0.1	0
	-S2	Not inspected in 2005				Not inspected in 2006			
	-S3	2	0	P	2	2	0	P	1
	-S3A	2	2	0.25-0.34	2	2	2	Tr-0.1	2
	-S5	2	2	3.0-5.0	2	2	2	0.3-5.3	2
J7-JR	-S1	13	0	P	2	13	12	P, Tr	2
J16-A	-S1	14	9	0.25	2	13	8	Tr-0.8	3
J16-E	-S1	6	0	---	0	12	3	Tr	0
	-S2	11	0	---	0	12	0	---	0
J16-L	-CMP	13	0	---	0	13	0	---	0
J19-D	-S1	5	4	2.5	2	4	2	Tr-0.1	1
J21-C	-CMP	7	2	Tr	1	9	7	0.1-0.5	2
J27-A	-S1	7	6	< 0.1	1	1	1	1.6	1
	-S2	1	1	1.5	1	1	1	3.7	1
J27-B	-S1	Monitoring site replaced by J27-RC				Monitoring site replaced by J27-RC			
J27-RC	-S1	5	0	P	1	1	0	P	1
	-S2	6	6	0.5	1	2	0	0	0
N6-C	-S1	Not inspected in 2005				Not inspected in 2006			
N6-F	-S1	5	4	1.5	2	9	3	Tr-0.13	2
N14-B	-S1	4	4	<0.1-1.5	1	4	1	0.5	0
	-S1A	3	0	P	0	4	0	P	1
	-S2	4	4	0.01-2.1	1	4	2	0.75-3.0	1
N14-F	-S1	12	0	---	0	13	0	---	0
N14-H	-S1	12	0	---	0	13	0	---	0
N14-P	-S1	5	2	0.2	1	4	0	---	0
WW-9	-S1	6	4	Tr-1.0	1	9	3	0.05-2.5	3

Notes:

P — Non-flowing sample collected from hand-dug cistern or pool.

Tr — Flow rate is a trickle, or less than 0.01 gpm

All flow values are in gallons per minute (GPM)

(rev. 4/1/08)

Table 1 (cont.)

Summary of Seepage Inspections and Monitoring Results, 2007-2008

Pond Site ID	Seep Site ID	2007 # Insp's	2007 # Observed Flows	2007 Range of Flows	2007 # WQ Samples	2008 # Insp's	2008 # Observed Flows	2008 Range of Flows	2008 # WQ Samples
BM-A1	-S1	2	2	0.26-0.3	2				
	-S2	2	0	---	0				
	-SP1	3	1	0.11	0				
J2-A	-S1	4	0	---	0				
J3-D	-S1	3	1	P, 1.5	2				
	-S2	3	1	P, 0.63	2				
J3-E	-S1	1	1	0.63	1				
	-S2	1	1	0.63	0				
J7-A	-S1	2	2	tr-0.24	1				
J7-CD	-S1	6	1	0.03	1				
J7-DAM	-S1	2	2	tr	1				
	-S1A	2	1	0.02	1				
	-S2	Not inspected in 2007							
	-S3	2	0	P	2				
	-S3A	3	3	tr-0.35	2				
	-S5	4	4	0.25-7.9	2				
J7-JR	-S1	14	0	P	1				
J16-A	-S1	14	2	P	2				
J16-E	-S1	13	1	0.5	0				
	-S2	13	0	---	0				
J16-L	-CMP	12	0	---	0				
J19-D	-S1	5	1	P, 0.08	1				
J21-C	-CMP	7	3	0.1-0.3	3				
J27-A	-S1	1	1	0.17	1				
	-S2	1	1	1.06	1				
J27-B	-S1	Monitoring site replaced by J27-RC				Monitoring site replaced by J27-RC			
J27-RC	-S1	1	0	P	1				
	-S2	1	0	---	0				
N6-C	-S1	6	3	tr	1				
N6-F	-S1	7	3	P, 0.53	2				
N14-B	-S1	4	2	tr-0.73	1				
	-S1A	4	0	P	0				
	-S2	4	2	0.2-1.03	1				
N14-F	-S1	13	0	---	0				
N14-H	-S1	13	0	---	0				
N14-P	-S1	4	0	---	0				
WW-9	-S1	6	3	0.5-1.32	2				

Notes:

P Non-flowing sample collected from hand-dug cistern or pool.

Tr Flow rate is a trickle, or less than 0.01 gpm

All flow values are in gallons per minute (GPM)

(rev. 4/1/08)

Table 2

Site Conditions at Monitored Seeps, 1999-2007

Seep Site ID	Number of Occurrences				Range of Flows (gpm)	Occurrences of Available Surface Water	Total Number of Inspections	Number of Water Quality Samples
	Flowing	Pooled	Wet/Damp	Dry				
BM-A1-S1	14	6	2		0.03-3.2	20	22	20
BM-A1-S2	10	4	5		Tr-1.2	14	19	11
BM-A1-SP1	8		3	1	0.1-5.2	8	12	6
J2-A-S1	1		1	20	15.6	1	22	1
J3-D-S1	4	1	2	12	Tr-1.5	5	19	3
J3-D-S2	7	2	1	7	0.04-0.63	9	17	7
J3-E-S1	12	4	1		Tr-1.9	16	17	10
J3-E-S2	10			5	Tr-0.63	10	15	4
J7-A-S1	12	1	2	1	Tr-2.7	13	16	10
J7-CD-S1	8		3	11	0.01-1.3	8	22	7
J7-DAM-S1	11	7	1		Tr-3.0	18	19	16
J7-DAM-S1A	13	4	2		Tr-0.45	17	19	13
J7-DAM-S2				4	---	0	4	0
J7-DAM-S3	1	8	1	3	0.32	9	13	8
J7-DAM-S3A	17				Tr-0.35	17	17	16
J7-DAM-S5	21				0.25-10.8	21	21	18
J7-JR-S1	3	34	23	2	Tr	37	62	7
J16-A-S1	35	5	31	5	Tr-0.5	40	76	16
J16-E-S1	17		32	2	Tr-1.0	17	51	3
J16-E-S2	3		15	31	Tr-0.1	3	49	1
J16-L-CMP			6	59	no flow	0	65	0
J19-D-S1	7	2	4	1	Tr-2.5	9	14	4
J21-C-CMP	14	1	1	8	Tr-0.5	15	24	7
J27-A-S1	10	4	3	1	Tr-7.5	14	18	8
J27-A-S2	7	1	2	12	0.1-3.7	8	22	6
J27-B-S1				1	removed	0	1	0
J27-RC-S1	2	17			1.0-2.0	19	19	10
J27-RC-S2	10		3	6	0.1-3.0	10	19	4
N6-C-S1	3	1	1	6	Tr	4	11	1
N6-F-S1	18	6	7	7	Tr-5.6	24	38	14
N14-B-S1	20	3	7		Tr-2.0	23	30	11
N14-B-S1A		8	5	2	no flow	8	15	3
N14-B-S2	17			10	0.01-3.0	17	27	7
N14-F-S1	1		7	46	1.5	1	54	1
N14-H-S1	2		9	44	0.25-2.5	2	55	1
N14-P-S1	2		2	9	0.1-0.2	2	13	1
WW-9-S1	12		10	7	Tr-5.2	12	29	8

Notes:

04/01/2008

---	site is no longer monitored
no flow	site does not flow
removed	pond removed...monitoring site replaced by J27-RC
Tr	flow rate is a trickle, or less than 0.01 gpm

Table 3

Summary of Exceedences of NNEPA Livestock, Wildlife, Secondary Human Contact and Aquatic Water Standards at PWCC NPDES Impoundment Seeps, 1999-2007

Seep Site ID	1999	2000	2001	2002	2003	2004	2005	2006	2007
BM-A1-S1	Al (13.6) 1/1 NO3 (111) 1/2 pH (4.72-5.21) 3/3 TDS (5180) 1/1 SO4 (2930) 1/1	NO3 (101) 1/2 pH (4.54-5.20) 3/3	pH (5.27-5.51) 2/2	pH (4.33-5.48) 2/2	pH (4.43-4.52) 2/2	Al (13.4) 1/1 NO3 (103) 1/2 pH (4.70-5.00) 2/2 TDS (4390-4810) 2/2 SO4 (2820) 1/1	pH (4.86-5.18) 2/2	pH (4.62-5.10) 2/2	Al (2.2) 1/1 pH (4.69) 1/2 TDS (4380) 1/1 SO4 (2300) 1/1
BM-A1-S2		Al (13.8-18.5) 2/2 Cd (5) 1/2 pH (3.22-3.45) 3/3 TDS (4010-4730) 3/3 SO4 (2580-3040) 2/2	NO3 (118) 1/1 pH (6.14) 1/1	pH (3.36) 1/1	pH (3.21) 1/1	pH (4.36) 1/1 TDS (4070) 1/1	pH (3.42-4.25) 2/2	pH (3.11-4.27) 2/2	
BM-A1-SP1		NO3 (113) 1/1					Al (7.8) 1/1 NO3 (166) 1/1 TDS (6240) 1/1 SO4 (3380) 1/1		
J2-A-S1					pH (6.49) 1/1				
J3-D-S1									Cl (1420) 1/2 Hg (0.2) 1/2 TDS (2700-4410) 2/2 SO4 (1370) 1/1
J3-D-S2							Cl (1400) 1/1 TDS (3910) 1/1		Al (0.56) 1/1 Cl (1880) 1/1 TDS (4630) 1/1
J3-E-S1		pH (5.98) 1/2			pH (6.42) 1/1		TDS (2700) 1/1 SO4 (1320) 1/1		TDS (2590) 1/1 SO4 (1300) 1/1
J3-E-S2								Al (0.11) 1/1	
J7-A-S1	Cd (3) 1/1 Cl (870) 1/1 TDS (5940) 1/1 SO4 (3030) 1/1								Cl (990) 1/1 TDS (6040) 1/1 SO4 (2700) 1/1
J7-CD-S1				Al (0.5) 1/1 Cr (30) 1/1 TDS (2440) 1/1 SO4 (1470) 1/1			Al (0.53) 1/1		Al (0.38) 1/1
J7-DAM-S1						TDS (3030) 1/1			TDS (2940) 1/1 SO4 (1360) 1/1
J7-DAM-S1A							Al (1.7) 1/1 TDS (5940) 1/1 SO4 (3440) 1/1		
J7-DAM-S3						TDS (2860) 1/1			TDS (2270) 1/1 SO4 (1020) 1/1
J7-DAM-S3A		pH (6.46) 1/2	pH (6.46) 1/2			TDS (3780) 1/1			TDS (4650) 1/1 SO4 (2200) 1/1
J7-DAM-S5	Hg (0.2) 1/1 TDS (3420) 1/1 SO4 (1680) 1/1	TDS (3520) 1/1 SO4 (1920) 1/1		TDS (2810) 1/1 SO4 (1540) 1/1		TDS (3640) 1/1			TDS (4020) 1/1 SO4 (1960) 1/1
J7-JR-S1					TDS (3440) 1/1 SO4 (2010) 1/1	Al (0.80) 1/1 Cu (50) 1/1 TDS (6490) 1/1 SO4 (3620) 1/1	TDS (6150) 1/1 SO4 (3590) 1/1	TDS (4270) 1/1 SO4 (2210) 1/1	Al (2.5) 1/1 TDS (4950) 1/1 SO4 (2800) 1/1

Table 3 (cont.)

Summary of Exceedences of NNEPA Livestock, Wildlife, Secondary Human Contact and Aquatic Water Standards at PWCC NPDES Impoundment Seeps, 1999-2007

Seep Site ID	1999	2000	2001	2002	2003	2004	2005	2006	2007
J16-A-S1	TDS (3330-3990) 2/2 SO4 (1940-2280) 2/2			Cu (30) 1/2 TDS (2310-2670) 2/2 SO4 (1490) 1/1					TDS (2910) 1/1 SO4 (1350) 1/1
J16-E-S2					Al (36.8) 1/1 pH (4.20) 1/1 TDS (8330) 1/1 SO4 (4820) 1/1				
J16-L-CMP									
J19-D-S1							TDS (6590) 1/1 SO4 (3950) 1/1	Hg (0.2) 1/1 TDS (6030) 1/1 SO4 (3550) 1/1	TDS (7340) 1/1 SO4 (4380) 1/1
J21-C-CMP									Al (1.37-2.36) 2/2
J27-A-S1									
J27-A-S2									Cl (750) 1/1
J27-B-S1									
J27-RC-S1									TDS (5870) 1/1 SO4 (3400) 1/1
J27-RC-S2									
N6-C-S1									TDS (5650) 1/1 SO4 (3380) 1/1
N6-F-S1	Al (154) 1/1 pH (4.10-4.28) 2/2 TDS (7270) 1/1 SO4 (5200) 1/1	pH (4.46) 1/1		pH (4.08) 1/1	pH (4.03-4.09) 2/2	pH (3.58-3.91) 2/2	pH (3.89-4.18) 2/2	pH (4.22-4.53) 2/2	Al (121-125) 2/2 pH (3.6-4.1) 2/2 TDS (5480-5540) 2/2 SO4 (3880-3900) 2/2
N14-B-S1	Hg (0.2) 1/2 pH (6.42) 1/4 TDS (3910-4210) 2/2 SO4 (2390-2720) 2/2		TDS (4310) 1/1	TDS (4370) 1/1 SO4 (2780) 1/1					Al (0.09) 1/1 TDS (2850) 1/1 SO4 (1640) 1/1
N14-B-S1A									
N14-B-S2	TDS (4470) 1/1 SO4 (2880) 1/1								TDS (3700) 1/1 SO4 (2100) 1/1
N14-F-S1					TDS (8890) 1/1 SO4 (5600) 1/1				
N14-H-S1					SO4 (1190) 1/1				
N14-P-S1							Al (6.8) 1/1 Cd (11) 1/1 pH (5.3) 1/1 TDS (5600) 1/1 SO4 (4030) 1/1		
WW-9-S1									Al (0.63) 1/2 TDS (7190) 1/2 SO4 (4400) 1/2

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Macro-constituents Al, Cl, NO3, TDS and SO4 are given in mg/l. Trace metals Cd, Cr and Hg are given in ug/l. pH is given in standard units.

Table 4

Summary of Exceedences of NNEPA Livestock, Wildlife, Secondary HC and Aquatic Water Standards at PWCC Impoundment Seeps, 1999-2007

Seep Site ID	Aluminum (mg/l)	Cadmium (ug/l)	Chloride (mg/l)	Chromium (ug/l)	Copper (ug/l)	Mercury (ug/l)	Nitrate (mg/l)	pH (S.U.)	Sulfate (mg/l)	TDS (mg/l)	Year of last exceedance
BM-A1-S1	2.2-13.6						101-111	4.33-5.51	2300-2930	4380-5180	2007 (Al,pH,TDS,SO4)
BM-A1-S2	13.8-18.5	5					118	3.11-6.14	2580-3040	4010-4730	2006 (pH)
BM-A1-SP1	1.9-7.8						113-166		3000-3380	5320-6240	2005 (all)
J2-A-S1								6.49			2003 (pH)
J3-D-S1			1420			0.2			1370	2700-4410	2007 (all)
J3-D-S2	0.56		1400-1880							3910-4630	2007 (Al,Cl,TDS)
J3-E-S1								5.98-6.42	1300-1320	2590-2700	2007 (TDS,SO4)
J3-E-S2	0.11										2006 (Al)
J7-A-S1		3	870-990						2700-3030	5940-6040	2007 (Cl,TDS,SO4)
J7-CD-S1	0.38-0.53			30					1470	2440	2007 (Al)
J7-DAM-S1										2940-3030	2007 (TDS)
J7-DAM-S1A	0.13-1.7								1360-3440	5940	2005 (TDS,SO4)
J7-DAM-S2											---
J7-DAM-S3									1020	2270-2860	2007 (TDS,SO4)
J7-DAM-S3A								6.46	2200	3780-4650	2007 (TDS,SO4)
J7-DAM-S5	0.1					0.2			1540-1960	2810-4020	2007 (TDS,SO4)
J7-JR-S1	0.8-2.5				50				2010-3620	3440-6490	2007 (Al,TDS,SO4)
J16-A-S1	0.3				30				1350-2280	2310-3990	2007 (TDS,SO4)
J16-E-S2	36.8							4.20-4.30	4820	8330	2003 (all)
J19-D-S1	0.2					0.2			3550-4380	6030-7340	2007 (Hg,TDS,SO4)
J21-C-CMP	1.37-2.36										2007 (Al)
J27-A-S1											---
J27-A-S2			750							2710	2007 (Cl,TDS)
J27-RC-S1									3400	5870	2007 (TDS,SO4)
J27-RC-S2											---
N6-C-S1									3380	5650	2007 (TDS,SO4)
N6-F-S1	121-154							3.58-4.53	3880-5200	5480-7270	2007 (all)
N14-B-S1	0.09-0.3					0.2		6.42	1640-2880	2850-4500	2007 (Al,TDS,SO4)
N14-B-S1A											---
N14-B-S2									2100-2880	3700-4470	2007 (TDS,SO4)
N14-F-S1									5600	8890	2003 (TDS,SO4)
N14-H-S1									1190		2003 (SO4)
N14-P-S1	6.8	11						5.3	4030	5600	2005 (all)
WW-9-S1	0.63								4400	7190	2007 (Al,TDS,SO4)

Standards

	Aluminum	Cadmium	Chloride	Chromium	Copper	Mercury	Nitrate	pH	Sulfate	TDS	
Livestock	0.5	50	600	1000	500	10	100	6.5-9.0	1000	2212	
Wildlife	NCNS	NCNS	NCNS	NCNS	NCNS	0.012	NCNS	NCNS	NCNS	NCNS	
Secondary HC	NCNS	700	NCNS	100	1300	420	2240000	6.5-9.0	NCNS	NCNS	
Acute Aquatic	0.75	Acute-Cd	NCNS	16	Acute-Cu	2.4	NCNS	6.5-9.0	NCNS	NCNS	
Chronic Aquatic	0.087	Chronic-Cd	NCNS	11	Chronic-Cu	0.012	NCNS	6.5-9.0	NCNS	NCNS	

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Source for livestock, wildlife, acute & chronic aquatic and partial-body standards is Navajo Nation Surface Water Quality Standards (2004).

Acute and Chronic standards are derived from complex equations utilizing lab-determined hardness values, and are not given here. Refer to NNEPA (2004, p.38) for these eqn's.

NCNS No current numeric standard

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Appendix 1

Summary of Analytical Results, 1986-2007
Storm Runoff

PWCC SITE ID	14	15	16	18	25	26	34	35	37	50	78	85	155	157	Applicable Water Use Standards NNEPA ScHC	L&W	AqHbtA	AqHbtC
Aluminum, Total	0.07-1090	15.4-1480	0.72-1270	0.95-1950	0.07-1640	0.7-1650	7.91-2460	40.6-586	15.1-1440	157-1660	3.34-1360	468	0.74-1380	14-976	NNS	0.5T	0.75	0.087
Aluminum, Diss.	<0.05-0.26	<0.05-0.14	<0.05-0.24	<0.05-0.19	<0.03-0.37	<0.03, 0.16-0.72	<0.03-0.45	0.82	<0.05-0.29	<0.05-0.19	<0.03-0.05	<0.05-0.24	<0.05	0.05-0.21	NNS	0.5T	0.75	0.087
Chloride	2-53	2-42	1-29	3-93	3-105	4-261	2-55	1-9	5-2850	3-50	6-52	3	2-54	<1-7	NNS	600	NNS	NNS
Sulfate	10-381	43-1550	10-1268	40-3132	70-4880	50-2700	30-2118	30-356	30-6660	33-1190	110-2320	29	20-680	20-298	NNS	1000	NNS	NNS
TDS	80-664	136-2490	100-1988	140-4230	200-7750	190-3635	122-3094	84-740	170-10170	72-2070	250-3350	114	94-1150	50-520	NNS	2212	NNS	NNS

Explanation

All constituents are given in mg/l

mg/l -- milligrams/liter
Diss. -- Dissolved concentration
TDS -- Total Dissolved solids
TSS -- Total Suspended Solids
NNS -- No Numeric Standard exists for this parameter.
NNEPA -- Navajo Nation Environmental Protection Agency, Surface Water Quality Standards (2004)

T -- Total concentration
< -- Concentration is less than MDL, but MDL may be higher than standard

ScHC Secondary Human Contact
L&W Livestock and Wildlife Watering
AqHbtA Aquatic Habitat, Acute
AqHbtC Aquatic Habitat, Chronic
nd Not detected at or above laboratory MDL
36 Concentration exceedes one or more applicable standards.

