ENERGY FUELS RESOURCES (USA) INC.

RESPONSES TO
REVIEW OF SEPTEMBER 10, 2012 ENERGY FUELS RESOURCES (USA) INC. RESPONSES TO ROUND 1 INTERROGATORIES ON REVISED INFILTRATION AND CONTAMINANT TRANSPORT MODELING REPORT, WHITE MESA MILL SITE, BLANDING, UTAH, REPORT DATED MARCH 2010

AUGUST 31, 2015

TABLE OF CONTENTS

ATTACHMENTS

DIVISION'S ASSESSMENT OF EFR RESPONSES TO RD 1 INTERROGATORY WHITE MESA REVISED ICTM REPORT; R313-24-4; 10CFR40 APPENDIX A, CRITERION 6(1); INT 01/1: INCONSISTENCIES BETWEEN REVISED ICTM REPORT AND RECLAMATION PLAN REV 5.0

Based on review of the information provided in the above EFR Response(s), the Division has concern that the argument provided by EFR that post-construction changes in soil properties at the White Mesa site should be minimal is not adequately-supported, e.g., it does not accord with published data, which show significant changes occur over time with nearly all soils, some more than others. EFR has not adequately demonstrated that the cover system has necessarily been designed to be close to the anticipated equilibrium state under long-term conditions, considering the many processes that can potentially disturb the soil over time in the currently designed cover system. These include freeze-thaw cycles, potential soil desiccation during drier climate episodes, reduction of or loss of vegetation in the cover, and deeper animal burrowing depths and deeper plant root penetration than currently estimated by EFR (see Section 11.3 of the Technical Memorandum and Table documenting the Division's review of EFR's Responses to the Rd 1 Interrogatories on the Rev 5.0 Reclamation Plan for additional details), coupled with the exacerbation of potential long-term biointrusion impacts due to the absence of a specifically designed biointrusion barrier in the currently proposed cover

Additional technical information needs to be provided to support the contention that post-construction changes in soil properties in the cover at the White Mesa site should be minimal. At a minimum, such information should include technical data on cover soil characteristics from other similarly-constructed soil cover systems using similar soils and at a site having climate, soils, and vegetation and animal species and population characteristics similar to those present at the White Mesa site. Such data should be acquired within several years (e.g., 5-10 years) after initial cover construction. Based on the April 2012 on-site soils testing, the geometric mean saturated hydraulic conductivity of soils expected to be representative of cover-system soils is approximately 9.5 x 10-4 cm/s (see data in Benson and Wang, 2012). This geometric mean saturated hydraulic conductivity value is outside (above) the range of values given above for long-term "terminal values" expected for cover-system soils (8 x 10-6 to 6 x 10-4 cm/s [Benson et al. 2011). Therefore, the statement on Page 4 of 70 of the Response that "the hydraulic test results for the soils stockpiled at White Mesa are within the range of parameter values anticipated to occur long-term as noted by Benson et al. (2011)" is not technically correct. Although the magnitude of changes in hydraulic conductivity values that might be expected to occur in the cover using soils having the range of saturated hydraulic conductivity values determined from the April 2012 soil stockpile tests would likely be less than for a cover initially constructed with lower-permeability soils, data are limited and insufficient data have been provided to demonstrate EFR's contention that that post-construction changes in soil properties at the White Mesa site should be minimal.

Based on the above considerations, the Division requests that, for modeling purposes, EFR more conservatively model the saturated hydraulic conductivity values of cover-system soils increasing over time. Alternatively, EFR may propose incorporating alternative components into cover system design or propose to revise the cover design to better deter such expected alterations from ever occurring.

The Division also requests that EFR complete a sensitivity analysis by modifying the soil hydraulic properties (e.g., residual and saturated soil water contents, soil water retention function parameters alpha and n, and saturated hydraulic conductivity) in a manner consistent with the likely increased saturated hydraulic conductivity and alpha parameter expected in the maximum potentially impacted frost damage zone due to soil structure development. The soil hydraulic parameter modifications should be adjusted in a manner that either is consistent with NRC recommendations for adjusting similar properties in this soil zone when estimating radon flux emanation (U.S. NRC 2003a, Section 5.1.3), or consistent with Benson et al. 2011 recommendations, whichever is more conservative for infiltration modeling. Provide information demonstrating that the specific adjustments selected and used in the infiltration modeling sensitivity analysis *provide the most conservative results (i.e., highest infiltration rate) (See also discussion under Response to Interrogatory 02/1 below).*

EFR's response also addressed items in Interrogatory White Mesa RECPLAN Rev 5.0 R313-24-4; 10CFR40 Appendix A; Int. 11/1 relating to the "Vegetation and Biointrusion Evaluation and Revegetation Plan" by referring to new information presented in Revised Attachment G dated August 2012. Based on review of that document, the information presented is not sufficient to demonstrate that vegetation cover will be sustainable over the long term and that it will be effective in promoting evapotranspiration. The Division requests that EFR: (i) Provide information on current vegetation on previously revegetated areas at the White Mesa Mill Site and the history of revegetation efforts and results at the site; (ii) Provide more detail on the results of vegetation surveys conducted in June 2012; (iii) Provide a map of current vegetation; (iv) Provide information on soil properties at reference areas to document that "sustainable levels" are achievable; and (v) Provide additional information on procedures to be used during soil amendment and weed management practices to be employed. In the discussion of succession, EFR should address regionally common shrub species that may colonize the site from lower elevation, warmer and drier sites.

Additional information also needs to be provided to support/defend the range of root density values listed in Table 01/1/3-1 of EFR's Response to Interrogatory 01/1, Item 3 on the Revised ICTM Report. The Division requests EFR provide example root density calculations showing how the estimated root density values were derived, and that EFR re-evaluate and further demonstrate that use of specific information contained in reference sources cited by EFR as the basis for deriving estimated root densities in soil are valid/appropriate for the semi-arid conditions at the White Mesa site. EFR should revise the root density estimation approach and estimated range of root densities in the cover as needed based on this re-evaluation (see discussion below). Additional comments on Revised (August 2012) Attachment G relative to sustainability of the vegetation cover and biointrusion issues are provided in Section 2.3 below and in the Technical Memorandum and Table documenting the Division's review of EFR's Responses to the Rd 1 Interrogatories on the Rev 5.0 Reclamation Plan.

In its Response, EFR indicated (Page D-13 in Revised Attachment G appended to the Response to the Rd 1 interrogatory) that the estimates of root density listed in Table D.7 of Revised Attachment G were based on the information contained in the following references: Bartos and Sims (1974), Sims and Singh (1978), Hopkins (1953), Lee and Lauenroth (1994), Jackson et al. (1996) and Gill et al. (1999)

In the Revised ICTM Report, stated root density values (e.g., 4.3 g/cm3) were off by several orders of magnitude and were revised downwards in EFR's Response to the Rd 1 interrogatories. However, root density calculation results still appear to be in error considerably. No calculations are shown. The Division request that pertinent calculations be provided. Supporting references were not provided. However, references were cited on Page D-13 of the Revised Attachment G.

These references include Bartos and Sims (1974) and Sims and Singh (1978), who are also referenced in regard to this topic in the original Revised ICTM Report. These particular references are not for semi-arid-zone plants but for grasses in other biomes, where root density may be greater than is realistic to assume for plants in a semi-arid environment. Use of t data from those references therefore may not be appropriate for describing root density in the cover-system soils at White Mesa under semi-arid conditions. Values obtained using those data should therefore be reconsidered when making application to synthetic soils in a different environment in southeastern Utah. Please address this issue and justify, if possible, the use of Bartos and Sims (1974) and Sims and Singh (1978).

Bartos and Sims (1974) reported yearly-averaged densities of shortgrass at four sites in Ft. Collins, Colorado of up to 1309 g/m2 in the upper 80 cm of soil. Dividing 1309 g/m2 by 0.80 m yields 1636 g/m3, or 1.6 x 10-3 g/cm3 for a[n average, near-surface] root density on a per-volume basis. This value is one to two orders of magnitude smaller than what is claimed in Table 1/1/3-1 of the Response to the Rd 1 interrogatory for anticipated performance at a comparable depth.

Sims and Singh (1978) reported a maximum value of average root biomass for grazed grasslands at eight areas of North American as varying from 71 to 1547 g/m2 in the upper 10 cm. Dividing 71 g/m2 by 0.10 m yields 710 g/m3, which is equal to 7.1 x 10-4 g/cm3 [for an average, near-surface root density]. Dividing 1547 g/m2 by 0.10 m yields 15470 g/m3, which is equal to 1.5 x 10-2 g/cm3 [for an average, near-surface root density]. Thus, average root biomass for grazed grasslands at the eight areas of North American studied by Sims and Singh (1978) tends to vary from 7.1 x 10-4 g/cm3 to 1.5 x 10-2 g/cm3. These values are also one to two orders of magnitude less than what is claimed in Table 1/1/3-1 of the Response for anticipated performance at a comparable depth. It therefore appears that the root density values listed in Table 01/13-1 of this Response may be in error by one to two orders of magnitude.

*Other references cited on Page D-13of Revised Attachment G include Hopkins (1953), Lee and Lauenroth (1994), Jackson et al. (1996) and Gill et al. (1999). Hopkins (1953) work was done on fertile farmland in Kansas, not comparable to the semi-arid land typical of southeastern Utah or to the synthesized soil material planned for fabrication and use for constructing the cover system. Such differences in soil characteristics notwithstanding, calculating root biomass for the fertile Kansas soil, based on Hopkins' (1953) numbers, an estimate for the root biomass, for example for the 30-45 cm depth interval, is 0.002 g/cm3. This is an order of magnitude lower than 0.035 g/cm3, the anticipated performance root biomass for that depth interval claimed in Table D.7. (The estimated root biomass (on a per-volume basis) for the 30-45 cm depth interval based on Hopkins (1953) data can be made in the following way. The soil columns are described in Hopkins (1953) as being three (3) inches thick, and 12 inches wide. The roots are cut into 6-inch segments, each representing a 6-inch long vertical section of earth. Thus, the block of earth for a Hopkins (1953) listed weight of soil is 3" x 12" x 6", or 216 cubic inches (3540 cm3). However, in this case, the relevant volume of soil is for a depth interval from 30-45 cm, equal to two and a half blocks (one from 30-36", one from 36-42", and one halfway down 42-48"). Thus, the volume of soil over that interval = 2.5*3540 cm3 = 8850 cm3. The total weight of roots for the 30-36" block, plus the total weight of roots for the 36-40" block, plus some fraction of the weight from the 40-45" block are added. For convenience, it is assumed that half of the root weight of the 40-45" block is in the upper part of that block. Dividing the total weight of roots (17.94 g) for these 2.5 blocks by the volume of the blocks gives 0.002 g/cm3.*

If it were instead assumed that, for example, 70 percent of the weight of the roots is in the upper half of the deepest block, then a root biomass value of 0.0021 g/cm3 could be estimated, essentially the same as when 0.5 was assumed)

Based on the above information, the Hopkins (1953) root mass values are an order of magnitude lower than those listed in Table D.7 of Revised Attachment G, i.e., 0.035 g/cm3. It appears, therefore, that the values in Table D.7 are in error.

Lee and Lauenroths (1994) focused on only three species of plants and do not provide weights needed to assess root biomass density, but they do provide an assessment of percent root length as a function of depth. Jackson et al. (1996) offer root biomass expressed on a per-area basis (rather than on a per-volume basis as is used in the Response) for eleven different biomes, ranging from boreal forest to tundra. It is not apparent to the Division which of these biomes, if any, would be comparable to that of the finished cover system. It is also not readily apparent how root biomass expressed on a per-area basis would be transformed from this data to a per-volume basis. Gill et al. (1999) likewise offer root biomass expressed on a per-area basis, and it is not readily apparent how root biomass expressed on a per-area basis would be transformed to a per-volume basis.

In addition to showing examples of calculations for all new results, the Division requests that EFR correct errors in Table D.7 of Revised Attachment G and on Page D-13 and Page D-14 of Revised Attachment G and elsewhere in the Revised ICTM Report and other supporting documents, as needed, and make appropriate corrections in the model and in the expression of its results. Alternatively, justify the existing values, if possible. Please cite references appropriately, and justify how information used from these references is relevant and appropriate for conditions at the White Mesa site.

Response:

Changes in Soil Properties

A workshop on April 30, 2013 attended by representatives from the Division, the Division's contractor (URS), EFRI, MWH, and Dr. Craig Benson provided for discussion of Division's February 2013 review comments on the Reclamation Plan, Revision 5.0 (DRC, 2013b) and the revised Infiltration and Contaminant Transport (ICTM) Report (DRC, 2013a). During this workshop, Dr. Benson presented material properties for the proposed cover materials for White Mesa and compared this data to the range of design recommendations provided in NUREG/CR-7028 (Benson et al., 2011) and the database of pedogenic-altered values at the Alternative Cover Assessment Program (ACAP) sites. Discussion from this workshop is summarized in the paragraphs below in this response (Changes in Soil Properties) and was prepared by Dr. Benson. Dr. Benson is the lead author for NUREG/CR-7028 (Benson et al., 2011) and was a lead inspector for the US EPA's Alternative Cover Assessment Program (ACAP), as described in Benson et al. (1999, 2001) and Malusis and Benson (2006). EFRI engaged Dr. Benson in the cover design for the White Mesa tailings cells with regards to selection of and evaluation of laboratory testing of the cover materials, comparison of the EFRI cover design with the Monticello cover system (presented in the August 2015 response document for Reclamation Plan, Revision 5.0 for the response to review comments on Interrogatory 14/1), and with evaluation of the long-term properties for the cover soils. EFRI also engaged Dr. Benson with regards to an overall review of the infiltration modeling and liner leakage calculations.

EFRI believes that soil properties used in the analyses reflect long-term conditions, and that the assumption of minimal change in soil properties is consistent with the most recent knowledge in this area. The most authoritative source of information on this topic is in NUREG/CR-7028 (Benson et al. 2011). EFRI's assumptions are consistent with, or conservative relative to, the properties recommended in NUREG/CR-7028.

Hydraulic properties used in the simulations for White Mesa are conservative relative to the recommendations in NUREG/CR-7028, or consistent with the recommendations, as shown in Table 1. Both the α and n parameters are within the ranges recommended in NUREG/CR-7028. However, saturated hydraulic conductivity is at least one order of magnitude higher than the recommended range, which will result in greater infiltration into the cover and greater percolation into the waste, resulting in more discharge of leachate to groundwater. Similarly, the lower bound of the range of saturated water content is slightly outside the range of the recommendations in NUREG/CR-7028, which will reduce available soil water storage within the cover and result in percolation exceeding that predicted with higher saturated water content.

As indicated in NUREG/CR-7028 and in Benson et al. (2007), hydrologic properties of cover soils evolve over time in response to conditions such as freezing and thawing, wetting and drying, and biota instruction. These processes are collectively known as pedogenesis. Natural pedogenic processes make the hydraulic properties of final cover soils more similar over time and representative of the natural state, regardless of the condition at the time of placement. To this end, larger changes in properties occur in soils that are placed at a higher level of compaction and are free of large voids and structure when placed. Smaller changes occur in soils that are compacted to a more natural state and include larger voids and structure when placed. Hydraulic properties of soils that are placed in a state consistent with natural conditions are expected not to change.

A graph illustrating this principle adapted from NUREG/CR-7028 is shown in Figure 1. After pedogenic processes change the soil structure, the saturated hydraulic conductivities coalesce in a band independent of the as-built saturated hydraulic conductivity, representing an equilibrium state consistent with natural conditions. The range of hydraulic properties for White Mesa is shown with the blue band, which falls above the range of in-service hydraulic conductivities reported in NUREG/CR-7028 and is therefore conservative. To be more realistic of long-term conditions, the saturated hydraulic conductivities used in the White Mesa analysis could be reduced to represent the long-term in-service range recommended in NUREG/CR-7028 (e.g., to represent the impact of long-term fines deposition from eolian erosive processes). However, the higher hydraulic conductivities used in the existing analysis for White Mesa result in a conservative prediction and therefore no adjustment of the saturated hydraulic conductivity is necessary. In addition, EFRI believes there is no reason to adjust the α and n parameters, as the parameters assumed in the analysis are already consistent with the parameters recommended in NUREG/CR-7028 for long-term conditions (Table 1). Any increase in α or decrease in n to follow trends with increasing saturated hydraulic conductivity would result in a more rapid decrease in unsaturated hydraulic conductivity with decreasing water saturation (increasing matric suction), thereby resulting in lower predicted percolation rate into the waste and lower flux of contaminants to groundwater (Figure 2).

Table 1. Ranges of hydraulic properties in NUREG CR-7028 and in analysis for White Mesa

Parameter	Units	NUREG Range	White Mesa Range for Analysis
Sat. hydraulic conductivity, K_s	cm/s	$1x10^{-5}$ to $5x10^{-4}$	$4.0x10^{-4}$ to $3.8x10^{-3}$
Saturated water content, θ_s	--	0.35 to 0.45	0.23 to 0.40
van Genuchten's α	1/kPa	0.01 to 0.33	0.07 to 0.2
van Genuchten's n	--	1.2 to 1.4	1.26 to 1.32

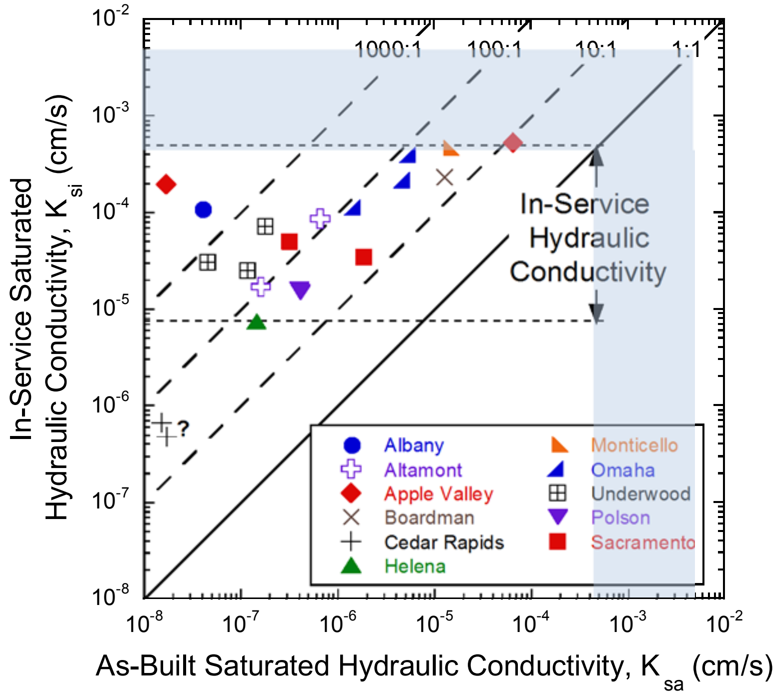

Figure 1. Comparison of in-service saturated hydraulic conductivity to as-built saturated hydraulic conductivity for cover soils from US EPA's ACAP as described in NUREG/CR-7028. Dashed lines represent increases in saturated hydraulic conductivity of 10, 100, and 1000 fold relative to as-built condition. Shaded band represents range of hydraulic properties assumed in analyses for White Mesa.

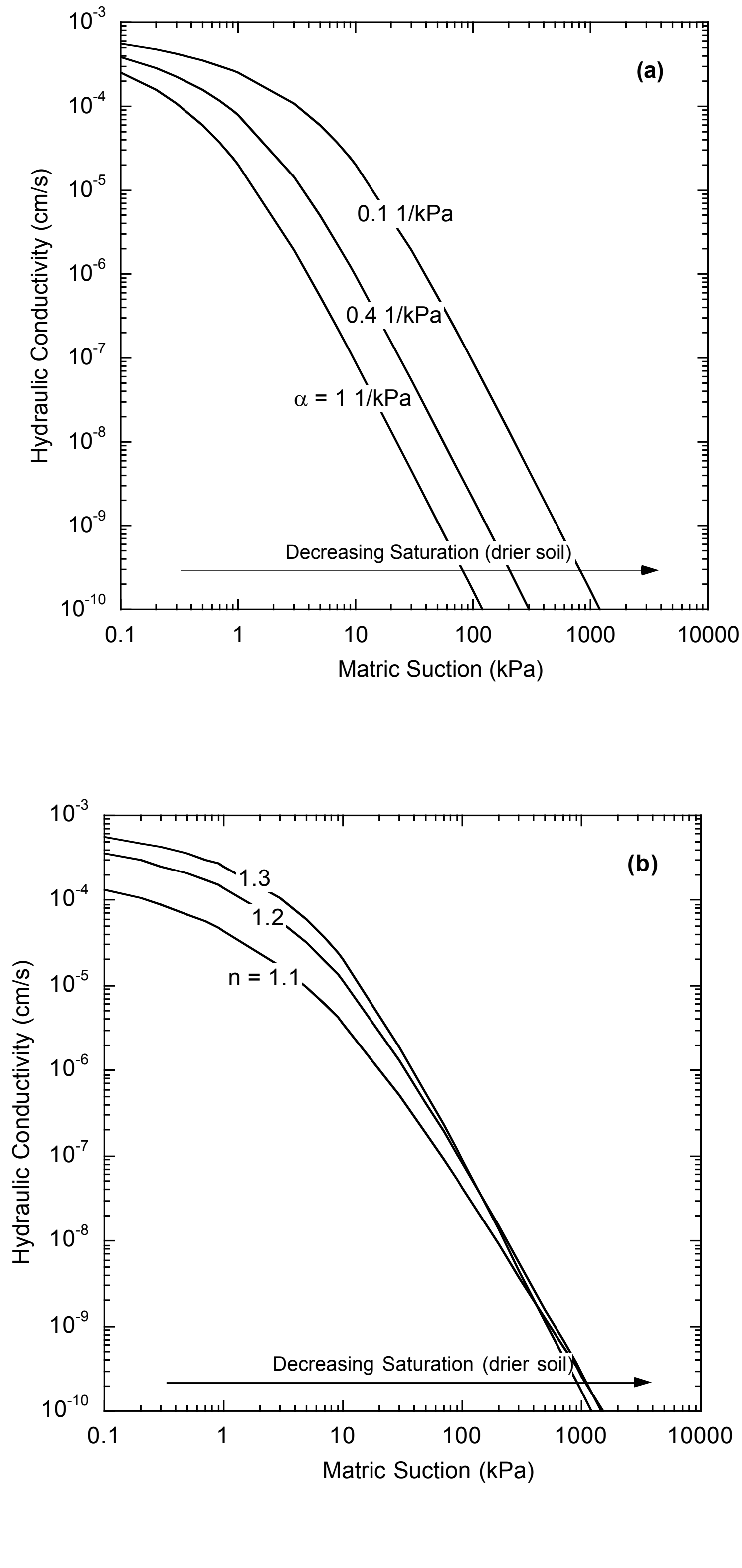

Figure 2. Impact of increasing a (a) or reducing n (b) on unsaturated hydraulic conductivity. For (a), n was set at 1.3. For (b), α was set at 0.1 1/kPa. Note: water saturation decreases monotonically as matric suction increases.

Vegetation

There has not been an evaluation of vegetation on previously revegetated areas at the Mill site. This information would have limited value in evaluating the proposed reclamation plan or in determining if future reclamation will produce a sustainable plant community on the tailings cells. The proposed reclamation plan is substantially different than previous reclamation efforts in terms of soil cover, soil amendments and species to be planted such that any comparisons would not provide any predictive value. The only reclamation that has occurred at the Mill site was seeding of Cell 2 in 2011. Seeding only included crested wheatgrass (*Agropyron desertorum*) and no evaluations have been conducted since seeding occurred.

Further details of the 2012 vegetation survey are provided in a revision of Appendix D (Vegetation and Biointrusion Evaluation) to the Updated Tailings Cover Design Report (Appendix D of the Reclamation Plan, Revision 5.0). The revised Vegetation and Bionintrusion Evaluation appendix is provided as Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

A map of current vegetation at the Mill Site does not exist. The most recent mapping of vegetation at the Mill site was conducted by Dames and Moore in 1977 (Dames and Moore, 1978) as part of the Environmental Report for the White Mesa Uranium Project. Further discussion of mapping units from 1977 and the 2012 survey is presented in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

There are no previously established reference areas provide information on soil properties to document that sustainable levels are achievable. However, soil that will be used as cover material on the tailings cells has been evaluated, and the results were included in Attachment G of EFRI (2012a) as Table D.9 (EFRI, 2012a). An update of this table is included as Table D.39 in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0. This table includes physical and chemical properties of the soil and also levels reported in the literature that would be considered sustainable. Those soil properties that appear to be deficient and would need improvement to achieve sustainability include: percent organic matter, total nitrogen, and extractable potassium. Amendments would be applied during reclamation to address these deficiencies and these amendments are discussed in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0. Over time, the soil-forming process of pedogenesis will continue as climate and on-site organisms (primarily plants and the soil microbial community) modify the soil over time. This process would include the addition of organic matter in the form of composted biosolids which will improve soil structure, water holding capacity, cation exchange capacity, buffering capacity, and overall soil fertility. All of the benefits will lead to a more productive soil and greater sustainability.

Further details on the use of an organic amendment including type, rates of application, source of material, and potential benefits are presented in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

A weed management plan is presented in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

Regionally common shrub species from areas that are characterized by lower elevation and having climatic conditions that are warmer and drier than the Mill site would include fourwing saltbush (*Atriplex canescens*), shadscale saltbush (*Atriplex confertifolia*), blackbrush (*Coleogyne ramosissima*), and Morman tea (*Ephedra viridis*).

Fourwing saltbush is one of the most widely distributed and important native shrubs on rangelands in the western United States including the Intermountain, Great Basin, and Great Plains regions (Welsh et al., 2003). Fourwing saltbush occurs most commonly in salt-desert scrub communities in the Great Basin, Mojave and Sonora Desert areas of western North America (Kearney et al., 1960; Welsh et al., 2003). In the Great Basin region it is often associated with black greasewood (*Sarcobatus vermiculatus*), black brush (*Coleogyne ramosissima*), big sagebrush (*Artemisia tridentata*), creosote bush (*Larrea tridentata*), rabbitbrush (*Chrysothamnus spp.*) and shadscale (*Atriplex confertifolia*) (Welsh et al., 2003).

Fourwing saltbush is adapted to most soils but is best suited to deep, well drained; loamy to sandy to gravely soils. It is very tolerant of saline soil conditions and somewhat tolerant of sodic soil conditions (Ogle and St. John, 2008).

Shadscale saltbush occurs throughout western North America from California and Oregon east to North Dakota and south to Arizona and Texas. The greatest concentrations of shadscale saltbush are found in the Great Basin and Colorado Plateau (Simonin, 2001). Shadscale saltbush can be found in warm desert shrub-steppe environments. Populations occur in low valleys, foothills and mesas from 2,500 to 7,500 feet elevation (Simonin, 2001). It often grows in association with other halophytes including mat-atriplex, and greasewood, but can also be found in sagebrush and pinyon-juniper communities (McArthur and Monsen, 2004; Welsh et al., 2003). Shadscale saltbush is highly drought tolerant and is adapted to sites receiving 6 to 12 inches annual precipitation. This species is tolerant of high saline conditions (pH 7.5-9.0) and is classified as a facultative halophyte (Branson et al., 1976). It prefers well-drained soils but may inhabit a wide range of soil textures from fine to gravelly.

Blackbrush occurs primarily in the transition zones in Great Basin deserts. It is found at elevations from 2,500 to 7,000 feet in areas where the annual temperature fluctuation can range from -11° to 116° Fahrenheit. It is drought-deciduous, meaning that it avoids water stress by becoming temporarily dormant and then shedding its older leaves as stress intensifies during the dry season. Spiny stems, coupled with chemical compounds in current year's growth, protect blackbrush from heavy browsing. It is adapted to dry and well-drained soils and is most abundant in sandy, gravelly, and rocky soils.

Green ephedra occurs on rocky or sandy slopes and plains in such plant communities as the juniper-pinyon woodland, the sagebrush desert, creosotebush deserts, and the desert grassland from 3,000 to 7,000 feet elevation (Benson and Darrow, 1981). Common associates include creosotebush (*Larrea tridentata*), shadscale saltbush, fourwing saltbush, big sagebrush, galleta, and sand dropseed (*Sporobolus cryptandrus*). Green ephedra is tolerant of calcareous, weakly saline, and slightly saline-alkaline (sodic) sites. It thrives in dry, well-drained sites and it is intolerant of wet sites and poor drainage. The plant is drought-resistant.

Based on this discussion of ecological characteristics of common shrub species from sites of lower elevation than the Mill site it is certainly possible that any one of these shrubs could occur at the Mill site if the future climate was warmer and drier than the present.