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Summary of Analytical Results, 1986-2007
Stream Baseflows

PWCC SITE ID	15	16	18	25	26	37 [a]	50	78	155	2A [b]	80R [b]	Applicable Water Use Standards NNEPA ScHC	L&W	AqHbtA	AqHbtC
Aluminum, Total	5.69-26	0.11-0.26	<0.03-0.61	<0.02-2.73	<0.03-0.25	0.55	129	<0.09-40	0.07-2.76	0.07-0.6	<0.2-0.4	NNS	0.5T	0.75	0.087
Aluminum, Diss.	<0.03-<0.05	<0.05	<0.03-<0.25	<0.03-<0.06	<0.03-<0.2	0.06	<0.05	<0.05	<0.03-0.07	---	---	NNS	0.5T	0.75	0.087
Chloride	48-55	6-22	35-158	30-59	43-140	360	18	45-62	22-49	145-214	88-118	NNS	600	NNS	NNS
Sulfate	2700-2976	471-2030	2854-5980	1990-3250	1720-4100	11980	364	2060-2550	712-2511	2850-4450	2390-2830	NNS	1000	NNS	NNS
TDS	3910-4460	852-3100	4518-9500	3160-5150	3010-6990	18464	668	3230-4100	1348-3878	5040-7070	4420-4990	NNS	2212	NNS	NNS

Explanation

All constituents are given in mg/l

mg/l -- milligrams/liter
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TDS -- Total Dissolved solids
TSS -- Total Suspended Solids
NNS -- No Numeric Standard exists for this parameter.
NNEPA -- Navajo Nation Environmental Protection Agency, Surface Water Quality Standards (2004)

ScHC Secondary Human Contact
L&W Livestock and Wildlife Watering
AqHbtA Aquatic Habitat, Acute
AqHbtC Aquatic Habitat, Chronic
nd Not detected at or above laboratory MDL
36 Concentration exceedes one or more applicable standards.

T -- Total concentration
< -- Concentration is less than MDL, but MDL may be higher than standard

[a] Sample of 5/24/94 was biased high for all major cations and anions due to dissolution of surficial salt crusts in vicinity of stream station.
[b] Temporary streamflow monitoring site.

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Summary of Analytical Results, 1986-2007
Springs

PWCC SITE ID	NSPG22	NSPG91	NSPG92	NSPG97 [a]	NSPG111	NSPG140	NSPG147	NSPG148	NSPG149	NSPG162	NSPG191	SSPG151	Goat Spring #2	Hogan Spring	Applicable Water Use Standards NNEPA ScHC	L&W	AqHbtA	AqHbtC
Aluminum, Total	0.06-0.5	0.03-7.58	0.07-2.02	—	<0.03-4.8	0.08-0.78	0.05-0.8	<0.2	<0.03	0.5-74.8	0.05-1.67	0.09-0.15	<0.03-<0.2	0.5-0.51	NNS	0.5T	0.75	0.087
Aluminum, Diss.	---	0.05-0.07	<0.03-<0.05	<0.5-<1	<0.05-<0.2	<0.03-0.09	0.07-0.12	—	---	69.3	—	—	<0.2	<0.2	NNS	0.5T	0.75	0.087
Chloride	44-58	6-36	12-123	60-89	41-187	18-126	51-250	57	42	293-900	14-35	47-173	64-75	55-98	NNS	600	NNS	NNS
Sulfate	4800-5650	669-2120	591-3730	3884-4375	3993-6651	986-6481	3780-9210	2430	180	8000-14800	510-810	4850-8960	3660-3730	2970-5100	NNS	1000	NNS	NNS
TDS	8410-9200	1156-3024	1018-6140	6652-7020	5470-8300	1554-9280	7460-13406	4390	560	11400-23300	940-1390	7050-14200	5350-5870	4380-8100	NNS	2212	NNS	NNS

Explanation

All constituents are given in mg/l

mg/l -- milligrams/liter
Diss. -- Dissolved concentration
TDS -- Total Dissolved solids
TSS -- Total Suspended Solids
NNS -- No Numeric Standard exists for this parameter.
NNEPA -- Navajo Nation Environmental Protection Agency, Surface Water Quality Standards (2004)

ScHC Secondary Human Contact
L&W Livestock and Wildlife Watering
AqHbtA Aquatic Habitat, Acute
AqHbtC Aquatic Habitat, Chronic
nd Not detected at or above laboratory MDL
36 Concentration exceedes one or more applicable standards.

T -- Total concentration
< -- Concentration is less than MDL, but MDL may be higher than standard

[a] Spring 97 has been mined-out.

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Summary of Analytical Results, 1986-2007
Alluvial Wells -- Unaffected

PWCC SITE ID	13/13R	29	31R	33R	68	69	71	72	73	76	76R/77	79/79R	87	93	Applicable Water Use Standards NNEPA ScHC	L&W	AqHbtA	AqHbtC
Aluminum, Diss.	<0.05-<0.5	<0.05-<0.5	<0.05-0.06	<0.03-<0.2	<0.05	<0.03-0.06	<0.03	<0.03-0.16	<0.03-0.07	<0.05	<0.03-0.08	<0.05	<0.03-0.05	<0.03-0.06	NNS	0.5T	0.75	0.087
Chloride	26-55	96-820	19-69	35-57	38-47	37-52	35-53	29-72	34-59	4-8	3-10	6-17	5-230	43-240	NNS	600	NNS	NNS
Sulfate	1832-2811	2058-4520	515-3811	3499-4321	3021-2700	1860-2500	2100-2880	2745-3690	2560-4338	364-403	175-294	457-683	340-9410	2120-3280	NNS	1000	NNS	NNS
TDS	2756-4444	3488-8370	1112-5480	5654-6770	2910-4162	2990-3840	3310-4380	4500-5580	4070-6566	794-864	460-765	910-1350	812-15100	3740-5860	NNS	2212	NNS	NNS

Explanation

All constituents are given in mg/l

mg/l -- milligrams/liter
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TDS -- Total Dissolved solids
TSS -- Total Suspended Solids
NNS -- No Numeric Standard exists for this parameter.
NNEPA -- Navajo Nation Environmental Protection Agency, Surface Water Quality Standards (2004)

T -- Total concentration
< -- Concentration is less than MDL, but MDL may be higher than standard

ScHC Secondary Human Contact
L&W Livestock and Wildlife Watering
AqHbtA Aquatic Habitat, Acute
AqHbtC Aquatic Habitat, Chronic
nd Not detected at or above laboratory method detection limit. (MDL)

36 Concentration exceedes one or more applicable standards.

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Summary of Analytical Results, 1986-2007
Alluvial Wells -- Unaffected

PWCC SITE ID	94/95/96	98/98R	99	99R	103R	104/104R	105	106R	107R/168	108/108R	169	110R/170	172	173	Applicable Water Use Standards NNEPA			
															ScHC	L&W	AqHbtA	AqHbtC
Aluminum, Diss.	<0.03-0.05	<0.05-0.12	10.5-22.6	<0.03-1.6	<0.03-<0.5	<0.03-0.56	<0.05-0.11	<0.03-<0.06	<0.03-<0.2	<0.03-0.2	<0.03-0.06	<0.03-0.2	<0.03-0.03	<0.03	NNS	0.5T	0.75	0.087
Chloride	35-104	54-845	97-220	100-311	1-9	8-87	12-73	16-62	31-65	44-86	32-52	32-70	23-76	29-43	NNS	600	NNS	NNS
Sulfate	2181-2881	4070-55443	6626-7071	4857-7615	1300-1733	370-2552	916-4371	760-1385	1700-2444	2390-3005	2031-2890	3293-5800	880-1790	1490-2440	NNS	1000	NNS	NNS
TDS	3652-4740	6730-80688	9154-10440	6408-10826	2336-2760	890-4058	1545-7362	1254-2242	2960-3710	3884-4640	3454-4410	5424-9540	1690-3170	2398-3740	NNS	2212	NNS	NNS

Explanation

All constituents are given in mg/l

mg/l -- milligrams/liter
Diss. -- Dissolved concentration
TDS -- Total Dissolved solids
TSS -- Total Suspended Solids
NNS -- No Numeric Standard exists for this parameter.
NNEPA -- Navajo Nation Environmental Protection Agency, Surface Water Quality Standards (2004)

T -- Total concentration
< -- Concentration is less than MDL, but MDL may be higher than standard

ScHC Secondary Human Contact
L&W Livestock and Wildlife Watering
AqHbtA Aquatic Habitat, Acute
AqHbtC Aquatic Habitat, Chronic
nd Not detected at or above laboratory method detection limit. (MDL)

36 Concentration exceedes one or more applicable standards.

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Summary of Analytical Results, 1986-2007
Wepo Wells -- Unaffected

PWCC SITE ID	38	41	47	47R	51	52	53	58	59	60	61	62R	65	66	67	68	Applicable Water Use Standards NNEPA ScHC	L&W	AqHbtA	AqHbtC
Aluminum, Diss.	<0.05-0.11	<0.03-0.08	<0.03-0.14	<0.03-0.06	<0.03-0.07	<0.03-0.06	<0.05-0.29	<0.03-<0.05	<0.03-1.69	<0.03-0.04	<0.03-1	<0.03-0.11	<0.03-0.15	<0.03-<0.2	<0.03-0.32	<0.03-<0.06	NNS	0.5T	0.75	0.087
Chloride	25-50	29-47	10-14	1-12	14-29	6-12	14-24	6-25	12-19	11-25	5-7	16-41	5-15	17-108	11-17	11-17	NNS	600	NNS	NNS
Sulfate	1743-2002	1282-2000	121-220	170-210	652-1554	45-86	1580-2676	465-675	1010-1200	130-1058	8-66	330-1130	8-148	1700-3050	10-587	260-590	NNS	1000	NNS	NNS
TDS	2866-3398	2390-3200	566-746	600-650	1228-2644	320-440	3450-4400	940-1150	1720-2000	650-2056	446-566	1330-2840	1562-1750	3422-5038	1118-1564	1030-1630	NNS	2212	NNS	NNS

Explanation

All constituents are given in mg/l

mg/l -- milligrams/liter
Diss. -- Dissolved concentration
TDS -- Total Dissolved solids
TSS -- Total Suspended Solids
NNS -- No Numeric Standard exists for this parameter.
NNEPA -- Navajo Nation Environmental Protection Agency, Surface Water Quality Standards (2004)

T -- Total concentration
< -- Concentration is less than MDL, but MDL may be higher than standard

ScHC Secondary Human Contact
L&W Livestock and Wildlife Watering
AqHbtA Aquatic Habitat, Acute
AqHbtC Aquatic Habitat, Chronic
nd Not detected at or above laboratory method detection limit. (MDL)

36 Concentration exceedes one or more applicable standards.

rev. 4/1/08

PEABODY WESTERN

Peabody Western Coal Company

May 8, 2008

Mr. John Tinger
U.S. Environmental Protection Agency
Region IX, CWA Standards and Permits
75 Hawthorne Street
San Francisco, CA 94105

RE: Interim Final Report on the Seepage Management Plan for NPDES Permit No. NN0022179 – Supplemental Information

Enclosed please find supplemental information Peabody Western Coal Company (PWCC) committed to sending you in my April 1, 2008 cover letter to the Interim Final Report for the Seepage Management Plan. The information consists of six captioned photos of representative riparian vegetation. Four photos were taken at proposed permanent impoundments, one photo shows the revegetated area below Pond J7-DAM, and one photo shows volunteer wetland vegetation in the drainage above Pond N10-A1.

Also enclosed are three documents related to selenium uptake by plants and selenium deficiency in livestock within the Black Mesa leasehold. The first document entitled "Site-specific selenium standards for the Black Mesa Mine Complex" includes analyses of selenium concentrations in soil, mine spoil, and reclaimed vegetation available for livestock forage; a study conducted in 1996 to determine selenium levels in livestock blood; and site-specific selenium standards proposed for the Black Mesa Complex. The second document is a memo from Dr. Ben Norman that summarizes his review of the 1996 livestock study on selenium levels. The third document is the Office of Surface Mining's approval package for site-specific selenium standards proposed as permit revisions by PWCC based on the studies provided in the first two documents.

If you have any questions or need additional information please don't hesitate to call me at 928.677.5130, email me at gwendt@peabodyenergy.com, or write to me at the address below at your earliest convenience.

Respectfully,

John Cochran / for

Gary Wendt
Manager Environmental

GWW

Enclosure

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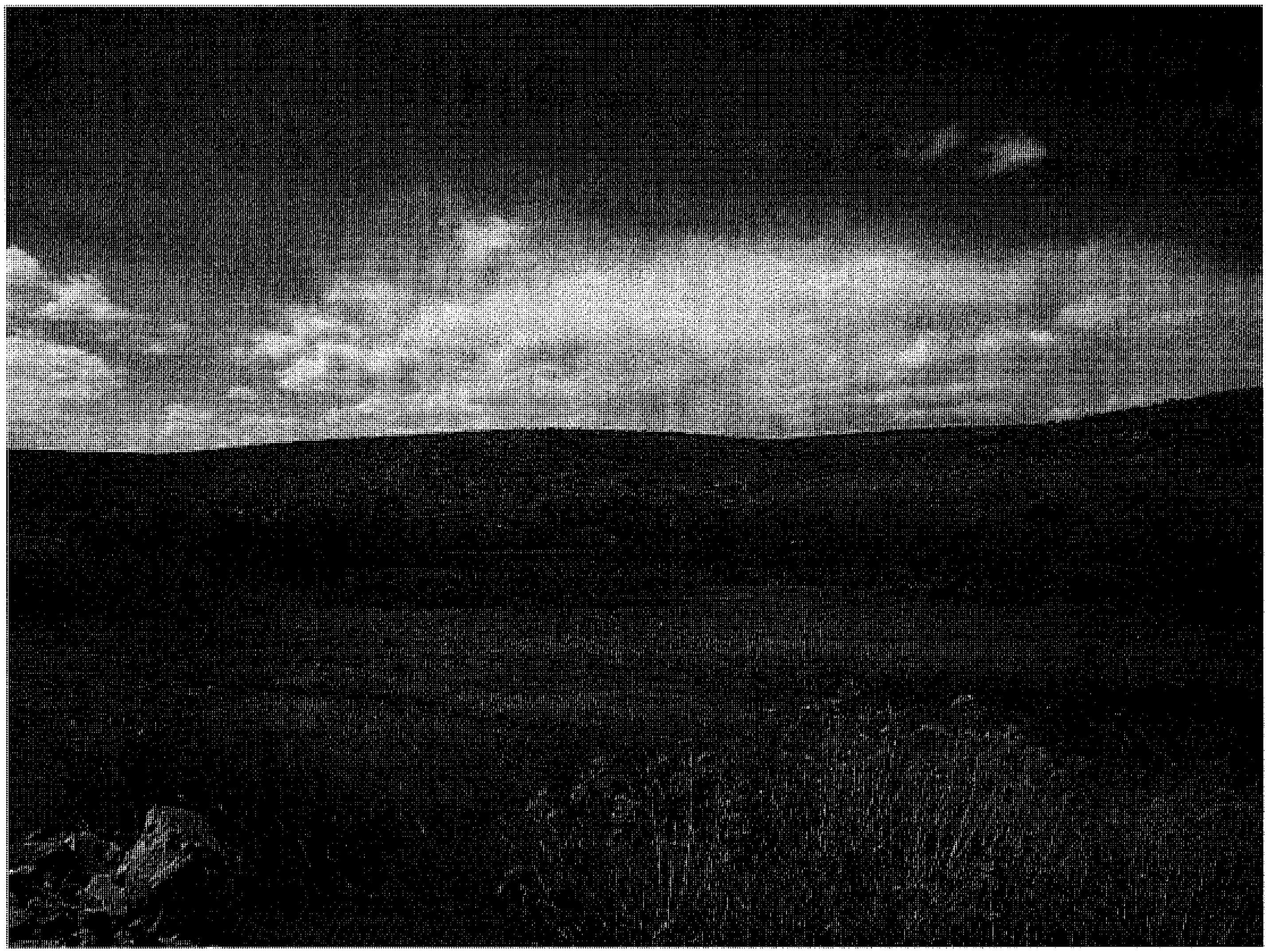
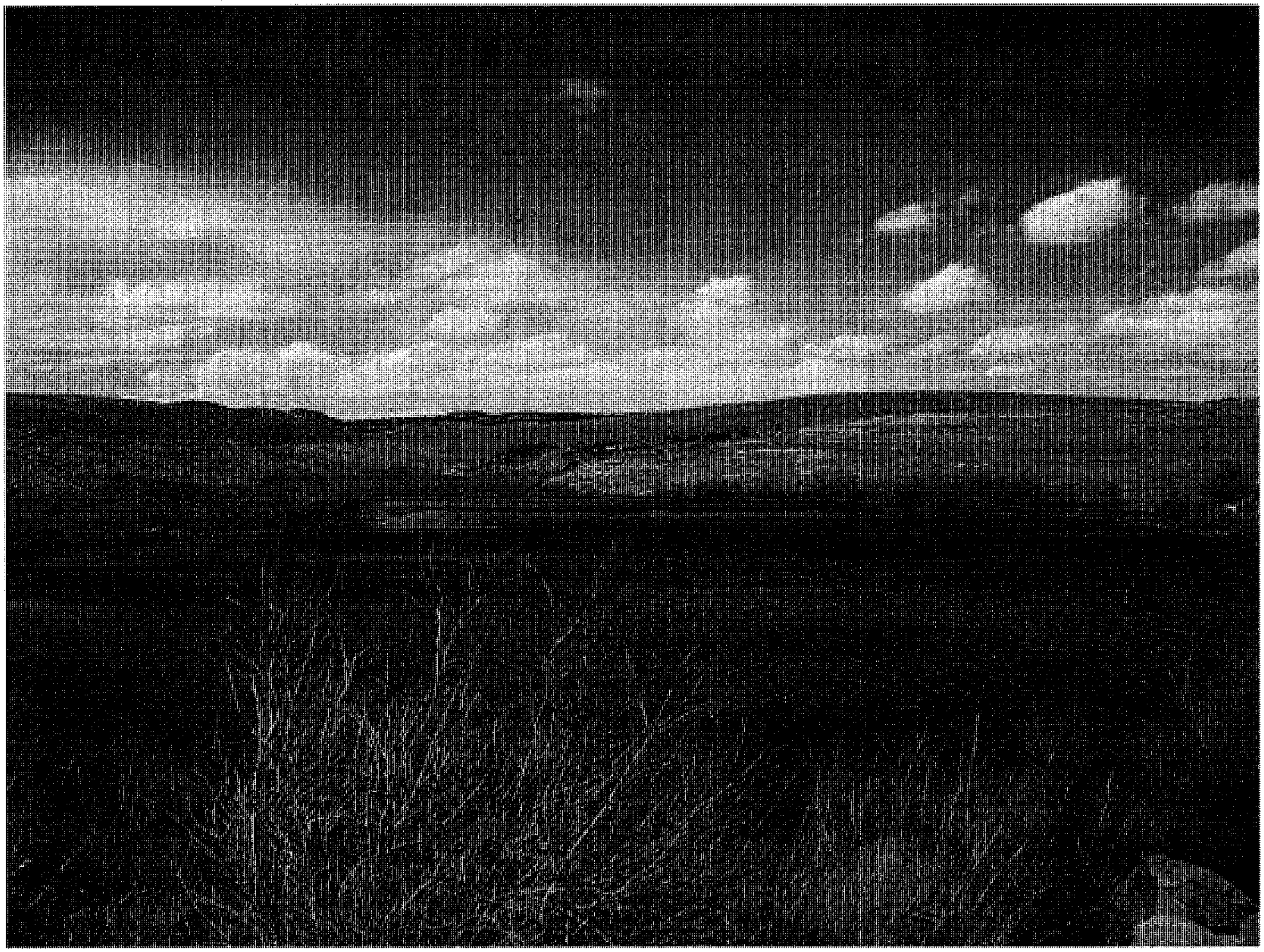
John Cochran (PIC)

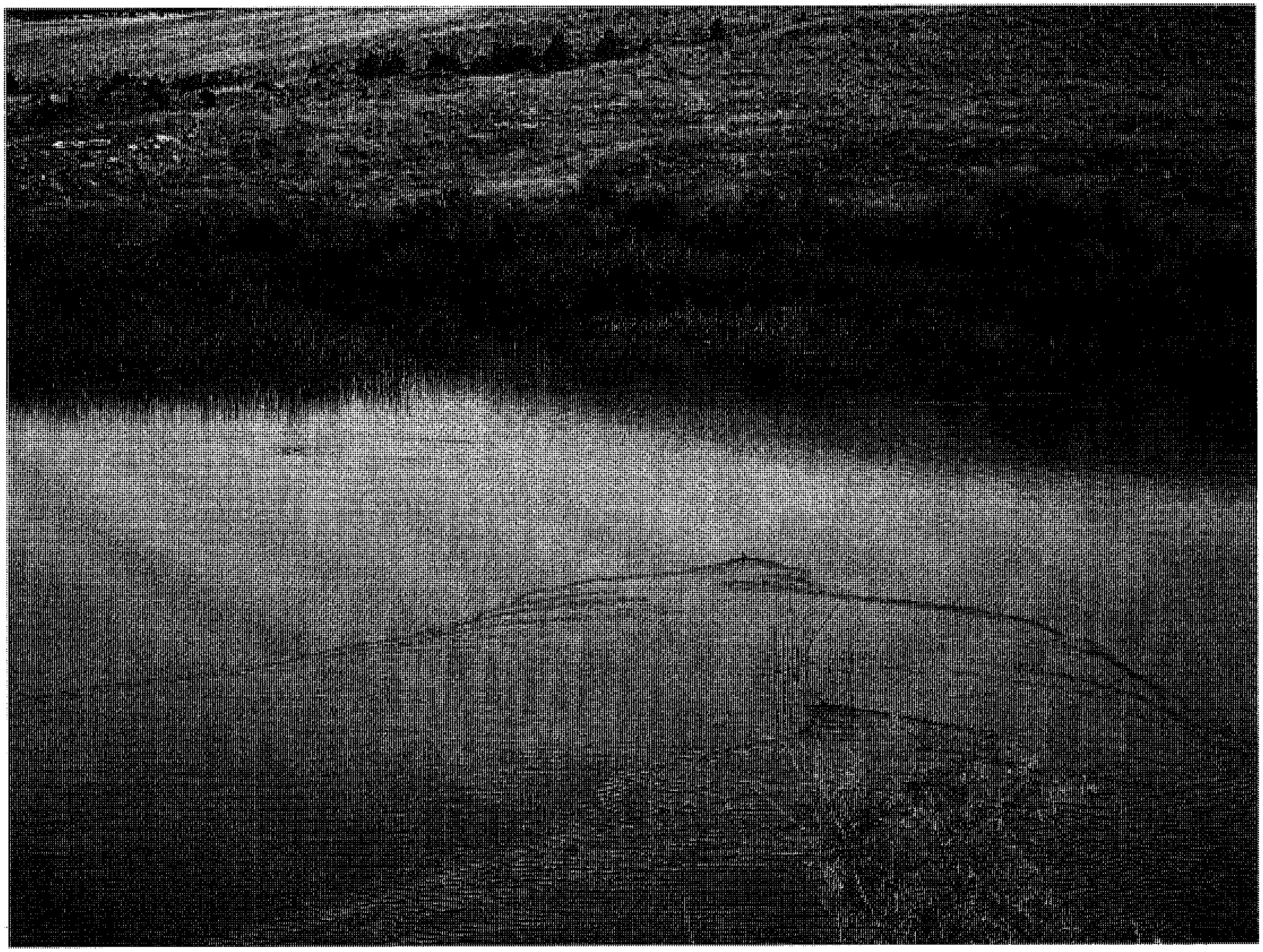
file



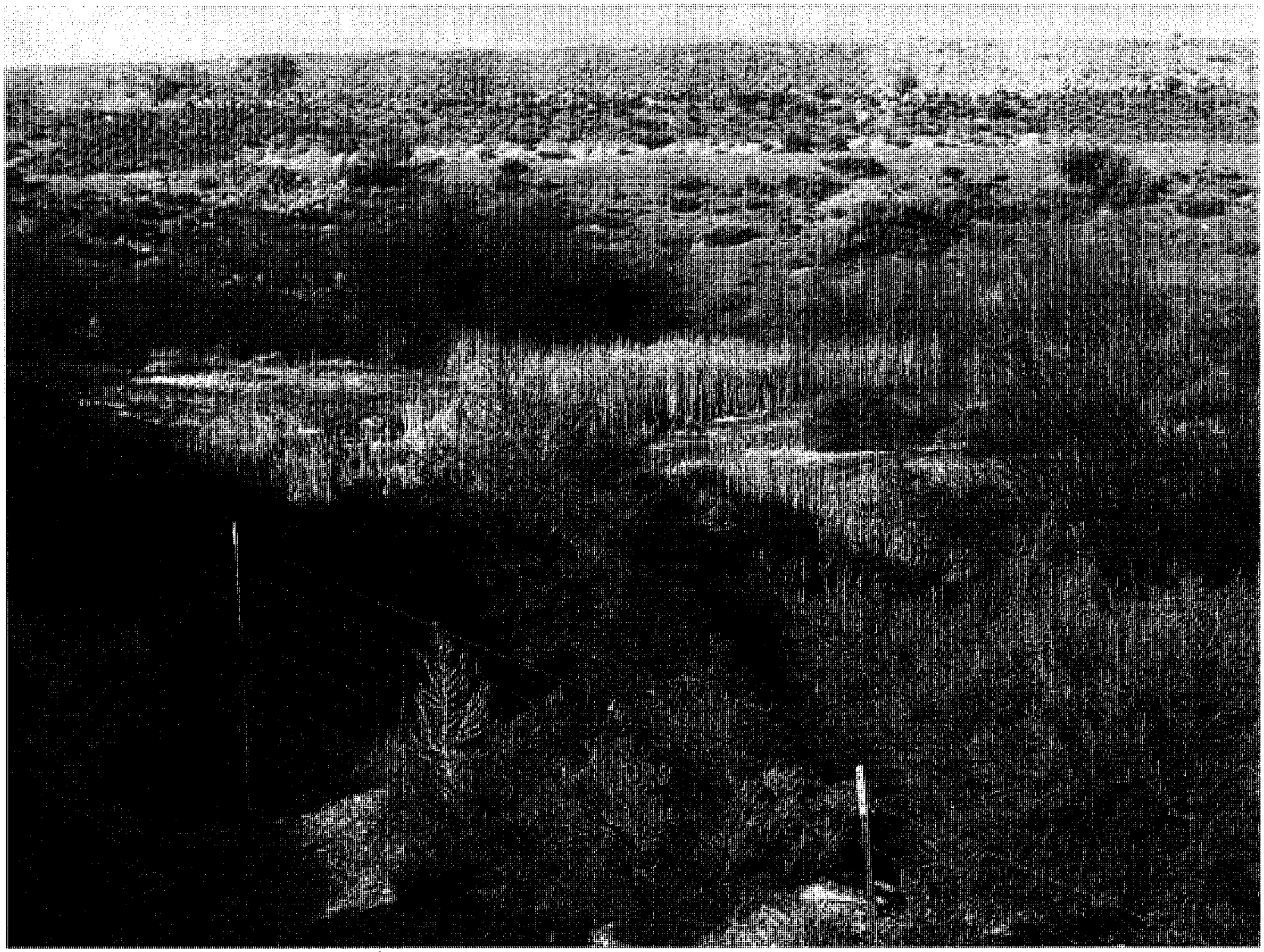
This view of proposed permanent pond N14-F shows an abundance of established wetland vegetation, including cattails and bulrushes. A variety of waterfowl frequent this pond, which features water year-round and provides nesting and foraging habitat.



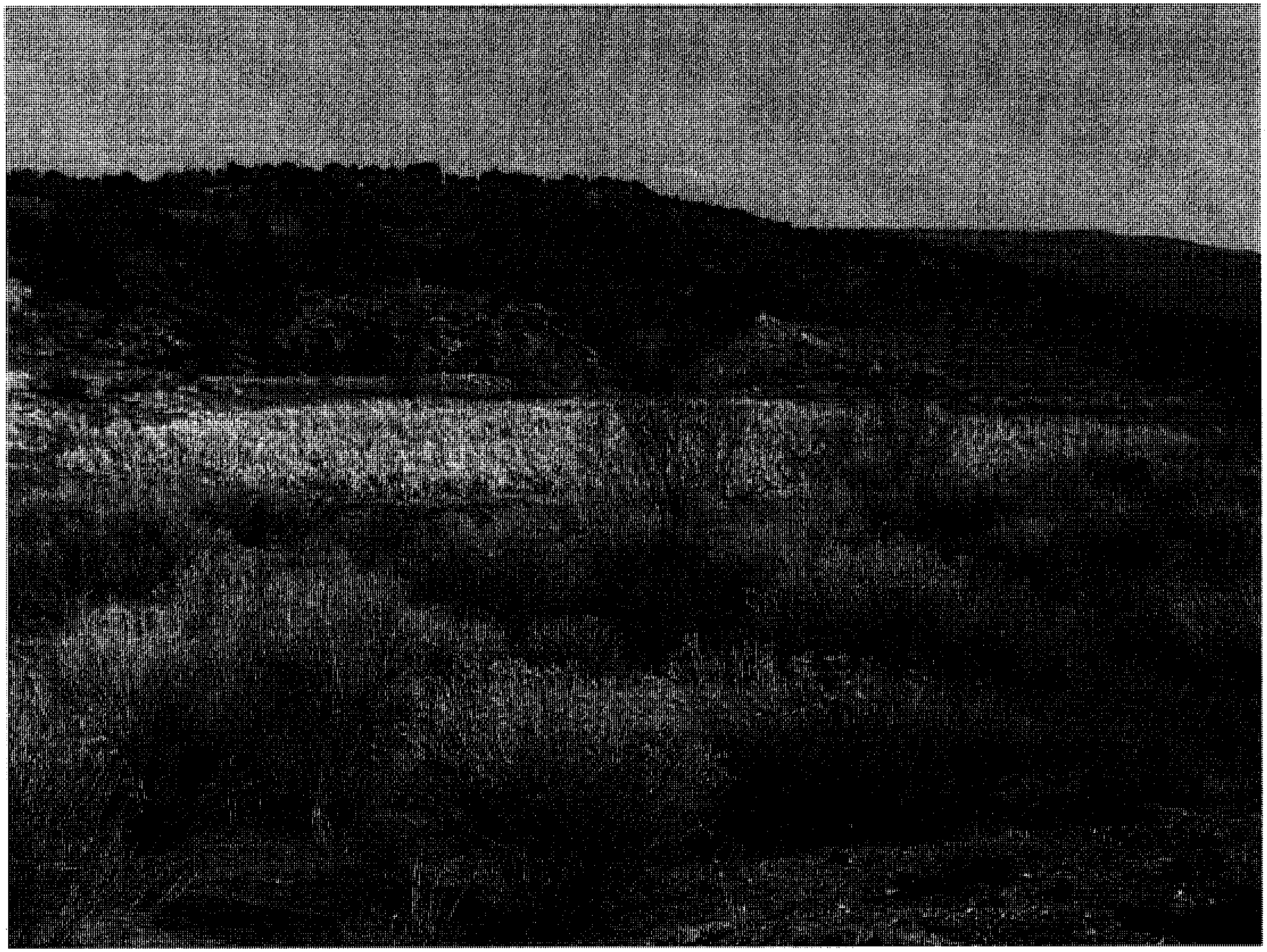
This view of proposed permanent pond N14-G shows the pond at high water in spring. Wetland vegetation includes heavy stands of bulrushes at the upper end of the pond that provide habitat for a variety of waterfowl including ducks, American coot, and great blue heron.



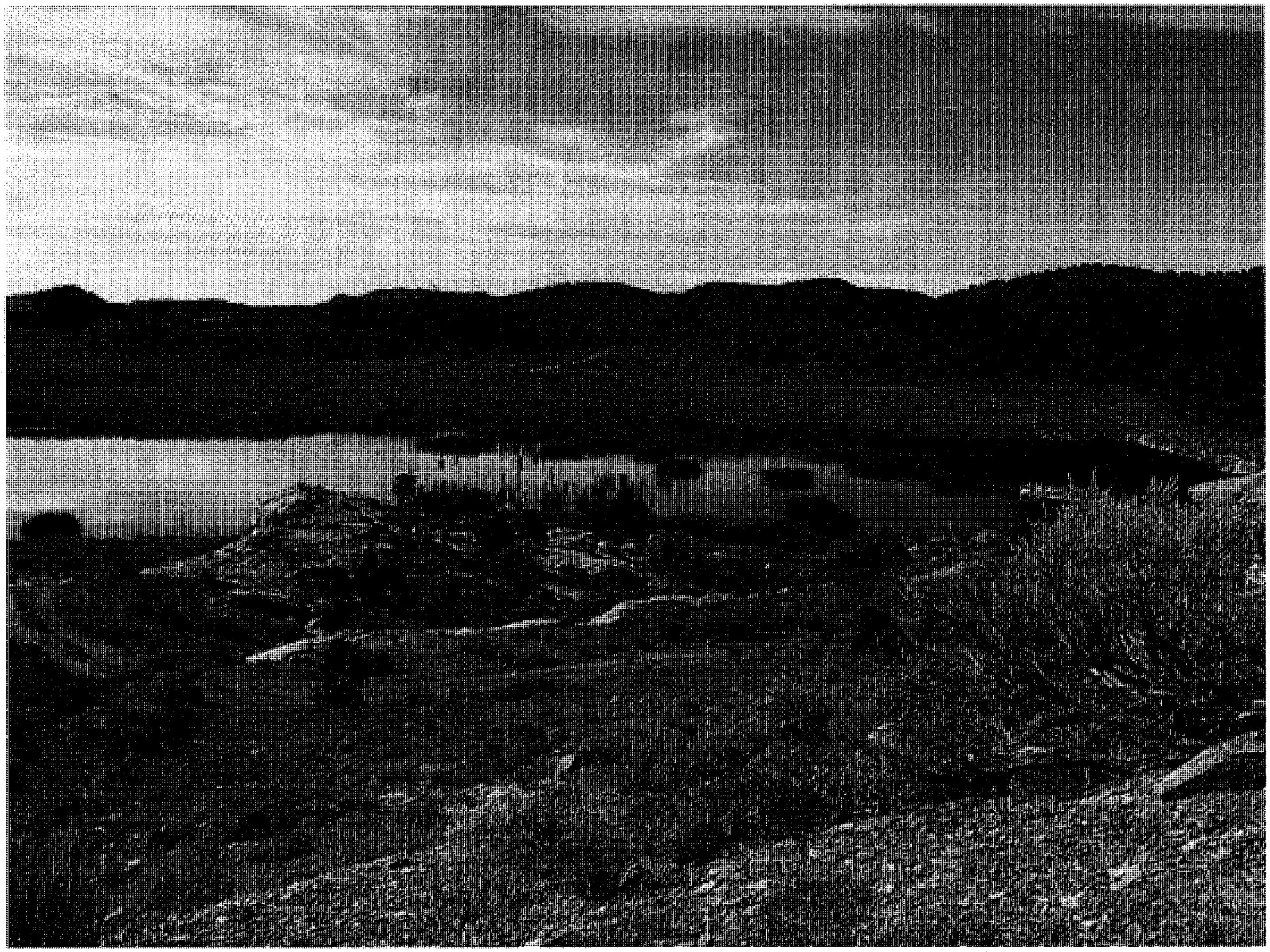
This view of proposed permanent pond N14-G shows well developed wetland habitat later in the summer. American coot shown in this image are especially attracted to the heavy stands of bulrushes and cattails present in the upper end of the pond as a result of persistent year-round water.



This is a view of the fenced wetland vegetation planted below the toe of dam at proposed permanent impoundment J7-DAM. Heavy stands of cattails are evident in the center of the photo. Willows and cottonwoods were planted in this area but have not yet developed sufficient size to be evident in the photo.



This is a view of cattails that have volunteered in the drainage just above pond N10-A. Pond N10-A has persistent water year-round and the zone of cattails has saturated soil conditions allowing for permanent cattail stands. Red-winged black birds commonly inhabit these stands.



This view shows proposed permanent impoundment J16-L looking west. The emergent vegetation in this image is predominantly bulrushes and provides abundant habitat for American coot and a variety of duck species. Great blue heron are common along the pond edges. Egrets and white-faced ibis have also been observed at this and other mine related ponds in the area.

SITE-SPECIFIC SELENIUM STANDARDS FOR THE BLACK MESA MINE COMPLEX

SUBMITTED BY:

Peabody Western Coal Company
Arizona Business Unit
P. O. Box 605
Navajo Route 41
Kayenta, Arizona 86033

SEPTEMBER 1998

REVISED FEBRUARY 1999

SITE-SPECIFIC SELENIUM STANDARDS FOR THE BLACK MESA MINE COMPLEX

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Site-Specific Selenium Standards for the Black Mesa Mine Complex

1.0 Introduction.

Permissible soil and spoil selenium (Se) concentrations in reclaimed mine environments ultimately depend on potential toxic effects in grazing animals. Over the past 15 years, Peabody Western Coal Company (PWCC) has used soil and plant accumulation experiments, epidermiologic data in animals, and regional literature with the specific goal of establishing a Se standard for the Black Mesa Mine Complex (BMMC).

The following soil, spoil, vegetation, and grazing information has been compiled and is being submitted to justify an environmentally acceptable Se threshold level for both the reclaimed root zone profile and vegetation community.

2.0 Regional Literature.

Selenium is widely distributed in the earth's crust, with soluble forms tending to concentrate in sedimentary materials, especially dark shale, coal stringers, and carbonaceous shale (Boon, 1989; Fisher et al., 1987; Munshower, 1983). Selenium is not considered an essential element for plant growth and development but is required in low concentrations for animal and human nutrition. The element is a common ingredient of many livestock dietary supplements and is an antioxidant and cancer prevention ingredient of human vitamin capsules.

Selenium has been used as a suitability criterion for premine and postmine soil and spoil for more than two decades. Preliminary investigations by Barth (1981) at the Colorado School of Mines Research Institute and early guidelines from Colorado (1982) and Wyoming (1980) suggested a maximum suitability criterion total-selenium (TOT-Se) value of 2.0 ppm. The established reclamation suitability criterion maximum of 2.0 ppm TOT-Se was reduced to 0.5 ppm in 1989 for the BMMC and later increased to 0.8 ppm in 1993 (OSMRE, 1989 & 1993).

The bioavailability of Se in soil, geologic bedrock, and spoil is partially controlled by the chemical and mineralogical occurrence of Se. The Se sequential extraction and fractionation procedure and related tests are designed and used to evaluate and determine potential stability of the Se-containing compounds in the soil medium (Tokunaga et al., 1991 and Munk, 1996). The hot-water soluble (HWS-Se), AB-DTPA extractable (ADE-Se), and total Se analyses are three different tests used to determine the availability of Se.

Since 1990, extensive Se studies have been conducted in the coal mining region of the Powder River Basin as summarized by Spackman et al., 1996. Briefly, an interactive research committee was formed in the early 1990s to address the issue of Se and mining in the Powder River Basin. The objectives of the committee were 1) to develop detailed sampling and Se analytical procedures for soil, overburden, spoil, and vegetation; 2) to identify Se levels in premining and postmining environments within the Powder River Basin; 3) to develop predictive relationships between Se in the environment and organisms; and 4) to identify appropriate suitability levels for Se in the postmining spoil. A three-phase research project was developed by the committee to address these objectives and results are presented in Spackman et al. (1995), Raisbeck et al. (1995), and Vicklund et al. (1995). Results from these studies relevant to the BMMC studies are discussed in appropriate sections of this report.

3.0 Premine Soil & Overburden Data from the BMMC.
Selenium concentrations in native soil and overburden samples from the BMMC are similar to those found in comparable geologic samples from other areas in the western U.S. Selenium levels in soil and overburden at the BMMC have been obtained from the analysis of samples collected from three different studies, including historic test borings (Permit AZ-0001D, Volume 12, Appendix B), recent highwall suitability testing of soil and shallow overburden (August 1995), and native soil sampling (October 1995). All premine soil and overburden samples were collected and analyzed according to OSMRE-approved protocols. These protocols include approved sampling containers, sampling devices and techniques, chain of custody documentation, approved analytical methods, and QA/QC procedures.

3.1 Historic Test Borings. Soil and overburden samples were collected between 1977 and 1985 from test borings within proposed mining areas as shown in Kayenta Mine Permit AZ-0001D, Volume 23, Drawing 85613 (PWCC, 1985). The data include analytical results for HWS-Se and TOT-Se as presented in Permit AZ-0001D, Volume 12, Appendix B (PWCC, 1985). The historical soil and overburden results for HWS-Se were determined for 675 samples collected from 30 deep overburden cores and 20 shallow highwall cores. The historical soil and overburden results for TOT-Se were obtained for 203 samples collected from 16 shallow overburden cores located in the N10, J19, and J21 mining areas. The mean concentration of HWS-Se and TOT-Se was 0.07 and 0.37 ppm, respectively for these soil and overburden samples from the BMMC (Table 1). About 15 percent of the total samples analyzed for both HWS-Se and TOT-Se exceeded the established limits for suitability; these were nearly always associated with shale and non-mineable coal strata. No unsuitable HWS-Se values were recorded for the 20 shallow highwall cores located in the J21 mining area.