Rather than attempting to address all the comments related to root densities, EFRI proposes to use root biomass data from a seeded site in Cheyenne, Wyoming that was seeded in the 1950s with root biomass data collected about 35 years after seeding (Redente et al. 1989). Data were collected as g/m^2 and will not be converted. The infiltration model uses a normalized root density function, so root measurement units are irrelevant. Further information is provided in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

Infiltration Modeling Results: Root Biomass and Soil Hydraulic Properties

As discussed above, the root biomass distribution with depth was updated to reflect parameterization using a mass per unit area approach. Two scenarios are presented below to evaluate the sensitivity of the root biomass distribution: an anticipated performance and a reduced performance (Table 2). The approach to use two different root biomass distributions was discussed during the April 2013 workshop with the Division. The justification for these two scenarios (two different root biomass distributions) is provided in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

The model infiltration results were based on the following conditions, which are consistent with the previous ICTM interrogatory response (EFRI 2012b) and information presented during the April 2013 workshop with the Division:

- A 3.08-m thick monolithic evapotranspiration (ET) conceptual cover design with base case soil hydraulic properties (Table 3).
- Percent cover of 40%.
- Base case climate scenario (57-year record between 1932 and 1988).

The 3.08m thick ET cover represents the approximately average cover design thickness for Cells 2, 3, 4A, and 4B. For the Reclamation Plan cover design, each tailings cell will have a different ET cover thickness, with minimum cover thicknesses of 3.20 m, 3.05m, and 2.90 m for Cells 2, 3, and 4A/4B, respectively. The model results represent the range of cover thicknesses. Results will differ slightly for the small differences in cover thickness and these differences will be documented in the next version of the ICTM Report.

The model simulated water flux rates for the anticipated and reduced performance root biomass distribution scenarios are presented in Figure 3. The average modeled infiltration rate for the base case and reduced performance scenarios was approximately 2.3 and 2.8 mm/yr, respectively. Results indicate that the amount of infiltration is not sensitive to the root biomass distribution. Conceptually, the model simulation results are in agreement with the general consensus that the establishment of vegetation is the most critical factor in reducing long-term infiltration rates through an ET cover system. For this reason, among other factors mentioned below, infiltration rates are only presented for a 40 percent vegetative cover scenario. Forty percent vegetative cover is the targeted reclamation goal success criterion, and is supported by vegetation reconnaissance near the site and studies published in the literature. Previous model results indicated little to no sensitivity to the percent vegetative cover (assuming 30 percent). Model scenarios that simulate conditions for an ET cover that achieves less than 40 percent vegetative cover is not supported; and the next iteration of the ICTM report will only report model simulation results for 40 percent vegetative cover.

For comparison, the model simulated water flux rates for the base case and upper/lower bound soil hydraulic property scenarios are presented in Figure 4. The upper/lower bound soil hydraulic property scenarios are consistent with assumptions documented in the previous interrogatory response (EFRI 2012b), and information that was presented during the April 2013 workshop with the DRC (Table 3). For these simulations all other parameter values and assumptions were held constant. The average modeled infiltration rate for the upper and lower bound soil hydraulic property scenarios was approximately 1.9 and 5.7 mm/yr, respectively. The results indicate that if the soils used to construct the cover were dominated by upper bound conditions (less available storage and higher permeability) the long-term infiltration rate could conceivable increase from approximately 2.3 mm/yr to 5.7 mm/yr. Overall, compared to the base case scenario, the upper bound soils scenario simulates more drainage during wet winters while the base case and lower bound soils scenarios are comparable. The upper bound soils scenario is considered to be conservative because parameterization within the ET cover system does not account for reduced permeability of the radon barrier layer, which would act to reduce infiltration; this is also an applicable finding for the base case and lower bound soils scenarios. Additionally, the results are considered conservative because the soil type used to represent an upper bound soils scenario will not be representative of the entire soil cover system; the upper bound soils type has been estimated to represent approximately 47 percent of total volume of available soil cover (with the base case soils type representing approximately 48 percent).

Table 2. Root biomass distribution for expected to occur within the ET cover system

Depth	Root Biomass Anticipated Performance (g/cm^2)	Root Biomass Reduced Performance (g/cm^2)
0-5	160	64
5-10	140	49
10-20	76	23
20-60	125	32
60-100	52	2

Table 3. Parameter values used to parameterize the cover model for the three hydraulic scenarios modeled using the van Genuchten-Mualem functions

Cover Layer	Purpose	Thickness (cm)	θ_r (-)	θ_s (-)	α (1/cm)	n (-)	K_s (cm/d)	l (-)	ρ_b (g/cm^3)
Upper Bound Soils									
1	Erosion Control	15	0.02	0.32	0.0080	1.35	11	0.5	1.70
2	Water Storage	107	0	0.23	0.022	1.32	130	0.5	1.85
3	Radon Barrier	110	0	0.16	0.022	1.32	130	0.5	2.07

4	Grading	76	0	0.26	0.022	1.32	130	0.5	1.74
Base Case Soils (Average)									
1	Erosion Control	15	0.02	0.32	0.0080	1.35	11	0.5	1.70
2	Water Storage	107	0	0.34	0.011	1.30	62	0.5	1.67
3	Radon Barrier	110	0	0.27	0.011	1.30	62	0.5	1.87
4	Grading	76	0	0.37	0.011	1.30	62	0.5	1.58
Lower Bound Soils									
1	Erosion Control	15	0.02	0.32	0.0080	1.35	11	0.5	1.70
2	Water Storage	107	0	0.40	0.0073	1.26	35	0.5	1.56
3	Radon Barrier	110	0	0.33	0.0073	1.26	35	0.5	1.75
4	Grading	76	0	0.43	0.0073	1.26	35	0.5	1.47

Note: The saturated and residual volumetric water contents for the erosion protection and water storage layers were corrected for the amount of gravel calculated using the approach suggested by Bouwer and Rice (1984). The base case scenario was obtained by averaging the B and U soil samples: the saturated/residual volumetric water contents, n, and ρ_b were arithmetically averaged while α and K_s were geometrically averaged.

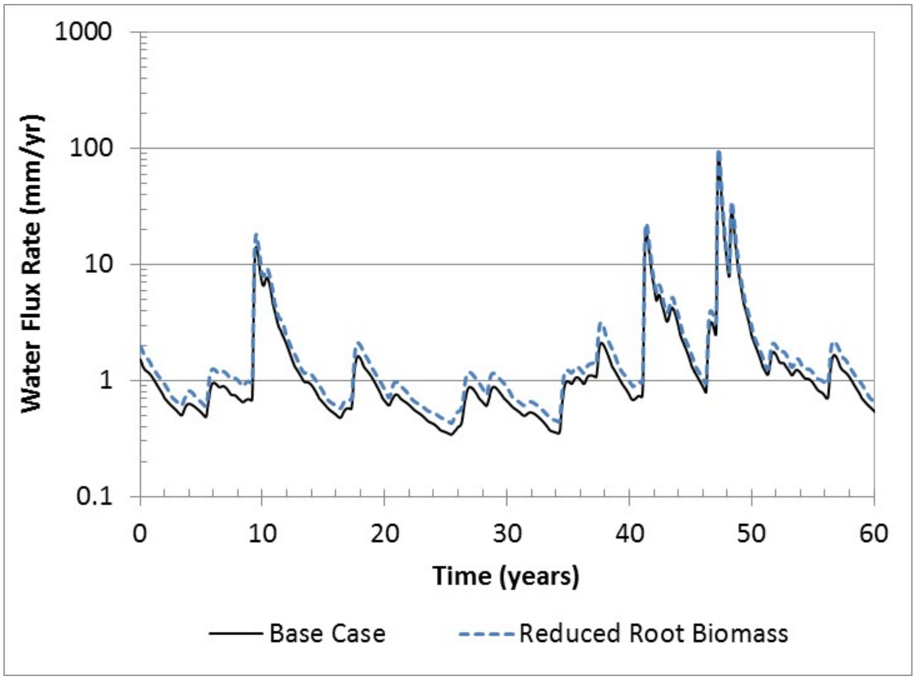

Figure 3. Model simulated water flux rate exiting the bottom of the ET cover for the base case and reduced performance root biomass distribution scenarios

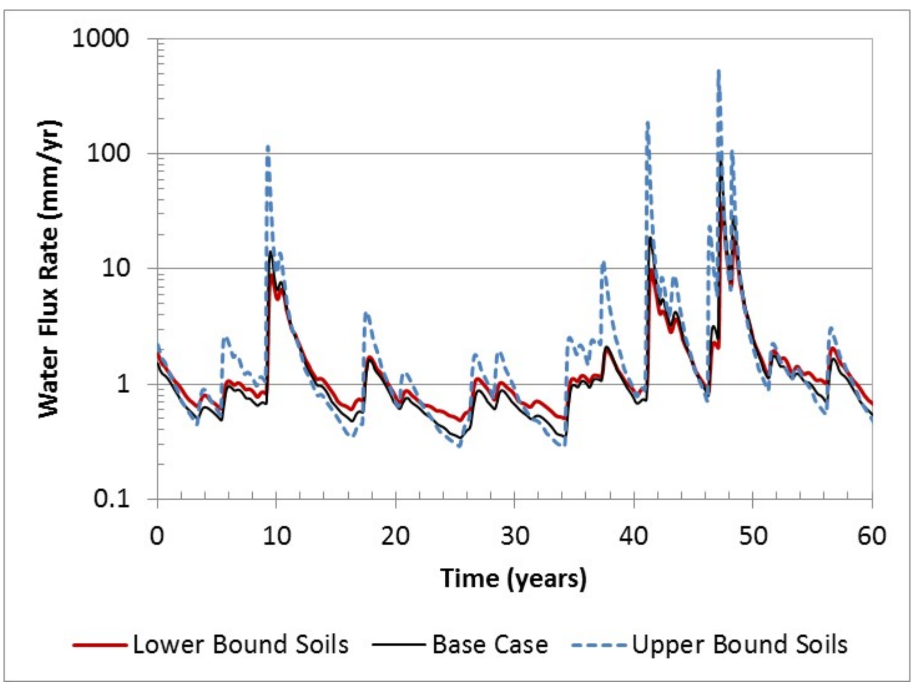

Figure 4. Model simulated water flux rate exiting the bottom of the ET cover for the base case and upper/lower bound soil hydraulic property scenarios

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DIVISION'S ASSESSMENT OF EFR RESPONSES TO RD 1 INTERROGATORY WHITE MESA REVISED ICTM REPORT; R313-24-4; 10CFR40 APPENDIX A, CRITERION 6(1); INT 02/1: COMPARISON OF COVER DESIGNS, SENSITIVITY ANALYSES, 'BATHTUB ANALYSIS', AND RADON EMANATION MODELING

Properties of Soils Proposed for Use in Cover Construction/ Infiltration Sensitivity Analyses

The hydraulic conductivity results from the August 2012 on-site soils testing provide useful information. However, EFR should provide additional information to allow the Division to further assess whether the parameterization of the hydraulic conductivity soil properties for use in the revised infiltration simulations is representative of long-term cover hydraulic conductivities that may occur in the cover during the postclosure period. Additional information provided should include the following:

- *For the Phase II soil sample testing to determine hydraulic conductivity, provide information on the diameter of, and the thickness of the prepared (recompacted) soils samples tested in the laboratory testing device (flexible-wall permeameter) that was used, and the specific ASTM D5084 Method testing procedure used in the testing; and*
- *Provide additional explanation and rationale to allow the Division to further assess whether the tested samples and tested sample sizes, and the soil samples themselves, may be considered as providing representative samples for estimating expected in-place long-term constructed conditions in the cover system proposed to be constructed using such soils. Consider the fact that the samples received by the testing laboratory were disturbed soil samples in 20-L buckets (Attachment B supporting EFR's Response to the Round 1 Interrogatory 02/1 on the Revised Reclamation Plan/Benson and Wang 2012), i.e., disturbed samples were used. Disturbed soil samples were used in the laboratory testing, rather than, for example, large (≥ 0.30 m- (12-inch-) diameter, ≥ 15 cm (6 inch-) thick undisturbed block samples of soil from an on-site compacted Test Pad constructed to simulate conditions in the cover system from which a large block undisturbed sample of compacted soil, if such a Test Pad were available, could have been collected for use in the testing.*

In supplying additional supporting information, EFR should consider relevant guidance such as that contained in Benson et al. 1994 and Benson et al. 1997, which recommend that small- diameter soil samples not be used in laboratory soil sample testing for hydraulic conductivity, and that for obtaining the most representative test results, laboratory testing should be conducted on undisturbed block soil samples of compacted soils (e.g., carved from oversized block samples excavated from an on-site compacted soil cover Test Pad) having a minimum diameter of 0.30 m (12 inches) and a minimum soil sample thickness of 15 cm (6 inches), and that ASTM D5084 [Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter], Method C procedures should be followed. These recommendations are intended to capture macropore characteristics of compacted clayey soil layers. Pending receipt and confirmation of testing results of samples performed using such procedures, the Division will consider that the April 2012 sample hydraulic conductivity testing results as preliminary and provisional and subject to unquantified uncertainty.

Based on review of EFR's Responses to the specific issues addressed in the first of this interrogatory, the Division has determined the following:

- *Additional information regarding details of the laboratory soil sample testing performed on the April 2012 soil samples needs to be provided for review to permit the Division to be able to independently evaluate whether the soil conditions assumed in the revised ET cover sensitivity analyses may or may not conservatively represent (bound) degraded soil cover conditions in the proposed ET cover [see the discussion provided in boldface text under '<u>Cover Soil Layer Properties</u>' above];*
- *EFR's finding that "…overall, these simulated values are slightly higher than measurements collected at the Monticello site for the last 12 years (average percolation rate of 0.63 mm/yr with a minimum and maximum rate of 0 and 3.8 mm/yr)" is not useful for corroborating the*

"reasonableness" of the revised predicted infiltration results. For instance, EFR has made no specific comparison between the in-situ soil conditions present at the subsurface infiltration test sites installed at the Monticello site and the soil conditions expected to occur within the degraded ET cover soils at the White Mesa site; and

- *In the revised ET cover infiltration analyses, EFR has not conducted and/or has not provided model output or details regarding an infiltration sensitivity case involving a scenario where water ponds on the proposed ET cover as a result of potential flattening of the cover surface due to future differential settlement within one or more areas of the tailings management cells [see the discussion provided under '<u>Revised Bathtubbing Analysis</u>' , in Section 3.3 under "Moisture Storage Capacity of Cover", and in Section 3.4, Other Cover Design-Related Issues, under "Cover Long-Term Erosion Protection Design Basis/Justification and Differential Settlement Issues Related to Infiltration Modeling Assumptions" below].*

EFR has conducted additional cover sensitivity analyses to assess effects of different assumed percentages of vegetation on the cover on predicted infiltration rates through the cover. However, EFR has not provided or supported sufficient details regarding the characteristics of the cover vegetation assumed in the revised infiltration sensitivity analyses. For example, the Division has concerns regarding the estimated root biomass (root density) values listed in Table 01/1/3-1 in EFR's September 10, 2012 Response to Rd Interrogatory 01/1 Item No.3 (see Section 1.3 above). Additionally, the ICTM report (or the Reclamation Plan) needs to provide: (1) definition of clear, concise, and measurable revegetation acceptance goals/criteria for the vegetation establishment on the tailings cell cover system, (2) a description of how EFR will conduct periodic post-closure monitoring and reporting to the Division of the vegetation community health, viability, success, and sustainability, (3) a description of proposed action plans, schedules and deadlines for remedial actions if/when needed to effectuate plant community success, and (4) similar follow-up monitoring of the plant community/cover system to ensure successful performance before release of the facility's surety bond and/or transfer of title to DOE. EFR should describe specific, quantitative goals for sustained shrub establishment (including rooting depths and minimum acceptable shrub cover percentages) that consider the need for deeper rooted plants to remove water that may accumulate lower in the cover profile in response to an exceptionally wet year or successive wet years. If that water is not removed, then it would be available for subsequent downward movement into the waste. At the same time, however, protection against biointrusion by roots of the compacted lower portion of the cover or the waste is required (see additional discussion below under "Potential Plant Root Penetration Depths"). The Division has concern that attempting to balance these competing objectives effectively in a cover system that has no capillary barrier would be very difficult or problematic. A capillary barrier, or a thorough justification for not incorporating one, is required by the Division. In developing the descriptions, plans, and goals for the vegetation establishment on the tailings cell cover, EFR should consider and address lessons learned from the post-closure monitoring and maintenance activities and corrective revegetation measures required at the Monticello, Utah tailings repository and other similar facilities in this regard (e.g., Waugh 2008; Sheader and Kastens undated, circa 2007; U.S. DOE 2007). EFR should assess the potential applicability and benefits of using vegetation health monitoring tools/metrics such as the Cover Vegetation Index recently implemented at the Monticello Repository (U.S. DOE 2009).

Corrective measures that may be needed to address/correct issues related to establishment of undesirable species, e.g., colonization by certain undesired grass/weedy species that may have more limited water stress tolerance than initially seeded grass species (e.g., Smesrud et al. 2012), seed or sprout predation following seeding/reseeding efforts, possible low success rates resulting from for shrub establishment efforts, etc., should be described.

Estimated costs for conducting these post-closure activities and corrective actions, and for reporting, once approved by the Division, will need to be incorporated in the financial surety estimate.

EFR also has not considered (as part of a possible upper bounding [reasonably worst-case] set of conditions), a scenario that includes no shrub vegetation on the cover (or alternatively, if adequately justified *based on data available for ET cover revegetation activities conducted at other similar sites, an assumed grass vegetation cover percentage value lower than the 30% lower bound value currently assumed). Such a scenario would be consistent with cover infiltration scenarios that have been performed in infiltration sensitivity analyses completed for other, similar facilities (e.g., for a proposed uranium mill tailings facility in Colorado [Kleinfelder 2009]). The Division also views this type of conservative scenario as appropriate and consistent with information provided in Sections 4.3.1 and 4.3.3 of U.S. DOE 1989 which indicate that "desert climates usually do not provide enough moisture to support plant reproduction except once every few years", and "…At very arid sites, vegetation on the cover may be sparse or absent (in the case of a sustained drought)".*

Additionally, the soils proposed by EFR for use in constructing the ET cover are extremely low in natural organic matter (OM) content, e.g., compared to soils used for constructing the Monticello Tailings Repository cover system e.g., zero to about 0.4 % according to Table D-5 in Appendix D of the Revised ICTM Report, compared to a recommended minimum OM content of from approximately 1.5 to 3.0%). These factors indicate that, given the natural climate conditions at the site (which could include possible prolonged (e.g., decadal to multi-decadal) future drought periods likely to create conditions unfavorable for sustaining plant growth in the cover), and without substantial and extensive OM enhancements incorporated into the soils prior to cover construction and possible periodic active post-closure intervention/maintenance measures such as reseeding, possible irrigation of the cover, etc…, the on-site soils tested to date appear to be unfavorable for use in constructing the ET cover. Use of such soils could result in a cover that is detrimental for vegetation growth and sustainability, especially during possible future drought periods.

The Division requests that EFR provide the additional information requested in the discussion under '<u>Cover Soil Layer Properties</u>' above and conduct the additional infiltration sensitivity analyses discussed in Section 3.3 under '<u>Revised Bathtubbing Analysis</u>' , under "Moisture Storage Capacity of Cover", and in Section 3.4, Other Cover Design-Related Issues, under "Cover Long-Term Erosion Protection Design Basis/Justification and Differential Settlement Issues Related to Infiltration Modeling Assumptions" below. Based on the results of developing and providing this additional information and completing these additional sensitivity analyses, EFR should revise their conclusions and interpretations and proposed technical approach and/or revise the currently proposed cover design accordingly to reflect the new information/modeling results.

<u>Potential Plant Root Penetration Depths</u>

Aspects of EFR's response to this interrogatory related to cover infiltration sensitivity analyses do not sufficiently address the Division's concerns with respect to the potential impacts on the cover from future plant root penetration. Assumptions made by EFR regarding the potential depth of bioinvasion by plants do not appear to be supported and do not appear to be accurate.

Jackson et al. (1996) discussed plant root depths in grasslands, deserts and other biomes. They reported on studies showing that plant roots can penetrate earthen materials very deeply, even in compact clay, hard pan or rock, and emphasized that many plants send tap roots down to great depths if needed to reach the groundwater table. They reported such depths to be up to 7 m for trees, 5 m for shrubs, 2.5 m for herbs, and 2 m for crops.

Goodwin (1956), according to Tabler (1964), indicated that Big Sagebrush roots apparently can penetrate indurate layers by slow vertical extension.

Schenk and Jackson (2002) indicated that the 90% range for root-system depth for forbs and semi-shrubs in areas of low water availability extends to 3.7 meters, with some significant percentage of other forbs and semi-shrubs penetrating to deeper depths. They also indicated that the 90% range for root-system depth for shrubs in areas of low water availability extends to 7.2 meters, with some significant percentage of shrubs penetrating deeper, with many tree roots tending to grow considerably deeper into soils, with the 90% range extending down to nearly 17 meters, with a maximum depth of about 58 m. these documented root-system depths far exceed the currently modeled one-meter root depth. Schenk and Jackson (2002) indicate that

"“...root channels and macro-pores are likely to act as conduits for water recharge deeper than predicted by simple infiltration models."

Hakonson (2002) suggested that most plants, including common plants as well as phreatophytes, are capable of sending down roots much more deeply than is generally anticipated if it is necessary for plants to do so to reach and acquire water. With respect to 2-m thick cover system in New Mexico, he indicated that"most 'shallow rooted' plant species have the capability to send roots much deeper than the couple of meters of cover proposed."

In an extreme case in fractured terrain, Phoenix (1955) reported that in the interior of Calamity Mesa, Colorado, miners encountered roots in fractures at depths of about 50 feet.

In contrast to the 1.8 meters assumed in the response, others have reported greater maximum rooting depths for big sagebrush. Cook and Lewis (1963) indicated that roots of big sagebrush were found in their study down to depths of 183 cm (6 feet). Sturges (1977) reported root depths of big sagebrush down to 213 cm. Campbell and Harris (1977) stated that roots of big sagebrush species have been found to extend to depths greater than 3 meters. Reynolds and Fraley (1989) reporedt big sagebrush root depths in their study down to 2.25 meters.

Others have reported even deeper rooting depths for big sagebrush. For example, Cook and Lewis (1963) reference work by Weaver and Clements (1938) who indicated Big Sagebrush roots extending to depths of 5 to 11 feet.

Figure 2 of Plate XLIV of Kearney et al. (1914) is said to be a copy of a photograph of Big Sagebrush at the edge of a stream near Nephi, Utah, where some of the stream banks had, at the time the photo was taken, recently caved in. The photo shows a Big Sagebrush taproot extending downward a great distance along the remaining cut bank edge. The figure caption states the distance is about 11 feet, while the text describes the distance as over 15 feet. Both depths are significantly large.

Tabler (1964) references work of Shantz and Zon (1924) who reported Big Sagebrush roots extending to depths of 4 to 18 feet. Foxx and Tierney (1984; 1985) claimed documentation in their database of reports of Big Sagebrush putting down roots to 914 centimeters (30 feet).

Please further address issues associated with plant bioinvasion of the cover system, including additional infiltration sensitivity analysis, to account for the potential for deeper-rooted plant penetration based on this and possibly other additional published information. Note that Big Sagebrush has been reported to send roots down deeper than 3 meters (9.84 feet), which, according to the Revised ICTM Report, is deeper than the base of the White Mesa cover system soil package, as currently planned in the Revised ICTM report, and as described for some areas of the cover and depicted on Sheet TRC-7 from the Revised Reclamation Plan (Denison Mines 2011).

Range of Possible Future Climate Conditions at White Mesa Site

Based on the review of the Response and the information provided in Attachment G, and selected published information, the Division has concern that EFR has not adequately addressed uncertainties associated with future climate conditions that may occur at the White Mesa site during the closed tailings embankment’s required service life (200 to 1,000 years). The Division has concern , that EFR has consequently not adequately addressed the types and ranges of plant responses that might occur for vegetation that would be established on the ET cover and in the surrounding terrain as a result of the potential changes in climate conditions during that required service period. Rather, EFR has primarily focused on the results of selected climate models/ hydrological model simulations which have several associated uncertainties and that are limited to timeframes of on the order of about 100 years, and has attempted to extrapolate findings from those selected climate model simulations to apply to, and to be representative of, conditions over a much longer time period than for which those simulation results were intended to apply. In so extrapolating those findings, EFR has not provided supporting technical justification, described what assumptions are involved, *or quantified what uncertainties are involved in attempts to project those findings/assumed conditions over that much more extended time period.*

As part of the review of this Response, the Division conducted a preliminary literature review of additional published information on climate models, and in particular, of some of the uncertainties associated with the use of such climate models. A summary of some of the uncertainties associated with such model, based on this review, is provided in the inset text below.

Discussion of Some Uncertainties Associated with Current Climate Models

Climate model practitioners and investigators acknowledge that there are several uncertainties associated with current climate models of the types that were cited in EFR's response and described in further detail in Attachment G of the Response. For example, MacDonald (2010) indicated that Cayan et al. 2010 considered the warming that has occurred during the Early 21st - Century Drought as part of the basis for their conclusions, but that although the warming that has occurred during that period is consistent with the warming that occurred during other periods of regional aridity in portions of the southwestern U.S. in the 20th century (e.g., 1900-9014; 1924-1936; 1953-1964, and 1988-1991), the amount of warming and the magnitude and prolonged nature of the high temperatures of the Early 21st-Century Drought have no analog in the 20th century. Woodhouse et al. 2010 used paleoclimatic records to show that the current warming in the Southwest may exceed any other warming episode experienced over the past 1,200 years.

Seager and Vecchi (2010) suggest that the great North American droughts of the past 200 years were caused by very small sea surface temperature (SST) anomalies in the eastern Pacific Ocean. They indicate that there has been a general cooling trend in the eastern Pacific following 1979 and that such cooling typically is associated with drought in the North American Southwest (NASW). MacDonald (2010) indicates that the drivers of such SST anomalies remain poorly understood, as does the potential impact of increasing greenhouse gasses on Pacific SSTs. Seager and Vecchi (2010) conclude that the general drying in recent decades and the 21st-Century Drought could be a result of natural decadal variability in Pacific SSTs.

In millennial-scale climate model simulations, Coats et al. (2012) found that the climate forecast model they used, although capable of simulating megadroughts through a persistent anomalous SST forcing in the tropical Pacific (e.g. the late 6th-century drought in the control run and the late 13th-century drought in the forced run), indicated that other mechanisms in the model could produce similarly extreme moisture anomalies in the NASW. Coats et al. (2012) noted a number of other uncertainties associated with the climate models being currently in use such as: (i) In the observational record, persistent droughts in the NASW have been tied to cool tropical Pacific SSTs but it is not known if this relation holds for the entire last millennium; (ii) There is observational evidence that warm tropical Atlantic SSTs can create a tendency towards dry conditions in the NASW (Seager et al. 2008; Kushnir et al. 2010; Nigam et al. 2011); and (iii) Longer records of proxy estimated tropical Pacific SST are needed to assess the state of El Nino Southern Oscillation (ENSO) during megadroughts and to determine how coherent previous NASW drought and ENSO variability may have been prior to the observational record.

As noted in Coats et. al. 2012, Cook et al. (2009) also indicated that although IPCC [AR4] climate models robustly predict a shift towards dry conditions in NASW, there is no agreement on the future state of the tropical Pacific, despite the strong connection between ENSO and NASW hydroclimate. Hunt (2011) also analyzed global multi-year drought and pluvial occurrences in a 10,000- year control run of the CSIRO AOGCM and found that persistent hydroclimate features can result from internal climatic variability, with stochastic atmospheric variability playing an important role.

Coats et al. 2012 indicated that model intercomparison employing multiple coupled Atmosphere Ocean General Circulation Models (AOGCMs) is needed to determine if stochastic atmospheric variability similarly influences NASW drought occurrences in the most recent generation of AOGCMs.

In summary, there are numerous uncertainties and complexities associated with the use of all regional climate models with regard to their ability to reliably forecast longer-term future climate conditions in the

NASW and at the White Mesa Site. The above discussion appears to corroborate an earlier assessment of the uncertainties associated with future climate modeling as developed and discussed in U.S. NRC 2003b. For this reason, attempts to extend the results from climate model predictions forecasting climate conditions through the end of the 21st century to timeframes of 200 to 1,000 years will likely result in further compounding of these uncertainties and is likely to result in highly unreliable predictions.

The above discussion is also generally consistent with previous assessments of the uncertainties associated with future climate modeling completed for the proposed Yucca Mountain Repository as described in NRC 1997 and by the Center for Nuclear Waste Regulatory Analysis (CNRWA) 2005. Those assessments provide some useful guidance and insights with respect to the forecasting potential future climate change at Yucca Mountain and for other sites. These assessments are summarized in the following paragraphs.

NRC staff, when evaluating methods for estimating future climates at Yucca Mountain in an Issue Resolution Status Report in 1997 (NRC 1997), concluded that careful consideration of indicators of past climatic conditions provides adequate information to bound the likely range of future climate conditions. The NRC staff also concluded that although anthropogenic influences on climate (i.e., emission of greenhouse gases such as carbon dioxide and methane) could overwhelm natural climate cycles inferred from the past 1 to 2 million years, the anthropogenic influences on climate are likely to diminish over the next few thousand years, allowing natural cycles to be reestablished. This conclusion was found to be consistent with the results of an expert elicitation study on future climate (Dewispelare, et al. 1993) in which three of the five participating experts believed that the principal effects of greenhouse gas emissions would dissipate in 3,000 to 5,000 years. The other two experts believed that the effects would last much longer.