Table 1. Summarized Mean Se Values from Studies Conducted at the BMMC.

Data Type	Year	Medium	HWS-Se (ppm)	TOT-Se (ppm)	ADE-Se (ppm)	N
Historic Drilling	1977-1985	Overburden	0.07	0.37	---	*
Shallow Drilling	1995	Overburden	0.02	0.27	0.02	452
Native Pedons	1995	Soil	0.01	0.38	0.02	261
Soil-Spoil Pedon	1984	Soil	0.01	---	---	247
Soil-Spoil Pedon	1984	Spoil	0.04	---	---	450
Soil-Spoil Pedon	1995	Soil	0.01	0.14	0.02	86
Soil-Spoil Pedon	1995	Spoil	0.03	0.84	0.05	113
Soil-Spoil Pedon	1996	Soil	0.01	0.13	0.02	24
Soil-Spoil Pedon	1996	Spoil	0.05	0.61	0.07	39
Initial Graded	1989-1998	Spoil	0.05	0.70	0.08	**

* The number of samples analyzed for HWS-Se and TOT-Se were 675 and 203, respectively.
** The number of samples analyzed for HWS-Se, ADE-Se, and TOT-Se were 1053, 687, and 1179, respectively.

Previous research studies indicate different rock types often contain inherently different concentrations of Se (Boon, 1989; Fisher et al., 1987; Munshower, 1983). This relationship is applicable to the historic test boring data collected from the BMMC. Shale, coal, and mudstone strata at the BMMC contained the highest concentrations of HWS-Se, with concentrations of 0.04 to 0.10 ppm. Siltstone contained slightly lower HWS-Se concentrations (0.03 ppm), and sandstone and soil contained the lowest concentrations (0.01 to 0.02 ppm). The shale and coal strata also had the highest TOT-Se concentrations (0.25 to 0.54 ppm) while sandstone had the lowest (0.11 ppm).

The historical soil and overburden test boring data indicate differences for HWS-Se with respect to depth. The mean HWS-Se value was 0.01 ppm for the zero to 2-foot and 2- to 4-foot depth classes. The greater than 4-foot depth class value was 0.04 ppm. This suggests soluble Se near the surface has been displaced by volatilization and leaching.

3.2 August 1995 Soil and Shallow Overburden Testing. Soil and overburden samples were collected from shallow holes in selected mining units in August 1995 to evaluate the suitability of these materials as plant-growth medium (spoil cover) in nearby reclamation areas (Drawing 1). Strata Service Drilling Corporation of Houston, Texas drilled the shallow soil and overburden holes in August 1995 and samples were collected and described by PWCC soil scientists. The data include analytical results for HWS-Se, ADE-Se, and TOT-Se (Appendix A, Table A-1). The laboratory analyses were completed by Inter-Mountain Lab, Farmington, New Mexico. The mean concentration of HWS-Se, ADE-Se, and TOT-Se was 0.02, 0.02, and 0.27 ppm, respectively for the 452 soil and overburden samples collected during August 1995 at the BMMC (Table 1). Half of the samples were analyzed for ADE-Se with the expectation that a valid correlation could be developed between HWS-Se and ADE-Se.

Grouping the data by texture indicated higher soluble, extractable, and total Se concentrations were again associated with the finer clay and clay loam soils while the loam and sandy loam soils had non-detectable and lower Se concentrations. The August 1995 soil and shallow overburden data indicate differences for HWS-Se, ADE-Se, and TOT-Se with respect to depth. The comparisons indicated no statistically significant differences between the upper two foot soil zones; however, these upper zones were significantly different than the samples from greater than the 4-foot depth class. Once again, these variations in Se levels with texture and depth confirm typical relationships found in the historical samples and other regional data from the western U.S. Se levels in native soil profiles increase with depth (Fisher and Munshower, 1990) while reclaimed spoil is often more homogenous due to extensive overburden mixing (Spackman et al., 1996).

3.3 October 1995 Native Soil Testing. Soil samples were collected from representative native areas during October 1995 (Drawing 1) to examine natural background Se concentrations at the BMMC. Native soils were sampled from the dominant soil series located in the pinyon-juniper woodland and sagebrush shrubland vegetative plant communities. A certified soil scientist collected samples from the sidewall of an excavated backhoe pit. The laboratory analyses were completed by Inter-Mountain Lab, Farmington, New Mexico. The standard operating procedures for the sampling and analysis of Se in soils, overburden, and spoil was used in part as the soil sampling and analysis protocol (Spackman, et al., 1994). Results for HWS-Se, ADE-Se, and TOT-Se are shown in Appendix A, Table A-2. The mean concentration of HWS-Se, ADE-Se, and TOT-Se was 0.01, 0.02, and 0.38 ppm, respectively for the 261 soil samples collected during October 1995 at the BMMC (Table 1).

4.0 Postmine Soil and Spoil Se Concentrations.

Selenium concentrations in postmine soil and spoil samples from the BMMC are similar to native soil and overburden samples at the BMMC and comparable geologic samples from other areas in the western U.S. Selenium levels in postmine soil and spoil have been obtained from analyses of samples collected from four different studies including, 1984 historic topsoil-spoil pedon testing, fall 1995 topsoil-spoil-plant testing, spring 1996 topsoil-spoil-plant testing, and routine graded spoil sampling from 1989 to 1998 (PWCC, 1985; PWCC, 1992-1998).

4.1 Spring 1984 Historic Topsoil-Spoil Pedon Testing. A postmine topsoil-spoil pedon study was performed at the BMMC during the spring 1984 field season to describe soil and spoil characteristics, evaluate plant performance, determine initial suitability standards, and review overall reclamation success. A certified professional soil scientist described and sampled 112 pedons in seven separate reclamation areas (Drawing 2). All pedons, with the exception of 18 in the J3 reclamation area, contained a top-dressing of topsoil. The reclaimed pedons ranged in age from 5 to 12 years. The methodology used to prepare the pedon descriptions followed standard techniques and procedures of the National Cooperative Soil Survey (NCSS). Laboratory analyses were completed by Peabody Central Lab, Freeburg, Illinois using methodology approved by OSMRE. The data include analytical results for HWS-Se (Appendix A, Table A-3). The mean concentration of HWS-Se was 0.01 ppm for the 247 soil samples and 0.04 ppm for the 450 spoil samples (Table 1).

4.2 Fall 1995 Topsoil-Spoil-Plant Testing. A coordinated postmine topsoil-spoil pedon and plant sampling study was conducted by PWCC and independent consultants at the BMMC during the fall 1995 field season to observe soil and spoil characteristics, evaluate plant performance, confirm suitability standards, and review reclamation success. The program involved collection of collocated soil and plant samples from all existing reclamation areas of the BMMC. A certified professional soil scientist described and sampled 86 pedons in 10 separate reclamation areas at the BMMC (Drawing 3). Study sites were selected from previously located random vegetation monitoring sites that fell within areas meeting various regulatory, topsoil thickness, and age criteria. These reclaimed pedons ranged in age from 5 to 23 years. Reclaimed sites were selected to represent the different topsoil cover type areas including no topsoil cover, thin (1.25 feet or less) cover soil, moderately thick (more than 1.25 feet up to 2.5 feet) cover soil, and thick (greater than 2.5 feet) cover soil over the spoil material (Table 2).

Table 2. Reclaimed Site Soil Cover Thickness – 1995 & 1996 Samples*.

No Topsoil Cover (0.0 feet)						
J27 A1	J27 A2	J27 A3	J27 A4	J3 A1	J3 A2	
J3 A3	J3 A4	J3 A5	J3 B1	N1N2 A1	N1N2 A2	
Thin Topsoil Cover (greater than 0.0 up to 1.25 feet)						
J7 A1	J7 A2	J7 A3	J7 A4	J7 A5	J27 B1	J27 B2
J27 B3	J27 B4	J3 B2	J3 B3	J1N6 A1	J1N6 A2	J1N6 A3
J1N6 B2	J1N6 B3	J1N6 B4	J1N6 B6	J1N6 C1	J1N6 C2	J1N6 C5
N7/8 1	N7/8 3	N1N2 B1	N1N2 B2	N1N2 B5	N1N2 B6	N1N2 B7
N1N2 B8	N10 1	N10 2	N10 3	N10 4	N14 1	N14 2
Moderately Thick Topsoil Cover (greater than 1.25 up to 2.50 feet)						
J7 B1	J7 B2	J7 B3	J7 B4	J1N6 B1	J1N6 B5	J1N6 C3
J1N6 C4	J1N6 C6	N7/8 2	N7/8 4	N7/8 5	N1N2 A3	N1N2 B3
N1N2 B4	N14 3	N14 4	N14 5	N14 6	N14 7	J16 1
J16 2	J16 3	J16 4	J16 5	J16 6	J21 A2	J21 A5
J21 A6	J21 B1	J21 B4	J21 B6			
Thick Topsoil Cover (greater than 2.5 feet)						
J7 B5	J21 A1	J21 A3	J21 A4	J21 B2	J21 B3	J21 B5
*As shown on Drawing 3.						

Laboratory analyses were completed by Inter-Mountain Lab, Farmington, New Mexico. Sampling and analysis protocol followed Spackman et al., 1994. The data include analytical results for HWS-Se, ADE-Se, and TOT-Se (Appendix A, Table A-4). The mean concentration of HWS-Se, ADE-Se, and TOT-Se was 0.01, 0.02, and 0.14 ppm, respectively for the 86 soil samples and 0.03, 0.05, and 0.84 ppm, respectively for the 113 spoil samples (Table 1).

4.3 Spring 1996 Topsoil-Spoil-Plant Testing. The final phase of the topsoil-spoil pedon and plant sampling study was conducted during spring 1996. Spring monitoring was completed at a representative number of reclamation sites to evaluate seasonal variability of Se concentrations in soil, spoil, and plants. A total of 22 sites were selected from the same 10 reclamation areas that had been sampled during the fall of 1995 (Drawing 3). The standard operating procedures for the sampling and analysis of Se in soils, overburden, and spoil was used in part as the soil sampling and analysis protocol (Spackman et al., 1994). Laboratory analyses were completed by Inter-Mountain Lab, Farmington, New Mexico. The data include analytical results for HWS-Se, ADE-Se, and TOT-Se (Appendix A, Table A-5). The mean concentration of HWS-Se, ADE-Se, and TOT-Se was 0.01, 0.02, and 0.13 ppm, respectively for 24 soil samples and 0.05, 0.07, and 0.61 ppm, respectively for the 39 spoil samples (Table 1).

4.4 Routine Graded Spoil Testing. PWCC continues to collect Se data from final graded postmine lands as required by Chapter 22 of Kayenta mining and reclamation Permit AZ-0001D (PWCC, 1985). The sample data and site location information is presented in the annual Minesoil Reconstruction and Revegetation Activities Reports for the BMMC that are submitted to OSMRE (PWCC, 1992-1998). The number of samples analyzed from 1989 to 1998 for HWS-Se, ADE-Se, and TOT-Se were 1053, 687, and 1179, respectively (Appendix A, Table A-6). The mean concentration of HWS-Se, ADE-Se, and TOT-Se was 0.05, 0.08, and 0.70 ppm, respectively for the spoil samples (Table 1).

5.0 Comparison Between Premine and Postmine Se Analyses.
In most instances, the mean HWS-Se, ADE-Se, and TOT-Se concentrations for premine soil and overburden compare closely with postmine soil and spoil sample results as shown in Table 1. The mean HWS Se concentration was 0.01 ppm and the mean ADE-Se concentration was 0.02 ppm for the soil samples collected from both the premine and postmine soil pedons. The mean TOT-Se concentration was 0.38 ppm for premine soil sites and 0.13 and 0.14 ppm for postmine soil pedons. These postmine values are lower than the premine values and are typical for sandy soils located in the western U.S. The higher mean TOT-Se level for premine soils is likely attributable to a portion of the representative pedons having shale parent material. These thin fine textured soils are generally classified as an unsuitable source of topsoil and are not salvaged during the reclamation process.

The mean HWS-Se concentration was 0.03 to 0.05 ppm for spoil samples, 0.07 ppm for premine overburden core samples, and 0.02 ppm for the shallow overburden. The shallow overburden Se value is more comparable with concentrations identified in the soil pedons. Se concentrations in the spoil are intermediate between the more soil like shallow overburden and deep overburden samples. This indicates overburden is being mixed during the spoiling and grading process creating homogenous spoil pedons as recognized by Spackman et al., 1996. The mean ADE-Se level of 0.02 ppm for the shallow overburden sites is more similar to soil material than the spoil Se concentrations that ranged from 0.05 to 0.08 ppm. No ADE-Se analyses were completed for any deep overburden cores. The mean TOT-Se concentration ranged from 0.61 to 0.84 ppm for spoil and from 0.37 to 0.38 ppm for the premine shallow and historic overburden test samples. All premine samples were collected only from shallow test borings (30 feet or less), therefore, the concentrations represent an intermediate value between soil and deeper overburden material. These Se values from the BMMC are quite similar to those identified at two other mine regions in the western U.S. Spoil, highwall, and overburden sampling by the Pittsburg and Midway Coal Mining Company at the McKinley Mine produced mean HWS-Se and TOT-Se values of 0.09 and 0.65 ppm for over 1900 samples. Sampling at numerous Wyoming coal mines and adjacent native areas in 1991 by Schladweiler (1995) produced mean TOT-Se, ADE-Se, and HWS-Se levels of 0.95, 0.11, and 0.12 ppm, respectively.

A good correlation was obtained between HWS-Se and ADE-Se for the BMMC samples as discussed later in Section 8.0. This relationship will be used to determine independent Se suitability standards for these two different extraction techniques. This relationship also supports using either the HWS-Se or ADE-Se analyses and standards independently of each other at the BMMC. This relationship is also very useful for comparing historical HWS-Se data with more recent ADE-Se analyses.

In conclusion, Se characteristics and relationships for soil, overburden, and spoil at the BMMC compare closely with other regional data from the western U.S. Se concentrations at BMMC increase with depth in the overburden strata. Soil material has the lowest Se concentrations while levels are intermediate in shallow overburden. Higher Se levels are associated with the finer soil/overburden, coal, and carbonaceous shale strata. HWS-Se, ADE-Se, and TOT-Se values for soil, overburden, and spoil at the BMMC have not varied measurably over the past 15 years. The three forms of Se, although dynamic, appear to be in a state of equilibrium within the reclaimed soil-spoil pedons.

6.0 Forage Se Analyses at the BMMC.

The most reliable and recommended method for assessing whether Se is deficient or excessive in soil and spoil is to use plant Se concentrations as a guide. PWCC conducted forage quality evaluations in several reclaimed units on the leasehold in 1995 and 1996 as described in Sections 4.2 and 4.3 (Table 2). The concentrations of Se found in all of the reclaimed forage sampled in these studies was comparable with background levels and values reported in the literature.

Dominant forage species, dominant vegetation, or potential Se accumulators (such as fourwing saltbush and broom snakeweed) were collected during fall 1995 and spring 1996 at the same sites described previously for the soil/spoil sampling (Drawing 3). ESCO Associates from Boulder, Colorado collected all vegetation samples and Inter-Mountain Laboratory in Farmington, New Mexico completed the analysis. The plant sampling and analytical methods followed those described by Steward et al. (1994) and ESCO (1996, 1997). Appendix B, Table B-1 lists the total plant selenium values for all plants sampled in fall 1995. The total plant selenium values for all plants sampled in spring 1996 are presented in Appendix B, Table B-3.

During 1995 and 1996, only two forage specimens from each year, both fourwing saltbush, exceeded 5 ppm, and composite samples representative of what the cattle would graze never exceeded 0.91 ppm in 1995 (Appendix B, Table B-2) and 1.9 ppm in 1996 (Appendix B, Table B-4). A large proportion of the plant samples in 1995 and 1996 had TOT-Se values below the detection limit (Appendix B, Tables B-1 and B-3). These forage samples would be classified Se deficient. The Se content in the plants at all of the reclaimed units decreased as soil cover increased.

Mean TOT-Se values for all plants sampled were 0.59, 0.54, 0.33, and 0.24 ppm for no cover, thin cover, moderately thick cover, and thick cover soil areas, respectively during fall 1995 (Table 3). Mean values for all grass species ranged from 0.16 to 0.39 ppm while fourwing saltbush ranged from 0.60 to 1.98 ppm. Over the combined reclaimed units, the mean TOT-Se level was 0.22 ppm for all grasses, 1.25 ppm for fourwing saltbush, and 0.44 ppm for all plants combined. Corresponding HWS-Se and ADE-Se values in soil and spoil range from 0.02 to 0.05 ppm, well below the existing maximum threshold limit of 0.15 ppm. The TOT-Se values range from 0.35 to 0.89 ppm with one value exceeding the established maximum threshold limit of 0.8 ppm. However, the associated plant Se values were well below the established maximum threshold limit of 5 ppm.

In many instances, weighted mean HWS-Se, ADE-Se, and TOT-Se values were determined for individual soil-spoil pedons, separate reclaimed areas, and different topsoil cover type areas (Tables 3 through 6). The weighted values were calculated based upon a particular sample's concentration multiplied by the thickness of the sample increment. These values were then summed for each specific pedon and divided by the sample depth to obtain a mean Se concentration for each sample site. Sample depths for each pedon were based upon the actual maximum plant rooting depth. This weighted average technique for determining Se concentrations throughout the entire soil profile was also used by Prodgers and Munshower (1990) and Schladweiler et al. 1990).

Table 3. Weighted Mean HWS-Se, ADE-Se, and TOT-Se in Soil and Spoil (all depths); TOT-Se in All Plants, Fourwing Saltbush, and All Grasses by Cover Soil Thickness – 1995 Samples.

	Soil and Spoil			All Plants	Saltbush	All Grasses
	HWS-Se	ADE-Se	TOT-Se	TOT-Se	TOT-Se	TOT-Se
Site Type	ppm	ppm	ppm	ppm	ppm	ppm
No Soil	0.03	0.05	0.61	0.59	1.19	0.39
Thin Soil	0.03	0.05	0.89	0.54	1.98*	0.20
Mod. Thick Soil	0.02	0.03	0.47	0.33	0.75	0.19
Thick Soil	0.03	0.04	0.35	0.24	0.60	0.16
All Soil Cover	0.03	0.04	0.66	0.44	1.25*	0.22

*Note: One outlier value of 21 ppm at N1N2B1. The mean value for fourwing saltbush excluding the 21 ppm value is 1.22 ppm for the thin soil cover and 0.97 ppm for all soil cover values.

Weighted average total plant Se levels that take into account forage production in each reclaimed unit were determined from the October 1995 plant samples collected in the reclaimed areas (Appendix B, Table B-2). The weighted average TOT-Se was 0.64, 0.36, 0.28, and 0.16 ppm for the no cover, thin cover, moderately thick cover, and thick cover soil areas, respectively.

Mean TOT-Se values for all plants sampled were 0.60, 0.71, 0.41, and 0.40 ppm for no cover, thin cover, moderately thick cover, and thick cover soil areas, respectively during spring 1996 (Table 4). Mean values for all grass species ranged from 0.16 to 0.53 ppm while fourwing saltbush ranged from 0.98 to 2.15 ppm. Over the combined units, the mean TOT-Se concentration was 0.29 ppm for all grasses, 1.59 ppm for fourwing saltbush, and 0.54 ppm for all plants combined. The 1995 and 1996 mean plant Se values are very similar. Corresponding HWS-Se and ADE-Se values in soil and spoil range from 0.02 to 0.07 ppm while TOT-Se values range from 0.32 to 0.57. These values are well below the established maximum threshold limits.

Weighted average total plant Se levels that take into account forage production in each reclaimed unit were determined from the spring 1996 plant samples collected in the reclaimed areas (Appendix B, Table B-4). The weighted average TOT-Se was 0.46, 0.39, 0.33, and 0.31 ppm for the no cover, thin cover, moderately thick cover, and thick cover soil areas, respectively.

Relative production for 1995 weighted average total plant Se values was determined from random sample data collected from larger areas, reflecting the extensive soil-spoil Se sampling effort. Relative production for 1996 weighted average plant TOT-Se was determined from only representative random or permanent transect data associated with the sample site locations.

Table 4. Weighted Mean HWS-Se, ADE-Se, and TOT-Se in Soil and Spoil (all Depths); TOT-Se in All Plants, Fourwing Saltbush, and All Grasses by Cover Soil Thickness – 1996 Samples.