The 1997 NRC review also commented on the role of mathematical climate models in estimating future climate. Based on the state of the art at the time, the NRC staff believed that "…attempts to use GCMs [global circulation models] to predict climate changes over tens of thousands of years would almost certainly remain controversial, leading to debate over the competence of one model and data set vs. another" (NRC 1997, p. 13). The help resolve this concern about mathematical climate models, NRC provided (1997) the following acceptance criterion:

- *The staff will not require climate modeling to estimate the range of future climates. If DOE uses numerical climate models, determine whether such models were calibrated with paleoclimate data before they were used for projection of future climate, and that their use suitably simulates the historical record (NRC, 1997, p. 6).*

Subsequent work by the NRC (NRC 2003b) and a 2005 independent review report (CNRWA 2005) reexamining the NRC 1997 evaluation of methods for estimating future climate change (at Yucca Mountain) found that, in terms of the characteristics of future climates (i.e., mean annual precipitation and temperature, seasonal weather patterns, and storm intensities), the characteristics inferred from paleoclimate reconstructions and present day analog records may represent the range of climate conditions that will occur in the future, even if the timing of these climates cannot be reliably estimated. The greatest uncertainty in future climate conditions relates to anthropogenic effects that may result in climates in southern Nevada that do not have analogs with present or Pleistocene climates, such as prolonged El Niño conditions. The nature, likelihood, and duration of such nonrepresentative climate conditions cannot be reliably assessed based on current research. Over longer time periods, the range of conditions inferred from the Pleistocene paleoclimate record reasonably bounds future climate during the period of geologic stability.

A primarily concern that was identified with respect to use of mathematical climate models was that such models could predict a prolonged period of semi-arid conditions at Yucca Mountain (at least over the next 10,000 years) that would not lead to a reasonably conservative estimate of net infiltration. The acceptance criterion that was established in the Yucca Mountain Review Plan (NRC 2003b) to address this concern is (CNRWA 2005):

- *"Verify that paleoclimate information is evaluated [over the past 500,000 years for the Yucca Mountain Repository case] as the basis for projections of future climate change." For example, confirm that numerical climate models, if used for projection of future climate, are calibrated based on such paleoclimate data (NRC 2003b, p. 2.2-58) [Italics added]."*

The preferred approach that was selected by the NRC for characterizing future climate conditions in assessing the performance of the potential repository was to rely on paleoclimate data to estimate the likely range of future climate conditions.

In addition to the above considerations, the EFR Response and the discussion in Attachment G do not specifically adequately address the known, long-term recurrent nature of pluvial (anomalously wet periods) climatic events. Persistent, multi-decadal drought and multi-decadal pluvial events have been a recurrent feature of North American hydroclimate since at least the time of the Medieval Climate Anomaly (e.g., see Cook et al. 2010; Schwinning et al. 2008). For example, the early twentieth century pluvial period (1905–1917), briefly described in EFR's Response (p. 12 of 70) in general terms as an early 20th century wetter period, was likely one of the largest pluvial events in the last thousand years (Woodhouse et al. 2005), where the climate in almost the entire western region of the U.S. was wetter than normal. The major wet anomaly for this pluvial period extended along an axis from the southwest and into the northern Great Plains (Cook et al. 2010). The time period for this pluvial event exceeds 10 years.

Peterson (1994) also evaluated paleoclimate and paleocultural information to define a Little Climate Optimum or Medieval Warm Period (A.D. 900 to A.D. 1300) as having occurred in the northern Colorado Plateau region of the southwestern U.S. During the height of that period, the region was characterized by greater winter and greater summer precipitation than today.

For the above reasons, EFR's choice to simulate an increased precipitation scenario by repeating the Blanding 1993 winter precipitation of 296 mm and PET data for a five-year period as part of the 57-year infiltration simulation [using climate data spanning the years 1932-1988]), as discussed above, is not clearly and transparently supported or demonstrated.

Based on the above considerations, the Division requests that EFR:

- *Reevaluate and further define an appropriate reasonably conservative upper bounding future climate condition using a method that is consistent with that described in the guidance outlined in NRC 1997 and NRC 2003b. Specifically, please provide additional information demonstrating, as appropriate, that any numerical climate models or results derived from any such models, if used as a basis for projecting future climate conditions at the White Mesa site be clearly calibrated to paleoclimate data; and*
- *Provide additional information, as appropriate, to support the contention made in this Response that "the 1993 winter precipitation of 296 mm and PET data for a five-year period as part of the 57-year infiltration simulation [using climate data spanning the years 1932-1988]) is anticipated to be similar to a Holocene wet climate scenario (up to about 13,000 years ago) based on information presented by Waugh and Peterson (1995)".*

<u>Porosity of Tailings (Item No. 2 of Interrogatory 02/1)</u>

The Division views the base case and range of porosity values used in the revised analyses to be reasonable and consistent with porosity values assumed in radon emanation analyses competed for similar facilities in Utah (e.g., NRC 2008) and is similar to the default porosity value of 0.40 (40%) recommended for tailings for use in radon emanation modeling in Regulatory Guide 3.64 (NRC 1989). For evaluating potential for bathtubbing, a lower tailings total porosity value is more conservative than a higher porosity value (e.g., porosity estimate of 57% previously assumed).

The tailings dewatering systems in Cells 2 and 3 are known to be much less efficient at dewatering the tailings in those cells than the tailings dewatering systems in Cells 4A and 4B are expected to be (based on *calculations). The Division interprets the current low efficiency of the tailings dewatering systems in Cells 2 and 3 as indicating that significantly longer amounts of time will be required to dewater tailings in Cells 2 and 3 compared to the time (estimated to be on the order of 5 ½ years) needed to dewater tailings in Cells 4A and 4B. Greater uncertainty exists regarding final thicknesses of the saturated portions of the tailings in Cells 2 and 3 when final cover placement would take place over these cells. Consistent with the intent of guidance contained in Sections 2.1 and 4.1 of NRC 2003a, more conservative upper bound saturated thicknesses should be estimated and evaluated in the bathtubbing analysis, based on extrapolation of current dewatering system rates, more detailed tailings dewatering analyses (see below) and that reflect the degree of uncertainty associated with the future dewatering of tailings in Cells 2 and 3.*

Additionally, EFR needs to provide additional information and details regarding the specific range of in-situ tailings properties and conditions used in the tailings dewatering analysis for Cells 2 and 3, including the range and distribution of hydraulic conductivity values (related to the range of possible distributions of sand vs. slimes tailings) assumed in the analysis. The analysis provided by EFR does not adequately reflect the variable tailings conditions that may exist in Cells 2 and 3, the dewatering model for Cells 2 and 3 appears to be overly simplistic, and the input parameters for the tailings properties used in the analysis appear to be estimated values and not based on site-specific testing of the tailings. The absence of in situ testing of the tailings properties is not consistent with guidance contained in Sections 2.1.2 through 2.1.4 of NRC 2003a. The possible maximum saturated thicknesses of tailings in Cells 2 and 3 prior to cover placement need to be estimated in more conservative manner (and incorporated accordingly into sensitivity analyses) to account for uncertainties associated with the continued effectiveness of the dewatering systems in Cells 2 and 3. A conservative range of possible in-situ residual tailings hydraulic conductivity conditions/distributions in Cells 2 and 3 needs to be considered in the analysis.

Revised Bathtubbing Analysis

Additionally, for assessing the potential for bathtubbing, the Division recommends that the value of infiltration used in the bathtubbing analysis scenario be the highest average infiltration rate obtained from the full range of model infiltration sensitivity analysis scenarios considered. The Division recommends that the same analysis scenario include a combination of: (i) maximum (upper bound) assumed hydraulic conductivities for the cover soils; (ii) an assumption of no grass vegetation on the ET cover; (iii) a flattened topslope inclination (unless the topslope inclinations in the current proposed cover design are increased to a minimum of 2 to 3 %); and (iv) an assumption that liner conditions in the tailings cells have the lowest defect sizes and frequencies and least permeable soil/GCL underliner values (effectively yielding the lowest overall calculated leakage rates) that EFR determined in its cell liner leachate leakage analyses.

Additional information needs to be provided on effects of expected higher infiltration rates through the (rock riprap-covered) sideslope areas on bathtubbing under such assumed reasonably worst-case conditions as described in the previous paragraph. Specifically, EFR needs to provide additional information on infiltration rates through the sideslope portions of the proposed cover and the potential effects (depending on geometric relationship of sideslope areas relative to areas covered by the cell liners) of such infiltration on bathtubbing, under the reasonably worst-case assumed conditions described in the above paragraph.

Missing Information in Attachment E-1

EFR provided the information was inadvertently omitted from Attachment E-1 of Appendix E of the Revised ICTM Report. The missing information was submitted as part of EFR's Response to the Rd 1 Interrogatories on the Revised (Rev 5.) Reclamation Plan (submitted to the Division on August 31, 2012),

Response:

Test Methods for Hydraulic Properties

As noted in the response above to review comments on Interrogatory 01/1, EFRI engaged Dr. Benson in the cover design for the White Mesa tailings cells with regards to selection of and evaluation of laboratory testing of the cover materials. Dr. Benson presented information on the hydraulic properties testing for the White Mesa cover soils at the April 2013 workshop with the Division. A summary of this discussion and some additional information is in the paragraphs below in this response (Test Methods for Hydraulic Properties and was prepared by Dr. Benson.

Hydraulic properties testing conducted for White Mesa consisted of conventional-scale tests on laboratory-compacted specimens prepared from disturbed samples delivered to the laboratory in 20-L buckets, which is conventional practice for the design phase. Each sample was carefully blended in the laboratory to eliminate any effects of segregation during shipping. Test specimens for measuring hydraulic properties were prepared at 85 percent relative compaction per standard Proctor (ASTM D698) to simulate the lower density and structure present under natural conditions, as recommended in Albright et al. (2010). Specimens for determination of saturated hydraulic conductivity were 152 mm in diameter and those for the soil water characteristic curve were 73 mm in diameter. These are conventional specimen sizes used for design and prediction. The compaction condition was selected to ensure that the structure in these specimens would be representative of long-term in-service conditions following the ACAP recommendations in Albright et al. (2010).

Large-scale undisturbed block samples are appropriate for evaluating the field hydraulic properties of as-built and in-service soils in final covers. They are removed from the as-built cover profile, and therefore are not yet available for testing or analysis for White Mesa. EFRI will collect large-scale undisturbed block samples during construction of the test section within the cover at White Mesa using the method described in Benson et al. (1994, 1995) and ASTM D7015-13 [Standard Practices for Obtaining Intact Block (Cubical and Cylindrical) Samples of Soils]. These samples will be tested at large-scale in the laboratory to obtain hydraulic properties representative of field-scale conditions following the methods described in NUREG/CR-7028 (Benson et al. 2011). Results of these tests will be compared to the hydraulic properties measured during design and used in the analyses to confirm that the hydraulic properties of the as-built cover and test section are consistent with the hydraulic properties used in the analysis. In addition, the surveillance program for the test section will include periodic sampling and testing of the cover soils using large-scale block samples. Results of the tests on these samples will also be compared to the hydraulic properties used in the analyses to confirm that the properties of the in-service cover are consistent with the assumptions used in the analysis.

EFRI believes that the comparison with the in-service soil properties from the cover at the DOE's Monticello Uranium Mill Disposal Tailings facility is valid and that the Monticello facility is the most appropriate analog available for the White Mesa facility. Broadly graded alluvia with fines of low plasticity (Gurdal et al. 2003) were used for the storage layers in the final cover at Monticello, and similar soils are proposed for White Mesa. In addition, the -40 fraction of the Monticello cover soils have a mean liquid limit =

32 and plasticity index = 17, which compares favorably to the mean liquid limit = 30 and plasticity index = 13 for the White Mesa soils.

The in-service hydraulic properties for the Monticello soils (Benson et al. 2008) also compare favorably with the properties measured for the White Mesa soils. For example, the in-service saturated hydraulic conductivities measured at Monticello using large-scale field and laboratory tests are compared in Figure 1 to those measured in the laboratory and used in the analysis for White Mesa. Except for two very permeable samples at the near surface, the Monticello soils have lower saturated hydraulic conductivity than those used in the analyses for White Mesa. The van Genuchten α parameter for White Mesa (Figure 2) is larger than the α parameter for Monticello, representing a soil with more structure (larger maximum pore sizes) than Monticello, and the n parameter for White Mesa is comparable to the n parameters measured for Monticello (Figure 2), representing a similar distribution of pore sizes in both soils.

Saturated volumetric water contents for the White Mesa soils are compared to the in-service conditions at Monticello in Figure 3. The range for White Mesa is broader than for Monticello, and the in-service conditions at Monticello fall at the upper end of the range used for White Mesa. Consequently, conditions simulated in the analyses for White Mesa have lower soil water storage capacity than those for Monticello, and therefore the predictions for White Mesa will be conservative (higher percolation rate into the disposal facility and greater leachate flux to groundwater).

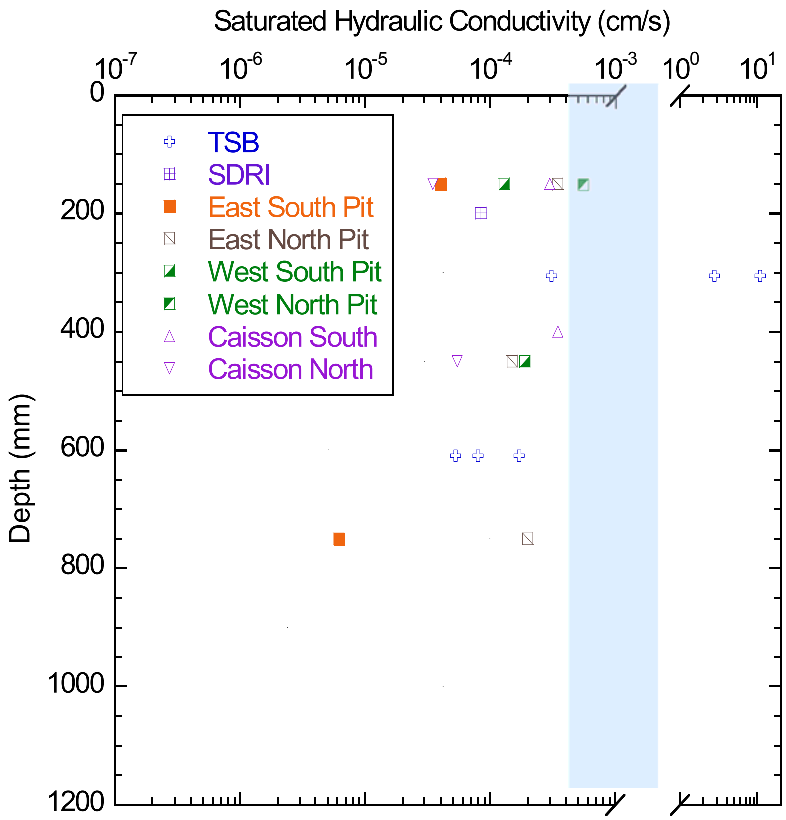

Figure 1. In-service saturated hydraulic conductivity of final cover soils at the Monticello Disposal Facility along with blue band showing range of saturated hydraulic conductivity for White Mesa

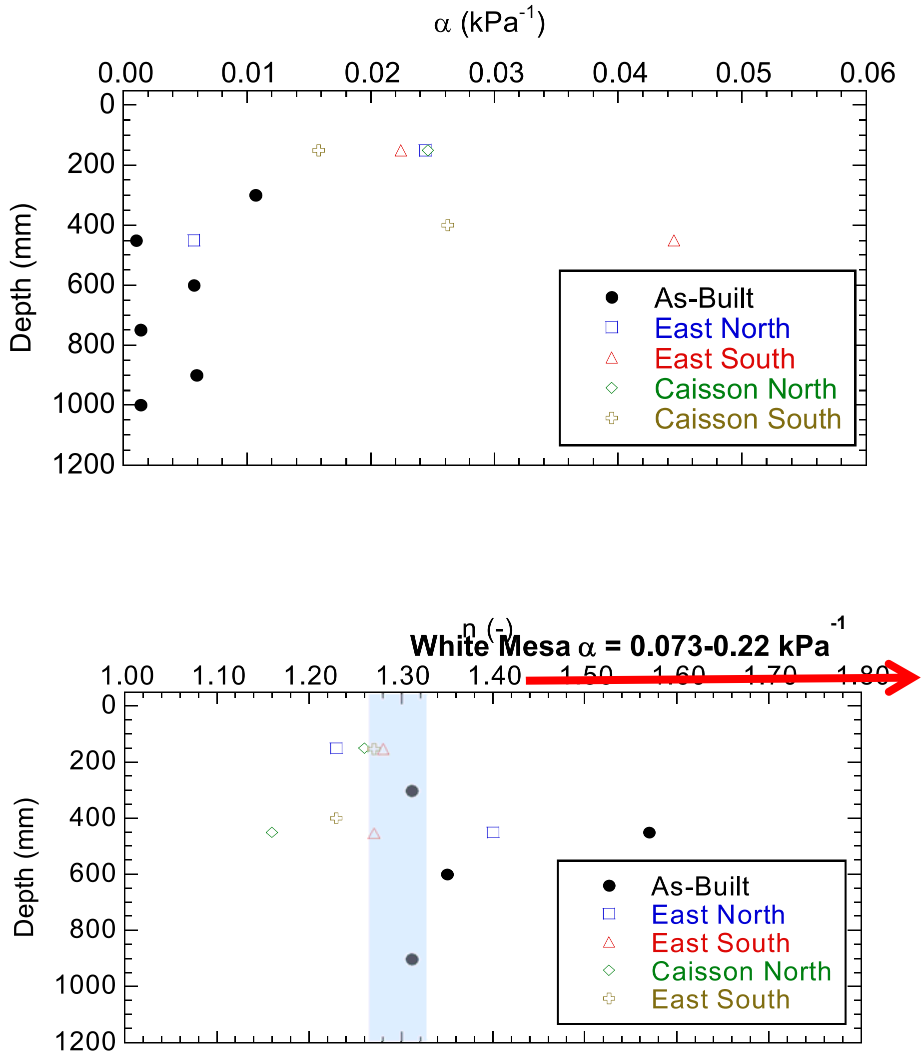

Figure 2. In-service van Genuchten α and n parameters for final cover soils at the Monticello Disposal Facility along with blue band with range of n for White Mesa. Tests on Monticello soils conducted in large-scale equipment on samples collected as large-scale blocks.

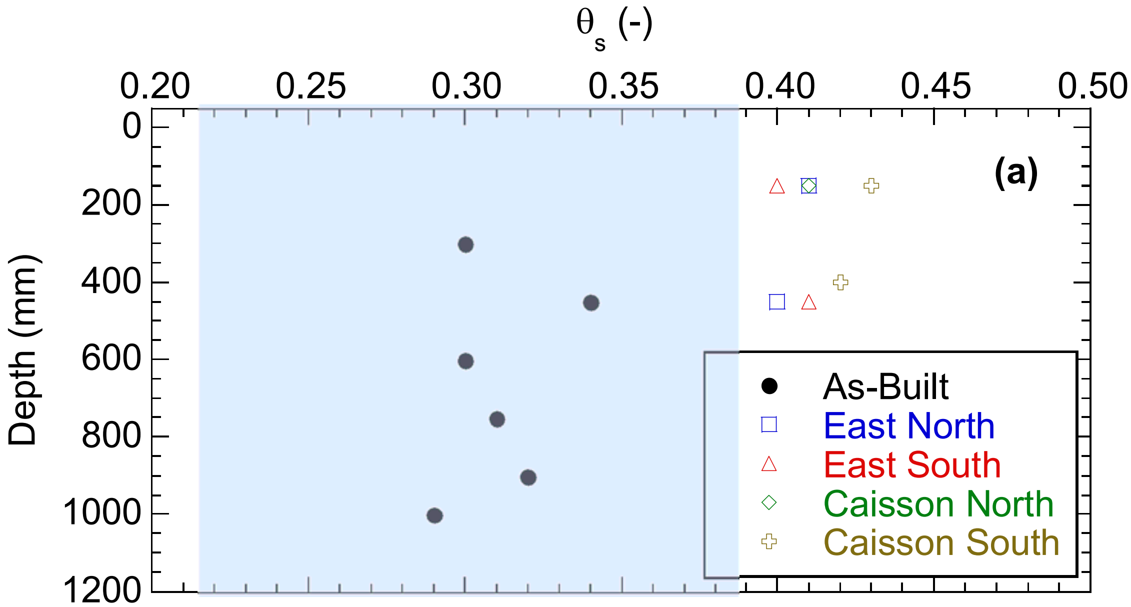

Figure 3. In-service saturated volumetric water content for final cover soils at the Monticello Disposal Facility along with blue band with range for White Mesa. Tests on Monticello soils conducted in large-scale equipment on samples collected as large-scale blocks.

Differential Settlement of Cover Surface

Settlement analyses have been revised to incorporate recently collected data and address the Division's review comments on responses to interrogatories for the Reclamation Plan, Revision 5.0. The revised analyses are presented in Attachment E of the August 2015 response document for Reclamation Plan, Revision 5.0. Results indicate that estimated differential settlement is sufficiently low that ponding is not expected to occur on a minimum cover slope of 0.5 percent.

Vegetation and Biointrusion

Estimated root biomass is presented in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

Appendix D (Vegetation and Biointrusion Evaluation) to the Updated Tailings Cover Design Report (Appendix D of the Reclamation Plan, Revision 5.0) has been modified to include information on revegetation acceptance goals/criteria that include shrub establishment goals. The revised Vegetation and Bionintrusion Evaluation appendix is provided as Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

A post-closure monitoring plan is included in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

Quantitative goals for sustained shrub establishment are described in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0 and include establishment of a minimum of 500 stems per acre. Two shrub species, fourwing saltbush (*Atriplex canescens*) and rubber rabbitbrush (*Ericameria nauseosa*), have been added to the proposed seed mixture. Both species have the potential for deep root penetration (e.g. six meters) when soil conditions allow (Kearney et al., 1960) but are not expected to root into the compacted radon attenuation layer because the targeted bulk density of the compacted zone of 1.8 gm/m^2 will inhibit root penetration (Mimore et al., 1969; Heilmen, 1981).

Corrective measures that may need implemented to control undesirable weedy species are addressed in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

Seed or sprout predation following seeding is not expected to inhibit successful reclamation of the tailing cells. Seed will be covered with soil and not left on the soil surface for predation to occur. If seed predation negatively affects revegetation success, then sites will be reseeded until a satisfactory stand of vegetation is achieved.

Two shrub species have been added to the proposed seed mixture. Fourwing saltbush and rubber rabbitbrush are easily established from seed and grow relatively quickly when compared to other shrub species. Monsen et al. (2004) rate both species as good to excellent in the categories of ease of seeding, initial establishment, final establishment, persistence, and growth rate. Therefore, low success rate is not expected from these species.

Changes in the relative cover of common weed species at the Monticello site are summarized from previous monitoring reports (DOE, 2003; DOE, 2004; DOE, 2005a; DOE, 2005b; DOE, 2006; and DOE, 2008) and presented in Table 1. These results demonstrate that weed species at the site remain well controlled.

Table 1. Changes in Weedy Species Over Time (Relative Cover Percentages, Zones A1 and B Combined from Monticello Disposal Cell Cover Revegetation

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008	Trend
Aegilops cylindrical	---	---	---	0.8	---	1.9	---	---	0.1	Not abundant; not increasing
Amaranthus bitoides	8.1	1.7	0.8	---	---	---	0.5	---	---	Nearly eliminated after two growing seasons
Bromus tectorum	1.9	18.3	4.5	18.2	35.6	56.3	15.5	21.0	12.8	Abundant weed peak in 2005
Chenopodium album	4.6	2.9	4.2	2.4	0.2	---	0.5	---	---	Nearly eliminated after four growing seasons
Convolvulus arvensis	---	---	---	---	0.2	0.2	0.5	0.5	---	Not abundant; not increasing
Lactuca serriola	---	---	0.1	1.9	1.9	1.6	1.0	---	1.4	Not abundant; not increasing
Salsola tragus	36.0	69.9	48.2	33.3	8.2	0.1	6.5	---	---	Once abundant; nearly eliminated in 2007/2008
Sisymbrium altissimum	---	3.8	---	1.7	3.1	2.8	6.5	0.5	0.2	Not abundant; not increasing; peak in 2006

Taken from DOE 2008

The following is taken from DOE (2008): "In Utah, weed law has recently been revised to reflect categories of weeds targeted for control. The main management goal for Category C weeds is not to eradicate the weed but to prevent its spread. Small quantities of *Convolvulus arvensis* (field bindweed), a Category C noxious weed, have been observed on the site since 2002, but this species has not spread. One San Juan County listed noxious weed, *Aegilops cylindrica* (jointed goatgrass) has been observed on the site since 2003 in small quantities and also has not spread. Another Category C noxious weed species, *Cirsium arvense* (Canada thistle), was observed and treated in 2006, and it has subsequently not been observed. One Category A noxious species, *Centaurea stoebe ssp. micranthos* (spotted knapweed) was discovered near the site's entrance gate and treated in 2008. Populations of *Acroptilon repens* (Russian knapweed), a Category B species, were treated near the office building in 2008. Neither of these noxious species has spread into the revegetated areas, and they will continue to be monitored and treated for eradication from the site. DOE will continue to monitor and manage the entire site, including portions of the site where vegetative success criteria have been met, for all noxious weed species."

Based on the success achieved at Monticello in controlling weeds, it is unlikely that the presence of weeds at the Mill Site will negatively affect revegetation goals, and the proposed weed management plan will help ensure revegetation success.

The suitability of the soil cover for sustained plant growth and the need for additional organic matter are discussed in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

The article by Jackson et al. (1996) cites other papers that discuss root growth through hardpans, caliche layers and fissures/cracks in rocks. Jackson's paper and none of the other papers talk about compacted clay or present bulk density values for any soils being referenced. It is common for roots to grow through hardpans and caliche or into rock fissures. In addition, many articles show extreme ranges in root growth, but these do not represent typical conditions and certainly will not represent conditions associated with the ET cover. As stated earlier and below, the radon attenuation layer will consist of soil that will be compacted to a bulk density that will inhibit root growth as demonstrated in cited literature in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

Further discussion is presented on soil compaction and root growth in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

Possible Future Climate

EFRI agrees that there are numerous uncertainties and complexities associated with the use of all regional climate models with regard to their ability to reliably forecast longer-term future climate conditions in the North American South West (NASW) and at the Mill site. Therefore, attempts to extend results from climate model predictions forecasting climate conditions through the end of the 21st century to timeframes of 200 to 1,000 years will likely further compound uncertainties and result in unreliable predictions. EFRI identified this concern in earlier discussions with DWMRC on the topic of climate change.

EFRI has reviewed the cited references on estimating the range of future climates (CNRWA 2005; NRC 2003; NRC 1997). The Center for Nuclear Waste Regulatory Analyses (CNRWA 2005) conducted an analysis of factors contributing to uncertainty in estimating future climates at Yucca Mountain. Their report concludes the following:

> "In summary, research performed within the last five years suggests that the timing of climate changes over the next 100,000 years may be difficult to infer from the patterns of climate change over the last 500,000 years due to the unusually low eccentricity of Earth's orbit and, possibly, the influence of anthropogenic greenhouses gases. After 100,000 years, the Earth's orbital climate forcing will be stronger, and the influence of greenhouse gases may have diminished so that the Pleistocene climate history may offer a better analog in terms of timing of climate changes. In terms of the characteristics of future climates (i.e., mean annual precipitation and temperature, seasonal weather patterns, and storm intensities), the characteristics inferred from paleoclimate reconstructions and present day analog records may represent the range of climate conditions that will occur in the future, even if the timing of these climates cannot be reliably estimated. The greatest uncertainty in future climate conditions relates to anthropogenic effects that may result in climates in southern Nevada that do not have analogs with present or Pleistocene climates, such as prolonged El Niño conditions. The nature, likelihood, and duration of such non-representative climate conditions cannot be reliably assessed based on current research. Over longer time periods, the range of conditions inferred from the Pleistocene paleoclimate record reasonably bounds future climate during the period of geologic stability."

We agree with NRC's preferred approach of using paleoclimate data to estimate the likely range of future conditions. In fact, the previous interrogatory response (EFRI 2012), in regard to possible future climate scenarios, was predicated on a paleoclimate approach. Building upon the discussion submitted as part of the previous interrogatory response (EFRI 2012), in a review of historical and paleoclimate data for the western United States, Woodhouse et al. (2005) provided evidence that suggests the early 20th century was characterized by a 13-year pluvial (wet) period (1905-1917). This wet period was an extremely rare event, not only in twentieth century, but in the past 12 centuries. The study found that the pluvial period was comprised of heavy to moderately heavy cool season winter precipitation events that occurred during a handful of extremely wet winters. It is important to note that, although the study indicated that the pluvial period spanned more than a decade, the total precipitation anomaly was largely attributed to a handful of extremely wet seasons during this time.