	Soil and Spoil			All Plants	Saltbush	All Grasses
	HWS-Se	ADE-Se	TOT-Se	TOT-Se	TOT-Se	TOT-Se
Site Type	ppm	ppm	ppm	ppm	ppm	ppm
No Soil	0.02	0.02	0.45	0.60	1.39	0.53
Thin Soil	0.04	0.07	0.57	0.71	2.15	0.30
Mod. Thick Soil	0.05	0.06	0.48	0.41	1.30	0.22
Thick Soil	0.02	0.03	0.32	0.40	0.98	0.16
All Soil Cover	0.04	0.06	0.50	0.54	1.59	0.29

Extensive forage feeding and field grazing experiments conducted by Spackman et al. (1996) in the Powder River Basin indicated Se concentrations of 10 to 15 ppm appeared to be a dietary threshold for measurable damage in animals. Conservatively, the contents of Se in vegetation on reclaimed lands must have a predominance of plants with Se less than 5 ppm (Spackman et al., 1996).

The 1995 and 1996 sample sites were grouped by reclaimed area to evaluate Se levels by probable grazing units. The 1995 plant sampling results from the BMMC show mean TOT-Se values range from 0.11 to 0.38 ppm for all grasses, 0.32 to 3.44 ppm for fourwing saltbush, and 0.16 to 0.86 ppm for all plants combined within the 10 reclamation areas (Table 5). Corresponding TOT-Se values in the soil and spoil ranged from 0.26 to 1.49 ppm with 5 areas having a mean value of 0.78 ppm or greater. The associated HWS-Se and ADE-Se values in the soil and spoil range from 0.01 to 0.07 ppm.

Table 5. Weighted Mean HWS-Se, ADE-Se, and TOT-Se in Soil and Spoil (all depths); TOT-Se in All Plants, Fourwing Saltbush, and All Grasses by Reclaimed Area – 1995 Samples.

	Soil & Spoil Weighted Mean Values			All Plants	Shrubs	All Grasses
Reclaimed	HWS-Se	ADE-Se	TOT-Se	TOT-Se	TOT-Se	TOT-Se
Area	ppm	ppm	ppm	ppm	ppm	ppm
J16	0.02	0.03	0.57	0.27	0.70	0.17
J1N6	0.04	0.05	0.78	0.41	1.08	0.20
J21	0.03	0.04	0.30	0.26	0.68	0.13
J27	0.03	0.07	1.00	0.66	2.45	0.27
J3	0.02	0.04	0.41	0.56	1.08	0.38
J7	0.02	0.04	0.78	0.16	0.32	0.11
N10	0.01	0.01	1.49*	0.18	NONE	0.17
N14	0.03	0.03	0.26	0.45	0.57	0.36
N1N2	0.04	0.04	0.60	0.86	3.44**	0.19
N7/8	0.01	0.02	0.86	0.43	0.86	0.32

*One outlier sample had a Se concentration of 6.7 ppm.
**One outlier fourwing saltbush sample had a value of 21 ppm. Without this value the mean is 1.25 ppm.

The 1996 plant sampling data show TOT-Se values range from less than 0.10 to 0.59 ppm for all grasses, 0.38 to 6.50 ppm for fourwing saltbush, and less than 0.10 to 1.29 ppm for the same 10 reclamation areas (Table 6). Corresponding TOT-Se values in the soil and spoil ranged from 0.22 to 0.76 ppm while HWS-Se and ADE-Se values range from 0.02 to 0.10 ppm.

Table 6. Weighted Mean HWS-Se, ADE-Se, and TOT-Se in Soil and Spoil (all depths); TOT-Se in All Plants, Fourwing Saltbush, and All Grasses by Reclaimed Area – 1996 Samples.

	Soil & Spoil Weighted Mean Values			All Plants	Shrubs	All Grasses
Reclaimed	HWS-Se	ADE-Se	TOT-Se	TOT-Se	TOT-Se	TOT-Se
Area	ppm	ppm	ppm	ppm	ppm	ppm
J16	0.02	0.02	0.74	<0.10	NONE	<0.10
J1N6	0.06	0.09	0.51	0.80	2.11	0.33
J21	0.03	0.04	0.38	0.35	1.05	0.12
J27	0.07	0.08	0.54	1.29	6.50	0.59
J3	0.03	0.03	0.35	0.39	1.09	0.19
J7	0.06	0.10	0.73	0.43	0.49	0.44
N10	0.02	0.03	0.41	0.16	NONE	0.16
N14	0.02	0.04	0.22	0.67	0.45	0.39
N1N2	0.04	0.05	0.59	0.51	0.70	0.52
N7/8	0.02	0.06	0.76	0.33	0.38	0.32

The combined all plant TOT-Se values from the 1995 and 1996 sample sites are an order of magnitude below the established conservative suitability criterion maximum of 5 ppm. Since five of the ten areas had combined soil and spoil TOT-Se values of 0.76 ppm or greater during 1995 and 1996, this suggests this maximum threshold limit of 0.8 ppm for soil and spoil at the BMMC is too conservative.

Vegetation Se values from premine and reclaimed sites in the Powder River Basin indicate low Se concentrations are typical such as reported for cool season perennial grasses with an average of 0.5 ppm. Only 1.6 and 2.0 percent of plant samples, mostly forbs, exceeded the 5 ppm threshold limit for premine and reclaimed land areas in the Powder River Basin, respectively (Spackman et al., 1996). The dominant grass species used for forage in the 10 reclaimed units at BMMC ranged from 0.22 to 0.29 ppm average TOT-Se. This level is about half the concentration of Se values reported for grasses in the Powder River Basin. Only 4 of the 459 plant samples or less than one percent, exceeded the 5 ppm maximum threshold value for reclaimed areas at the BMMC. The four samples were fourwing saltbush. This is similar to studies in the Powder River Basin. Concentrations of Se in vegetation do not change significantly over time (Spackman et al., 1996) although studies by Vicklund et al. (1995) suggest Se concentrations may decline. The fall 1995 and spring 1996 TOT-Se values for plants were quite similar although 1996 values were consistently greater. The mean values for 1996 versus 1995 were 0.54 and 0.44 ppm for all plants combined, 0.29 and 0.22 ppm for all grasses, and 1.59 and 1.25 ppm for fourwing saltbush. HWS-Se and ADE-Se values for soil and spoil were also slightly greater during spring 1996 compared to fall 1995; however, TOT-Se values were less during 1996.

In conclusion, the 1995 and 1996 Soil-Spoil-Plant Pedon sampling was conducted at the BMMC to compare Se levels in the reclaimed soil profile to Se concentrations in the various established plant species. Tables 3 through 6 lists Se concentrations for soils, spoils, and plants at the four soil cover thickness groups and 10 separate reclaimed areas for 1995 and 1996.

Mean TOT-Se level for all plants combined have very favorable concentrations for grazing animals. Mean TOT-Se values in plants were slightly greater in spring 1996 compared to fall 1995; however, this difference was not significant and would not affect grazing management practices. Soil and spoil TOT-Se values between 0.8 and 1.5 ppm did not result in TOT-Se values for grasses or shrubs greater than 5 ppm. Once again, this suggests the current maximum threshold limit of 0.8 ppm for soil and spoil at the BMMC is too conservative.

7.0 Livestock Studies at the BMMC – 1996.

Livestock studies were conducted within the N1N2 prelaw reclaimed pasture from April until October 1996. Over half of the N1N2 pasture does not have any soil cover (sites N1N2A1 and N1N2A2, Table 2) and the remainder of the area has a very thin soil cover (sites N1N2B1, N1N2B2, N1N2B5, N1N2B6, N1N2B7, and N1N2B8). This area has HWS-Se, ADE-Se, and TOT-Se values similar to graded spoil with little or no diluting soil cover. Even in this environment, 1995 and 1996 plant Se values (Appendix B, Tables B1 and B2) were well below the 5 ppm maximum threshold limit except for one fourwing saltbush sample of 21 ppm at site N1N2B1 in 1995. It is probable that this is a bad lab value since no other vegetation sample approached this value. This same fourwing saltbush was sampled in spring 1996 and had a Se value of only 1.26 ppm. Also, the weighted selenium values for this soil-spoil pedon during fall 1995 and spring 1996 were very similar (HWS-Se = 0.08 and 0.09 ppm, ADE-Se = 0.10 and 0.11 ppm, and TOT-Se = 0.94 and 1.23 ppm).

As noted previously, weighted average forage Se levels were determined for reclaimed areas using relative production data. This allows a more realistic appraisal of potential Se in the diets of foraging livestock. In fall 1995 the weighted average forage Se levels for no soil areas within the N1N2 reclaimed area was 0.909 ppm and for thin soil areas was 0.695 ppm (Appendix B, Table B2). The spring 1996 weighted average forage Se levels for no soil areas within N1N2 reclaimed areas was 0.615 ppm and for thin soil areas was 0.566 ppm (Appendix B, Table B4). All values are well below the recommended maximum threshold level of 5 ppm for forages in reclaimed areas (Spackman et al., 1996).

Range forage samples were collected from the N1N2 reclaimed pasture for nutritional analysis by Dr. Ben Norman, Extension Veterinarian from UC-Davis and Dr. Robert Kattnig, Livestock Specialist, University of Arizona. These samples were collected in April and August 1996 and were independent of the extensive sampling efforts by PWCC in May 1996. The range forage samples analyzed by Dr. Norman and Dr. Kattnig varied from 0.057 ppm to 1.95 ppm total plant selenium for the 9 different plant samples (Table 7). PWCC fall 1995 and spring 1996 sample averages and ranges for similar species are included for comparison. All samples are below the recommended maximum threshold level of 5 ppm. Three of the samples collected by Dr. Kattnig and Dr. Norman are below 0.100 ppm total plant selenium, as are several of PWCC's fall 1995 samples, and would be considered deficient. In these samples only fourwing saltbush approaches the 5 ppm maximum threshold limit. It is unlikely that fourwing saltbush would provide a significant portion of the grazing diet on a day to day basis. This species represents only 5.6 percent relative cover and 7.2 percent relative production in this reclaimed pasture.

The livestock were rotated through a series of pastures in the N1N2 reclaimed area to ensure adequate forage and proper grazing use. The forage quantity was good since these areas had not been grazed previously. Adequate water was provided, as was free choice protein/mineral block. Trace elements including Se (as sodium selenite) were included in the mineral block. The Se analysis for this mineral block was 0.3 ppm. Herd monitoring during the grazing season showed heavy use of the protein/mineral block (Richard Aro, Bureau of Indian Affairs, personal communication). The calves present with the herd were generally young and not weaned. Their primary intake of any selenium was likely from lactation, with incidental intake from forage and the protein/mineral block.

Table 7. Se Analysis Results for Various Plant Specimens from the N1N2 Reclaimed Area Pasture.

Specimen/ Composite	Sample Date[1]	Se, ppm	PWCC Fall 1995 Se, ppm	PWCC Spring 1996 Se, ppm
Agropyron smithii	8/22/96	0.183	0.55	0.32
Elymus junceus	8/22/96	0.124	0.217 (0.05-0.65)	0.47 (0.43-0.51)
Chrysothamnus nauseosus	8/22/96	0.173	----	----
Atriplex canescens	8/22/96	1.950	1.029 (0.25-3.25)[2]	0.94 (0.52-1.26)
Agropyron intermedium	8/22/96	0.410	0.05	0.92
Agropyron desertorum	8/22/96	0.114	0.163 (0.05-0.25)	0.52 (0.33-0.76)
Bromus inermis	8/22/96	0.057	0.05	----
Grass composite	4/26/96	0.085	0.19	0.52
Grass composite	4/26/96	0.059	----	----

[1] Kattnig/Norman sample dates

[2] 21 ppm Atriplex canescens value not included

The livestock study was completed by Dr. Norman and Dr. Kattnig with assistance from Dr. Joseph Bahe, Veterinary Clinician, Navajo Nation (Norman, 1996). The clinical health and whole blood Se levels were monitored for 25 to 65 cows, calves, and bulls from their day of arrival at the N1N2 reclaimed area pasture on April 21, 1996 until their departure on October 22, 1996. The livestock were either from resident herds near the study area or were brought in from areas outside of Black Mesa. During the study all bulls and some cows and calves were removed from the pasture. A number of cows had calves of varying age but none were weaned during the study period. Table C-1 in Appendix C lists whole blood Se levels for all livestock from the initial turn-in to the end of the study. The initial blood samples were taken from the 65 head of cattle comprised of 4 bulls, 32 cows, and 29 calves. During the July 1996 blood sampling only 31 cows and no calves or bulls were sampled. The final group sampled in October 1996 included 11 cows and 14 calves.

Whole blood Se data for cows and calves sampled two or more times during the 1996 N1N2 reclaimed area grazing is presented in Appendix C, Table C-2. Table 8 summarizes mean whole blood Se levels for study area cattle at varying sample periods. The mean whole blood Se levels for the entire 65 head herd sampled at the start of the study on April 22, 1996 was 0.222 ppm, with a range of .082 ppm to 0.332 ppm. The study results were also grouped by cows and calves that were sampled two or more times during the study period. Thirty-one cows out of the original 65 head herd were sampled again on July 15, 1996. No calves or bulls were sampled during this period. These 31 cows had mean whole blood Se levels of 0.229 ppm (0.139 ppm to 0.332 ppm) on April 22 and 0.215 ppm (0.169 ppm to 0.480 ppm) on July 15. The 14 calves sampled on April 22 had a mean whole blood Se level of 0.220 ppm (0.153 ppm to 0.294

ppm). The same 14 calves sampled on October 22 had a mean whole blood Se level of 0.218 ppm (0.178 ppm to 0.259 ppm). Eleven cows were sampled at the beginning, middle, and end of the study. The 11 cows had mean whole blood Se levels of 0.217 ppm (0.163 ppm to 0.254 ppm) on April 22, 0.230 ppm (0.169 ppm to 0.480 ppm) on July 15, and 0.199 ppm (0.164 ppm to 0.227 ppm) on October 22.

Table 8. Whole Blood Se Values (ppm Wet Weight) for Cattle from the N1N2 Reclaimed Pasture Study Area.

Initial Sample, Entire Herd (Bulls, Cows, Calves)						
Date	**Mean**	**Median**	**Maximum**	**Minimum**	**Sample Size**	
4/22/96	0.222	0.228	0.332	0.082	65	

Cows and Calves With Two or More Samples (No Calves Sampled on 7/15/96)						
Date	**Type**	**Mean**	**Median**	**Maximum**	**Minimum**	**Sample Size**
4/22/96	Cows	0.229	0.235	0.332	0.139	31
7/15/96	Cows	0.215	0.207	0.480	0.169	31
10/22/96	Cows	0.199	0.204	0.227	0.164	11
4/22/96	Calves	0.220	0.226	0.294	0.153	14
10/22/96	Calves	0.218	0.221	0.259	0.178	14

Cows Sampled at the Beginning, Middle, and End of the Study						
Date	**Mean**	**Median**	**Maximum**	**Minimum**	**Sample Size**	
4/22/96	0.217	0.216	0.254	0.163	11	
7/15/96	0.230	0.211	0.480	0.169	11	
10/22/96	0.199	0.204	0.227	0.164	11	

As can be seen in Table 8, mean bovine whole blood Se values were in the low 0.200 ppm range with very similar median values. The mean value had dropped below 0.200 ppm by the end of the grazing study for the 11 cows sampled over the entire study. Figure 1 illustrates mature cow whole blood Se values by sample date for 31 cows sampled two times and 11 cows sampled three times during the study period. The results show that the majority of these 31 cows had lower whole blood Se levels for samples taken after the initial sampling period. This same relationship applies to the 11 cows sampled three times. Figure 1 also illustrates the narrow range of whole blood Se levels for the 31 and 11 cows. The mean whole blood Se level for the 11 cows sampled all three periods rose to 0.230 ppm in July due to one value of 0.480 ppm for cow L48. Though this one value is much higher than the other cows sampled during the July period, it is still well below the value of 5 ppm normally considered as a threshold value.

To further illustrate the trend in whole blood Se levels for cattle sampled during the entire study period, 5 cows were selected which had blood work representative of the range of blood Se levels for the herd. The whole blood Se values for these 5 cows are shown in Table 9 and are plotted for the study period in Figure 2. Again, the mean whole blood Se levels for the 5 cows decreased over the study period though two cows (K41 and L49) had slightly higher values at the end of the study.

Table 9. Whole Blood Se Levels for Five Cows Representative of the Range of Herd Whole Blood Se Values.

Cow ID #	4/22/96	7/15/96	10/22/96
G7	0.247	0.211	0.227
K41	0.210	0.187	0.218
L49	0.216	0.238	0.226
M56	0.235	0.222	0.207
M57	0.254	0.211	0.187
Mean	0.232	0.214	0.213
Median	0.235	0.211	0.218
Std. Dev.	0.019	0.019	0.017
Conf., alpha .05	0.017	0.016	0.015

The mean whole blood Se levels in Tables 8 and 9 are considered to be at desirable husbandry levels established for normal animals (Norman, 1996). Cows and calves had very similar whole blood Se values. Blood values above 5.0 ppm are usually related to cases of Se toxicosis. Se deficiencies occur at levels below 0.10 ppm. It can be clearly seen from the study results that blood Se levels were in the extreme lower range of acceptable Se levels for cattle and are similar to what operators try to maintain at a minimum in their livestock for proper husbandry. Dr. Norman found no evidence of Se toxicosis in any of the cattle. The cattle were clinically normal. Toes (hooves) from two animals were sent to the Wyoming Veterinary Laboratories and Dr. O'toole, an expert in this area, found no evidence of Se toxicosis.

The N1N2 reclaimed pasture areas were included in the overall 1995 and 1996 sampling efforts to assess total plant Se levels in reclaimed areas. Weighted average plant Se levels were determined from these samples and vegetation monitoring data to assess dietary intake of Se from forage in reclaimed areas. The N1N2 reclaimed pasture areas were in the upper ranges of plant Se values for all sampling areas but remained well below the maximum threshold level of 5 ppm. A livestock study was conducted in the N1N2 reclaimed area pasture from April to October 1996. Included in the study was analysis of livestock for whole blood Se levels. Livestock came into the pasture with low normal levels of Se in their blood. The livestock continued to have low normal whole blood Se levels throughout the study period and were only slightly above deficiency levels by the end of the study. The level of plant available Se plus the Se in the mineral/protein block resulted in very little change in the Se status of the livestock during the study period. Trends for mean whole blood Se levels were lower by the end of the study period. Again, this suggests the current maximum threshold limits of 0.15 ppm for HWS-Se and 0.8 ppm for TOT-Se for spoil at the BMMC are far too conservative.

8.0 Site-Specific Selenium Correlation.

Soil-plant Se correlations are known to be site (native or reclaimed) and vegetation (grass or shrub) dependent (Vance et al., 1995; Sharmasarkar and Vance, 1995; Schladweiler et al., 1993; Prodgers and Munshower, 1990). Sharmasarkar and Vance determined AB-DTPA extractable Se to be the best predictor of Se correlations of soils and plants under field conditions and concluded that 0.25 and 0.68 ppm ADE-Se was correlated to 5 ppm Se in shrubs of undisturbed range land and reclaimed mine environments, respectively. Soil and vegetation Se analyses must be completed simultaneously because the soil plant system is dynamic (Spackman et al., 1996).

Spackman and others (1996) recommends vegetation sampling on reclaimed lands be triggered by spoil concentrations between 0.3 and 0.8 ppm ADE-Se. They also suggest that all spoil ADE-Se levels greater than 0.8 ppm be mitigated prior to soil redistribution and revegetation. Lastly, where ADE-Se levels between 0.3 and 0.8 ppm occur in the spoil, Spackman and others (1996) recommend the vegetation be sampled before bond release to assure Se concentrations in vegetation are predominantly less than the 5 ppm threshold.

As previously discussed in Section 4.0, similar mean concentrations of HWS-Se, ADE-Se, and TOT-Se exist in premine soil compared to postmine topsoil and premine overburden compared to spoil based on over 3500 samples analyzed at the BMMC. Mean HWS-Se levels in 5 to 23 year old reclaimed topsoil-spoil pedons showed little fluctuation over the past 15 years. This suggests a state of equilibrium exists in these profiles whereby natural chemical weathering processes and plant adsorption, plant volatilization, biological (microbial) volatilization, and leaching are in a state of equilibrium. The amount of time it takes to reach equilibrium within the reclaimed environment is a site specific phenomenon (Spackman et al., 1996).

HWS-Se has for more than 50 years been the most accepted indicator of selenium levels in soil that might cause potential toxicity problems in plants. The HWS-Se suitability criterion of 0.15 ppm has been universally established for a number of years; however, site-specific differences are anticipated. The ADE-Se and TOT-Se methods are also used for determining soil suitability; however, precise universal suitability limits for these two methods have been lacking due to the poor correlation that often occurs between extractable and total Se analyses.

The following analyses were completed to determine whether predictive statistical relationships for the three different Se extraction methods could be derived and used for spoil at the BMMC. The 1995 and 1996 soil-spoil pedon data, which represent the existing 10 reclamation units over the entire BMMC, were combined into one data set. The spoil data were then selected since this was the material for which site-specific suitability criteria were desired. This produced 152 sample pairs of selenium data (Table 10) on which a regression analysis has been completed.

Table 10. Linear Regression Analysis Between HWS-Se, ADE-Se, and TOT-Se for Weathered Spoil at the BMMC.

Variable		Sample Number	Linear Regression Coefficients*		Correlation Coefficient
Dependent	Independent	(N)	Slope (m)	Intercept (b)	(r)
ADE-Se	HWS-Se	152	1.023	0.019	0.85**
TOT-Se	HWS-Se	152	6.245	0.564	0.31**
TOT-Se	ADE-Se	152	6.156	0.448	0.37**

*According to the equation y = mx + b where
x = independent variable and
y = dependent variable.
**Significant at the 0.01 probability level.

Statistical correlations between HWS-Se, ADE-Se, and TOT-Se are shown in Table 10. An excellent and very valid (to a 99.5 percent degree of certainty) strong positive linear correlation was obtained between HWS-Se and ADE-Se. The regression analysis indicates that a value of 0.15 ppm for HWS-Se correlates to a value of 0.17 ppm for ADE-Se.

A less strong very valid (to a 99.5 percent degree of certainty) positive linear correlation was obtained between HWS-Se and TOT-Se. The regression analysis indicates that a value of 0.15 ppm for HWS-Se correlates to a value of 1.50 ppm for TOT-Se. Similarly, a less strong very valid (to a 99.5 percent degree of certainty) positive linear correlation was obtained between ADE-Se and TOT-Se. The regression analysis indicates that a value of 0.17 ppm for ADE-Se correlates to a value of 1.50 ppm for TOT-Se. These two correlations will be used later in this section to establish conservative site-specific maximum suitability standards for HWS-Se, ADE-Se, and TOT-Se at the BMMC.

The soil-spoil plant pedon study performed during the fall of 1995 and spring of 1996 produced a significant Se data set for various plant species to which TOT-Se concentrations in spoil can be compared. The mean TOT-Se level in the soil-spoil pedons ranged from 0.22 to 1.49 ppm for the 10 reclaimed areas. Associated mean TOT-Se levels for all plants combined ranged from <0.10 to 1.29 ppm. This relationship indicates soil-spoil TOT-Se levels would need to increase substantially above 0.8 ppm to have plant TOT-Se levels that were greater than 5 ppm.

The following analyses were completed to determine whether site-specific predictive statistical relationships could be derived and used for soil-spoil pedons and reclaimed plant communities at the BMMC. Sharmasarkar and Vance (1995) demonstrated the importance of determining site-specific soil-plant Se correlations for specific vegetation types like grasses and shrubs and for unique land use categories such as native, reclaimed, and abandoned mine land areas. Prodgers and Munshower (1990) and Schladweiler et al. (1993) also divided plants into similar groups, based on Se concentrations, and then statistically evaluated relationships between extractable soil Se and total plant Se. Therefore, the soil and plant Se data were combined from the 1995 and 1996 sampling periods for the thin and moderately thick topsoil thickness classes. The zero to six inch areas and deep (greater than 30 inches) cover soil areas were omitted from this analysis because these classes are more like abandoned mine land and native soil areas, respectively. Weighted HWS-Se, ADE-Se, and TOT-Se values for each soil-spoil profile were determined using procedures specified in Section 6.0. These weighting procedures are identical to those used by Sharmasarkar and Vance (1995) and Prodgers and Munshower (1990).

Prior to performing the statistical evaluations, the combined data set for the thin and moderately deep soil cover categories was reviewed for outliers, inconsistencies between lab data, and abnormal field description information. Sites N14-3 and J1N6B1, both sampled in 1995 and 1996 and Site J27-B3 sampled in 1995 only, were deleted because these sites are actually undisturbed subsoil and substratum soil profiles as described on the field description sheets. Sites N1N2B1, J3-B2, J27-B1, and J27-B2 were omitted because the thickness of soil cover was less than six inches. These four sites are more similar to non-topsoiled reclaimed areas. Five sites, J7-A1, J7-A5, N1N2B4, J7-A4, and J27-B4 were deleted because the HWS-Se and ADE-Se lab values varied significantly with each other. Sites N14-2 and J21-A6 had TOT-Se values equal to or greater than the ADE- or HWS-Se levels while Site N7/8-1 had an excessively elevated TOT-Se value. The spring 1996 sample Site J1N6B6 was omitted because the soil pit was inadvertently located an excessive distance, 315 feet, from the vegetation sample area. Lastly, sample Site N1N2B7 was omitted as an outlier because the major plant rooting depth was excessive extending to 53 inches. A similar quality control approach was also applied by other researchers before performing statistical analysis and correlation (Prodgers and Munshower, 1990; Schladweiler et al., 1993).

The final database that was used for statistical analysis, including site-specific correlations, is shown in Appendix A, Table A-7. This table contains 63 sets of soil-spoil pedon and plant Se data on which numerous regression analyses were calculated.

The soil-plant Se correlation for specific soil extractions and vegetation types are presented in Table 11. Soil-spoil ADE-Se and HWS-Se were correlated to total plant Se levels in fourwing saltbush (ATRCAN), Russian wildrye (ELYJUN), and the three major species of grasses (ELYJUN, ARGDES, and ARGSMI) combined. Soil-spoil TOT-Se was only correlated to the total plant Se values in fourwing saltbush. The ADE-Se, HWS-Se, and TOT-Se soil extraction methods were all more strongly correlated (r=0.62, 0.57, and 0.42, respectively at the 0.01 probability level) with the total plant Se values of fourwing saltbush than were any of the grasses in reclaimed pedons at the BMMC. Statistical analysis results from Sharmasarkar and Vance (1995) also showed shrubs to be the most significant type of vegetation for soil-plant Se correlation in range lands and reclaimed mine land environments.

Table 11. Statistical Analysis of Soil-Spoil [1] and Plant Selenium Correlations [2].

X (ppm)	Y (ppm)	N	Regression Equation	r [3]	MTSL (ppm)
ADE-Se	ATRCAN	50	Y = 0.34 + 11.06X	0.62*	0.42
ADE-Se	ELYJUN	31	Y = 0.08 + 2.29X	0.40**	2.14
ADE-Se	ARGDES	24	Y = 0.12 + 1.24X	0.23	3.93
ADE-Se	ARGSMI	26	Y = 0.17 + 1.88X	0.20	2.56
ADE-Se	GRASS	56	Y = 0.10 + 1.92X	0.29**	2.55
HWS-Se	ATRCAN	50	Y = 0.44 + 12.38X	0.57*	0.36
HWS-Se	ELYJUN	31	Y = 0.10 + 2.57X	0.35***	1.90
HWS-Se	ARGDES	24	Y = 0.13 + 1.28X	0.20	3.80
HWS-Se	ARGSMI	26	Y = 0.15 + 3.22X	0.30	1.50
HWS-Se	GRASS	56	Y = 0.11 + 2.26X	0.28**	2.16
TOT-Se	ATRCAN	50	Y = 0.48 + 0.59X	0.42*	7.66
TOT-Se	ELYJUN	31	Y = 0.15 + 0.05X	0.14	97.0
TOT-Se	ARGDES	24	Y = 0.12 + 0.07X	0.24	69.6
TOT-Se	ARGSMI	26	Y = 0.23 + 0.03X	0.12	159.0
TOT-Se	GRASS	56	Y = 0.14 + 0.05X	0.21	97.2

[1] Includes reclaimed pedons with 6 to 30 inches of topsoil cover that were sampled during fall 1995 and spring 1996 (see Appendix A, Table A-7.

[2] X = Extractable soil selenium, Y = Total plant selenium, N = Number of samples, r = correlation coefficient, MTSL = Maximum threshold suitability limit (regression value of soil selenium corresponding to 5 ppm or less plant Se), ELYJUN = Russian wildrye, AGRDES = Desert wheatgrass, AGRSMI = Western wheatgrass, ATRCAN = Fourwing saltbush, and ppm = Parts per million.

[3] *, **, and *** = Significant at 0.01, 0.05, and 0.10 probability levels, respectively.

The maximum threshold suitability limit (soil suitability limit of Se corresponding to 5 ppm total plant Se) for the HWS-Se, ADE-Se, and TOT-Se extraction methods correlated with fourwing saltbush were 0.36, 0.42, and 7.66 ppm, respectively. The ADE-Se value of 0.42 ppm is less than the value of 0.68 ppm determined by Sharmasarkar and Vance (1995) for reclaimed mine environments and slightly greater than 0.3 ppm recommended by Spackman and others (1996) in Wyoming.

Upper confidence interval limits were determined for each of the three strongly correlated regression equations. The resultant site-specific maximum threshold suitability limits (MTSL) for HWS-Se, ADE-Se, and TOT-Se are 0.26, 0.31, and 4.5 ppm respectively. Since TOT-Se had the weakest correlation, the 4.5 ppm MTSL was investigated further based upon the correlation data presented in Table 10. A MTSL of slightly less than 2.5 ppm was calculated for TOT-Se using the regression data in Table 10 and MTSL values of 0.26 and 0.31 ppm for HWS-Se and ADE-Se, respectively.

The resultant site-specific MTSL of 0.26, 0.31, and 2.5 ppm for HWS-Se, ADE-Se, and TOT-Se are representative for the BMMC. The MTSL values are very conservative since the upper confidence interval limit was used, fourwing saltbush was used as the best predictor even though it extracts much more Se from soil compared to grasses and it comprises only 5 to 7 percent of the plant composition in the reclaimed landscape, and the reclaimed pedons will be covered with 1.0 to 2.5 feet of topsoil that normally has low Se values.

9.0 Final Site-Specific Se Standards for the BMMC.

Extensive soil, overburden, topsoil, spoil, plant, and animal testing at the BMMC shows existing maximum Se threshold limits should be revised to better represent actual site-specific characteristics and relationships. The following HWS-Se, ADE-Se, and TOT-Se maximum threshold suitability limits are justified for the BMMC based upon this data (Table 12). PWCC will implement the approved spoil mitigation plan in all areas where these concentrations of Se are exceeded. HWS-Se and ADE-Se analyses and standards will generally be used independently of each other at the BMMC.

Table 12. HWS-Se, ADE-Se, and TOT-Se Maximum Threshold Suitability Limits for Regraded Spoil at the BMMC.

	Regraded Spoil
Parameter	**0.0 to 3.0 feet**
HWS-Se, ppm	0.26*
ADE-Se, ppm	0.31*
TOT-Se, ppm	2.50*

*PWCC will implement the approved spoil mitigation plan in all areas where these concentrations of selenium are exceeded. HWS-Se and ADE-Se analyses and standards will typically be used independently of each other at the BMMC.

These revised maximum threshold suitability limits for Se are comparable to other recent investigations reported in the literature for the western U.S. Munk (1995) justified a TOT-Se limit of 2.1 ppm for the secondary root zone (i.e., below six inches of suitable cover) at the Burnham Mine in New Mexico for Consolidation Coal Company. The standard was set conservatively at 2.1 ppm because higher concentrations of Se in the spoil were not encountered during sampling. The Pittsburg and Midway Coal Mining Company at McKinley Mine on New Mexico Mining and Minerals Division lands proposes to use 1.4 ppm TOT-Se and 0.25 ppm HWS-Se as the upper suitability limit whereby values in excess would be mitigated prior to topsoil replacement. Sharmasarkar and Vance (1995) concluded that 0.68 ppm ADE-Se was correlated to 5 ppm Se in shrubs of disturbed and reclaimed mine environments in Wyoming. Based on this study, the Se subcommittee on Soils, Vegetation, Overburden, and Wildlife recommend an upper maximum threshold limit of 0.8 ppm ADE-Se exist before spoil is mitigated by burial. They recommended vegetation sampling wherever spoil ADE-Se levels ranged between 0.3 and 0.8 ppm. Since PWCC's maximum threshold suitability limits for HWS-Se and ADE-Se are 0.26 and 0.31 ppm, respectively, no vegetation sampling is proposed at the BMMC.

10.0 Conclusions.

- The Se levels in premine soil and overburden at the BMMC are similar to other typical southwestern areas with Se increasing with depth and being more concentrated in shale, coal, and clay strata.
- HWS-Se and ADE-Se levels in postmine topsoil are similar to premine soil at the BMMC; however, postmine TOT-Se levels are considerably (about 50%) less.
- HWS-Se concentrations in postmine spoil are about 50% less than in the native overburden strata at the BMMC.

- An excellent and very valid site-specific positive linear correlation exists between HWS-Se and ADE-Se at the BMMC. These analyses can be used interchangeably with a high degree of certainty.
- Mean plant TOT-Se values for all grass species combined were 0.22 to 0.29 ppm on reclaimed lands, about half the concentration reported for grasses in the Powder River Basin.
- Mean TOT-Se values for spoil sampled in fall 1995 from the BMMC was 0.84 ppm; the corresponding mean TOT-Se plant level was 0.44 ppm, an order of magnitude less than the threshold value of 5 ppm.
- About 99.5 percent of all plant samples analyzed during fall 1995 and spring 1996 had Se values less than the recommended threshold maximum of 5 ppm.
- Average whole bovine blood Se levels were in the 0.200 ppm range with very similar median values during the entire 1996 grazing season. These Se levels are only slightly above the recommended minimum of 0.1 ppm at which deficiency symptoms begin to occur and well below the threshold of 5.0 ppm.
- A large proportion of the plants sampled in 1995 and 1996 had TOT-Se values below the detection limit and would be classified Se deficient according to established grazing husbandry standards.
- The 1996 grazing study was conducted in a reclaimed area where no spoil mitigation practices were implemented and where over half of the pasture did not have any topsoil and the remainder of the area has a very thin soil cover. Mean TOT-Se values in the spoil were 0.6 ppm and plants 0.7 ppm during the combined 1995 and 1996 sampling seasons.
- The reclaimed area that had the thickest cover soil, i.e., J21 had the lowest Se level in grasses of 0.12 ppm while the thinnest cover soil area, J27 had the highest Se level in grasses of 0.43 ppm. The level at J21 is only slightly above the recommended deficiency level of 0.10 ppm. The Se level at J27 is very desirable per grazing husbandry standards and is an order of magnitude below the recommended maximum threshold limit of 5.0 ppm.
- The extensive soil, overburden, topsoil, spoil, plant, and animal testing at the BMMC shows existing maximum Se threshold limits should be revised to better represent actual site-specific characteristics and relationships.
- An excellent and very valid site-specific positive linear correlation exists between HWS-Se, ADE-Se, and TOT-Se in soil pedons and the total Se in fourwing saltbush plants.
- Maximum Se threshold limits of 0.26, 0.31, and 2.5 ppm for HWS-Se, ADE-Se, and TOT-Se, respectively, are justified at the BMMC for the regraded spoil at 0.0 to 3.0 feet. These values are very conservative because they are based upon upper confidence interval limits, were calculated based on Se uptake by shrubs, and do not account for the replaced soil cover.
- Selenium levels in topsoil and spoil at the BMMC have remained consistent over the past 15 years.
- The proposed maximum threshold limits are comparable to those recently proposed and/or approved in the Powder River Basin and southwestern U.S.
- Se concentrations in postmine soil and spoil samples from the BMMC are similar to native soil and overburden samples at the BMMC and comparable geologic samples from other areas in the western U.S.

11.0 References Cited.

Barth, R.C., L.G. Cox, A. Giardinelli, S. M. Sutton, and L. C. Tisdel. 1981. State of the Art and Guidelines for Surface Coal Mine Overburden Sampling and Analysis, Phase I Report: Survey of Current Methods and Procedures. Submitted to USDI-OSM on C/N J5101047 by Colorado School of Mines Research Institute, Golden.

Boon, D.Y. 1989. Potential Selenium Problems in Great Plains Soils, p. 107-121. IN: Selenium in Agriculture and the Environment, edited by L. W. Jacobs. Soil Science Society of America Special Publication No. 23. Madison, Wisconsin.

Colorado Mined Land Reclamation Division (CMLRD). 1982. Guidelines for the Collection of Baseline Water Quality and Overburden Geochemistry Data. Department of Natural Resources, Denver.

ESCO Associates, Inc. (ESCO). 1996 & 1997. 1995 & 1996 Annual Vegetation Monitoring Reports. Black Mesa and Kayenta Mines. Prepared for: Peabody Western Coal Company, Flagstaff, Arizona.

Fisher, S.E., Jr., F.F. Munshower, and F. Parady. 1987. Selenium, p. 109-133. IN: Reclaiming Minesoils and Overburden in the Western United States – Analytic Parameters and Procedures, edited by R. D. Williams and G. E. Schuman. Soil Conservation Society of America. Ankeny, Iowa.

Fisher, S.E., Jr. and F.F. Munshower. 1990. Selenium Issues in Drastically Disturbed Land Reclamation Planning in Arid and Semiarid Environments. IN: Proceedings of the 1990 Billings Land Reclamation Symposium on Selenium in Arid and Semiarid Environments, Western United States, Severson, Fisher, and Gough (eds), U. S. Geological Survey Circular 1064, Government Printing Office.

Munk, L.P. 1996. Reclamation Materials Suitability Assessment – Burnham Mine, San Juan County, New Mexico. Consolidation Coal Company, Sesser, Illinois 62884.

Munshower, F.F. 1983. Microelements and Their Role in Surface Mine Planning, p. 807-844. IN: Coal Development: Collected Papers, Volume 2, edited by D. Books. Bureau of Land Management. Casper, Wyoming.

Norman, B.B. 1996. Complete Grazing Season – Black Mesa Navajo Cattle Turnout (N1N2 Prelaw Area). In conjunction with Dr. Harry Ohlendorf, CH2M Hill, Sacramento, California and Peabody Western Coal Company, Flagstaff, Arizona.

Office of Surface Mining Reclamation and Enforcement (OSMRE). 1989. Criteria for Evaluation of Overburden and Regraded Spoils. Western Regional Coordinating Center, Denver, CO.

OSMRE. 1993. Revised Criteria for Evaluation of Overburden and Regraded Spoils. Western Regional Coordinating Center, Denver, CO.

Peabody Western Coal Company (PWCC). 1985. Minesoil Reconstruction. IN: PWCC's Surface Mining Permit AZ-0001D, Volume 11, Chapter 22. Submitted to the Office of Surface Mining Reclamation and Enforcement by Peabody's Western Division, Flagstaff, Arizona.

Peabody Western Coal Company (PWCC). 1992-1998. 1989-1997 Minesoil Reconstruction and Revegetation Activities Reports, Black Mesa and Kayenta Mines, Flagstaff, Arizona. Report Prepared for: The Office of Surface Mining Reclamation and Enforcement, Western Regional Coordinating Center, Denver, Colorado.

Prodgers, R.A. and F.F. Munshower. 1990. AB-DTPA extractable soil selenium as a predictor of seleniferous vegetation, pp. 67-71. IN: Proceedings of the Billings Land Reclamation Symposium on Selenium in Arid and Semiarid Environments, Western United States. U.S. Geological Survey Circular 1064.

Raisbeck, M.F., D.G. Steward, G.F. Vance, L.K. Spackman, J.G. Luther, and L.E. Vicklund. 1995. Selenium and mining in the Powder River Basin, Wyoming: Phase III – Selenium in target organisms. Amer. Soc. Surface Mining and Reclamation Symposium, Gillette, WY, available as Special Publication from the Office of Surface Mining in Denver, CO., Selenium: Mining, Reclamation and Environmental Impacts.

Schladweiler, B.K. 1995. Relationship Between Soil Selenium Concentrations and Selenium Uptake by Vegetation on Surface Coal Mine Lands in Wyoming. University of Wyoming, Department of Plant, Soil, and Insect Sciences, Masters Thesis, Laramie, WY.

Schladweiler, B.K., G.F. Vance, P.K. Carroll, M.S. Page, P. Wanek, D.L. Bonett, R.N. Pasch, and S.E. Williams. 1993. Comparison of selenium uptake by vegetation on surface coal mine lands in Wyoming and seasonal variability of uptake, pp. 828-838. IN: Proceedings of the Tenth National Meeting, American Society of Surface Mining and Reclamation, Volume 2. Spokane, WA.