The conclusions of the Woodhouse et al. (2005) study are in general agreement with precipitation data collected near the White Mesa Mill. An analysis of the Blanding weather station, though somewhat limited by data availability during the pluvial period suggested by Woodhouse et al. (2005), is suggestive of a timeframe with winter precipitation above the long-term average. For example, the period between 1905 and 1917 contained three out of the ten largest years of winter precipitation (1907, 1909, and 1914). Data availability and climate statistics for the Blanding weather station were documented in the previous interrogatory response (EFRI 2012), and was discussed during the April 2013 workshop with the Division.

The discussion included above has been used to help determine an approach to concatenate a synthetic wet precipitation scenario. The objective was to establish a wet precipitation scenario that could be used to parameterize the infiltration model and determine an upper bound, conservative estimate of potential future infiltration rates, as well as a lower bound estimate. The analyses presented by Woodhouse et al. (2005), and the analysis of measured climate data near the White Mesa Mill, suggest that the assignment of a 10-year wet period would provide for a conservative estimate of potential infiltration; a lower bound estimate could be evaluated by the assignment of a 10-year dry period. To this effect, the 10 wettest winters and 10 driest winters were assumed to occur consecutively during the model simulation, and were inserted into the 57-year simulation period. While previous model simulations assuming 5 consecutive wet or dry years may be equally justifiable in the context of historical and paleoclimate data, inherent uncertainty associated with modeling potential infiltration for an unknown climate scenario has lead us toward this more conservative approach.

Infiltration Modeling Results: Climate

The model simulated water flux rates for the lower/upper bound and anticipated climate scenarios are presented in Figure 4. The average modeled infiltration rate for the lower bound and base case climate scenarios was approximately 2.3 mm/yr. The lower bound scenario took into account a reduction in percent cover from 40 percent to 10 percent during the 10-year dry period; all other assumptions were held constant. The model results indicated little to no sensitivity to the inclusion of a 10-year dry period. The average modeled infiltration rate for the upper bound climate scenarios was approximately 8.6 mm/yr. The inclusion of a 10-year wet period results in a significant increase in the average infiltration rate. Analysis of the cumulative drainage during the simulation duration (Figure 5) indicates a continual, decadal increase in drainage during the simulated pluvial period, which accounts for approximately 80 percent of the cumulative drainage. It is hard to imagine that in the future a potential pluvial phase would be dominated by the continual presence of the 10 wettest winters; rather, the 10-year wet period would be anticipated to consist of a mix of below average, average, and above average amounts of precipitation. Overall, the inclusion of a 10-year pluvial period that contains the 10 wettest winters provides for a conservative upper bound estimate of potential infiltration.

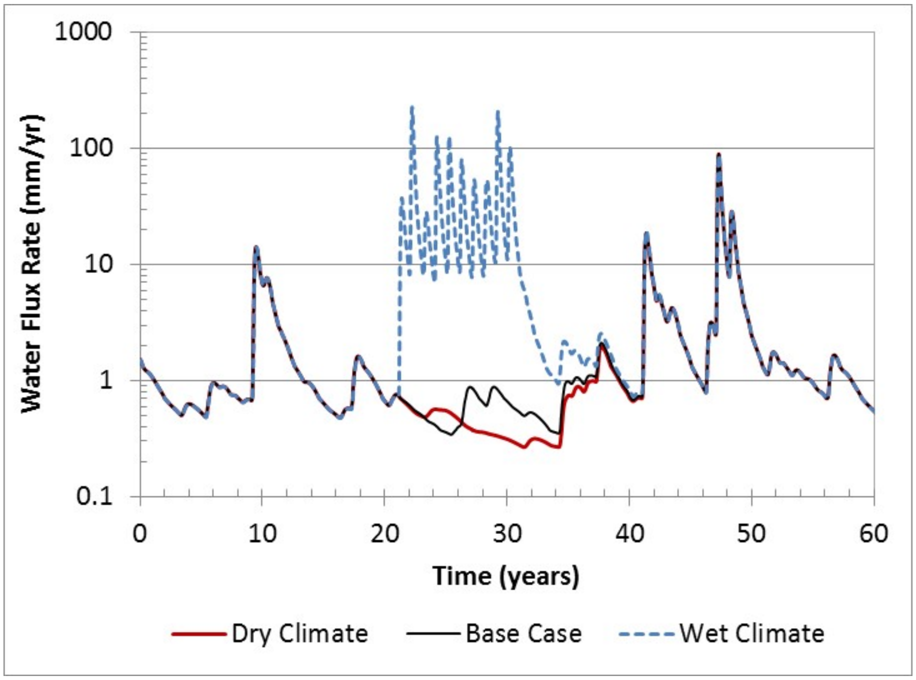

Figure 4. Model simulated water flux rate exiting the bottom of the ET cover for the base case and upper and lower bound climate scenarios

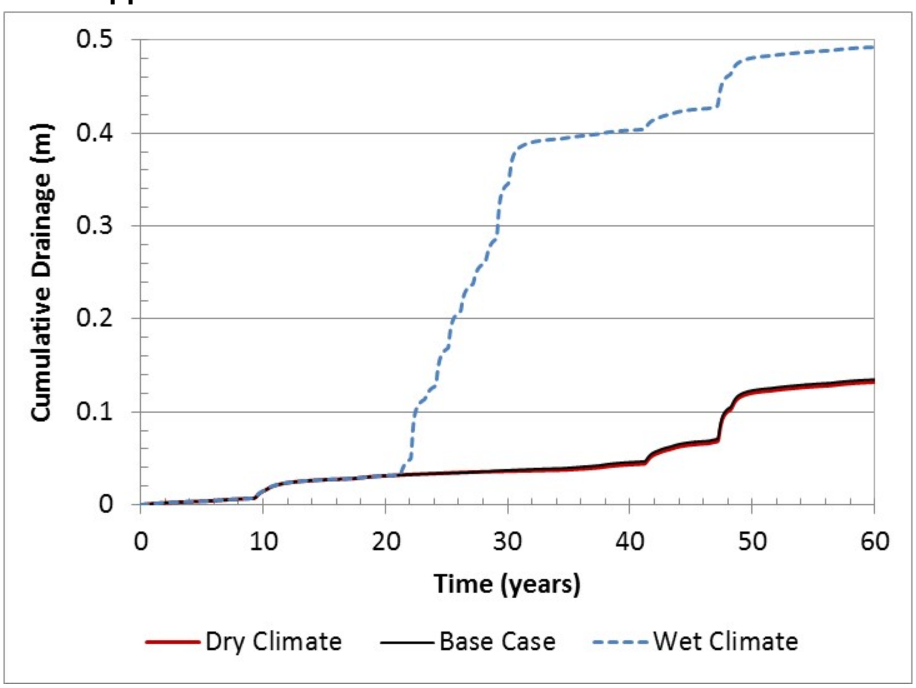

Figure 5. Model simulated cumulative drainage exiting the bottom of the ET cover for the base case and upper and lower bound climate scenarios

Tailings Porosity and Dewatering

The lower bound long-term tailings porosity is estimated as 0.45 for the tailings as presented in the revised radon emanation analyses in Attachment H of the August 2015 response document for the Reclamation Plan, Revision 5.0. This value was used to evaluate the “bathtub effect” for Cells 2, 3, 4A and 4B for conditions after active maintenance. Water level conditions after active maintenance have been assumed to be 1.5 meters (5 feet) above the liner. Based on revised technical analyses conducted and presented in the August 2015 response document for Reclamation Plan, Revision 5.0, a water level of 1.5 meters (5 feet) above the liner will not present differential settlement concerns for the cover. EFRI will continue to dewater the tailings cells during active maintenance and plans to install mini-piezometers to across the cells prior to the first phase of cover placement. Data collected from the piezometers will provide information on the rate and extent of dewatering of the cells to confirm when the final phase of cover can be placed and when active maintenance is no longer required.

Potential Bathtub Effect

EFRI disagrees with combining multiple levels of conservatism for the evaluation of the “bathtub effect”. Use of a lower-bound porosity (0.45) with the average modeled infiltration rate (2.3 mm/yr) is reasonably conservative for the time period of 200 years after active maintenance.

Using these assumptions and using a potential leakage rate from the liner of 1 mm/year, a water level in the tailings after active maintenance of 1.5 m and conservatively estimating the unsaturated tailings are at 50 percent saturation, the potential head increase in the tailings is calculated to be 2.7 m. This is well below the total average thickness of tailings in Cells 2, 3, 4A, and 4B, indicating that there is no potential for a “bathtub effect” during the 200 years after closure.

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DIVISION'S ASSESSMENT OF EFR RESPONSES TO RD 1 INTERROGATORY WHITE MESA REVISED ICTM REPORT; R313-24-4; 10CFR40 APPENDIX A, CRITERION 6(1); INT 03/1: MOISTURE STORAGE CAPACITY OF COVER

Based on review of the EFR Response to the items addressed in this Rd 1 interrogatory on the ICTM Report and the EFR Response to the Round 1 Interrogatories on the Revised (Rev 5.0) Reclamation Plan to infiltration rates through the proposed ET cover, the Division finds the information provided in the Response regarding the gradient parameterization incorporated into the infiltration modeling to be acceptable. However, the Division has concern that the infiltration analyses presented in the Revised ICTM Report and described in the Response to the Round 1 Interrogatories on the Revised ICTM Report and on the Rev 5.0 Reclamation Plan are not sufficiently conservative to bound the uncertainty associated with possible future flattening of the cover topslope inclination (see the discussion under Section 3.4, Other Cover Design-Related Issues, under "Cover Long-Term Erosion Protection Design Basis/Justification and Differential Settlement Issues Related to Infiltration Modeling Assumptions" below). Additionally, similar to the assessment for potential for bathtubbing, the Division recommends that the value of infiltration used in the infiltration sensitivity analysis scenario for evaluating the cover soil moisture holding capacity be the highest average infiltration obtained from the full range of model infiltration scenarios considered, and that the same scenario include the following additional assumptions: (i) assumed maximum (upper bound) assumed hydraulic conductivities for the cover soils; (ii) the assumption of no grass vegetation on the ET cover; (iii) the assumption of a flattened topslope inclination (unless the topslope inclinations in the current proposed cover design are increased to a minimum of 2 to 3 %). Additional information needed from EFR in order to resolve these concerns related to the soil moisture storage capacity of the cover is provided in the table attached to this Technical Memorandum and in the "Technical Memorandum, Revised (Rev. 5.0) Reclamation Plan Review".

Response:

Settlement analyses have been revised to incorporate recently collected data and to address the Division's review comments on responses to interrogatories for the Reclamation Plan, Revision 5.0. The revised analyses are presented in Attachment E of the August 2015 response document for Reclamation Plan, Revision 5.0. The results indicate that the estimated differential settlement is sufficiently low that ponding is not expected to occur on a minimum cover slope of 0.5 percent.

A response to the comment regarding the bathtub effect calculations and assumptions is discussed in interrogatory response 02/1.

OTHER COVER DESIGN-RELATED ISSUES (RELATED TO RD INTERROGATORIES 02/1 AND 03/1)

Division's Assessment of EFR Responses to Cover Long-Term Erosion Protection Design Basis/Justification and Differential Settlement Issues Related to Infiltration Modeling Assumptions

Information presented in the EFR Responses to the above interrogatory items and a discussion of the content of the revised calculations are described in detail in the document entitled "Technical Memorandum, Revised (Rev. 5.0) Reclamation Plan Review". However, the erosion protection analyses methodology used by EFR to support the proposed cover design is based on assumptions that EFR has not yet demonstrated valid assumptions for the proposed ET cover design for the tailings management cells area. Based on the Division's review of the information provided by EFR to date, EFR has not adequately demonstrated to the Division's satisfaction that flattening of the proposed ET cover surface would not occur (due to post-closure differential settlement). Based on this consideration, the Division has concern that the infiltration analyses presented in the Revised ICTM Report and described in the Response to the Round 1 Interrogatories on the Revised ICTM Report and on the Rev 5.0 Reclamation Plan are not sufficiently conservative to bound the uncertainties associated with predicting whether such cover topslope flattening might occur following construction of the (currently proposed) cover. Additional information needed from EFR in order to resolve concerns related to the current erosion protection technical basis justification and future cover infiltration rate - related uncertainties is provided in the table attached to this Technical Memorandum and in the "Technical Memorandum, Revised (Rev. 5.0) Reclamation Plan Review".

Division's Assessment of EFR Responses to Suitability of/Impacts from Using Soils Tested in April 2012 for Constructing ET Cover

The results of April 2012 soil testing suggest that the on-site soils tested appear to be suitable for establishment of vegetation cover, with the use of soil amendments as discussed in Attachment G submitted by EFR in its Response. However, the Reclamation Plan, and specifically, Attachment G, do not provide sufficient information on the types, amounts, sources, methods of application, estimated costs, and limitations of the potential amendments that are discussed to demonstrate that use of the on-site soils will be suitable and cost-effective. The Revised ICTM Report, and the Rev 5.0 Reclamation Plan and Appendix G also do not provide sufficient details regarding future contingency measures that would be implemented for rectifying cover revegetation problems if they occur.

The Division requests that EFR provide additional information in the Reclamation Plan, and specifically, in Attachment G to allow the Division to determine that sufficient information has been provided on the types, amounts, sources, methods of application, estimated costs, and limitations of the potential soil amendments and soil amendment practices to demonstrate that use of the on-site soils will be suitable and not cost-prohibitive. EFR should provide additional details regarding the soil amendment procedures to further substantiate/demonstrate that use of the on-site soils will be adequate for facilitating sustainable performance of the cover with respect to the establishment and sustainability/longevity of vegetation on the cover for promoting evapotranspiration throughout the cover performance period (200 to 1,000 years). The Division also requests that EFR provide additional details regarding contingency measures for rectifying cover and provide information demonstrating that such proposed future remedial measures, if required, are reasonable and reflective of cover revegetation remedies that have been required and shown to be effective for other similar facilities (e.g., Monticello tailings repository – e.g., see U.S. DOE 2007; Waugh et al. 2008).

Alternatively, EFR should explain a plan for use of alternate soils and/or the possible need for bentonite amendment of these higher-Ksat soils, if necessary, for constructing the cover, in order to satisfy applicable long-term cover design (e.g., infiltration reduction) objectives, considering results of additional infiltration sensitivity analyses using these amended soils that include more *conservative assumptions regarding the effects of potential long-term changes in properties of these amended soils in the completed cover.*

Division's Assessment of EFR Responses to Cover Design Safety Factor

Based on review of this Response, it appears to be acceptable to not include a specific FOS into the cover design to specifically address the above-identified uncertainties. In a preliminary review of peer-reviewed literature, no published guidance documents specifically addressing this matter were identified by URS or by the Division. However, during its review of the information provided by EFR, the Division/URS evaluated the information to determine whether an appropriate, and adequately justified, reasonably conservative range of input conditions and parameter values have been assumed by EFR, and that sufficient sensitivity analyses have been included as part of all modeling simulations and calculations that incorporate the full range of these assumed conditions and parameter values. All analyses and model sensitivity analyses have also been reviewed to determine whether they have been performed in accordance with applicable NRC guidance and other applicable and relevant criteria and accepted industry practices. Results of that evaluation are applied to other specific interrogatory items that are addressed in this document. Therefore no further action is required of EFR with respect to the request that a specific safety factor be applied to the projected infiltration design or performance of the cover.

Response:

Differential Settlement of Cover Surface

Settlement analyses have been revised to incorporate recently collected data and to address the Division's review comments on responses to interrogatories for the Reclamation Plan, Revision 5.0. The revised analyses are presented in Attachment E of the August 2015 response document for Reclamation Plan, Revision 5.0. The results indicate that estimated differential settlement is sufficiently low that ponding is not expected to occur on a minimum cover slope of 0.5 percent.

Erosional Stability for Cover Surface

Erosional stability analyses have been updated to incorporate revised cover grading and addressthe Division's review comments on responses to interrogatories for the Reclamation Plan, Revision 5.0. The revised analyses are presented in Attachment F of the August 2015 response document for Reclamation Plan, Revision 5.0. Erosion protection proposed for the cover surface meets erosional stability requirements.

Organic Amendments for Cover Soils

A discussion on organic amendments is presented in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0. A discussion of contingency measures to address remedial revegetation approaches is also presented in Attachment G.1 to the August 2015 response document for Reclamation Plan, Revision 5.0.

DIVISION'S ASSESSMENT OF EFR RESPONSES TO RD 1 INTERROGATORY WHITE MESA REVISED ICTM REPORT; R313-24-4; 10CFR40 APPENDIX A, CRITERION 6(1); INT 04/1: EVALUATION OF POTENTIAL FLOW THROUGH TAILINGS CELL LINERS

EFR discussed various lines of evidence to support their contention that their assumption that an appropriate Ks value for the crushed sandstone/washed gravel bedding layers underlying Cells 2 and 3 to use in the leakage analysis similar to the Ks value used in the December 2010 Revised ICTM Report (2 x 10^{-9} m/sec) and that the geomembrane defect sizes and frequencies assumed in the calculations presented in Appendix L of the Revised ICTM Report (Denison 2010) are reasonable and do not require revision. Evidence cited by EFR includes:

- *"No significant leakage indicated by the leak detection systems;*
- *No leakage indicated by mounding of the perched aquifer water table surface;*
- *No observations of contamination (e.g., acid leaching, dissolution of carbonates, gypsum precipitation, staining) in the bedrock core samples were recorded during drilling of monitoring wells installed adjacent to the cells during spring 2005 as noted during inspection of the core by MWH (Appendix C);*
- *Total uranium was detected at background levels in bedrock core samples collected while drilling monitoring wells adjacent to the cells as noted by analyses presented in Appendix A;*
- *No contaminants detected in groundwater at levels above natural background concentrations (INTERA, 2007a; 2007b; 2008). The lack of groundwater contamination is corroborated by the following:*
    - *The apparent groundwater age beneath the tailings cells is dominated by water that is at least approximately 55 years old as determined from measurements of tritium and helium in groundwater within the vicinity and downgradient of the mill (Hurst and Solomon 2008). In other words, recharge at the land surface occurred prior to 1952 (Schwartz and Zhang 2003) and takes at least 55 years to reach the perched aquifer.*
    - *Groundwater beneath the tailings cells is not influenced by more modern water that may have leaked from the tailings cells.*
    - *No contaminants detected in groundwater as evaluated through measurements of stable isotopes for oxygen and sulfate in groundwater within the vicinity and downgradient of the mill (Hurst and Solomon 2008) indicative that significant leakage from the tailings cells have not occurred."*

Based on review of the above Response, in the opinion of the Division, the bullet points listed by EFR do not provide evidence that no significant leakage has occurred through the liner systems beneath Cells 2 & 3 over the past 30 years. The Division finds that the analyses and conclusions presented in this Response do not sufficiently bound and are not sufficiently conservative to represent the full range of site and liner conditions that likely exist at and beneath cells 2 and 3 to assess potential impacts associated with potential leakage of leachate from Cells 2 and 3.

The point that "no observations of contamination (e.g., acid leaching, dissolution of carbonates, gypsum precipitation, staining) were recorded during drilling of monitoring wells installed between and adjacent to the cells during spring 2005" is not evidence that "no significant leakage has occurred through the liner systems beneath Cells 2 & 3 over the past 30 years." Instead, this finding indicates that leakage was not observed at these well locations, but it still could exist elsewhere inside/directly below the footprint area of the contiguous tailings cells.

Average groundwater flow velocities in the Burro Canyon Formation downgradient of the tailings cells are indicated in the Revised ICTM Report (p. 2-12) to be on the order of 1.7 to 3.2 ft/yr. This would imply that a constituent in a hypothetical groundwater plume in the groundwater would have only moved approximately 102 feet (e.g., 32 years x 3.2 ft/yr) in the aquifer over the past 32 years. The distance between upgradient and downgradient edges of Cell 3, where upgradient and downgradient wells are located, is, by comparison, on the order of 1,000 feet. If a release source (e.g., the location of a defect in the cell liner) were situated near the northern margin of Cell 3, and the release resulted in a plume of capable of being detected in a downgradient monitoring well, it is unlikely that the contamination would have been detected in any of the monitoring wells (e.g., MW-39, MW-30, MW-31) installed along the downgradient edge of Cell 3 by the present time. Hence, groundwater contaminant detection at the present time may be more likely only in cases where the contaminant source is located just a short distance upgradient from one of these monitoring wells.

Additionally, analytical results of groundwater monitoring conducted during the 1st and/or 2nd Quarters of 2012 indicate that Groundwater Concentration Limits (GWCLs) for the constituents listed in the following table were exceeded for the monitoring wells listed in the table that are located immediately downgradient of the edge of either Cell 2 or Cell 3:

Well No./ Cell Downgradient of	Parameter Exceeding GWPL	GWCL	Concentration Detected
MW-29/ Cell 2	Manganese	5624 µg/L	6140 µg/L
MW-30/ Cell 2	Nitrate + Nitrite Uranium Selenium	5 mg/L 8.32 mg/L 34 µg/L	15 -18 mg/L 8.38 µg/L (March 2012) 35 – 39.1 µg/L
MW-31/ Cell 2	Nitrate + Nitrite TDS Chloride Sulfate	5 mg/L 1320 mg/L 143 mg/L 532 mg/L	20 -22 mg/L 1360 – 1460 mg/L 151 - 160 mg/L 538-547 mg/L
MW-5/ Cell 3	Uranium	7.5 µg/L	18.6 µg/L (Q1 2012)
MW-11/ Cell 3	Manganese	131.29 µg/L	154 µg/L; 132 µg/L
MW-12/ Cell 3	Selenium	25 µg/L	27.2 µg/L (Q1 2012)

Although the magnitudes of exceedance of applicable GWCLs for the constituents reported in the above table are typically small and/or might have only occurred once to date, these reported exceedances reflect more recent groundwater monitoring data than referenced in the EFR Response and indicate that EFR's argument that no contaminants have been released from Cell 2 and/or Cell that have been detected in groundwater monitoring wells above background concentrations is not, or may not be defensible.

Additionally, information provided by EFR in "Response 2 (May 31, 2012)" to this interrogatory indicates that substantial volumes (but at rates below specified Action Leakage Rate trigger levels) of leachate have accumulated in the Leak Detection Systems underlying the primary geomembrane liners in Cells 4A and 4B since the time of their installation. Because the liners in Cells 2 and 3 were installed using older liner technologies and materials than were used in Cells 4A and 4B, and the Cell 2 and Cell 3 liners are older than those in Cells 4A and 4B, it would be reasonable and conservative to assume that leakage rates through the liners in Cells 2 and 3 would be substantially higher than leakage rates occurring through the primary liners in Cells 4A and 4B. For example, estimates of failure time for PVC *liners range from about two decades to possibly a century or more. However, there remains much uncertainty about PVC liner longevity, and actual lifetimes will vary depending on liner and leachate properties and other environmental characteristics. One manufacturer, for example, claims a lifetime for their PVC liners, when buried in the subsurface, of only up to 20 years (Enviroconsystems, 2012). Likewise, CLI (2010), a geosynthetic solutions provider, indicates that for landfill liners,… "in buried applications, PVC can provide a service life of over 20 years." AccuGeo (2012), another liner manufacturer, indicates, "...buried PVC liners will have a life of 20 years or more" (AccuGeo, 2012).*

For further evaluating potential leakage rates from Cells 2 and 3, the Division requests that EFR perform an uncertainty analysis relative to PVC liner longevity in its infiltration modeling, or justify not doing so. Uncertainty analyses should involve at least one model run for liner failure occurring after decades (e.g., 20 years), and at least one model run for failure at about 100 years, or some alternative timeframe as justified by EFR.

For evaluating the appropriateness of some of the evidence EFR provided in the Response to support EFR's contention that Cells 2 and 3 are not currently experiencing significant leakage, detailed calculations were not provided (with input parameter assumptions and information supporting those assumptions) directly calculating the vertical transport time of constituents potentially seeping from below the base of Cell 2 and Cell 3 through the in-situ vadose zone bedrock materials underlying the liners of these cells to the top of the perched water zone underlying those cells, but would have been useful.

Based on the considerations described above and the available information, the Division assumes that tailings Cells 2 and 3 have a higher probability of releasing leachate to the groundwater system than do tailings Cells 4A and 4B. This probability is further heightened due to the much lower tailings dewatering rate observed in these two cells compared to Cells 4A and 4B, which has resulted in a more prolonged duration of elevated leachate levels present in Cells 2 and 3 to the present time. The rate at which leachate head levels in Cells 4A and 4B are predicted to be reduced is considerably higher than the dewatering rate in Cells 2 and 3 due to the more modern and more extensive tailings dewatering systems installed in Cells 4A and 4B.

Conclusions presented by EFR in the current Response to this interrogatory are as follows:

- *The Ks value assigned to the liner underlay materials using the value assumed in Appendix L is considered to be a reasonable and appropriate assumption, and that an attempt to decrease this value would result in potential leakage rates that do not appear to be realistic (i.e., too conservative); and*
- *Therefore, a higher Ks for the liner bedding materials does not seem to be justified to represent potential in-place liner conditions beneath Cells 2 and 3 and the calculations presented in the 2010 Revised ICTM Report do not require adjustment.*

Based on review of the Response, the Division requests that EFR:

- *Revise the liner leakage calculations and resulting conclusions from those currently presented in the Response to reflect a more conservative range of assumptions and the results of revised analyses incorporating those more conservative assumptions, that coincide more closely with current site information and conditions (see additional discussion at the end of this section), and that are consistent with a postulation that the liners in Cells 2 and 3 could allow leakage rates higher than or equal to measured leakage flux rates currently occurring through the primary liners in Cells 4A and 4B;*
- *Quantify the degree to which the revised analyses result in flux rates through the liner systems in Cells 2 and 3 indicate higher leakage rates than leachate flux rates currently observed through*

the primary liners in Cells 4A and 4B, under all comparable assumed operational conditions and all assumed liner defect frequencies; and

- *Provide a detailed travel time calculation or calculations, analogous to those discussed on p. 38 of 70 in "Response 1 (May 31, 2012)", but that instead calculate the vertical transport time of constituents potentially seeping from directly below the base of Cells 2 and 3 through the in- situ vadose zone bedrock materials to the top of the perched water zone. Include information on the hydraulic conductivity value(s) assumed and the effective field porosity value assumed for the bedrock materials and provide a basis for the value assumed (i.e., field measurements). Alternatively, if no single value of effective porosity is available or appropriate for the site, provide a range of effective porosity values assumed and use this range of values in the travel time calculations. Compare the value(s) of effective porosity used to the default value of 10 percent recommended for use by NRC at Title I UMTRCA sites in Section 4.3.1.3.2 of NRC 1993 (considered by the Division to be a relevant conservative default value for this type of analysis).*

The Second Phase Tailings Management System Construction Report (Energy Fuels Nuclear Inc. 1983) noted that a gravel-sand mixture derived from crushing of loose [Dakota] sandstone, with some washed concrete sand in some areas, was used to construct the compacted bedding layer, where present, immediately beneath the liner in Cell 3; and that a similar process and materials were used for the liner bedding material in Cell 2. In some areas, liner was laid directly on compacted bedrock.

Table 5.5.1 of Bear (1972) differentiates between "gravel" and "clean sand or sand and gravel", and gives a range of values for hydraulic conductivity for sand and gravel between 10^{-3} and 10^{0} cm/sec. These values may approximate values of hydraulic conductivity for a crushed sandstone. USACE (1993) refers to a value for hydraulic conductivity of 1.4×10^{-3} cm/sec and indicates that "clean, washed concrete sand is usually about this permeable". Elsewhere, USACE (1993) refers to "clean washed concrete sand with a permeability [hydraulic conductivity] of 10 ft/day", which equates to 3.5×10^{-3} cm/sec. "Washed concrete sand" used in one project is reported by Dwyer (1998) as having a hydraulic conductivity of at least 10^{-2} cm/sec. A falling-head permeameter test of "Nova Scotia washed concrete sand" is reported as having indicated a hydraulic conductivity of the sand in the range of 1×10^{-4} to 2×10^{-4} m/s (Mooers and Waller,1997), equivalent to 1×10^{-2} to 2×10^{-2} cm/sec. All of these reported ranges of hydraulic conductivity values exceed (by a few to several orders of magnitude) the geometric mean value of 9.0×10^{-7} m/sec (9×10^{-5} cm/sec) assumed for this underlay material by EFR in the revised calculations described in the Response (August 31, 2012) to this Rd 1 interrogatory.

Based on the above information, unless EFR can provide more conclusive data, the Division requests that these higher values be used for the hydraulic conductivity of the underlay materials, or, at a minimum, that EFR run additional sensitivity analyses that incorporate these higher hydraulic conductivity values, to assess the impact of these higher values on the Cells 2 and 3 leakage rate calculations.

Response:

EFRI is in the process of revising the contaminant transport model. The potential flux rate through the liner will be applied in the contaminant transport model as a boundary condition. The revised approach for calculating potential water flux rates through the liners beneath Cells 2 and 3 as was presented to the Division during the April 2013 workshop will be used for the analyses. This approach was adopted to better reflect design differences between the tailings cells, and to account for the low permeability of compacted soils and tailings above the liner, which will act to restrict potential water movement from the tailings into the underlying drainage system and bedrock vadose zone. The potential estimated flux rate through the liner will also reflect the tailings data collected in October 2013.

DIVISION'S ASSESSMENT OF EFR RESPONSES TO RD 1 INTERROGATORY WHITE MESA REVISED ICTM REPORT; R313-24-4; 10CFR40 APPENDIX A, CRITERION 6(1); INT 05/1: CONTAMINANT TRANSPORT MODELING

Response 1

The Division request that EFR provide additional information regarding the potential locations and distribution of fractures in the area beneath and downgradient of the tailings management cells area based on the information discussed below.

The interpretation provided in EFR's response above is similar to that presented in previous correspondence submitted by the Licensee in response to Round 1 Interrogatories submitted by on the Cell 4B Environmental Report (DUSA 2009). In that Response, the Licensee provided a letter, dated November 10, 2009, from Hydro Geo Chem which indicated that the reported sub-horizontal, limonite-stained features interpreted in the 1978 ER (Dames & Moore 1978) as bedding plane fractures may not be actual fractures but may represent structurally weaker zones along bedding planes that appear as partings in core samples. According to the Hydro Geo Chem report, examination of core samples collected during drilling of angle borings beneath tailings Cells 3 and 4A indicate that where fractures were present in cores, they were cemented with gypsum. They indicated that open fractures significant enough to impact groundwater movement in the perched zone were not identified in that investigation. Hydro Geo Chem also concluded that no fractures were reported in cores from MW-3A, MW-16, or MW-23, the existing wells adjacent to or at the current location of Cell 4B. Hydro Geo Chem concluded that this made it even less likely that potentially undetected fractures could significantly affect subsurface fluid flow in the vicinity of proposed Cell 4B, and that, should the sub-horizontal features reported in the 1978 ER actually represent fractures, their sub-horizontal nature would prevent them from acting as vertical conduits from the tailing cell to the perched groundwater.

The Licensee also previously referred to the same Hydro Geo Chem Letter Report dated February 8, 2010 ('HGC, 2010a') that provided additional information and also recommended the installation of new monitoring wells MW-33 and MW-34 in the area of Cell 4B. These wells, as proposed, would be screened across the perched zone. In a meeting with the Division on February 18, 2010, the Licensee agreed to install three new wells, including a third monitoring well, MW-35, adjacent to the western edge of Cell 4B. New well MW-35 was proposed to help further define subsurface conditions and potential groundwater migration patterns downgradient of proposed Cell 4B.

The Division incorporated a new Permit condition requiring that a minimum of three additional downgradient groundwater monitoring wells be installed near Cell 4B. The Division requests that additional geologic data available from the wellbores for these three wells (MW-33 through MW-35) be evaluated and interpreted with respect to the additional information that these wells borings provide regarding the potential occurrence and distribution of fractures and conglomeratic zones downgradient of the Cell4 B/tailings management cells area. EFR should supplement and/or revise the interpretation provided in the Response above to reflect the results of their evaluation of this additional wellbore data.

Response:

In the preceding Division response (DRC, 2013) this comment was incorrectly listed as Response 4. Previously, this topic was discussed as Response 1. We have corrected the order here.

Additional evaluations and interpretations in regard to the potential occurrence and distribution of fractures and conglomeratic zones downgradient of Cell 4B was addressed by HGC (2015). HGC (2015) is included as Attachment A. A brief summary of the findings and conclusions is presented below.

HGC's (2015) findings and conclusions drew from historical information collected at the site, as supplemented from information collected from installation and testing of groundwater monitoring wells (MW-33 through MW-37) and additional information collected from the installation and testing of DR-series piezometers (DR-7, DR-10, DR-11, DR-12, and DR-13), which are located immediately downgradient (west, southwest, and south) of Cell 4B.

Overall, hydrogeologic data provided by borings MW-33 through MW-37 and the DR-series borings are generally consistent with previous data used to characterize hydrogeologic conditions in the vicinity of Cell 4B. No conditions during drilling of MW-33 through MW-37 or the DR-series borings were noted that would indicate the presence of open fractures. Additionally, lithologic data collected at these locations support the finding that the Dakota Sandstone and Burro Canyon Formation in the vicinity of Cell 4B consist of sandstone with occasional relatively thin, subhorizontal, shaly and conglomeratic horizons that may or may not be correlatable between boreholes.

The findings summarized here are consistent with the previous interrogatory response. This information will be incorporated into the next iteration of the ICTM report.

Response 2

Based on a review of the EFR Response, the approach discussed concerning the initial geochemical conditions in vadose zone pore water where only calcium, carbonate, and DO (2 mg/L) at concentrations representing equilibrium with calcite and HFO is reasonable and is supported by the solid phase data available for the vadose zone bedrock and DO data available for the underlying groundwater. An assumption that redox is controlled by the oxygen couple and the concentrations of other constituents is zero is also reasonable and provides for a conservative simulation of constituent transport. The discussion provided in the Response should be included in the revised ICTM report to justify the initial geochemical conditions assumed for the vadose zone pore water.

Response:

As suggested by the Division, discussion included in the previous interrogatory response (EFRI 2012) regarding justification for the initial geochemical conditions will be updated and included in the next iteration of the ICTM report.

Response 3

Based on a review of the EFR Response, using aluminum to obtain a charge balance in the PHREEQC modeling appears to be reasonable for cation deficient solutions. The explanation provided in the Response should be included in the revised ICTM report for clarity.

Response:

As suggested by the Division, discussion included in the previous interrogatory response (EFRI 2012) regarding charge balance assumptions will be updated and included in the next iteration of the ICTM report.

Response 4

Based on a review of the EFR Response, the clarification regarding the primary and duplicate sample pairs is useful and the explanation regarding duplicates in this Response should be included in the revised ICTM report. However, the sample statistics, particularly ANP ranges derived from the geometric mean and standard deviation appears to be in error. The apparent error is based on a misconception concerning the use of the geometric mean and the geometric standard deviation in describing the spread or distribution of the data. EFR states on page C-7 of Appendix C that "to support the sensitivity analysis, and determine a range of values for the amount of ANP, the geometric mean plus one geometric standard deviation was selected for an upper bound, while the geometric mean minus one standard deviation was selected as a lower bound. The geometric mean plus one geometric standard deviation corresponds to approximately 68% of the observations." These are incorrect approaches to use with lognormally distributed data. To find the proper bounding limits, the geometric mean must be multiplied (or divided) by the geometric standard deviation. Naturally log-normally distributed data have an asymmetric distribution and different values for mode, median and mean.

*Adding the same value on either side of the mean, as EFR has done, does not properly characterize the interval containing 68.3% of the data. Bleam (2011) explains the concept: "Log-normal distributions are asymmetric about the geometric mean. The lower limit of a range covering 68.3% of the population is the geometric mean divided by the geometric standard deviation while the upper limit is the geometric mean multiplied by the geometric standard deviation." Thus, the approach used in the Revised ICTM Report is not statistically correct; it does not follow standard professional practice. The natural data need to be first transformed by taking their logarithms, the transformed data need to be tested for normality, the mean and standard deviation of the transformed data need to be calculated, and then these intermediate parameters need to be exponentiated to obtain the geometric mean (GM) and the geometric standard deviation (GSD). The value of the lower bound of the population interval containing the central 68.3% of the data is equal to the geometric mean divided by the geometric standard deviation (GM/GSD) ; the upper bound is equal to geometric mean multiplied by the geometric standard deviation (GM*GSD). A similar issue exists for the HFO data.*

An example is provided for ANP at Well MW-24. There are 9 data points. Thus, N-1 = 8. As indicated in Table C-15, the arithmetic mean is 7. The standard deviation is 7.68. The geometric mean (GM) is 5.17. The geometric standard deviation (GSD) is 2.06. The geometric mean is an appropriate measure of central tendency for the data, assuming that the ANP data are lognormally distributed. The lower bound of the interior 68.3% data-dispersion interval is the quotient of the geometric mean divided by the geometric standard deviation. This quotient is equal to 2.51 mg CaCO3/kg rock. The upper bound of the interior 68.3% data-dispersion interval is the product of the geometric mean and the geometric standard deviation. This product is equal to 10.7 mg CaCO3/kg rock. Thus, again assuming log-normality, the interior 68.3% of the data in the actual population should statistically fall within the range 2.51 to 10.7 mg CaCO3/kg rock. Within the sample population, six of nine values, or 67%, fall in that estimated range, which is in excellent agreement with the theoretical value for the population.

Thus, the results of ICTM model sensitivity runs for ANP are in error because they do not account for a sufficiently wide distribution of data. Accordingly, please correct all incorrect statistical calculations, and re-run the model sensitivity analysis for ANP and HFO using the lognormal distribution and the correct distribution parameters. Alternatively, the most conservative (i.e., the lowest) ANP or HFO values can be used in the model. A value of the geometric mean divided by two geometric standard deviations can be used. This will give a limit or bound above which 95.5% of the data values in the population should exist. Only 4.4% of the data values in the population should be less. Revise, as appropriate, the text, tables, and figures in the revised ICTM report and Appendix C to correct any statistical errors that may be present for ANP and HFO. Furthermore, revisit the statistics for any other data that have a lognormal distribution and determine the correct, as appropriate, upper and lower bounds of the data determined using geometric means and standard deviations.

As an aside, a minor editorial clarification is needed on page M-10 where it is stated that "the amount of ANP present in the bedrock vadose zone was reported as grams of calcite (CaCO3) per kilogram or rock." Please note that the original data reported in Appendix A are not reported using these particular units, although the units reported are equivalent. The text should be revised to reflect the actual reported units and the subsequent conversion to equivalent units used to develop the model input parameters.

Response:

In the previous Division response (DRC, 2013) this comment was incorrectly listed as Response 4. Previously, this topic was discussed as Response 1. We have corrected the order here.

Statistical calculations for the amount of acid neutralization potential (ANP) and hydrous ferric oxide (HFO) will be corrected in the next iteration of the ICTM report based on the comments received above. Accompanying text, tables, figures, and model simulation results will be revised as appropriate.

Model inputs for ANP will be bounded using the geometric mean divided/multiplied by the geometric standard deviation (a spread of data that accounts for 68.3 percent of the population). This approach is being proposed because if inputs ranges were to account for 95.5 percent of the population the lower bound value would approach the minimum, which is not appropriate. Using the minimum would significantly underestimate the observed mineralogical variability. Reference to the originally reported units of ANP will be noted in the next iteration of the ICTM report.

Model input for HFO will continue to use the geometric mean. The sensitivity of HFO will not be evaluated because the simulations conservatively assume that additional HFO will not precipitate from solution during transport.

Response 5

Based on a review of the EFR Response, a question arises as to why a dry bulk density of 2.0 g/cm^3 was assigned. Additionally, Please provide further discussion of the rationale used for selecting a bulk density value of 2.0 g/cm^3 for bedrock for use in converting ANP and HFO values from rock mass to rock unit volume. Discuss locations of core samples considered with respect to: (1) locations of core boreholes with respect to the different disposal cells; and (2) the depth intervals of the core sample intervals considered with respect to the thickness of the vadose zone at each core interval location. Further justify *the value of bulk density chosen (or different bulk density values that may be selected for use at different locations), including need for excluding from consideration any core interval(s) that lie within the saturated zone (e.g., See Table C-3 in Appendix C of the Revised ICTM Report). Please revise any affected calculations, re-run the model, and revise the ICTM report, as appropriate.*

Response:

Dry bulk density of the bedrock vadose zone was measured from samples of retrieved core. Samples with dry bulk density measurements coincided with samples that were tested for hydraulic properties. The sample intervals were collected from two different locations. One hole (MW-30) was located near the midpoint between Cells 2 and 3, while the second hole (MW-23) was located at the southwest corner of Cell 3. Sample intervals ranged between 0.2 and 0.5 feet, and were collected at different depths within the bedrock vadose zone. Dry bulk density of the five measurements ranged between 1.8 and 2.3 g/cm^3. The arithmetic average was 2.1 g/cm^3. Dry bulk density used in the calculations was consistent with the sample used to represent the hydraulic properties of the bedrock vadose zone (MW-23, 55.5 to 56.0 feet below ground surface). This value (2.0 g/cm^3) was nearly equivalent to the arithmetic mean (2.1 g/cm^3). Sensitivity to the dry bulk density was not evaluated because of the limited range of measured values. This assumption is justified because the mineralogical variability was much greater than the dry bulk density variability. Use of the minimum and maximum dry bulk densities would have decreased and increased the converted values used in the model approximately 10 percent and 15 percent, respectively. This discussion will be included with the next iteration of the ICTM report.

Response 6

Based on a review of the EFR Response, the approach discussed concerning the DO concentration in the tailings pore water is reasonable and is supported by the geochemical data available for the tailings pore water. The results suggest that the fixed DO condition is likely more conservative as it predicts uranium to be transported to greater depths than redox value determined using nitrogen and iron species. The decreased uranium transport under the iron redox couple scenario is likely due to increased sorption on HFO precipitated in the vadose zone. The discussion provided in the Response should be included in the revised ICTM report to justify the initial DO concentrations selected.

Response:

As suggested by the Division, discussion included in the previous interrogatory response (EFRI 2012) regarding dissolved oxygen (DO) concentrations will be updated and included in the next iteration of the ICTM report.

Response 7

Based on a review of the EFR Response, the chloride diffusion coefficient selected to represent all solutes in the model is reasonable. The sensitivity analysis provided in the Response suggests that the selected diffusion coefficient likely overestimates the diffusive transport depth of most of the solutes simulated. The *discussion provided in the Response should be included in the revised ICTM report to justify the diffusion coefficient selected.*

Response:

As suggested by the Division, discussion included in the previous interrogatory response (EFRI 2012) regarding the diffusion coefficient used in the model will be updated and included in the next iteration of the ICTM report.

Response 8

Based on a review of the EFR Response, the discussion provided outlines recharge rates for relatively comparable environments to White Mesa and suggests that regional recharge rates can vary from 0.1 to 6 percent of average annual amount of precipitation. However, EFR's justification for assuming 1 percent of the average annual amount of precipitation is not clear. It appears based on the studies cited in the Response that the assumed 1 percent recharge rate used in the model is on the lower end of the recharge rates reported for similar sites. In fact, the recharge rate chosen for the model appears to be up to 5 times less than average annual recharge rates reported for similar sites located on the Colorado Plateau (Healy 2010[1]). Additional justification for selecting a recharge rate equal to 1 percent of the average annual amount of precipitation should be provided or sensitivity analyses varying the initial average annual recharge rate within a reasonable range (e.g., 1 to 5 percent) should be performed to demonstrate the sensitivity of the model results to the initial volumetric water contents and pressure head distributions.

The comparison of volumetric water content and pressure head profiles provided in the Response appears to reasonably demonstrate that the post-closure volumetric water contents and pressure heads reach steady state in about 100 years, given the assumed initial recharge rate of 1 percent, the assumed maximum head conditions estimated for the operation of Cells 2 and 3 and the subsequent estimated dewatering rate used in the model. The discussion provided in the Response, as well as any additional sensitivity analyses of the assumed initial recharge rate, should be included in the revised ICTM report to justify the initial water content and pressure head distributions selected for the flow model.

Response:

Sensitivity analyses that varied the initial recharge rate were presented to the Division during the April 2013 workshop. Sensitivity analyses evaluated a range of probable recharge rates between 0.1 percent and 5 percent of the average annual precipitation. These model (sensitivity) simulation results will be discussed as part of the next iteration of the ICTM report.

Additionally, the next iteration of the ICTM report will include an updated discussion regarding the demonstration of post-closure steady state volumetric water contents and pressure heads, similar to what was presented in the previous interrogatory response (EFRI 2012).

Response 9

Based on a review of the EFR Response, the explanation provided is reasonable and should be included in the revised ICTM report for clarity. The revised ICTM report should further develop and discuss the apparent K_d values for sulfate predicted by the model.

Response:

As suggested by the Division, discussion included in the previous interrogatory response (EFRI 2012) regarding uranium transport, in comparison to sulfate, will be updated and included in the next iteration of the ICTM report. Because sulfate participates in sorption and mineral precipitation reactions, apparent K_d values for sulfate predicted by the model will not be included in the next iteration of the ICTM report.

Response 10

Based on a review of the EFR Response, the explanation provided is reasonable and should be included in the revised ICTM report for clarity.

Response:

As suggested by the Division, discussion included in the previous interrogatory response (EFRI 2012) regarding rationale for not showing the initial concentration of sulfate and uranium on some figures will be updated and included in the next iteration of the ICTM report.

Response 11

Based on a review of the EFR Response, the explanation provided is reasonable and should be included in the revised ICTM report for clarity. Further discussion should be provided regarding the relative degree or percentage of loading predicted for the surface sites and its impact on sorption of uranium as well as other constituents.

Response:

As suggested by the Division, discussion included in the previous interrogatory response (EFRI 2012) regarding uranium transport will be updated and included in the next iteration of the ICTM report.

References for Responses

Energy Fuels Resources (USA) Inc. (EFRI), 2012. Responses to Interrogatories – Round 1 for the Revised Infiltration and Contaminant Transport Modeling Report, March 2010, Submitted September 10.

Hydro Geo Chem, Inc. (HGC), 2015. Letter from Stewart J. Smith of Hydro Geo Chem, Inc. to Kathy Weinel of Energy Fuels Resources (USA) Inc., July 17.

Utah Department of Environmental Quality, Division of Radiation Control (DRC), 2013. Radioactive Material License (RML) Number UT 1900479: Review of September 10, 2012 Energy Fuels Resources (USA), Inc. Responses to Round 1 Interrogatories on Revised Infiltration and Contaminant Transport Modeling (ICTM) Report, White Mesa Mill Site, Blanding, Utah, report dated March 2010. February 7.

ATTACHMENT A

SUPPORTING DOCUMENTATION FOR INTERROGATORY 05/1:

HYDRO GEO CHEM, INC. (HGC), 2015. LETTER FROM STEWART J. SMITH OF HYDRO GEO CHEM, INC. TO KATHY WEINEL OF ENERGY FUELS RESOURCS (USA) INC., JULY 17.

HYDRO GEO CHEM, INC.
Environmental Science & Technology

July 17, 2015

Kathy Weinel
Quality Assurance Manager
Energy Fuels Resources (USA) Inc.
225 Union Boulevard, Suite 600
Lakewood, Colorado 80228

Dear Ms.Weinel,

This letter provides an update to HGC (2009)[1]; HGC (2010a)[2]; and HGC (2010b)[3], which addressed specific elements of the hydrogeology of proposed tailings cell 4B at the White Mesa Uranium Mill located near Blanding, Utah (the site). Specifically, HGC (2009)[1] addressed concerns about possible fracturing in the Dakota Sandstone and Burro Canyon Formation; HGC (2010a)[2] addressed concerns that included conglomeratic zones and/or lenses that may exist in the Dakota Sandstone and Burro Canyon Formation beneath cell 4B and their potential impact on groundwater monitoring beneath cell 4B; and HGC (2010b)[3] provided lithologic cross-sections of the Dakota Sandstone and Burro Canyon Formation within the vicinity of and beneath cell 4B.

Since the above letters were prepared, tailings cell 4B has become operational, groundwater monitoring wells MW-33 through MW-37 have been installed along the southern and western dikes of the cell, and an investigation of the perched zone hydrogeology southwest of cell 4B has been conducted as described in the Southwest Area Investigation report (HGC, 2012)[4]. This letter discusses the additional hydrogeologic data provided by these installations and investigations with regard to the presence of conglomeratic horizons and potential fracturing within the Dakota Sandstone and Burro Canyon Formation as discussed in HGC (2009)[1], HGC (2010a)[2] and HGC (2010b)[3].

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[1] HGC, 2009. Letter to David Frydenlund, Esq., Denison Mines. November 10, 2009.

[2] HGC, 2010a. Letter to David Frydenlund, Esq., Denison Mines. February 10, 2010.

[3] HGC, 2010b. Letter to David Frydenlund, Esq., Denison Mines. February 12, 2010.

[4] HGC, 2012. Second Revision. Hydrogeology of the Perched Groundwater Zone in the Area Southwest of the Tailings Cells, White Mesa Uranium Mill Site, Blanding Utah. Energy Fuels Resources (USA) Inc., January 12, 2012, Revised August 3, 2012, Second Revision November 7, 2012.

51 West Wetmore, Suite 101 Tucson, Arizona 85705-1678 HGC 520.293.1500 520.293.1550-Fax 800.727.5547-Toll Free

Summary of Previous Findings

The interpretation and conclusions provided in HGC (2009)[1], HGC (2010a)[2] and HGC (2010b)[3] were based on available data at that time.

HGC (2009)[1] addressed potential fracturing in the Dakota Sandstone and Burro Canyon Formation beneath proposed cell 4B. Specific concerns were raised over sub-horizontal limonite-stained features that had been interpreted as bedding plane fractures. HGC concluded that these features may not be fractures and may represent structurally weaker zones along bedding planes that appear as partings in core samples. Partings along bedding planes were observed by HGC in cores collected at the site during drilling of perched zone monitoring wells, including well MW-3A, located downgradient of cell 4B, and well MW-23, adjacent to cell 4B. HGC noted that similar features were reported at former well MW-16, located near the center of proposed tailing cell 4B; that observed partings were in some cases associated with limonite staining; and in most cases this staining was consistent with a diagenetic origin.

HGC's examination of core samples collected during drilling of angle borings beneath tailing cell 3 and cell 4a indicated the presence of similar features. Where fractures were present in these cores, they were cemented with gypsum. Open fractures significant enough to impact groundwater movement in the perched zone were not identified.

Furthermore, HGC noted that no fractures were reported in cores from MW-3A, MW-16, or MW-23, making it even less likely that potentially undetected fractures could significantly affect subsurface fluid flow in the vicinity of proposed cell 4B. Should the limonite-stained sub-horizontal features actually represent fractures, their sub-horizontal nature would prevent them from acting as vertical conduits from the tailing cell to the perched groundwater.

HGC (2010a)[2] and HGC (2010b)[3] addressed concerns that included conglomeratic zones and/or lenses that may exist in the Dakota Sandstone and Burro Canyon Formation beneath cell 4B, and the potential impact of these features on groundwater monitoring beneath cell 4B. HGC (2010a)[2] concluded that available lithologic and hydraulic test data from the immediate vicinity of proposed cell 4B did not indicate an association between conglomeratic materials and higher permeability in the vadose zone. Furthermore, based on lithologic logs of MW-16 (located beneath proposed cell 4B), Boring #19 (reported to be near proposed cell 4B), and MW-23 (located at the northwest corner of proposed cell 4B), conglomeratic zones significant enough to impact groundwater movement in the vadose zone were not identified and were not considered to be of concern in the vicinity of proposed cell 4B.

Furthermore, as discussed in HGC (2010a)[2], should unidentified high permeability conglomeratic layers exist within the vadose zone beneath proposed cell 4B, they would likely be beneficial with regard to timely detection of any seepage that may occur. Interbedded conglomeratic layers or lenses are expected to be sub-horizontal and to spread any seepage entering them over a wider area. This would reduce the chances that any seepage originating from a highly localized source could pass undetected between perched monitoring wells. HGC also noted that the leak detection system to be integrated into cell 4B should be considered in assessing groundwater monitoring. The cell 4B system would be more robust than systems installed at tailings cells 1, 2, and 3 which further reduces the potential for any leak to develop and go undetected by the groundwater monitoring well network.

HGC (2010b)[3] provided lithologic cross sections based on logs from wells MW-3A, MW-15, MW-16, MW-17, MW-23, MW-28, and MW-29. The lithologic cross-sections depicted lithologies that included sandstone, siltstone, shale, conglomerate, 'shale with silt', 'sand with silt', and 'sandstone with intermittent conglomeratic features'. These cross-sections show that sandstone is the dominant lithology and that relatively thin, subhorizontal interbeds of siltstone, shale, and conglomerate occur within the sandstone. These interbeds are generally not correlatable between boreholes.

Recent Data Specific to Areas Near and Downgradient of Cell 4B

Installation and testing of groundwater monitoring wells MW-33 through MW-37 (shown on Figure 1) is described in HGC (2010c)[5] and HGC (2011)[6]. Wells were installed by air rotary and cuttings logged at 2 ½ foot intervals. Lithologic logs are provided in Appendix A. Each boring was terminated within the Brushy Basin Member. Slug tests were conducted at all wells except MW-33 (which is dry) and MW-34 (which has insufficient water column for testing). Hydraulic conductivity estimates (using the KGS solution method on automatically logged data) varied from 1.3 x 10^{-5} cm/s at MW-37 to 4.5 x 10-4 cm/s at MW-36.

Additional data downgradient of cell 4B was collected during the Southwest Area Investigation as described in HGC (2012)[4]. This investigation included the installation and testing of DR-series piezometers shown in Figure 1. DR-7, DR-10, DR-11, DR-12, and DR-13 are located immediately down gradient (west, southwest, and south) of cell 4B. Borings were installed by air rotary and cuttings logged at 2 ½ foot intervals. Lithologic logs of all DR-series borings are provided in Appendix A. Each boring was terminated within the Brushy Basin Member. Slug tests were conducted at all piezometers having sufficient water column for testing. DR-6, DR-7, DR-12, and DR-15 were not tested. The hydraulic conductivity estimates at DR-10, DR-11, and DR-13 (the closest tested wells downgradient of cell 4B) using the KGS solution method on automatically logged data were 2.9 x 10^{-6} cm/s, 8.9 x 10-6 cm/s, and 5.9 x 10-6 cm/s, respectively.

Because borings were installed by air rotary and cores were not collected, and because hydraulic tests were conducted only within the saturated zones, vadose zone information regarding hydraulic conductivity and potential presence of vadose zone fractures are not provided by the recent data. Lithologic and water level information provided by MW-33 through MW-37 and DR-series borings do provide supplemental information within the vicinity of and downgradient of cell 4B. In general, the more recent data are consistent with previous interpretations of the area near cell 4B. Lithologies of the Dakota Sandstone and Burro Canyon Formation are generally similar to those of previous

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[5] HGC, 2010c. Installation and Hydraulic Testing of Perched Monitoring Wells MW-33, MW-34, and MW-35 at the White Mesa Uranium Mill Near Blanding, Utah. Denison Mines (USA) Corporation, October 11, 2010.

[6] HGC, 2011. Installation and Hydraulic Testing of Perched Monitoring Wells MW-36 and MW-37 at the White Mesa Uranium Mill Near Blanding, Utah. Denison Mines (USA) Corporation, June 28, 2011.

borings, consisting of sandstone with relatively thin, subhorizontal shaly and conglomeratic horizons. Notable information from the recent borings includes the relative abundance of shaly materials (shales and shaly sandstones) within the Dakota Sandstone/Burro Canyon Formation at MW-33 (located at the southwest corner of cell 4B).

Furthermore, no conditions during drilling of MW-33 through MW-37 or DR-series borings were noted that would indicate the presence of open fractures. No loss in circulation was encountered in any of the borings and particularly hard drilling was encountered in many of the borings as noted in the logs of MW-34 and MW-37, located at the cell 4B margin, and at DR-8, DR-10, DR-11, DR-15, DR-18, DR-21, and DR-22, located southwest and generally downgradient of cell 4B.

Although vadose zone hydraulic conductivities were not tested in recent borings, no consistent association between conglomeratic zones and higher hydraulic conductivity was noted within the saturated zone. Table 1 lists hydraulic conductivities of tested wells having conglomeratic materials reported within the saturated zone. Hydraulic conductivities ranged from a relatively low 8.88 x 10^{-6} cm/s at DR-11 to a relatively high 4.49 x 10-4 cm/s at DR-9. The hydraulic conductivities at the remaining Table 1 wells were 3.48 x 10-4 cm/s (MW-35); 3.29 x 10-5 cm/s (DR-19); 3.29 x 10-5 cm/s (DR-21); and 1.64 x 10-5 cm/s (DR-24).

Site information available as of June, 2014 is summarized in HGC (2014)[7]. HGC (2014)[7] provided lithologic cross-sections N-S and W-E (Figures 2 and 3) that extend from the southern and western dikes of cell 4B. Cross-section WNW-ESE (Figure 4) is a new cross-section that extends from DR-17 to MW-17 and follows portions of the downgradient margins of cells 4B and 4A. The locations of cross-sections are shown in Figure 1. Cross-sections N-S, W-E, and WNW-ESE show that, as described above, the Dakota Sandstone and Burro Canyon Formation in the vicinity of cell 4B consist of sandstone with relatively thin, subhorizontal shaly and conglomeratic horizons that may or may not be correlatable between boreholes. The relative abundance of shaly materials logged within the Dakota Sandstone/Burro Canyon Formation at MW-33 is shown in cross-section WNW-ESE (Figure 4). In general, the lithologic interpretation reflected in Figures 2, 3, and 4 is similar to that provided in HGC (2010b)[3].