Sharmasarkar, S. and G.F. Vance. 1995. Characterization and Correlation of Soil and Plant Selenium in some Range and Coal Mine Environments of Wyoming, Commun. Soil Sci. Plant Anal., 26(15 & 16), 2577-2591.

Spackman, L.K., D.G. Steward, G.F. Vance, L.E. Vicklund, J.G. Luther, and M.F. Raisbeck. 1996. Interpretation of Selenium Research for Regulatory Application. Joint Committee on Selenium in Soils, Vegetation, Overburden, and Wildlife. Submitted to Rick Chancellor, Administrator of Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.

Spackman, L.K., D.G. Steward, L.E. Vicklund, G.F. Vance, and J.G. Luther. 1995. Selenium and Mining in the Powder River Basin, Wyoming: Phase II – The rooting zone-plant relationship. Amer. Soc. Surface Mining and Reclamation Symposium, Gillette, WY, available as Special Publication from the Office of Surface Mining in Denver, CO., Selenium: Mining, Reclamation and Environmental Impacts.

Spackman, L.K., G.F. Vance, L.E. Vicklund, P.K. Carroll, D.G. Steward, and J.G. Luther. 1994. Standard Operating Procedures for the Sampling and Analysis of Selenium in Soil and Overburden/Spoil Material. Research Publication MP-82. College of Agriculture, University of Wyoming, Laramie, WY. 13 pp.

Steward, D.G., J.G. Luther, P.K. Carroll, L.E. Vicklund, G.F. Vance, and L.K. Spackman. 1994. Standard Operating Procedures for Sampling Selenium in Vegetation. Research Publication MP-77. College of Agriculture, University of Wyoming, Laramie, WY. 6pp.

Tokunaga, T.K., D.S. Lipton, S.M. Benson, A.W. Yee, J.M. Oldfather, E.C. Duckart, P. W. Johannis, and K.L. Halvorsen. 1991. Soil selenium fractionation, depth profiles, and time trends in a vegetated site at Kesterson Reservoir. Water, Air, and Soil Pollution. 57-58: 31-34.

Vance, G.F., S. Sharmasarkar, K.J. Reddy, and L.K. Spackman. 1995. The Importance of Solution Selenium Speciation in Mobility and Plant Uptake of Selenium from Wyoming Coal Mine Land Reclamation, Final Report submitted to the Abandoned Coal Mine Land Research Program, University of Wyoming, Office of Research, Laramie, Wyoming.

Vicklund, L.E., G.F. Vance, D.G. Steward, L.K. Spackman, and J.G. Luther. 1995. Selenium and Mining in the Powder River Basin, Wyoming: Phase I – Vegetation Analysis. Amer. Soc. Surface Mining and Reclamation Symposium, Gillette, WY, available as Special Publication from the Office of Surface Mining in Denver, CO. Selenium: Mining, Reclamation, and Environmental Impacts.

Wyoming Department of Environmental Quality – Land Quality Division. 1980. Guidelin

Figure 1. Bovine Whole Blood Se Values by Sample Date for 31 Cows Sampled Two or More Times in the N1N2 Reclaimed Area Pasture Study

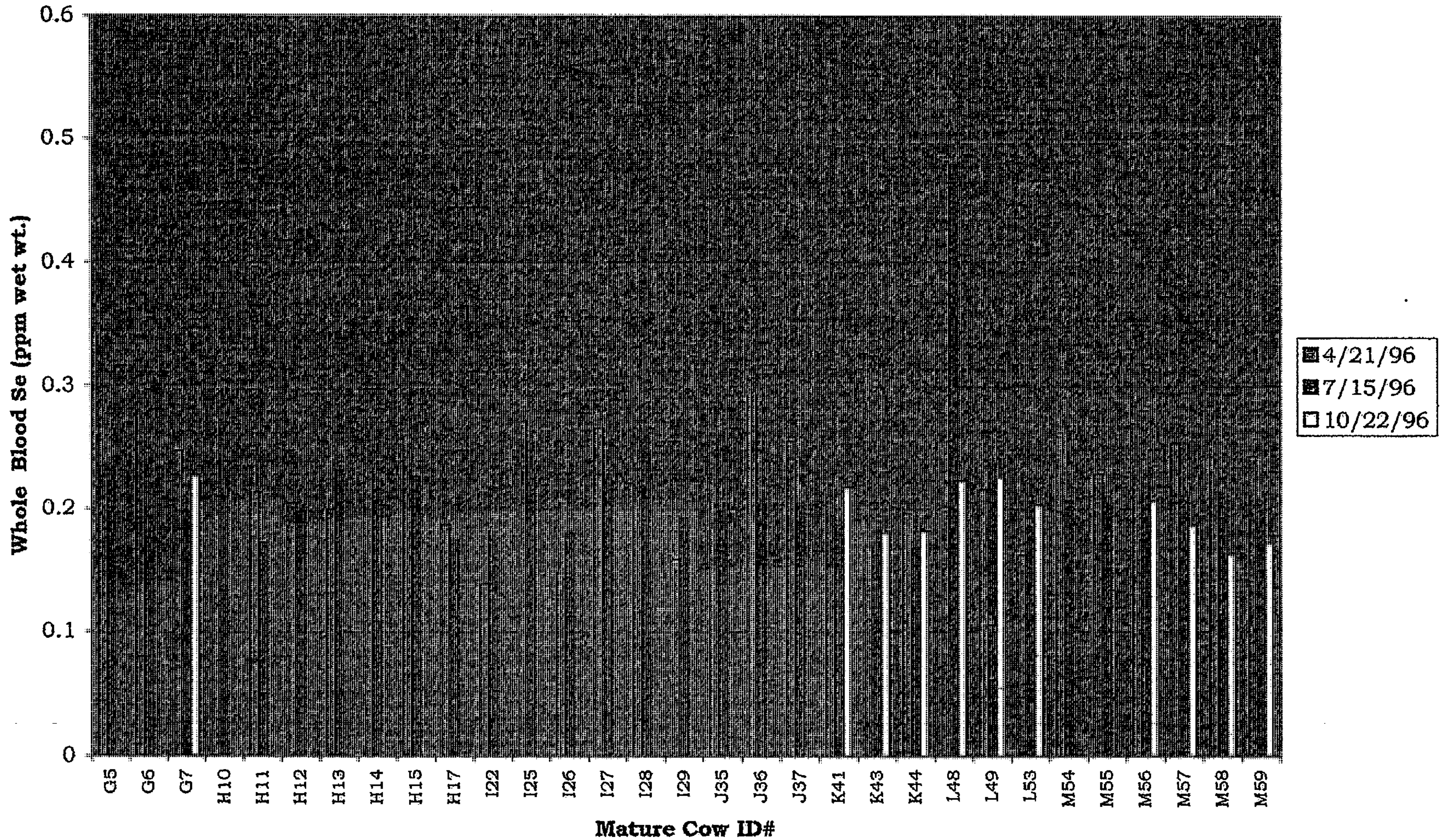
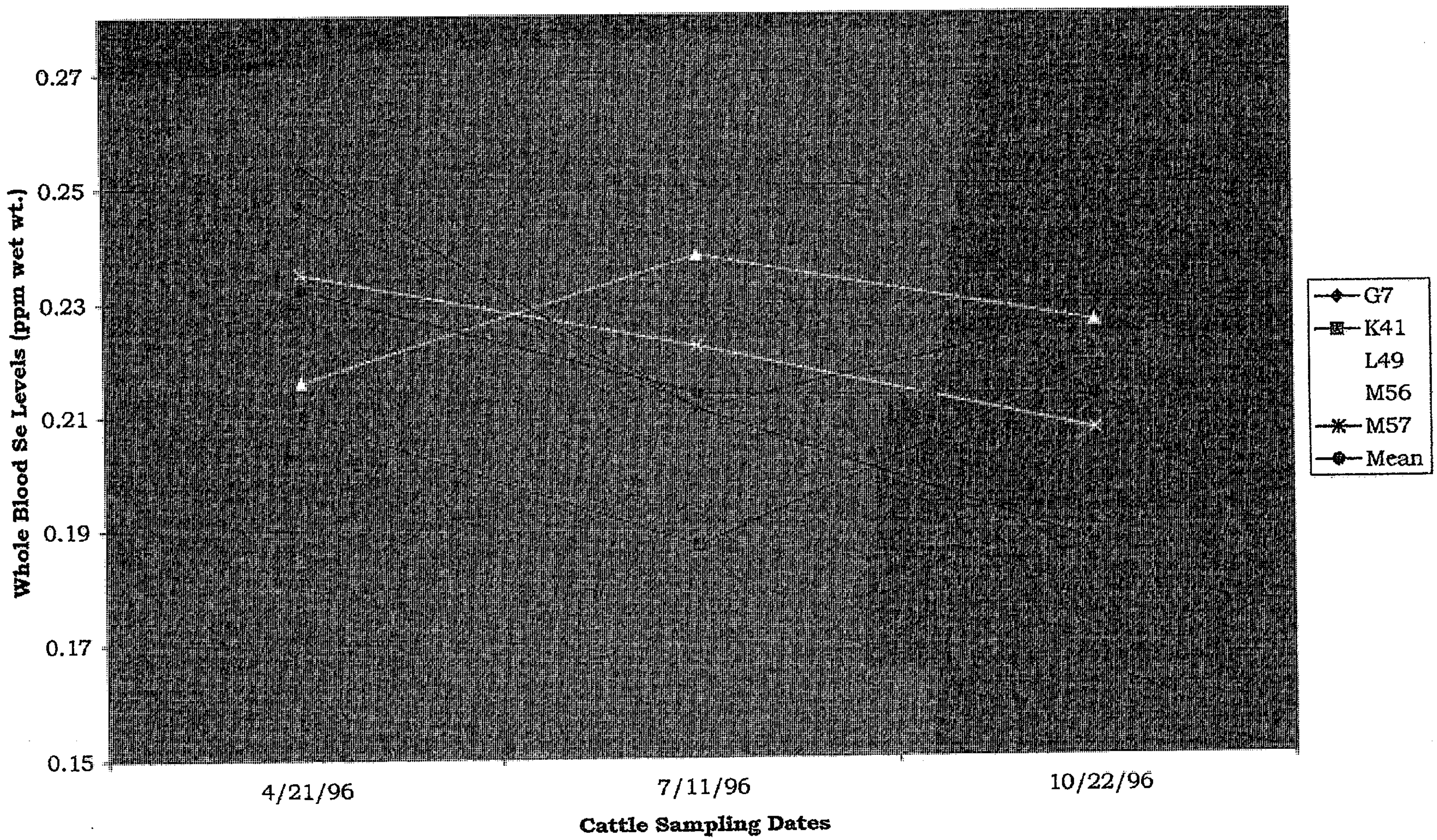


Figure 2. Trend in Bovine Whole Blood Se Levels for Five Cows Sampled Over the Study Period for the N1N2 Reclaimed Area Pasture.



Received 4/13/99, [illegible]

United States Department of the Interior

OFFICE OF SURFACE MINING
Reclamation and Enforcement
1999 Broadway, Suite 3320
Denver, Colorado 80202-5733

IN REPLY REFER TO:

April 7, 1999

Mr. Gary Wendt
Manager, Environmental Affairs
Peabody Western Coal Company
P.O. Box 605
Navajo Route 41
Kayenta, Arizona 86033

RE: Approval of a Permit Revision for Permit AZ0001D /Revised Selenium Standards / **Black Mesa and Kayenta Mine** / OSM Project AZ-0001-D-I-34

Dear Mr. Wendt:

The Office of Surface Mining (OSM) has completed the review of Peabody Western Coal Company's (PWCC's) requested Selenium Standards Permit Revisions dated September 17, 1998 and February 5, 1999. OSM's technical review finds that the submittals have adequately addressed the requirements of the Surface Mining Control and Reclamation Act of 1977 (SMCRA) and Federal regulations at 30 CFR 750, 816.22, and 816.102. Therefore, PWCC's requested permit revision, dated September 17, 1998 and revised on February 5, 1999, to change the selenium standards for recently graded spoil is approved.

By copy of this letter, OSM/WRCC requests PWCC, other OSM offices, and other agencies to insert, in accordance with insertion instructions, the materials transmitted with OSM's memorandum dated September 28, 1998, OSM ID: 98/09/23-06 and February 12, 1999, OSM ID 99/02/08-17 in the approved permit application package and to appropriately file the enclosed decision document.

Should you have any questions regarding this decision, please contact me at (303) 844-1496.

Sincerely,

Jerry D. Gavette

Jerry D. Gavette, Team Leader
Black Mesa/Kayenta Mine Team
Indian, State & Federal Programs Team

Enclosures

cc: AFO
BLM-Phoenix
BIA-Navajo Area
BIA-Keams Canyon Agency
BIA-Hopi Area Office
Navajo Minerals Department
Hopi Office of Mining
and Mineral Resources

Findings for Approval of an Minor Revision
Permit No. AZ0001D
Minor Revision AZ-0001-D-I-34
Peabody Western Coal Company
Kayenta Mine

Based on a review of the application for the permit revision described below:

On September 23, 1998, PWCC submitted a proposed revision to change the selenium standards for the Black Mesa Mine Complex. The proposed revision is based on 15 years of soil and plant accumulation experiments, epidermiologic data in animals, and regional literature to establish a selenium standard for the Black Mesa Mine Complex (BMMC). The extensive compendium of soil, overburden, topsoil, spoil, plant, and animal testing shows the existing maximum selenium threshold limit could be revised to better represent actual site-specific characteristics and relationships.

PWCC's request is based on:

- Premine soil and overburden data
- Historic test borings
- August 1995 Soil and Shallow Overburden Testing
- October 1995 Native Soil Testing
- Postmine Soil and Spoil Se Concentrations
- Spring 1994 Historic Topsoil-Spoil Pedon Testing
- Fall 1995 Topsoil-Spoil-Plant Testing
- Spring 1996 Topsoil-Spoil-Plant Testing
- Routine Graded Spoil Testing
- Forage Se Analyses
- 1996 Livestock Studies

Currently the approved permit application package (PAP) contains "Suitability Criteria for Evaluating Graded Spoil". The criteria for selenium are as follows:

	Good	Fair	Unsuitable
Selenium (Total)	0.0-0.8 ppm	0.0-0.8 ppm	>0.8 ppm
Selenium (HWS)	0.0-0.15 ppm	0.0-0.15 ppm	>0.15 ppm

PWCC's revision request proposes to change the selenium standards to maximum Se threshold limits of 0.26, 0.31, and 2.5 ppm for HWS-Se, ADE-Se, and TOT-Se, respectively. These maximum threshold limits would apply to the regraded spoil at 0.0 to 3.0 feet. The current criteria for topsoil would remain the same. PWCC's data and analyses show that these values are conservative based upon the upper 90% confidence interval limits, were calculated based on Se uptake by shrubs (four-wing saltbush) and do not account for the replaced one foot cover of soil material.

Including all material submitted by Peabody Western Coal Company through April 6, 1999 concerning this revision, and the technical review and evaluation of the permit application (see attachment), I find that:

1. Reclamation as required by the Surface Mining Control and Reclamation Act of 1977 (SMCRA) and the Federal Program for Indian Lands can be accomplished under the reclamation plan contained in the permit application package, as revised.

2. The application is complete and accurate and the applicant has complied with all requirements of SMCRA and the Federal Program for Indian Lands.

3. No other requirements under 30 CFR § 773.15(c) are applicable.

4. As indicated,

   The application does not indicate that the applicant has added a new partner, officer, principal, principal shareholder, director, or person with a similar ownership or control function required to be listed in the application pursuant to 30 CFR § 778.13(c)

5. Environmental Reevaluation and Finding of No Significant Impact

   This permit revision action has been reviewed by OSM, and it has been determined that it involves a decision for a minor revision to a permit where the environmental impacts of the permit approval have been adequately analyzed in a previous environmental document for the mining operation, and the actions proposed in the minor revision do not change the environmental impacts. The discussion of environmental impacts in the environmental impact statement (EIS), prepared for approval of the Black Mesa-Kayenta Mine, Navajo and Hopi Indian Reservations, Arizona permit application May 17, 1990, remains current and adequate for OSM to take action on this permit revision for the following reasons: 1) there is no additional disturbance within the currently approved disturbance area within the currently approved Kayenta Mine Permit Area, that was analyzed in the EIS, and; 2) no additional environmental impacts would occur beyond those identified in the EIS.

The Navajo Nation, BIA, Hopi Tribe and BLM were notified concerning the minor revision. Neither the Navajo Nation, Hopi Tribe, nor BLM submitted comments or concerns. The BIA Navajo Area Office submitted a memo dated October 13, 1998, stating they had no specific comments.

Therefore, application for revision AZ-0001-D-I-34 Federal permit No. AZ0001D is hereby approved.

Jerry D. Gavette (signature) 4/7/99

Jerry D. Gavette, Team Leader
Black Mesa/Kayenta Mine Team
Western Regional Coordinating Center
Office of Surface Mining

Date

TECHNICAL REVIEW STAGE (TS)
RESPONSE FORMAT

Mine/Subject: Black Mesa/Kayenta

Project Number: AZ- 0001- D- I - 34

WATS Work Request Number: FPD06272

Short Title: Selenium Standards

A. **Review Criteria:** 30 CFR 750's, 30 CFR 816.22 and 30 CFR 816.102

B. **Materials Reviewed:** Regraded Spoil Sampling Program, approved Maximum Threshold Limits for Evaluating Recently Graded Spoil at the BMMC and submitted revision request.

C. ☒ 1 No Deficiencies.

☐ 2 Deficiency(s) Resolvable by a Permit Condition.

None

☐ 3 Deficiency(s) For Which a Finding Cannot Be Made:

None

1. a) Statement of Deficiency:

   b) Discussion:

   c) Recommendation:

D. **Permit Condition(s):**

None

1. a) Proposed Condition:

   b) Discussion:

E. **Evaluation:** Peabody Western Coal Company (PWCC) submitted a proposed permit revision to revise the selenium standards for the Black Mesa Mine Complex. The proposed revision is based on 15 years of soil and plant accumulation experiments, epidermiologic data in animals, and regional literature to establish a selenium standard for the Black Mesa Mine

Complex (BMMC). The extensive compendium of soil, overburden, topsoil, spoil, plant, and animal testing shows the existing maximum selenium threshold limit could be revised to better represent actual site-specific characteristics and relationships.

PWCC's request is based on:

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- Fall 1995 Topsoil-Spoil-Plant Testing
- Spring 1996 Topsoil-Spoil-Plant Testing
- Routine Graded Spoil Testing
- Forage Se Analyses
- 1996 Livestock Studies

The sampling and testing of soil, overburden, plants and livestock at the BMMC conclude in part that:

> The Se levels in premine soil and overburden at the BMMC are similar to other typical southwestern areas with Se increasing with depth and being more concentrated in shale, coal, and clay strata.
>
> Hot water soluble Selenium (HWS-Se) and AB-DTPA extractable Selenium (ADE-Se) levels in postmine topsoil are similar to premine soil at the BMMC ; however, postmine total-selenium (TOT-Se) levels are considerably less (about 50%).
>
> HWS-Se concentrations in postmine spoil are about 50% less than in the native overburden strata at the BMMC.
>
> Mean plant TOT-Se values for all grass species combined were 0.22 to 0.29 ppm on reclaimed lands, about half the concentration reported for grasses in the Powder River Basin.
>
> About 99.5 percent of all plant samples analyzed during fall 1995 and spring 1996 had Se values less than the recommended threshold maximum of 5 ppm.
>
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Selenium (HWS)	0.0-0.15 ppm	0.0-0.15 ppm	>0.15 ppm

PWCC's revision request proposes to change the selenium standards to maximum Se threshold limits of 0.26, 0.31, and 2.5 ppm for HWS-Se, ADE-Se, and TOT-Se, respectively. The proposed Se values are based on total Se content of fourwing saltbush, a secondary Se accumulator. The proposed values are also based on regression analysis of soil Se to plant Se, and the upper confidence limit of the calculated regression equations. These maximum threshold limits would apply to the regraded spoil at 0.0 to 3.0 feet. The current criteria for topsoil would remain the same.

Based on review of the information submitted by PWCC the proposed revision is justified, does not reduce the level of environmental protection at the mines, and should be approved.

F. Assignee Signature/Surnames:

Except for any deficiencies noted under Part C (boxes 2 & 3), the remaining parts of the application are in compliance with the Review Criteria of Part A.

CRCDOCS JERRY D. GAVETTE CERTIFIED PROFESSIONAL SOIL SCIENTIST NO. 781

Prepared by: Jerry D. Gavette Date: 4/6/99
Jerry D. Gavette
Certified Professional Soil Scientist
My Certification Expires December 31, 2000

Reviewed by: Robert C. Postle Date: 4/6/99
Robert C. Postle
Ecologist

Reviewed by: Gayle P. Turner Date: 4/7/99
Gayle Turner
Soil Scientist

Reviewed by: Rebecca Siegle Date: 4/6/99
Rebecca Siegle
Soil Scientist

Herd Summary for Dr. Harry Ohlendorf, CH2M HILL
Sacramento, CA

COMPLETE GRAZING SEASON, 1996
BLACK MESA NAVAJO CATTLE TURNOUT
(N1N2 PRELAW AREA)

APRIL 21, JULY 15 AND OCTOBER 22, 1996

Ben B. Norman, DVM, PhD, MPVM, PAS
U.C. Extension Veterinarian, Emeritus

Diplomate: American College of Veterinary Nutrition (AVMA)
Diplomate: American Registry of Professional Animal Scientists (Nutrition)

507 Isla Place, Davis, CA 95616-0136
(916) 756-1977, 756-1999 Fax
bbnorman@ucdavis.edu

In conjunction with: Dr. Harry Ohlendorf
CH2M HILL, Sacramento, CA

and

Peabody Western Coal Company
Flagstaff, AZ

Review of the selenium effects on cattle in the PreLaw N1N2 pasture, from April 21, 1996 to October 22, 1996

Nov. 14, 1996

To: Mr. Brian Dunfee
Peabody Western Coal Company, Inc.
Flagstaff, Arizona

Via: Dr. Harry Ohlendorf
CH2M HILL
Sacramento, CA

From: Ben B. Norman, DVM, PhD, MPVM, PAS
Diplomate, American College of Veterinary Nutrition
Board Certification, American College of Animal Nutrition
U.C. Extension Veterinarian, Emeritus
507 Isla Place, Davis, CA 95616-0136

We have monitored clinical health and whole blood selenium and whole blood arsenic levels for 25 to 65 cows and calves from 4 to 7 herds from their day of arrival to the NIN2 pasture on April 21, 1996 to their departure on Oct. 22, 1996. We have interim samples taken at 3 months on the pasture (July 15th).

Table 1.
Whole bovine blood selenium values, ppm wet weight.

Date	Mean	Median	High	Low	N =
April 22	0.228	0.233	0.332	0.139	61
July 15	0.215	0.207	0.480	0.169	31
Oct. 22	0.210	0.218	0.259	0.164	25

The average values were in the low 0.200 parts per million with very similar median values. Very few values in the entire set were outside the 0.200-0.299 ppm range. Whole blood is used for the measure since 65% of the Se is in the red cells, 35% is in the plasma, and 25% is in the serum. It is more repeatable and is a better long term evaluator of selenium. Serum selenium tends to measure very recent dietary history (what they ate the last few days.) Blood values above 2.0 ppm are of concern and values above 5.0 ppm are usually related to cases of selenium toxicosis. Selenium is not well measured by many laboratories. The U.C. Veterinary Toxicology Laboratory is used as a reference laboratory for the State of California and satisfies FDA GPL practices and meets forensic sample custody practices. We used this laboratory.

I find no evidence of selenium toxicosis. The blood levels seen are those most husbandry people try to maintain in their normal animals. The cattle were clinically normal. Toes (hooves) from two animals were sent to the Wyoming Veterinary Laboratory and Dr. O'toole found no evidence of selenium toxicosis (he is an expert in this area.) With the exception of occasional samples of four wing salt bush, the plants from this site were below problem selenium levels. This salt bush is not heavily grazed with adequate forage, and should not cause concern. It is widely distributed in common desert pastures and is not considered to cause selenium problems.

laboratory personnel in California, Arizona, Colorado and Wyoming expedited our sample processing and their report writing.

Plants were sampled in August, 1996, and evaluated at the University of Arizona, Tucson. These plants do not meet beef nutrient requirements for Cu, iP and Na. (These are reflected in the clinical chemistries from the animals.) Iron (Fe), Se, Mn, Zn, Ca and K are mostly at adequate dietary concentrations. Mo is below detection limits. Levels of S had no pasture effects on the cattle.

MINERALS: Se

SELENIUM (Se): Whole blood selenium is a better evaluator of selenium than plasma or serum, because plasma and serum are overly influenced by dietary exposure in the last few days. Because many laboratories have difficulty performing Se analysis, we used the Toxicology Unit of the U.C. California Veterinary Diagnostic Laboratory System, which is used as a reference laboratory by the State of California and meets GLP practices for FDA and meets forensic custodial control of samples.

Table 1.
Whole bovine blood selenium values, ppm wet weight.

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The average values were in the low 0.200 parts per million (ppm). Very few of the entire set were outside of the 0.200 - 0.299 range. These are good Se values for producing beef cattle. Se deficiencies occur well below 0.1 ppm. Values of toxic concern start at 2.0 ppm whole blood and cattle with selenium toxicosis usually have 5.0 ppm for higher. Cows #56 and #58 had Se values of 0.207 and 0.164 ppm on Oct. 22, when they were lame indicating that Se was not a part of the lameness problem. **I find no evidence of selenium problems or toxicosis in any of these animals.**

SCIENTIFIC PARTICIPANTS

Note: The personnel listed below collected and/or processed the samples used in this report. **The interpretation of the data is Dr. Norman's medical opinion. Other reasonable scientists reviewing the same data might have different opinions.**

For CM2H HILL

Ben B. Norman, DVM, PhD, MPVM, PAS: Animal Project Leader; Veterinarian with B.Sc. in Agriculture, M.Sc. in Pathology, and Ph.D. in Nutrition, M.P.V.M. in Epidemiology; Diplomate, Veterinary Nutrition, American College of Veterinary Nutrition; Diplomate, Board Certification in Animal Nutrition, American Registry of Professional Animal Scientists; Certified Nutrition Specialist, Board of Nutrition (U.S.); graduate training in Epidemiology, University of California, Davis, Johns Hopkins University, Tufts University. 507 Isla Place, Davis, CA 95616. (916) 756-1977 home, 756-1999 Fax, UC Extension Veterinarian, Emeritus,752-6891 bbnorman@ucdavis.edu

Navajo Nation

Joseph Bahe, DVM: Veterinary Clinician: Washington State University graduate. Navajo Veterinary Program. Tuba City Veterinary Clinic, Box 767, Tuba City, AZ. (520) 283-4644 work, 283-5302 Fax, 283-4451 home. Veterinary Clinician with specific experience on the Black Mesa. Native Navajo speaker. Assisted by **Mr. Emmett Black,** his veterinary technician and a native Navajo speaker extremely familiar with the Black Mesa road system and family locations.

University of Arizona

Robert Kattnig, Ph.D.; Cooperative Extension Livestock Specialist, Department of Animal Science, College of Agriculture, University of Arizona, Tucson, AZ 85721. (520) 621-9757. Some plant samples were processed through Dr. Kattinig's unit.

Laboratories

Dr. Eileen Johnson, Veterinary Parasitologist, Veterinary Medical Teaching Hospital, School of Veterinary Medicine, University of California, Davis, CA
Dr. Frank Galey, Jr., Chief of Toxicology Unit, California Veterinary Diagnostic Laboratory System, School of Veterinary Medicine, University of California, Davis, CA.
Dr. Sharon Hayatala, Chief of Serology Unit, California Veterinary Diagnostic Laboratory System, School of Veterinary Medicine, University o California, Davis, CA
Biopsy Pathology Section, VMTH, School of Veterinary Medicine, U.C.D., Davis, CA
Dr. G. A. Bradley, University of Arizona Veterinary Diagnostic Laboratory, Tucson, AZ
Dr. Donal O'Toole, Wyoming State Veterinary Laboratory, Laramie, WY
Dr. R. W. Norrdin, Colorado State Veterinary Laboratory, Ft. Collins, CO

PLANT MATERIAL

August, 1996 N1N2 Plant samples:

Selenium (Se) - varies from 0.057 - 1.95 ppm for nine different plants. All are below the maximum tolerable concentration of 2.0 ppm. Two are below 0.1 ppm and would be considered deficient. **Only one, the 1.95 ppm plant approaches problem levels. The other 6 would support selenium nutrition without problem. It is unlikely that Atriplex (1.95 ppm) would provide a significant portion of the grazing diet on a day-to-day basis.**

SUBJECT: Preliminary Draft Proposal for Seep Management Report

DATE: September 7, 2007 draft

FROM: John Tinger

TO: Gary Wendt, John Cochran, PWCC

CC: Navajo EPA, OSMRE: meeting attendees of Aug 15 seep management meeting.

Proposal for an "Interim Final Report" on the Seep Management results, including data summary needs and an analysis of 3 potential outcomes for each pond. Priorities of addressing seeps are:

1) reclaim as many ponds as possible
2) eliminate monitoring requirements for seeps not causing problems
3) continue monitoring where data is inconclusive
4) permanent fix for problem areas
5) explore if regulatory variances are applicable

Information Summary

The report should include an expanded summary of information to justify decision for each seep:

For each impoundment/seep, please describe:

- How many times inspected,
- how many times a flow was observed, how many times sampled
- the range of flows observed
- exceedances of Livestock standards (already done)
- exceedances of acute standards, exceendances of chronic standards

- Is pond permanent or temporary ?
- What is current use of pond (e.g., is it an outfall location; internal pond; treatment for reclaimed, active, or shop areas, etc. ?)
- Can pond be removed ? (now ? in future ?)
- What is extent of 404 permit, if known ? (top of dam, toe of dam, 100 feet from toe of dam, etc)
- BMPs utilized (vegetation, fencing, dewatering)
- Potential BMPs to be evaluated (e.g., pond removal, vegetation, passive pH treatment, clay lining, dewatering, other)

I think you have most of this information is readily available already. Also, additional information we discussed at the meeting that would be good to incorporate as I do not believe I have seen it:

- Information on plant study for selenium uptake
- Information on selenium deficiency in livestock in the area

Logic flow for seep determinations

For each pond,

1. Has monitoring characterized the seeps to be meeting water quality standards ?

>>> If yes, then PWCC should evaluate if this pond can be removed to eliminate seep. If pond must remain permanent, or if pond is required to be retained for treatment, revise permit to: "PWCC shall continue to visually inspect and conduct field monitoring (pH, conductivity, salinity) of these seep areas as described in the Seep Management Plan. If a significant change in flow, visible characteristics, or field monitoring characteristics is observed, PWCC shall conduct laboratory analysis of the seep and document results in the annual report. Otherwise, no additional sampling is required."

Example ponds: J27-A, J27 RC, J16A, etc.

2. Has monitoring demonstrated either:

a) **inconclusive data** to characterize seeps as meeting water quality standards (e.g, if seep rarely flows and only 1 or 2 data points available, or if monitoring is close to water quality standard and/or above detection limit); or

b) data was violating water quality standards but trend has shown **improvement over time ?**

>>>> If yes, then PWCC should evaluate if this pond can be removed. If pond must remain permanent, or if pond is required to be retained for treatment, then the Permit shall require that the Seep Management Plan will continue to be implemented for monitoring and managing ponds. The Seep Management Plan should evaluate potential BMPs such as vegetation or passive treatment as appropriate for the pollutants of concern.

Example ponds : J-16 E (1 sample with Se 141 ug/L); J2A with pH ~ 6.3,

3. Has monitoring demonstrated that seeps are not meeting water quality standards?

>>>>If yes, then PWCC should evaluate if pond can be removed.

>>> If NO:

I. >> If NO because pond is temporary but currently needed for treatment, then establish schedule for removal/reclamation. In meantime, can seep be treated ? (for example, plant vegetation ? what is 404 permit area ? if pH is problem, can passive treatment be installed?). In this case, the Permit will require continued monitoring of the seep in accordance with the Seep Management Plan.

II. >>> If NO because pond has been identified as a permanent pond, is it be possible to change this designation and make another pond without seep problems a permanent pond in its place ? (potential involvement of PWCC, Navajo Nation, OSM & EPA)

III. >>> If pond must remain permanent, then evaluate 1) permanent treatment of the seep, including lining the pond to eliminate seep.

IV >>>> If pond must remain permanent, and treatment is infeasible, then evaluate regulatory variances. [It is my initial opinion that it may be appropriate to pursue a regulatory variance with the Navajo Nation EPA through either a site-specific objective or more possibly a net benefit determination if the TDS and sulfate standards for livestock are exceeded. I think a net benefit variance in this case (eg, the pond itself provides livestock and wildlife watering benefit that would not present without the pond) would be most appropriate. I do not believe this would be appropriate where bioaccumulative criteria (e.g., Se) is being exceeded at the seep. This would require approval by the Navajo EPA].

e.g., biggest issues here
J-7 dam. Permanent pond that cannot be removed. Flow of seeps not insignificant (tens of gallons/minute). Fencing & vegetation in place. Se levels above WQS but appear to have decreased over time. Is treatment feasible ? Is lining or sealing off flow conduit with bentonite clay feasible ?

BMA-1 –not permanent but needed for treatment of shop areas. Question: Can drainage from shop areas be isolated or contained so that pond can be reclaimed ?

PEABODY WESTERN

Peabody Western Coal Company

October 10, 1997

Mr. Terry Oda
U.S.EPA Region IX (W-5-1)
75 Hawthorne Street
San Francisco, CA 94103

RE: Black Mesa Complex Seepage Management Plan - NPDES Permit No. AZ0022179

Dear Mr. Oda:

Attached please find Peabody Western Coal Company's (PWCC) Seepage Management Plan for the Black Mesa Complex. In my letter to you dated July 11, 1997, PWCC committed to develop the plan and submit it to both the U.S. Environmental Protection Agency (USEPA) and the Navajo Nation Environmental Protection Agency (NNEPA) for review and approval within 90 days.

PWCC is prepared to implement the plan upon receipt of written approval. If you have any questions about the plan or wish to discuss it further, please do not hesitate to contact John Cochran (520/677-5018) or me (520/677-5068).

Sincerely,

Brian P. Dunfee
Senior Manager
Environmental Affairs

bd

c: Patrick Antonio, Navajo Nation EPA

Peabody Western Coal Company • 1300 South Yale Street • Flagstaff, Arizona 86001 • Telephone (602) 774-5253 • Fax (602) 773-4596

Seepage Management Plan

Black Mesa Complex
10/7/97

This document outlines Peabody Western Coal Company's plan to address impoundment seeps at the Black Mesa Complex. The objectives of the plan are to minimize impacts to the prevailing hydrologic balance, protect livestock drinking water, and to enhance riparian vegetation. The plan contains two components: 1) Seep Monitoring; and 2) Seep Management. Upon approval, PWCC will implement the plan through the term of the existing NPDES permit.

<u>Seep Monitoring</u>

Monitoring of seeps below NPDES impoundments at the Black Mesa Complex will reflect a continuation of the plan developed and implemented as part of PWCC's compliance with the requirement contained in Section A.5 of the NPDES Permit (No. AZ0022179). The plan consists of periodic inspections, monitoring, and reporting.

1. Inspections

Two types of inspections will be conducted: 1) Quarterly Pond Inspections; and 2) Semi-Annual Seep Inspections.

Quarterly inspections of all sedimentation ponds at the Black Mesa Complex, including ponds permitted for discharges under the NPDES permit, have been and will continue to be conducted as part of PWCC's mining permit commitments with the Office of Surface Mining. During these inspections, the downstream side of each embankment is checked for evidence of seepage. These observations will be recorded on modified form sheets. Impoundments observed to be seeping based on the documented forms will be included during the next semi-annual seep inspection.

Twenty NPDES impoundments were inspected for seeps as part of the comprehensive study of seeps performed in 1995 by PWCC to satisfy Part A.5 of the NPDES permit. These ponds were BM-A1, J16-A, J16-D, J16-E, J16-I, J2-A, J27-B, J3-D, J3-E, J7-B, J7-DAM, J7-I, KM-E, N14-B, N14-C, N14-P, N5-E, N6-C, N6-F, and WW-9. Pond J7-B has since been removed and reclaimed. All of the remaining nineteen ponds will continue to be inspected on a quarterly basis as part of the ongoing OSM inspection commitment.

Seeps were observed at eight of the aforementioned ponds during the 1995 comprehensive study. These eight ponds were BM-A1, J2-A, J3-D, J3-E, J7-DAM, J16-A, J27-B, and N14-B. On a semi-annual basis (May/June, and October/November) PWCC will inspect for flowing seeps the downstream areas below each of these ponds, and any other ponds at which seeps were identified during the quarterly inspection, including each embankment, embankment toe, downstream channel, and banks within 100 yards. The point of origin for each seep will be noted, and both water quality sampling and flow measurement locations will be staked or flagged, and surveyed at a later date to determine location coordinates and elevations. Water quality sampling locations will be selected to facilitate the collection of representative samples.

2. Monitoring

Data consisting of discharge rate, field water quality parameters, and select laboratory analytical parameters will be collected during each semi-annual inspection. Monitoring, sample collection, sample processing, and sample shipping will be conducted in accordance with standard operating procedures (SOP's) developed for conducting routine hydrologic monitoring activities at the Black Mesa Complex. Electrical conductivity (EC), pH, and temperature will be measured in the field at the time discharge is measured and water quality samples are collected. Samples will be shipped to a certified contract laboratory for analysis. At a minimum, water quality samples will be analyzed for iron (total and dissolved), selenium (total recoverable and dissolved), and nitrate.

3. Reporting

Reports will be compiled and submitted for regulatory review on an annual basis.
The annual reports will include seep location maps, inspection summaries, and monitoring results. Reports will also include PWCC's assessment of the monitoring data collected as related to impacts to the prevailing hydrologic balance and potential threat to livestock health. Based on the monitoring data and PWCC 's assessment, the report will include details regarding management activities proposed to ensure the seeps have no significant impacts or pose no threat to livestock health.

Seep Management

Depending on the chemical nature and persistence of each seep, plans for managing seeps below NPDES impoundments may involve dewatering of impoundments in accordance with the existing NPDES permit, installation of fencing or riprap, and implementation of a vegetation enhancement program at appropriate locations. These management plans will be implemented at those seeps, which have and continue to indicate quantifiable potential for significant impact to the prevailing hydrologic balance and/or a threat to livestock water sources.

1. Dewatering

PWCC's NPDES permit (No. AZ0022179) allows for lagoon dewatering of impoundments. Dewatering has the potential for providing dilution (treatment) of downgradient seep discharges and removing the source water. Additionally, PWCC has equipment to allow for pond-to-pond transfer of impounded water. Both options will be used in order to reduce and possibly eliminate the source of upgradient water to seeps, when logistics and compliance with effluent limits permit.

2. Fencing and Riprap

Fencing of those seeps found to contain water that poses a threat to livestock health will be implemented providing local residents have no objection regarding access for livestock. Fencing will consist of 48-inch height woven wire (4-inch mesh) topped with one strand of barbed wire. Fenced areas will be limited to the immediate vicinity of the seep. For those seeps at which local residents object to fencing, large diameter rock riprap will be placed at the surface to restrict access to seep water.

3. Vegetation Enhancement

PWCC will develop and implement a vegetation enhancement program at those seeps which show persistent discharges and suitable edaphic conditions. The program will consist of establishing phryeatophytic and emergent native vegetation, which can use large amounts of both surface and shallow ground water. Vegetation will include cottonwood trees (*Populus fremontii* or *Populus acuminata*), willows (*Salix* species), cattail (*Typha latifolia*), and graminoids including western wheatgrass (*Agropyron smithii*) and commercially available sedges and rushes. These vegetation communities will be established in the vicinity of seeps to reduce or possibly eliminate seeps. Additionally, the program may be implemented in the vicinity of the upgradient impoundment or along inlets where surface water inflows are persistent.

Upon approval of this plan, PWCC proposes to implement vegetation enhancement at select locations associated with two impoundments at which seeps have historically been monitored; Pond J7-DAM and Pond BM-A1. Below J7-DAM, current vegetation will be inventoried, and a planting program will be developed and implemented for the immediate areas around each seep and a short distance below the point where flow from each seep confluence. Above BM-A1, a planting program will be developed and implemented along the main drainage to the pond. Fencing of these areas will be needed to protect the developing vegetation from livestock, providing local residents do not object to the fencing.

4. Additional Management Options

In the event the above management activities have been exhausted and further monitoring of a seep continues to indicate either a significant impact to the prevailing hydrologic balance or a threat to livestock health, PWCC will investigate other options for seep management. These options include for example: 1) constructing spring boxes at seeps to completely capture seep water in order to either treat the water prior to discharge, or to pump the seep water back to the upgradient impoundment; 2) constructing coffer dams below each seep; and 3) removing the sedimentation structure completely, once approval is granted by the Office of Surface Mining.