Summary and Conclusions

Hydrogeologic data provided by borings MW-33 through MW-37 and DR-series borings (the 'recent' data), are generally consistent with previous data used to characterize hydrogeologic conditions in the vicinity of cell 4B. Because recent borings were not cored and hydraulic tests were performed only within the saturated zone, vadose zone information regarding hydraulic conductivity and potential presence of vadose zone fractures are not provided. However, no conditions during drilling of MW-33 through MW-37 or DR-series borings were noted that would indicate the presence of open fractures. No loss in circulation was encountered in any of the borings and particularly hard drilling was encountered in many of the borings as noted in the logs of MW-34 and

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[7] HGC, 2014. Hydrogeology of the White Mesa Uranium Mill, Blanding, Utah. Energy Fuels Resources (USA) Inc., June 6, 2014

MW-37, located at the cell 4B margin, and at DR-8, DR-10, DR-11, DR-15, DR-18, DR-21, and DR-22, located southwest and generally downgradient of cell 4B.Both pre-existing and recent data show that the Dakota Sandstone and Burro Canyon Formation in the vicinity of cell 4B consist of sandstone with relatively thin, subhorizontal, shaly and conglomeratic horizons that may or may not be correlatable between boreholes. Recent data also show that shaly materials are relatively abundant within the Dakota Sandstone/Burro Canyon Formation in boring MW-33 (located at the southwest corner of cell 4B).

No consistent association between conglomeratic zones and higher hydraulic conductivity has been noted within either the vadose or saturated zones near cell 4B. Should sub-horizontal interbedded conglomeratic layers or lenses have higher conductivity, they are expected to spread any seepage entering them over a wider area thereby reducing the chances that any seepage originating from a highly localized source could pass undetected between perched monitoring wells. Furthermore, the leak detection system integrated into cell 4B is more robust than systems installed at tailings cells 1, 2, and 3, which further reduces the possibility that an undetected leak could develop.

Sincerely,

Stewart J. Smith
Associate Hydrogeologist

Attachments: Table (1); Figures (4); Appendix (1)

TABLE

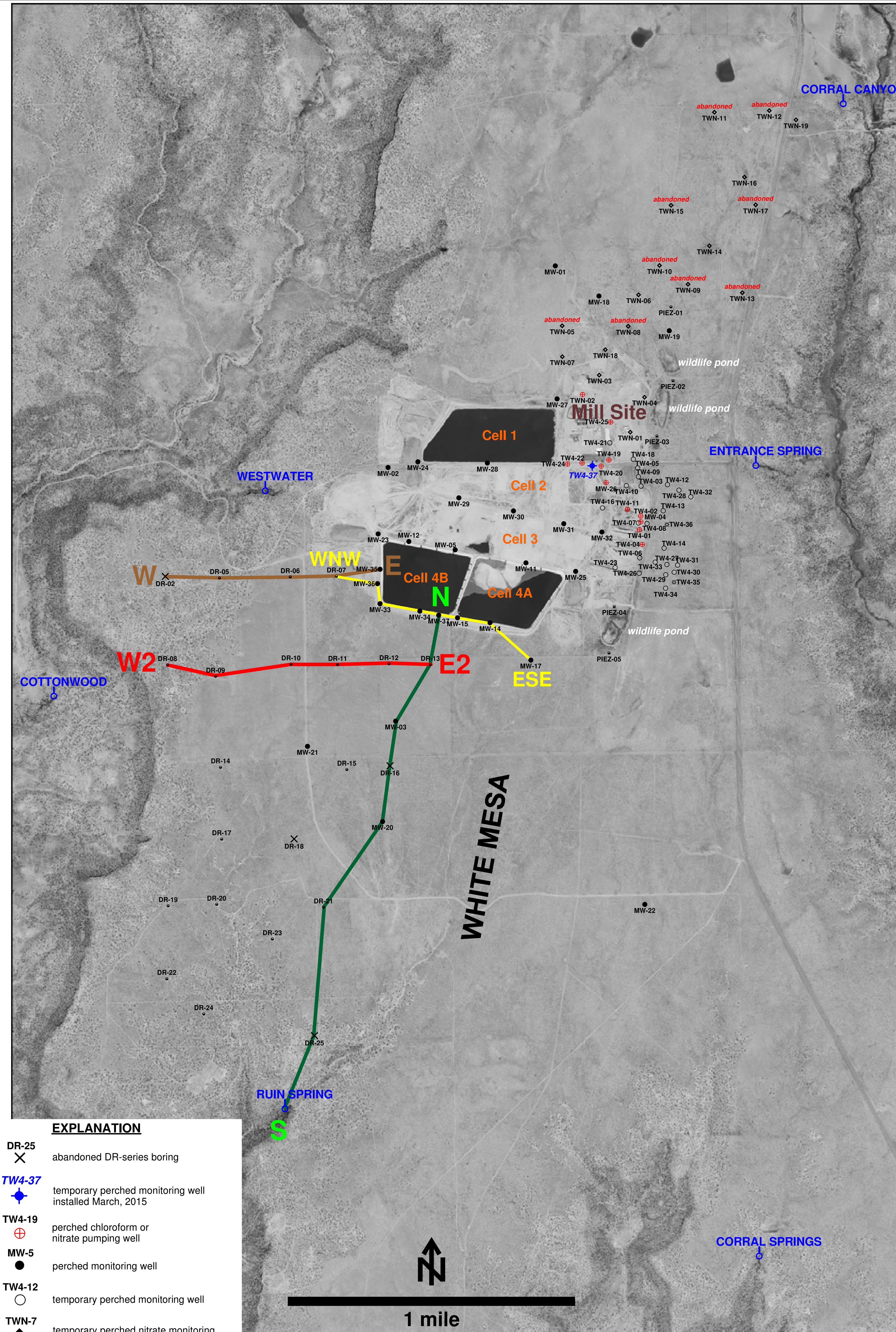
TABLE 1
Results of Slug test Analyses in Wells
Southwest of Cell 4B
Having Conglomerate Reported Within Saturated Interval

		Automatically Logged Data			Hand Collected Data		
		KGS		Bouwer-Rice	KGS		Bouwer-Rice
Test	Saturated Thickness	K (cm/s)	Ss (1/ft)	K (cm/s)	K (cm/s)	Ss (1/ft)	K (cm/s)
MW-35	12	3.48E-04	1.95E-05	2.18E-04	2.59E-04	1.78E-05	1.65E-04
DR-9	24.5	4.49E-04	4.30E-06	3.41E-04	4.73E-04	1.21E-05	4.73E-04
DR-11	8.9	8.88E-06	8.88E-04	1.54E-05	5.83E-06	2.22E-03	1.11E-05
DR-19	3.5	3.29E-05	2.54E-03	3.78E-05	3.39E-05	1.86E-03	4.08E-05
DR-21	13.5	3.29E-05	7.17E-06	3.60E-05	2.21E-05	1.87E-04	3.49E-05
DR-24	17.4	1.64E-05	7.49E-05	1.43E-05	1.64E-05	7.49E-05	8.23E-06
DR-24(et)	17.4	NA	NA	NA	NA	NA	1.97E-05

Notes:

Bouwer-Rice = Unconfined Bouwer-Rice solution method in Aqtesolv™ unless otherwise noted
cm/s = centimeters per second
ft = feet
K = hydraulic conductivity
KGS = Unconfined KGS solution method in Aqtesolv™ unless otherwise noted
Ss= specific storage
et= early time data
NA=not applicable

FIGURES



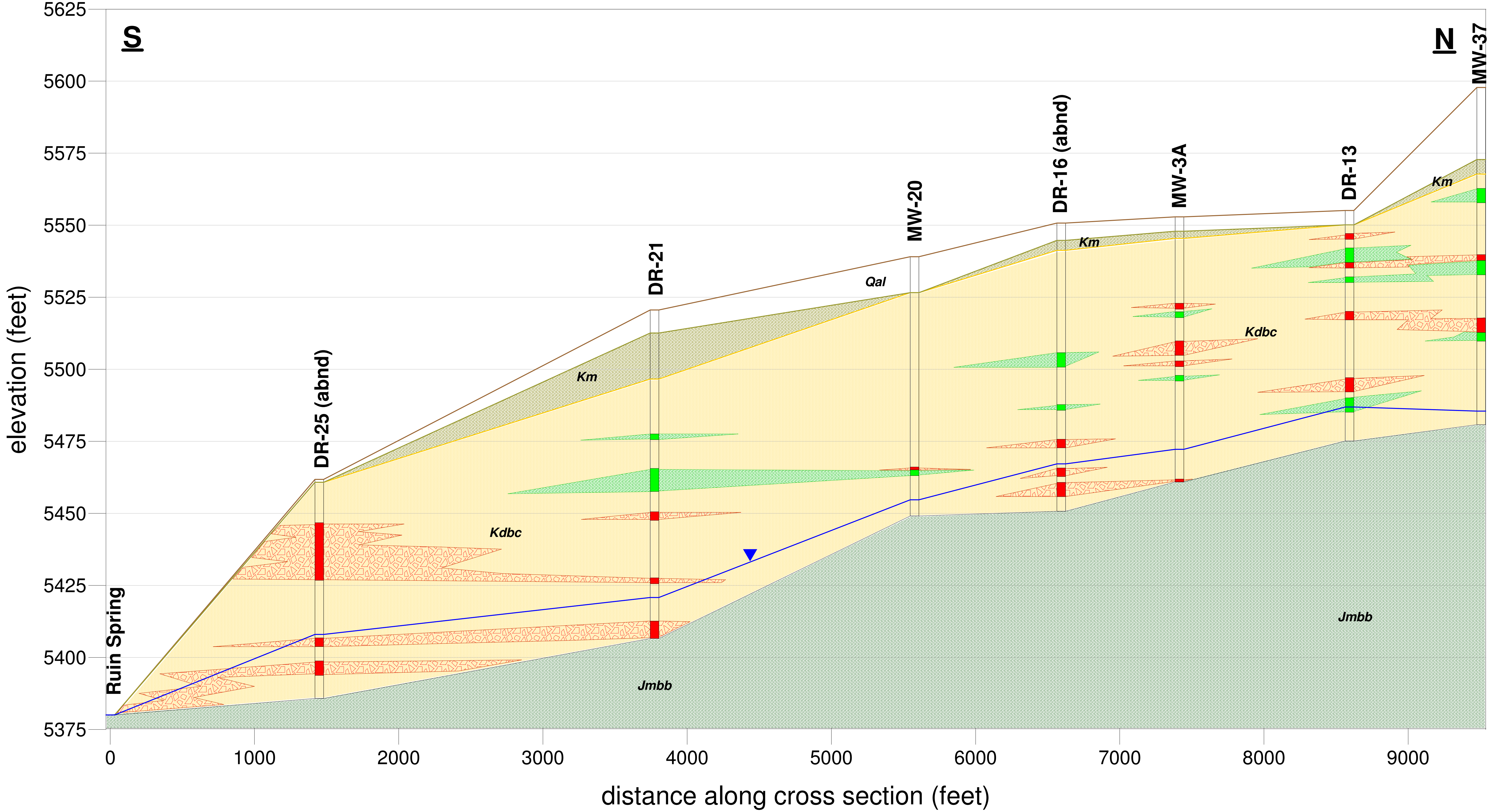
EXPLANATION

DR-25 ✕	abandoned DR-series boring
TW4-37	temporary perched monitoring well installed March, 2015
TW4-19	perched chloroform or nitrate pumping well
MW-5 ●	perched monitoring well
TW4-12 ○	temporary perched monitoring well
TWN-7 ◆	temporary perched nitrate monitoring well
PIEZ-1	perched piezometer
TW4-35 ☼	temporary perched monitoring well installed May, 2014
RUIN SPRING	seep or spring

HYDRO
GEO
CHEM, INC.

WHITE MESA SITE PLAN SHOWING LOCATIONS OF PERCHED WELLS, PIEZOMETERS, AND CROSS-SECTIONS

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/17/2015	H:/718000/ cell4bjune2015/Uxsectloc.srf	1



EXPLANATION

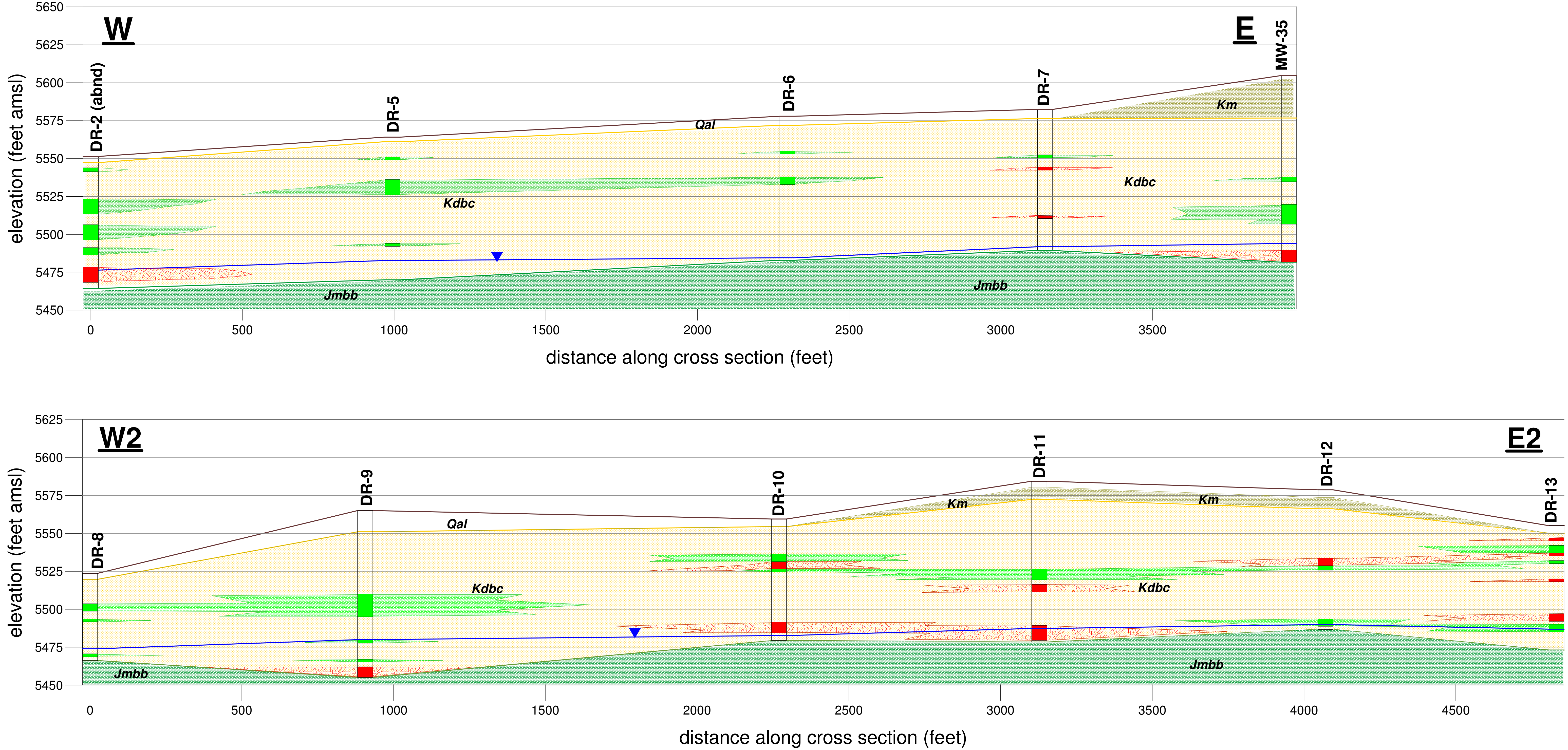
vertical exaggeration = 20:1

Symbol	Description
Qal	Alluvium/Fill
Km	Mancos Shale
Kdbc	Dakota Sandstone/ Burro Canyon Formation
	Shale/claystone within Dakota/Burro Canyon
	Conglomerate within Dakota/Burro Canyon
Jmbb	Brushy Basin Member of Morrison Formation
	Piezometric surface

HYDRO GEO CHEM, INC.

INTERPRETIVE NORTH-SOUTH CROSS SECTION (S-N) SOUTHWEST INVESTIGATION AREA

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/8/2015	H:/718000/ cell4bjune2015/nsxsswb.srf	2



EXPLANATION

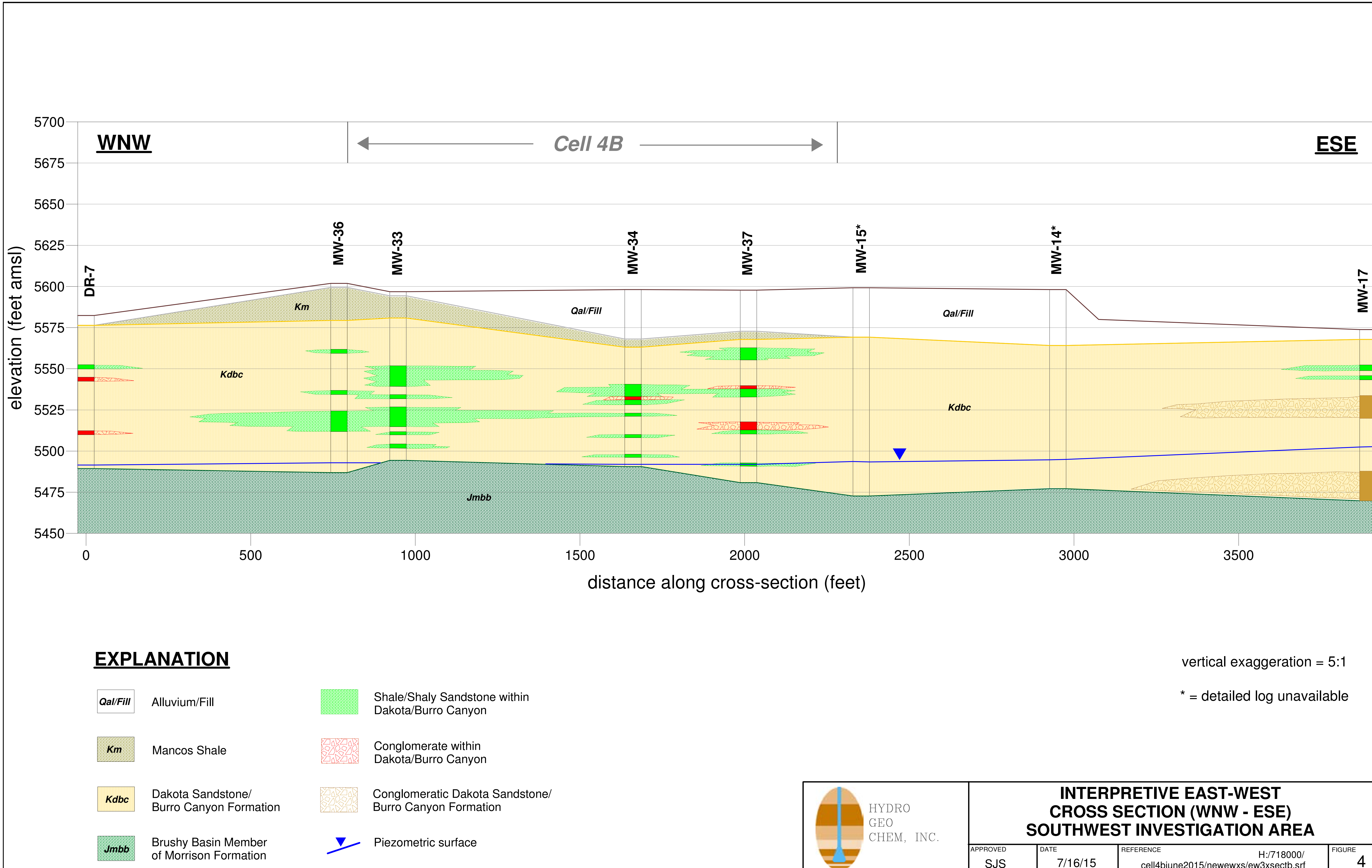
Symbol	Description
Qal	Alluvium/Fill
Km	Mancos Shale
Kdbc	Dakota Sandstone/ Burro Canyon Formation
	Shale/claystone within Dakota/Burro Canyon
	Conglomerate within Dakota/Burro Canyon
Jmbb	Brushy Basin Member of Morrison Formation
	Piezometric surface

vertical exaggeration = 5:1

HYDRO GEO CHEM, INC.

INTERPRETIVE EAST-WEST CROSS SECTIONS (W-E and W2-E2) SOUTHWEST INVESTIGATION AREA

APPROVED	DATE	REFERENCE	FIGURE
SJS	7/8/2015	H:/718000/ cell4bjune2015/ewxsswb_2.srf	3



WNW
Cell 4B
ESE
elevation (feet amsl)
5700
5675
5650
5625
5600
5575
5550
5525
5500
5475
5450
DR-7
MW-36
MW-33
MW-34
MW-37
MW-15*
MW-14*
MW-17
Km
Qal/Fill
Qal/Fill
Kdbc
Kdbc
Jmbb
0
500
1000
1500
2000
2500
3000
3500
distance along cross-section (feet)
EXPLANATION
Qal/Fill Alluvium/Fill
Km Mancos Shale
Kdbc Dakota Sandstone/ Burro Canyon Formation
Jmbb Brushy Basin Member of Morrison Formation
Shale/Shaly Sandstone within Dakota/Burro Canyon
Conglomerate within Dakota/Burro Canyon
Conglomeratic Dakota Sandstone/ Burro Canyon Formation
Piezometric surface
vertical exaggeration = 5:1
* = detailed log unavailable
HYDRO GEO CHEM, INC.
INTERPRETIVE EAST-WEST CROSS SECTION (WNW - ESE) SOUTHWEST INVESTIGATION AREA
APPROVED SJS
DATE 7/16/15
REFERENCE H:/718000/ cell4bjune2015/newewxs/ew3xsectb.srf
FIGURE 4

APPENDIX A

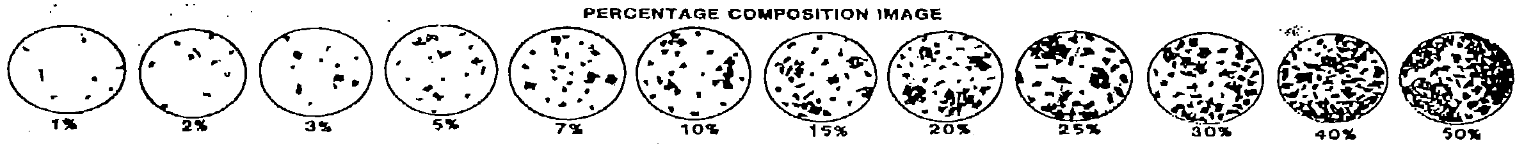
LITHOLOGIC LOGS

Date 8-31-10 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. MW-33
Property White Mesa Mill Tailings Cell Unit No. ____ Sec. ____ Twp. ____ Rge. ____
County San Juan State Utah Location ____ Elev. ____

PAGE 1 OF 1
T.D. PROBE ____
T.D. DRILL 110.0
FLUID LEVEL Dry Hole

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rd bn											S			surface soil
5.0						mdst	rd bn - lt pk											VS			mancos shale fm.
7.5						sndy mdst	rd bn - lt pk	m-cr	m	a								VS			
10.0						sndy mdst	rd bn	m	m	a								VS			
12.5						mdst	rd bn											S			
15.0						sh	vlt pk											VS			
17.5						sh, qtz ss	lt pk	m-cr	m	a								VS			Dakota fm. contact @ 16.0 ft.
20.0						qtz ss	tn	m cr	m	a								S			
22.5						qtz ss	rd bn - tn	m-cr	m	r								M			
25.0						qtz ss	lt gy bn	m	w	r								m			
27.5						qtz ss	lt gy bn	m-cr	m	a		L						N			
30.0						qtz ss	gy bn	m-cr	p	a		L						vw			
32.5						qtz ss	gy bn	f-vcr	p	a								vw			
35.0						qtz ss	gy bn	m-vcr	p	a								N			
37.5						qtz ss	gy bn	m-cr	p	a								N			
40.0						qtz ss	gy bn	m-gr	p	a								N			
42.5						mdy qtz ss	lt rd bn	f-cr	p	a								S			mdst is believed to be material from 12.5' above
45.0						qtz ss	tn	f-gr	p	a								S			multi colored chert grains and frag.
47.5						qtz ss, sh	tn	f-gr	p	a								m			some chert grains and fragments
50.0						qtz ss, sh	tn - lt gy	f-gr	p	a								vw			some chert grains and fragments.
52.5						qtz ss, sh	tn - lt gy	f-gr	p	a								w			abunt chert grains
55.0						qtz ss, sh	tn - lt gy	f-gr	p	a								w			" " "
57.5						sh												w			
60.0						sltst.												w			
62.5						sndy sh	lt gy tn	f-m	m	a								N			
65.0						sndy sh	lt gy tn	f-m	m	a								N			
67.5						sltst	lt tn											N			
70.0						qtz ss, sh	lt tn - lt gy	f-m	m	a								S			
72.5						sh	lt gy											w			
75.0						sh	bl gy - yw or					L						vw			
77.5						sh	bl gy											N			
80.0						sltst - ss	tn	vf-f	m	r								N			
82.5						qtz ss, sh	gy tn - yw or	m	w	r		L						N			
85.0						qtz ss	vlt gy tn	m-cr	m	a								w			qtz ss
87.5						qtz ss, sh	vlt tn - lt gn	m-cr	m	a								N			
90.0						qtz ss	lt tn	m-cr	m	a								w			
92.5						qtz ss	lt tn	cr-vcr	m	a								m			
95.0						qtz ss, sh	lt tn - lt gn	m-cr	p	a								N			
97.5						qtz ss	lt tn	m-vcr	p	a								N			sparse chert grains
100.0						qtz ss	tn	m-gr	p	a								vw			" " " some contamination from up hole cuttings
102.5						qtz ss	tn bn	m-cr	m	a		L						m			
105.0						sh	gy gn - pp bn											N			Brushy Basin Ct @ 102.5
107.5						sh	gy gn - pp bn											vw			
110.0						sh	gy gn - pp bn											N			T.D. Well bore was dry to T.D.

PERCENTAGE COMPOSITION IMAGE



Date 8-31-10 Geologist L. Casebolt Drilling Co. Boyles Exploration Co. Hole No. MW-34

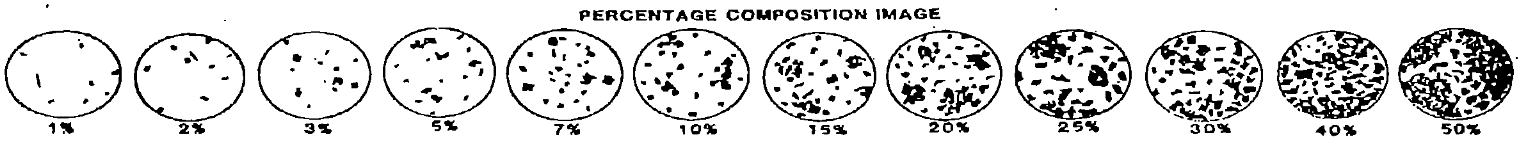
Property White Mesa Project Tailings Cell Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location Tailings cell DIKE Elev. ______

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 115.0
FLUID LEVEL ______

Depth	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
2.5	mdst	rd bn							VS			Compacted fill material for cell dike
5.0	mdst	rd bn-yw bn							VS			" " " " " "
7.5	mdst	rd bn							VS			" " " " " "
10.0	mdst	rd bn							VS			" " " " " "
12.5	mdst	rd bn							VS			" " " " " "
15.0	mdst	rd bn							VS			" " " " " "
17.5	mdst	pk bn							VS			" " " " " "
20.0	sndy mdst	yw gy bn	f-m	P	a				VS			" " " " " "
22.5	sndy mdst	rd bn	f-m	P	a				VS			" " " " " "
25.0	sndy mdst	lt rd bn	f-m	m	a				VS			" " " " " "
27.5	sndy mdst	lt rd bn	f-m	m	a				VS			" " " " " "
30.0	sndy sh	lt pk tn	f-m	P	a				VW			" " " " " "
32.5	qtz ss	tn	m	m	a		L		VW			Mancos Shale fm.
35.0	sndy sh	yw gy bn	m-cr	m	a				N			" " "
37.5	qtz ss	lt bn	m-cr	m	a		L		N			Dakota fm contact @ 35.0 ft.
40.0	qtz ss	lt gy bn	f-cr	P	a				m	tr	Hy	poss. tr of hydrocarbon
42.5	qtz ss	v lt tn-wh	f-vcr	P	A				VW			Very hard drilling
45.0	qtz ss	v lt tn	f-m	m	a				N			" " "
47.5	qtz ss	wh	m-vcr	P	A				N			" " " sparse chert grains
50.0	qtz ss	wh	m-gr	P	A				VW			" " " chert grains
52.5	qtz ss	v lt tn	f-vcr	P	A				VW			
55.0	qtz ss	tn	m	w	R				N			
57.5	qtz ss	tn	f-m	m	a				N			
60.0	qtz ss, sh	lt tn - v lt gn	m-vcr	P	a				N			
62.5	qtz ss, sh	lt tn - lt gn	cr-gr	P	a				N			abund multi colored chert grains & frags.
65.0	qtz ss, sh	lt tn - lt gn	m-gr	P	a				N			" " " " " "
67.5	sh, cgl	dk gy - lt gy gn	gr	P	a				N			" " " " " "
70.0	qtz ss, sh	yw tn - gy gn	f-cr	P	a			Tr	N			dissem. pyrite
72.5	qtz ss	dk tn	f-cr	P	a		L		N			sparse chert grains
75.0	qtz ss	tn	f-cr	P	a				S			sparse chert grains
77.5	qtz ss, sh	tn - lt gy	f-cr	P	a		L		S			
80.0	qtz ss	tn	m-cr	P	a				S			
82.5	qtz ss	tn	f-m	m	r				N			
85.0	qtz ss	tn	f	w	r				S			sparse chert grains
87.5	qtz ss	tn	f	w	r				N			
90.0	qtz ss, sh	v lt gy tn	f	w	r				VW			
92.5	qtz ss	v lt tn	f-m	m	r				N			
95.0	qtz ss	v lt tn	m	m	r				N			
97.5	qtz ss	v lt tn	m	w	r				N			
100.0	qtz ss	v lt tn	m	w	a				N			
102.5	qtz ss, sh	v lt tn-wh	f-m	m	r				S			
105.0	qtz ss	gy bn	m-vcr	P	a				S	tr	hy	
107.5	qtz ss	gy bn	m-vcr						M			Moisture first noted @ 107.5
110.0	sh, qtz ss	gy bn	v-vcr						m			Brushy Basin fm contact @ 107.5
112.5	sh	lt gy gn							N			
115.0	sh	gy gn - pp bn							N			mottled frags.

PERCENTAGE COMPOSITION IMAGE



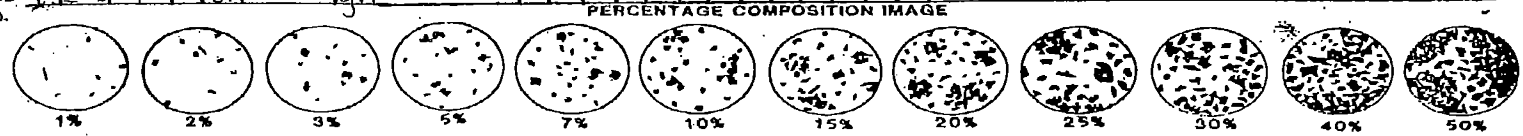
1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Date 9-1-10 Geologist L. Casebolt Drilling Co. Boyles Exploration Co. Hole No. MW-35
Property White Mesa Project Tailings Cell Unit No. Sec. Twp. Rge.
County San Juan State Utah Location Elev.

PAGE 1 OF 1
T.D. PROBE 127.0'
T.D. DRILL 127.5
FLUID LEVEL 112.6 (9-2-10)

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rdbn											W			Surface soil
5.0						sndy mdst	rdbn	f	p	a								S			Mancos Shale fm.
7.5						sndy mdst	lt rdbn	f-m	p	a								VS			
10.0						qtz ss	lt rdbn	vf-m	p	a								VS			
12.5						mdst	rdbn											VS			
15.0						mdst-sh	rdbn-ltpktn											VS			
17.5						shale	wh											VS	tr	HY	
20.0						sndy sh.	lt pktn	f-m	p	a								VS			
22.5						sndysh	lt pktn	f-m	p	a								VS			
25.0						sndysh	ywgybn	f m	p	a		L						S			
27.5						sndysh	ywgybn	f-m	p	a		L						W			
30.0						qtzss	tn	m	m	a		L						N			Dakota Ct. @ 27.5
32.5						qtz ss	lt tn	m	m	a								N			
35.0						qtz ss	lt tn	m	m	a								N			
37.5						qtz ss	v.lt bn	m-cr	p	a								N			
40.0						qtz ss	vlt bn	m-cr	p	a								N			
42.5						qtz ss	bn	f-m	m	a								N			
45.0						qtz ss	tn	f	w	r								N			
47.5						qtz ss	gybn	f-m	w	r								N			
50.0						qtz ss.	vlt tn	f	w	r								N			
52.5						qtz ss	vlt tn	f	w	r								N			
55.0						qtz ss	tn	f-m	m	a								N			
57.5						qtzss	tn	m-cr	p	a								N			abund wh-pk chert grains
60.0						qtz ss	tn	f-m	m	r								N			some wh chert grains
62.5						qtz ss	tn	f-m	m	r								N			
65.0						qtz ss	gytn	m	w	r								N			some wh-dkgy chert frags.
67.5						qtz ss	gytn	m-vcr	p	a								N			abund wh-dkgy chert frags.
70.0						sndy sh	lt ywgy	vf f	p	a		L						N			thin shale lens
72.5						qtz ss	tn	f-m	m	a								N			
75.0						qtz ss	tn	m	w	r								N			
77.5						qtz ss	tn	f-m	m	r								N			
80.0						qtzss	tn	m	m	r								N			
82.5						qtz ss	tn	m	w	r								N			
85.0						qtz ss	tn	m	w	r								N			
87.5						qtz ss, sh	ltgygn	m	m	r								N			
90.0						sndysh	ltgygn	f	m	r								N			
92.5						sh	ltgn											N			
95.0						sh	ltgn						tr	c				N			py
97.5						sh	ltgygn						tr	c				N			py
100.0						qtzss	ltpktn	f-m	m	a			tr	c				N			py
102.5						qtz ss	ltgy	m	w	r								N			
105.0						qtz ss	ltgy	m	w	r								W			
107.5						qtz ss	ltgy	m-cr	m	r								W			
110.0						qtz ss	ltgy	m-cr	m	r								W			
112.5						qtz ss	ltgy	f-m	m	r								VS			Moisture first noted 112.5
115.0						qtz ss	ltgybn	m-cr	m	r								N			tr hydrocarbon
117.5						qtz ss, cgl	dk ywgy	m-cr	p	r								N			abund dk chert frags & grains
120.0						qtz ss, cgl	wh-dkgy	vcr	p	r			tr	c				N			" " " " "
122.5						qtzss cgl	wh-dkgy	vcr	p	a								N			" " " " "
125.0						cgl-sh	gy-gn	vcr	p	a			tr	c				N			Brushy Basin Contact @ 123.6'
127.5						sh	gn											N			
TD.																					

PERCENTAGE COMPOSITION IMAGE

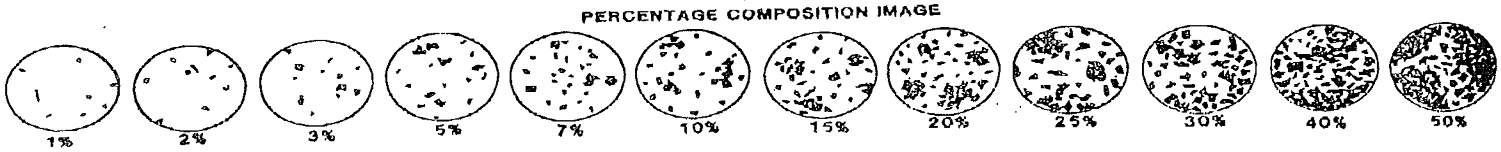


Date 26 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration, Inc. Hole No. MW 36
Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______
County San Juan State Utah Location ______ Elev. ≈5615

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 120.0
FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
2.5						mdst	rdbn											S			Surface soil-unconsolidated CL
5.0						mdst, sh	rdbn-ltpk											VS			Mancos Sh CL
7.5							rdbn											VS			CL
10.0							rdbn											S			
12.5							rdbn											S			
15.0							rdbn-ltpk											VS			
17.5							ltpk											VS			
20.0							ltywtn											VS			
22.5						sltst	ltpktn											S			
25.0						qtz ss	ywtn	m	w	r								N			Upper Dakota Ct @ 22.5 ft.
27.5						qtz ss	tn	m	w	r								N			
30.0						qtz ss	tn	m	w	r		L						N			
32.5						qtz ss	tn	m	w	a		L						N			
35.0						qtz ss	tn	m	w	a								N			
37.5						qtz ss	tn	m	w	a								N			
40.0						qtz ss	tn	m-c	m	a								N			
42.5						qtz ss, sh	tn-gy	m-c	m	a								N			
45.0						qtz ss	tn	m	w	r								N			
47.5						qtz ss	tn	f-m	m	r								N			
50.0						qtz ss	tn	m	w	R								N			
52.5						qtz ss	tn	m-c	m	r								N			
55.0						qtz ss	tn	m	w	r								N			
57.5						qtz ss	tn	m	w	R								N			
60.0						qtz ss	ltbn	m-c	m	r								N			some wh-gy chert grains and frags.
62.5						qtz ss	tn	m-vc	f	r								N			″
65.0						sh, sltst	gy-lttn											N			CL
67.5						sh	ltgytn											N			CH
70.0						qtz ss	vltgy	vf-f	m	r								N			
72.5						qtz ss	ltywbn	m	w	r		L						N			
75.0						qtz ss	lttn-ltywbn	m	w	r		L						S			
77.5						qtz ss	wh-lttn	m	w	r		L						W			CH
80.0						sh	ltblgy											N			
82.5						sh	pprdbn											N			
85.0						sh	pprdbn											N			mottled cuttings
87.5						sh	ltblgy, pprdbn											N			
90.0						sh	ltblgy						1%	A				VW			
92.5						qtz ss	vlttn	vf	w	r								N			
95.0						qtz ss	vltn	vf	w	r								N			
97.5						qtz ss	vltn	f-m	m	r		L						VW			
100.0						qtz ss	vlttn	f-m	m	r								N			
102.5						qtz ss	wh	m	w	r								N			
105.0						qtz ss	vlttn	m	w	R		L						N			
107.5						qtz ss	vlttn	m	w	r								N			
110.0						qtz ss	vlttn	m	w	r								N			
112.5						qtz ss	vlttn	f-m	m	a								W			moisture first noted
115.0						qtz ss	vlttn	f-m	m	r			Tr	C				S			Brushy Basin Ct. @ 115.0
117.5						sh	blgn											N			
120.0						sh	blgn											N			T.D.
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 25 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration, Inc. Hole No. MW-37

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location CELL 4B DIKE Elev. 5618 ≈

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 120.0
FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rdbn											VS			Compacted Tailings Cell Dike Material
5.0						mdst	rdbn											VS			"
7.5						mdst	rdbn											VS			"
10.0						mdst	rdbn											VS			"
12.5						mdst	rdbn											VS			"
15.0						mdst	rdbn											VS			"
17.5						mdst	rdbn											VS			"
20.0						mdst	rdbn											VS			"
22.5						mdst	rdbn											VS			"
25.0						mdst	rdbn											VS			"
27.5						sh	ywbn											VS			Mancos Sh
30.0						sh-mdst	rdbn-ltpk											VS			Mancos Sh.
32.5						qtzss, sh	tn	f-m	m	r								VS			upper Dakota Ct @ 30.0'
35.0						qtzss	tn	f-m	m	r								VW			
37.5						qtz ss sh	tn	f-m	m	r								N			
40.0						qtzss, sh	gybn	m	m	r								N			
42.5						qtzss, sh	wh-ltorbn-dkgy	m	m	r								N			
45.0						qtzss	wh-ltorbn	f-m	m	r		L						N			
47.5						qtz ss	vlttn	m	w	R		L						VW			
50.0						qtzss, qtzite	wh	m	w	R								N			Very hard drilling
52.5						qtzss-qtzite	wh	f-m	w	r								N			extremely hard drilling
55.0						qtz ss-qtzite	wh-lttn	f-m	w	r								N			moisture first noted @ 54'
57.5						qtzss	tn	f-m	w	r								N			abund. chert grains
60.0						qtzss, cgl	lttn	m-peb	p	a								N			very abund chert grains and pebbles.
62.5						cgl-sh	ltywgygn	peb	p	a								N			Some chert pebble frags.
65.0						sh-cgl	ltgn-tn	peb	p	a								N			" " " .
67.5						sltst, qtz ss	lt tn	vf-peb	p	a								N			
70.0						qtzss	lttn	vf-peb	p	r								N			
72.5						qtz ss	lttn	f-peb	p	r								VW			
75.0						qtz ss	lttn	m-peb	p	r								S			
77.5						qtzss	vlttn	m-peb	p	r		L						VW			abund chert frags.
80.0						qtz ss	vltbn	m	w	r		L						N			
82.5						qtzss, cgl	wh-vdkgy	m peb	p	r		L						N			Abund. water @ 80.0' abund chert frags & pebbles.
85.0						sh, qtzss, cg	lttn-gn	f-peb	p	r		L						N			abund chert frags and pebble.
87.5						sh, qtzss	gn-wh	f-peb	p	r								N			
90.0						qtz ss	wh	m-peb	m	r								N			
92.5						qtz ss	ltgybn	m-peb	m	r		L						N			
95.0						qtz ss	vlttn	m	w	R		L						N			
97.5						qtz ss	vlttn	m-peb	p	r								N			
100.0						qtz ss	lttn	m-c	p	r								N			
102.5						qtz ss	lttn	f-m	m	r								W			
105.0						qtz ss	lttn	f-m	m	r								N			
107.5						qtzss, sh	lttn-gn	f-peb	p	r								N			
110.0						qtz ss	wh-tn	m	w	R			Tr	C				N			
112.5						qtz ss	vlttn	m	w	R			3%	C				W			
115.0						qtz ss	wh-blgn	f-m	m	r			1%	C				W			
117.5						qtzss, sh	wh-blgn											N			Brushy Basin Ct @ 117.0' (good contact)
120.0						sh	blgn-gnbn											N			120.0 T.D.
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE

Date 5 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR2

Property White Mesa Mill Project Cell 48 Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈5576

PAGE 1 OF 1

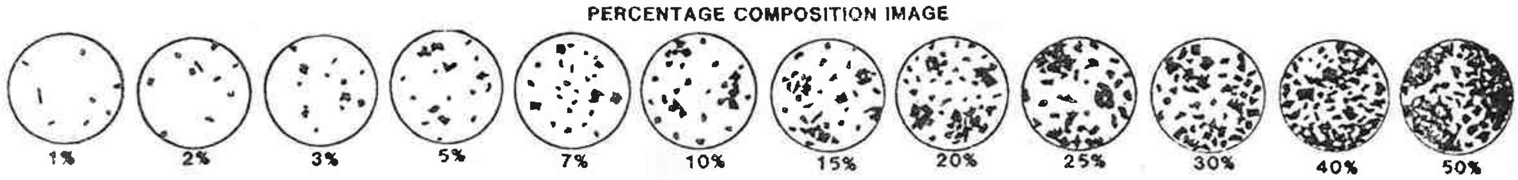
T.D. PROBE ______

T.D. DRILL 95.0

FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						sndy mdst	rdbn-ltpktn	f-c	p	a								S			Surface Soil to 2.0' Mancos Shale (unconsolidated)
5.0						sh-qtz ss	ltpktn	m-c	f	a								VS			Upper Dakota Ct. @ 4.0' (unconsol. to 4.0')
7.5						qtz ss	lt br	m-c	f	a		H						N			wh chert grains
10.0						sh	ywgy											S			
12.5						sh-qtz ss	dkgy	m-c	f	a								M			
15.0						qtz ss	ywtn	m	w	R								N			
17.5						qtz ss	ywtn	m	w	R		L						N			sparce limonite grain coating
20.0						qtz ss	ltgytn	m	w	R								N			gy qtz grains
22.5						qtz ss	ywtn	m-peb	p	a								N			Moist cuttings this morning, dk chert grains & peb.
25.0						qtz ss	ywtn	m-peb	p	a								N			lt-dk chert grains
27.5						qtz ss	lt tn	f-m	w	R								N			
30.0						sh	ywgybl											N			
32.5						sh	ywgybl											N			
35.0						sh	ywgybl											N			
37.5						sh	ywgybl											N			
40.0						qtz ss sltst	lt ywtn	slt-vf	m	r								N			
42.5						qtz ss sltst	lt tn	slt-vf	m	r								N			
45.0						qtz ss sltst	lt tn	slt-vf	m	r								N			
47.5						sltst-sh	lt ywgn											N			
50.0						sh	ltgn-ltpprd											N			
52.5						sltst-qtz ss	lt blgy	slt-m	p	a								N			
55.0						sltst-qtz ss	lt tn	slt-vf	m	r								N			
57.5						qtz ss	lt tn	f	w	r								M			
60.0						qtz ss	lt tn	f	w	r								N			
62.5						sltst-sh	ywgytn											N			
65.0						sh	ltgn-ppbn											N			
67.5						qtz ss	ltgytn	vf-m	m	r			tr	a				N			
70.0						qtz ss	lt tn	m	w	R								N			
72.5						qtz ss	lt tn	m	w	R								N			
75.0						qtz/chert ss	gytn	m-peb	p	a								N			abund dk-lt chert grains & pebbles.
77.5						qtz ss cgl	orgy	vc-peb	p	A								N			abund multi colored chert grains
80.0						qtz ss, cgl	orgy	vc-peb	p	A								N			Well began producing approx 3gpm @ 78.0'
82.5						cgl, qtz ss	wh-ltgy	m-peb	p	A	si							N			
85.0						qtz ss	wh-ltgy	m-peb	f	A	si							N			
87.5						qtz ss, sh	wh-gn	m-vc	p	a	si	L						N			Brushy Basin Ct. @ 87.0' good ct. poss. oil as cement?
90.0						sh	gn-ppbn											N			flow increased to 20gpm @ 87.0'
92.5						sh	gn-ppbn											N			
95.0						sh	gn-ppbn											N			T.D. some telltale rd chert grains · 1-2mm
97.5																					
100.0																					(noteable dk bn material (dead oil?) in
102.5																					interstacese of sand grains @ 87.5)
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					Note: this well completed on 6 May 2011

PERCENTAGE COMPOSITION IMAGE

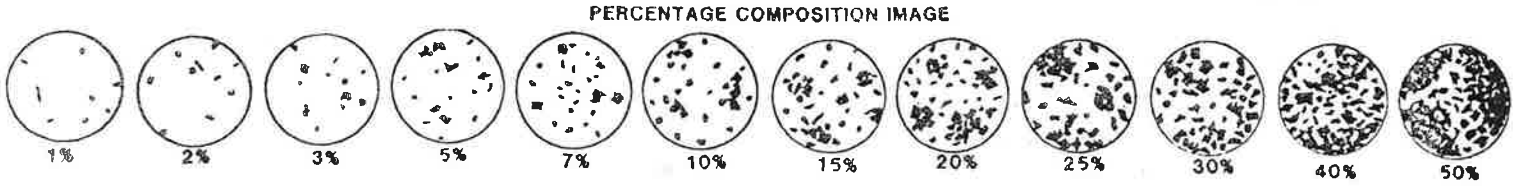


Date 5 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR5
Property White Mesa Mill Project cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______
County San Juan State Utah Location ______ Elev. ≈5560

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 100.0
FLUID LEVEL ______

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
0																					
2.5						mdst	rdbn											S			Surface Soil - unconsolidated CL
5.0						qtz ss, mdst	ywrdbn	m-c	m	a								N			Upper Dakota Ct. @ 3.0'
7.5						qtz ss	ltorbn	m-c	m	a		L						N			
10.0						qtz ss	tn	m	W	r								N			
12.5						qtz ss	tn	m	w	r								N			
15.0						qtz ss, sh	ltbn - ltgy	f	w	a		L						N			
17.5						qtz ss	vltbn	f	w	a		L						N			
20.0						qtz ss	ywgy	vf-c	P	r								N			some chert grains
22.5						qtz ss	ltgy	m-c	m	R								N			" " "
25.0						qtz ss	tn	m	W	R								N			
27.5						qtz ss	ltgy	m-c	m	r								N			
30.0						sndy sh	vltywgy	f-m	m	r								N			CH
32.5						sh	ltywgy											N			CH
35.0						sh	ywgy											N			
37.5						qtz ss, sh	tn - orgy	f-m	m	r		L						N			
40.0						qtz ss	tn	m	W	r								N			
42.5						qtz ss	ltbn	m-c	m	r		L						N			Some chert frags. and grains
45.0						qtz ss	tn	m	w	r								N			
47.5						qtz ss	vltbn	m	W	r								N			
50.0						qtz ss	ltbn	M	w	r								N			
52.5						qtz ss	lttn	M	W	r								N			
55.0						qtz ss	ltgytn	m	W	r								N			
57.5						qtz ss	ltgytn	m	w	a								N			
60.0						qtz ss	ltgytn	f-m	m	a								N			
62.5						qtz ss	wh-vdkbn	f-peb	P	a								W			moisture 1st noticed chert pebble frags.
65.0						qtz ss, sh	wh-vltgn	vf-c	P	a								N			
67.5						qtz ss	vltgytn	m-peb	P	r								N			abund. chert grains
70.0						qtz ss	vltgytn	m-c	m	r								N			
72.5						qtz ss, sh	vltgytn	m-peb	f	r								N			some chert frags + grains
75.0						qtz ss	vltgytn	m	w	r		L						N			
77.5						qtz ss	vltgytn	m	w	r								N			
80.0						qtz ss	ltortn	m	w	r		L						N			very hard drilling
82.5						qtz ss	lttn	m	w	r		L						N			"
85.0						qtz ss	lttn	M	w	R								N			"
87.5						qtz ss	vlttn	m-c	m	a								N			"
90.0						qtz ss	vlttn	f-m	f	r								N			"
92.5						qtz ss	vlttn	f-m	f	r								N			"
95.0						qtz ss, sh	wh-gn	f-m	f	r			Tr	A				m			Brushy Basin Ct. @ 94.0' good contact
97.5						sh	gn											N			
100.0						sh	gn											N			T.D. telltale small red chert grains
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 5 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Inc. Hole No. DR6

Property White Mesa mill Project cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____

County San Juan State Utah Location ____ Elev. ≈5579

PAGE 1 OF 1

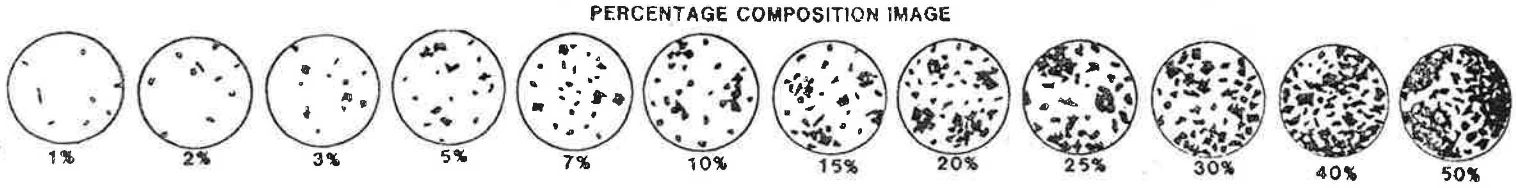
T.D. PROBE ____

T.D. DRILL 100.0

FLUID LEVEL ____

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rdbn											W			Surface Soil - unconsolidated - CH
5.0						mdst, sh	rdbn, ltpk											VS			Mancos Shale 〃 CH
7.5						qtz ss, sh	ltpktn	f-m	m	r		L						VS			Upper Dakota Fm Ct. @ 6.0'
10.0						qtz ss	tn	m	w	r								N			
12.5						qtz ss	tn	m-c	m	a		L						N			
15.0						qtz ss	tn	m	w	a								N			
17.5						qtz ss	tn	m	w	a								N			
20.0						qtz ss	tn	m	w	a								N			
22.5						qtz ss	tn	m-c	m	a		L						N			
25.0						qtz ss, sh	orbn	m	w	r		L						N			
27.5						qtz ss	tn	m	w	r								N			
30.0						qtz ss	tn	m	w	a								N			
32.5						qtz ss	tn	m	w	a								N			
35.0						qtz ss	tn	m	w	R								N			
37.5						qtz ss	tn	m	w	r								N			
40.0						qtz ss.	tn	m	w	r								N			sparse chert grains
42.5						qtz ss, sh	tn-vltgn	m-vc	p	a								N			
45.0						sh, qtz ss	ltywgy	m	w	r								N			CL
47.5						qtz ss	vlt tn	m	w	r								N			
50.0						qtz ss	vlttn	f	w	r								N			
52.5						qtz ss	vlttn	m-c	m	r								N			
55.0						qtz ss	lttn	m-vc	f	r		L						N			
57.5						qtz ss	lttn	m	w	r								N			
60.0						qtz ss	lttn	f-c	f	r								N			
62.5						qtz ss	ltpktn	m	w	R								N			
65.0						qtz ss	vltgy	f-m	f	r								N			
67.5						qtz ss	vltgy	m	W	R								N			
70.0						qtz ss	vltgy	m	w	r								N			
72.5						qtz ss	vltgy	f	w	r								N			
75.0						qtz ss	vltgy	f	w	r								N			
77.5						qtz ss	tn	m-vc	m	r								N			chert frag + grains
80.0						qtz ss	ltgytn	m	W	R								N			
82.5						qtz ss	ltgytn	m-c	m	r								N			Mositure 1st noticed @ 80.0'
85.0						qtz ss	ltgytn	m-c	m	r								N			
87.5						qtz ss	ltgytn	m-peb	p	a								N			chert pebbles + frags.
90.0						qtz ss	tn	m-peb	p	a								N			〃 〃 〃
92.5						qtz ss	tn	c-peb	p	a								N			〃 〃 〃
95.0						qtz ss	ltgytn	c-peb	p	a			tr	C				VS			
97.5						sh	ppbn-gn											N			Brushy Basin Ct @ 95.0' good contact
100.0						sh	ppbn-gn											N			T.D.
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 27 APR 2011 Geologist L. CASEROLT Drilling Co. BAYLES EXPLORATION CO. Hole No. DR7

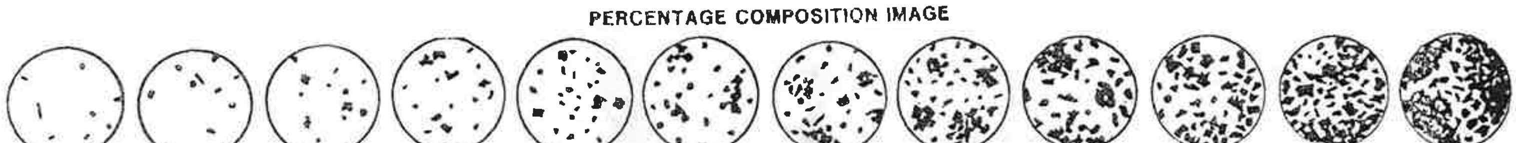
Property WHITE MESA MILL Project CELL 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County SAN JUAN State UTAH Location ______ Elev. 5594

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 100.6
FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rdbn											N			Surface soil-unconsolidated CH
5.0						mdst	rdbn											W			Surface soil - unconsolidated CH
7.5						qtz ss	orbn	m-c	m	a		L						VS			Upper Dakota Ct @ 6.0'
10.0						qtz ss	ortn	m-c	m	A								N			
12.5						qtz ss	lt bn	m	w	a								N			
15.0						qtz ss	lt bn	m	w	a								N			
17.5						qtz ss	ortn	m-c	m	a								N			
20.0						qtz ss	tn	m	w	a								N			
22.5						qtz ss	tn	m	w	r								N			
25.0						qtz ss	lt bn	m-c	m	r								N			Some chert frags.
27.5						qtz ss	tn	m	w	r								N			
30.0						qtz ss	ltgytn	f-m	m	r								N			
32.5						qtz ss, sh	ltgytn	m	w	r								N			
35.0						qtz ss	ltgybn	m-c	m	r								N			
37.5						qtz ss	vltgytn	f	w	R								N			
40.0						qtz ss, cgl	ltgytn	m-peb	f	r								N			
42.5						sh, qtz ss	lt ywgy	vf-f	m	r		L						N			CH
45.0						qtz ss	lt tn	f-m	m	r		L						N			
47.5						qtz ss	ltpktn	m-c	f	R								N			
50.0						qtz ss	ltpktn	m-c	f	R								N			
52.5						qtz ss	ltpktn	m-peb	f	a								N			some multi colored chert grains
55.0						qtz ss	vltpktn	m	w	R								N			
57.5						qtz ss	vltpktn	f-m	m	r								N			
60.0						qtz ss	ltpktn	m-peb	f	a								N			
62.5						qtz ss	ltgytn	m	w	a								N			
65.0						qtz ss	ltgytn	m-c	m	a								N			
67.5						qtz ss	bn	c-vc	m	a								N			abund. chert frags
70.0						qtz ss	ltgybn	m-vc	m	a								N			
72.5						qtz ss, cgl	bn	c-peb	m	a								N			
75.0						qtz ss	gytn	m-c	m	r								N			
77.5						qtz ss	ltgytn	m	w	r								N			moisture first noted, some chert grains
80.0						qtz ss	ortn	m-c	m	r								N			
82.5						qtz ss	orpktn	m	w	R								N			
85.0						qtz ss	tn	m	w	R								N			
87.5						qtz ss	lt tn	m	w	R								N			
90.0						qtz ss	gytn	m	w	R								N			
92.5						qtz ss	gytn	m-c	m	r								VW			
95.0						qtz ss, sh, cgl	wh, lt blgn	m-peb	m	r								W			Brushy Basin Fm Ct @ 93.0' chert pebbles.
97.5						sh	pprdbn-gn											N			mottled frags.
100.0						sh, qtz ss	gn-vltgy	vf-c	p	r			Tr	A				N			T.D.
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Date 5 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR8

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈5537

PAGE 1 OF 1

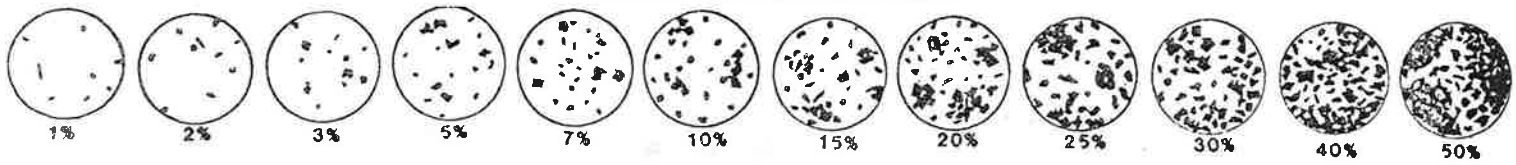
T.D. PROBE ______

T.D. DRILL 70.0

FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						sh, qtz ss	ltywgy	vf	w	r								VS			Mancos Shale - soil was removed during site prep CL
5.0						sh - qtz ss	ltywgy	vf	w	r								S			upper Dakota Fm Ct @ 4.0' ML
7.5						qtz ss	tn	f-m	m	a		L						N			
10.0						qtz ss	tn	f-m	m	a								N			
12.5						qtz ss	tn	m	w	a								N			
15.0						qtz ss	tn	m-c	m	a								N			
17.5						qtz ss	pktn	m-c	f	r								N			
20.0						qtz ss	tn	f-m	f	r								N			
22.5						sh, qtz ss	ltywgy	f-m	f	r								N			CL
25.0						qtz ss, sh	ltywgy	f-m	f	r								N			ML
27.5						qtz ss, sltst	lttn	vf-m	f	r		L						N			
30.0						qtz ss, sh	lttn	vf-m	f	r		L						N			
32.5						qtz ss, sh	lttn-ltywgy	m	w	r								N			very hard drilling
35.0						qtz ss	ltgyrn	m-c	m	R		L						N			some dkgy chert grains
37.5						qtz ss, qtzite	ltgyrn	m-vc	f	a								N			abund " " "
40.0						qtz ss, qtzite	wh	m-vc	f	a								N			very hard drilling
42.5						qtz ss, qtzite	wh	m-vc	f	a								N			extremely hard drilling
45.0						qtz ss, qtzite	wh	m-vc	f	a								N			" " "
47.5						qtz ss, qtzite	wh	m-pebl	p	a								N			" " "
50.0						qtz ss, qtzite	wh-vlttn	m-vc	p	a								N			" " "
52.5						qtz ss, qtzite	wh-or-dkgy	m pebl	p	A								N			" " "
55.0						sh	ltgybl											N			
57.5						qtz ss, qtzite	ltgytn	f-m	m	r								W			
60.0						sh	gygn-pprdbn											N			Brushy Basin Ct @ 57.5' cutting are mottled.
62.5						sh	gn-pprdbn											N			tale tell rd chert grains
65.0						sh	gn											N			
67.5						sh	gn						Tr	A				N			
70.0						sh	gn											N			TD.
72.5																					
75.0																					
77.5																					
80.0																					
82.5																					
85.0																					
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 4 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR 9

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ____ Twp. ____ Rge. ____

County San Juan State Utah Location ______________ Elev. ≈ 5562

PAGE 1 OF 1

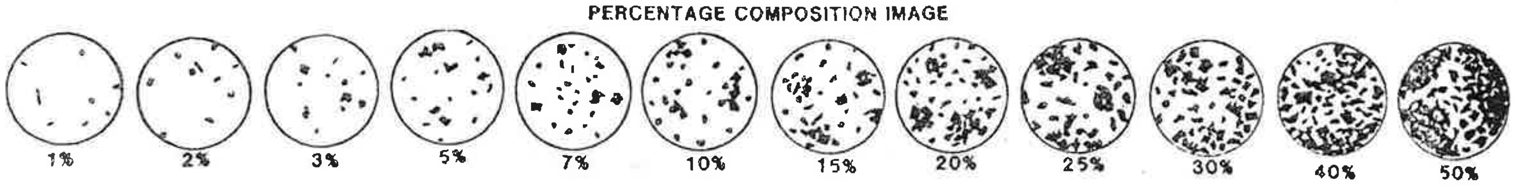
T.D. PROBE ______

T.D. DRILL 115.0

FLUID LEVEL ______

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
0																					
2.5						mdst	rdbn-ltpk											W			Surface soil to 2.0', Mancos Shale to 2.5 CL
5.0						qtz ss, sh	rdbn	f-m	m	r								S			unconsolidated ML
7.5						qtz ss, sh	rdbn	f	w	r								N			" ML
10.0						qtz ss, sh	rdbn	vf-f	m	r								W			
12.5						qtz ss	rdbn	m	w	r								VS			
15.0						sh, qtz ss	dk gybn	f-m	m	a		L						VS			Upper Dakota Fm Ct @ 14.0'
17.5						qtz ss	tn	m	w	a		L						N			
20.0						qtz ss	tn	m	w	a								N			
22.5						qtz ss	tn	f-m	m	a								N			
25.0						qtz ss	tn	m	w	a								N			
27.5						qtz ss	tn	f	w	r								N			
30.0						qtz ss	tn	m	w	r								N			
32.5						qtz ss	tn	m	w	a								N			
35.0						qtz ss	tn	m	w	a								N			
37.5						qtz ss	tn	m	w	a								N			
40.0						qtz ss	tn	m-c	m	a								N			
42.5						qtz ss	tn	m	w	r								N			
45.0						qtz ss	tn	f	w	r								W			
47.5						qtz ss	orgy	c-vc	p	a								N			abund chert frags
50.0						qtz ss	orgy	c-vc	p	a		L						W			" " "
52.5						qtz ss	tn	m-c	m	a								N			
55.0						qtz ss	tn	m-c	m	a								N			
57.5						sh	ywgy											N			
60.0						qtz ss, sh	ywgy	f	w	r								N			
62.5						qtz ss, sh	gy	f-m	m	r								N			
65.0						qtz ss, sh	gy	f	w	r								N			
67.5						qtz ss, sh	gy	f	w	r								N			
70.0						qtz ss, sh	gy	vf-f	m	r			tr	A				N			
72.5						qtz ss	gy	vf-f	m	r			tr	A				N			
75.0						qtz ss	wh	vf-f	m	r								N			
77.5						qtz ss	lt tn	m	w	r								N			
80.0						qtz ss	lt tn	m	w	a								N			
82.5						qtz ss	lt tn	m	w	a								N			
85.0						qtz ss	ltgytn	m	w	R								N			moisture first noted @ 85.0'
87.5						qtz ss, sh	ltgytn	m	w	R								N			
90.0						qtz ss	lt tn	m-c	m	r								N			
92.5						qtz ss	lt tn	m	w	r								S			
95.0						qtz ss	lt tn	m	w	r								N			
97.5						qtz ss	lt tn	m	w	R								N			
100.0						qtz ss, sh	ltywgy	m	w	R								N			
102.5						qtz ss	wh	m	w	r								N			
105.0						qtz ss, cgl	wh-dkgy	c-peb	p	a			1%	C				N			
107.5						qtz ss, cgl	wh-dkgy	c-peb	p	a			1%	C				VW			
110.0						qtz ss, cgl	dkgy-gn	c-peb	p	a								N			
112.5						sh	gn											N			Brushy Basin Ct @ 110.0
115.0						sh	gn											N			T.D.
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 4 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Inc. Hole No. DR 10

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈5559

PAGE 1 OF 1

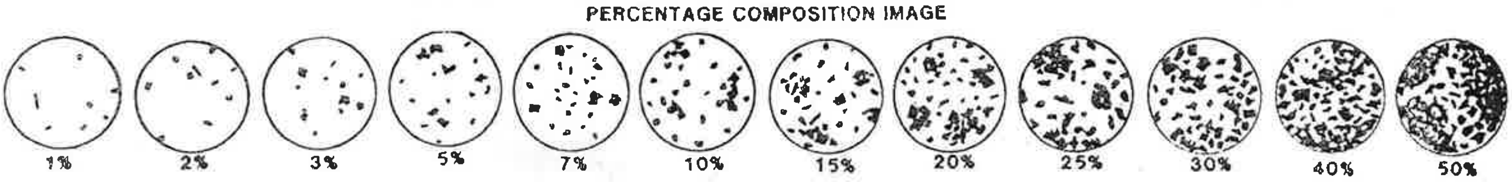
T.D. PROBE ______

T.D. DRILL 90.0

FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0 – 2.5						mdst	rdbn											W			Surface Soil . Unconsolidated CH
5.0						mdst	rdbn											W			Surface Soil " CH
7.5						qtz ss	tn	m	w	a		L						N			Upper Dakota Fm Ct @ 5.0'
10.0						qtz ss	tn	m	w	a		L						N			
12.5						qtz ss	tn	f	w	a								N			
15.0						qtz ss	tn	m	w	a								N			
17.5						qtz ss	tn	m-c	m	a								N			some chert frags and grains
20.0						qtz ss	tn	f-m	m	r								N			
22.5						qtz ss	tn	f-m	m	r								N			
25.0						qtz ss, sh	ltywgy	f-m	m	r								N			sandy lean clay CL
27.5						qtz ss, sh	ltgy	f-m	m	r		L						N			" " " CL some chert pebbles.
30.0						qtz ss, cgl, sh	dkywgy	f-peb	m	r								N			sandy lean clay CL " " "
32.5						qtz ss, cgl	ywgy	vf-peb	m	r								N			
35.0						qtz ss, sh	ywgy	vf-c	m	r								N			Lean clay CL, some chert grains
37.5						qtz ss	ywtn	f	w	r								N			
40.0						qtz ss	ywtn	f	w	r								N			
42.5						qtz ss	pktn	f	w	r								N			
45.0						qtz ss	ywgy-tn	f-m	m	r		L						N			
47.5						qtz ss	tn	f	w	r		L						N			
50.0						qtz ss	tn	m	w	r								N			
52.5						qtz ss	tn	M	w	r								N			
55.0						qtz ss	lt bn	m-peb	m	r		H						N			abund chert grains
57.5						qtz ss	tn	m	w	R								N			
60.0						qtz ss	tn	m	w	R								N			
62.5						qtz ss	tn	m-c	m	a								N			
65.0						qtz ss	lt ortn	m-c	m	a		L						N			
67.5						qtz ss	vltgy	m-c	m	r								N			very hard drilling!
70.0						qtz ss, cgl	ltgybn	m-peb	p	a								N			very abund chert frags + grains
72.5						qtzite, cgl	gytn	m-peb	p	a								N			" " "
75.0						qtzite, cgl	gytn	m-vc	p	a								N			
77.5						qtzite	gytn-wh	m-vc	p	a								N			very abund chert frags + grains
80.0						qtzite	gytn-wh	m-vc	p	a								N			
82.5						sltst, sh	gn											N			Brushy Basin Ct @ 80.0'
85.0						sltst, sh	gn											N			
87.5						sh	gn											N			
90.0						sh	gn											N			T.D.
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 6 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Inc. Hole No. DR11

Property White Mesa Mill Project cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____

County San Juan State Utah Location ____ Elev. ≈5582

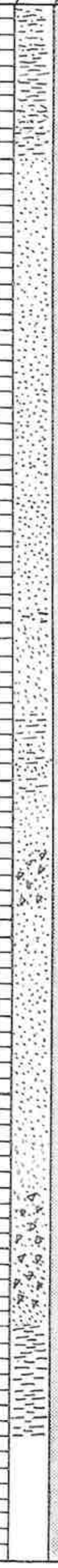
PAGE 1 OF 1

T.D. PROBE ____

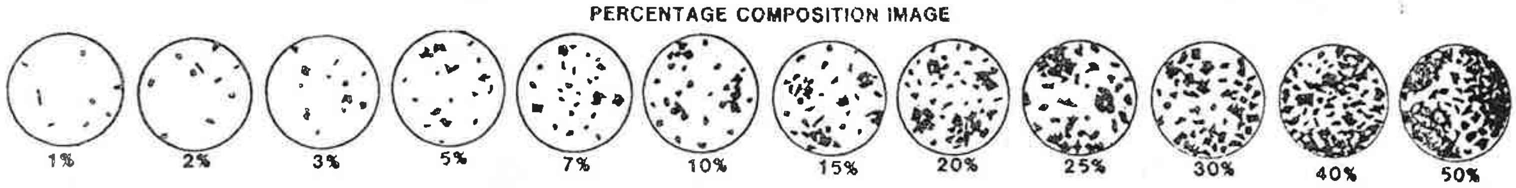
T.D. DRILL 115.0

FLUID LEVEL ____

Depth	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	React. 10% HCL	Remarks
2.5	mdst	rdbn								W	Surface Soil (unconsolidated)
5.0	mdst, sh	rdbn, ltpk								VS	surface soil (unconsolidated, Mancos shale @ 4.0'
7.5	sndy sh	rdbn	m	f	r					VS	
10.0	sh, qtz ss	rdbn-ltpk	m	m	r					VS	
12.5	sh, qtz ss	ltpk-vlttn	m	m	r					VS	Upper Dakota Fm Ct. @ 12.0'
15.0	qtz ss	ltgybn	m-c	m	r					S	
17.5	qtz ss	lt yw	m-vc	f	a		L			N	abund. lt colored chert frags.
20.0	qtz ss	ltgytn	m-c	f	r					N	
22.5	qtz ss	ltgytn	m	w	r					N	
25.0	qtz ss	ltgytn	f-m	w	r					N	
27.5	qtz ss	ltgytn	M	W	R					N	
30.0	qtz ss	ltgytn	c	w	r					N	
32.5	qtz ss	lttn	f	w	r					N	
35.0	qtz ss	lt tn	f-c	P	a					N	some dk chert grains.
37.5	qtz ss	gytn	m-c	M	r					N	abund. dk chert grains
40.0	qtz ss	lt tn	M	W	R					N	
42.5	qtz ss	lt tn	m-c	m	a					N	
45.0	qtz ss	lt tn	m	W	R					N	
47.5	qtz ss	ltgytn	C	W	R					N	
50.0	qtz ss, sh	tn-ltgn	c-peb	P	A					N	multicolored chert frag & grit
52.5	qtz ss	tn	m-vc	M	r					N	" " " " "
55.0	qtz ss	tn	m-c	M	r					N	
57.5	qtz ss, sltst	lt blgy	m-peb	f	a					N	chert pebble frags.
60.0	sltst, qtz ss	lt blgy	f-vc	P	a					N	
62.5	sltst, qtz ss	lt blgy	f-vc	P	a					N	
65.0	qtz ss, sltst	lt blgy-lt tn	m-c	m	a					N	
67.5	qtz ss	tn	m-c	m	a					S	
70.0	qtz ss, cgl	tn bn	m-peb	P	a					M	multicolored chert frags.
72.5	qtz ss, cgl	tn bn	c-peb	P	a					N	
75.0	qtz ss	ltgytn	m-c	m	a					N	
77.5	qtz ss	ltgy tn	m-vc	f	a					N	
80.0	qtz ss	ltgytn	f-m	W	r					N	moisture first noted @ 80.0
82.5	qtz ss	ltgy tn	m-c	w	r					N	
85.0	qtz ss	ltgytn	m	W	R					N	
87.5	qtz ss	ltgytn	f-m	m	r					N	
90.0	qtz ss	ltgytn	f-m	m	r					N	
92.5	qtz ss	gytn	m-peb	f	r					N	
95.0	qtz ss	gytn	c-peb	m	r					N	
97.5	qtz ss, cgl	gytn	c-peb	m	r					N	
100.0	qtz ss, cgl	gytn	m-c	m	r					N	very hard drilling
102.5	qtz ss, cgl	tn bn	m-peb	p	a					N	" " " abund. dkgy chert frags.
105.0	qtz ss, cgl	tn bn	m-peb	P	a			tr		N	" " " gy chert frags.
107.5	qtz ss, sh	wh-gygn	f-peb	P	a					N	Brushy Basin Ct. @ 106.0' good contact chert frags.
110.0	sh	gygn						<1%	A/C	N	some masses of sulfide (pyrite?)
112.5	sh	gygn								N	
115.0	sh	gygn-bpbn								N	T.D. mottled cuttings
117.5											
120.0											
122.5											
125.0											



PERCENTAGE COMPOSITION IMAGE



Date 28 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR12

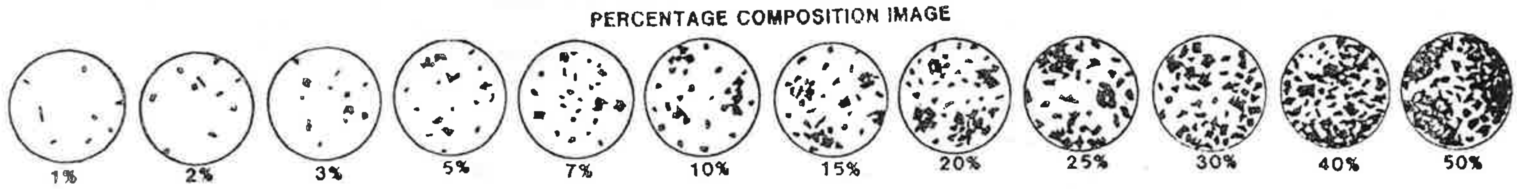
Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈5584

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 100.0
FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
2.5						mdst	rdbn											W			Surface Soil unconsolidated fat clay w/ sand CH
5.0						mdst	rdbn											VW			Surface Soil " " " CH
7.5						sh	ltpktn											VS			Mancos Shale Fm. consolidated. Lean clay w/ sand CL
10.0						sh	ltpktn											VS			" "
12.5						sh	ltpktn											S			" "
15.0						qtz ss, sh	lt bn	m	w	r		L						N			Upper Dakota Ct @ 12.5'
17.5						qtz ss	tn	m	w	r		L						N			
20.0						qtz ss	lt or tn	m	w	r		L						N			
22.5						qtz ss	tn	m	w	a								N			
25.0						qtz ss	tn	m	w	a								N			
27.5						qtz ss	ltgytn	m	w	r								N			some chert grains
30.0						qtz ss	tn	m-c	m	r								N			" " "
32.5						qtz ss	tn	m-c	m	r								N			
35.0						qtz ss	tn	m-c	m	r								N			
37.5						qtz ss	lt or tn	m	w	R		L						N			
40.0						qtz ss	tn	m	w	R								N			
42.5						qtz ss	tn	m-peb	f	a								N			some chert grains
45.0						qtz ss	lt bn	f-peb	p	a								N			" " "
47.5						qtz ss, sh, Cgl	tn-gn	f-peb	p	a								N			" " "
50.0						qtz ss, sh, Cgl	gn-tn	m-peb	p	A								N			" " "
52.5						qtz ss, sh	gn-tn	m-peb	p	a								N			abund. chert frags, grains
55.0						qtz ss	tn	m-peb	p	a		L						N			" " " "
57.5						qtz ss	tn	f-c	p	a		L						N			
60.0						qtz ss	tn	f-c	p	a								N			
62.5						qtz ss	ltgytn	m	w	r								N			
65.0						qtz ss	ltgytn	m	w	r								N			
67.5						qtz ss	ltgytn	m	w	r								N			
70.0						qtz ss	tn	m	w	r								N			
72.5						qtz ss	ltgytn	m	w	r								N			
75.0						qtz ss	lt bn	m	w	a								N			
77.5						qtz ss	ltgytn	m	w	a								N			
80.0						qtz ss	tn	f-m	m	r								N			
82.5						qtz ss	tn	m	w	a								N			
85.0						qtz ss	tn	m-c	m	a			tr	C				N			
87.5						qtz ss, sh	gn-tn	f-c	m	a			tr	C				N			
90.0						qtz ss, sh	wh-ltgn	f-m	m	r			tr	C				N			
92.5						qtz ss, sh	wh-ltgn	f-m	m	r								N			Brushy Basin Ct @ 92.0 ft.
95.0						sh	gn, rdbn											N			
97.5						qtz ss, sh	wh-gn	f-m	m	R								N			
100.0						sh	gn-rdbn											N			T.D. Mottled Frags.
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 27 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR13

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. 5575

PAGE 1 OF 1

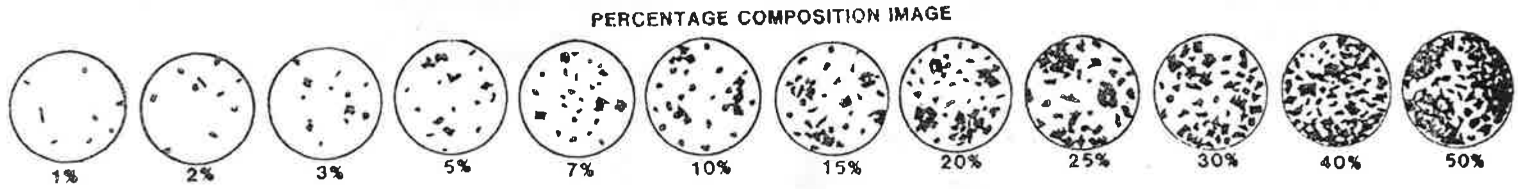
T.D. PROBE ______

T.D. DRILL 90.0

FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rdbn											W			Surface Soil - unconsolidated - lean clay w/sand CL
5.0						mdst	rdbn											S			surface Soil - unconsolidated - lean clay w/sand CL
7.5						qtz ss	ortn	m-peb	p	A								N			upper Dakota Ct @ 5.0' abund. chert frags, pebbles,
10.0						qtz ss, cgl	gy ortn	m-peb	p	A								N			abundant chert frags & pebbles.
12.5						qtz ss	ortn	m-peb	p	r		L						N			" " " "
15.0						qtz ss, sh	ltgy tn	m-peb	p	a								N			Some chert frag. & pebbles sandy fat clay CH
17.5						qtz ss, sh	ltgygntn	m-peb	p	a								N			" " " "
20.0						qtz ss, cgl	ltgytn-rd	m-peb	p	a								N			" " " "
22.5						qtz ss	lt tn	m-c	m	a								N			
25.0						qtz ss, sh	lt tn-ltgn	m-vc	f	a								N			
27.5						qtz ss, sh	lttn-ltgygn	m-peb	p	a								N			
30.0						qtz ss	tn	m	w	r								N			
32.5						qtz ss	tn	m	w	a								N			
35.0						qtz ss	lt bn	m-peb	p	a								N			
37.5						qtz ss, cgl	dk bn	m-peb	p	a								W			
40.0						qtz ss	tn	m	w	R								N			
42.5						qtzs	tn	m-peb	p	r								N			
45.0						qtz ss	tn	f-peb	p	a								N			
47.5						qtz ss	tn	m	w	r								N			
50.0						qtz ss	tn	m	w	r								N			
52.5						qtz ss	vlttn	m	w	r								N			
55.0						qtz ss	vlttn	m	w	r								N			
57.5						qtz ss	lt tn	m	w	r								N			
60.0						qtz ss, cgl	gytn	m-peb	p	a		L						N			abund multi colored chert frags & grains
62.5						qtz ss, cgl	ltgytn	m-peb	p	a		L						N			" " " " " "
65.0						qtz ss	lt tn	m	w	r								VS			
67.5						sh, qtz ss	lt blgy	m-peb	p	a								VW			
70.0						qtz ss, sh	wh-blgy	vf-m	f	r								N			
72.5						qtz ss	wh-ltgy	f	w	r								N			
75.0						qtz ss	wh-ltgy	f	w	r								N			
77.5						qtz ss	wh-ltblgn	f	w	r								N			
80.0						qtz ss	wh-ltblgn	f	w	r								N			sparse chert pebble frags.
82.5						sh	gy-rdbn											N			Brushy Basin Fm Ct @ 80.0'
85.0						sh	blgy-rdbn											N			
87.5						sh	blgy-rdbn											N			
90.0						sh	pprdbn-gn											N			TD
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Date 29 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR14

Property White Mesa Mill Project CELL 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈ 5546

PAGE 1 OF 1

T.D. PROBE ______

T.D. DRILL 100.0

FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite: Amount	Pyrite: Habit	Pyrite: Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon: Amount	Carbon: Type	Remarks
0–2.5						mdst	rdbn											N			Surface Soil.
2.5–5.0						mdst	rdbn											VS			Mancos Shale
5.0–7.5						qtz ss	tn	m	w	a								W			Upper Dakota Fm Ct. @ 5.0'
7.5–10.0						qtz ss	tn	m	w	a								N			
10.0–12.5						qtz ss	lt tn	m	w	a								N			
12.5–15.0						qtz ss	wh-lt tn	m	w	a		L						N			
15.0–17.5						qtz ss	wh-lt tn	m-c	m	a								N			some chert grains
17.5–20.0						qtz ss	tn	f-c	f	a								N			
20.0–22.5						qtz ss, cgl, sh	lt gy	m-peb	f	a								N			abund. dk gy chert frags.
22.5–25.0						qtz ss	tn	m	w	r								N			
25.0–27.5						qtz ss	tn	m-c	m	r								N			
27.5–30.0						qtz ss	tn	m-c	m	r								N			
30.0–32.5						qtz ss	tn	m	w	r								N			
32.5–35.0						qtz ss	tn	f-m	m	r		H						N			
35.0–37.5						qtz ss	tn	m	w	a								N			
37.5–40.0						qtz ss	lt or tn	m	w	r								N			
40.0–42.5						qtz ss	gy tn	m-peb	m	r								N			
42.5–45.0						qtz ss, sh	lt gy tn	f-m	m	r								N			
45.0–47.5						qtz ss	lt gy tn	f-m	m	r			1%	A				N			
47.5–50.0						qtz ss	lt or tn	f	w	r								N			
50.0–52.5						qtz ss slst	lt gy tn	f-m	m	a								N			
52.5–55.0						qtz ss	lt pk tn	m	w	r		H						N			
55.0–57.5						qtz ss	tn	m	w	r								N			
57.5–60.0						qtz ss	tn	m-c	m	r								N			
60.0–62.5						qtz ss	dk gy tn	c-vc	m	a								N			
62.5–65.0						qtz ss	lt gy tn	m	w	a								N			
65.0–67.5						qtz ss	lt gy tn	m	w	r								N			
67.5–70.0						qtz ss	lt tn	m-c	m	r								N			
70.0–72.5						qtz ss	lt tn	m-c	m	r								N			
72.5–75.0						qtz ss	lt tn	m	w	r								N			
75.0–77.5						qtz ss	lt tn	m	w	r								N			
77.5–80.0						qtz ss	lt gy tn	m-c	m	r								N			
80.0–82.5						qtz ss	lt gy bn	m-peb	m	r								N			
82.5–85.0						qtz ss	gy tn	f-m	m	r		L						N			
85.0–87.5						qtz ss	tn	f-m	m	r		L						N			
87.5–90.0						qtz ss	tn	f-m	m	a								N			
90.0–92.5						qtz ss	tn	m	w	r								N			
92.5–95.0						qtz ss, sh	wh-tn, gn	m	w	r		L	tr	c				N			Brushy Basin Fm Ct @ 94.0' good ct.
95.0–97.5						sh	pp bn											N			
97.5–100.0						sh	pp bn-gn											N			T.D.

Depth scale: 0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5, 25.0, 27.5, 30.0, 32.5, 35.0, 37.5, 40.0, 42.5, 45.0, 47.5, 50.0, 52.5, 55.0, 57.5, 60.0, 62.5, 65.0, 67.5, 70.0, 72.5, 75.0, 77.5, 80.0, 82.5, 85.0, 87.5, 90.0, 92.5, 95.0, 97.5, 100.0, 102.5, 105.0, 107.5, 110.0, 112.5, 115.0, 117.5, 120.0, 122.5, 125.0

PERCENTAGE COMPOSITION IMAGE

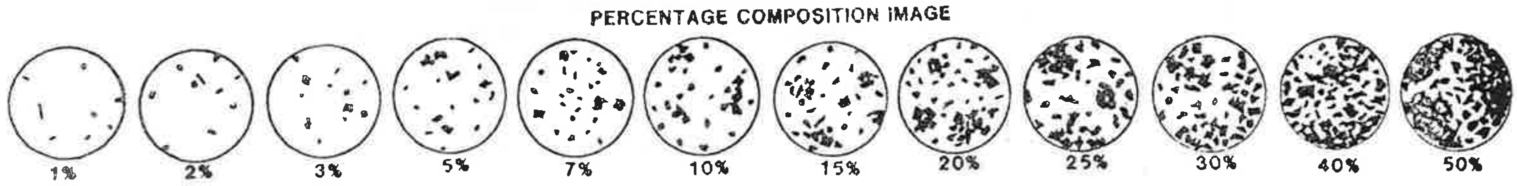
1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Date 28 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR15
Property White Mesa Mill Project Cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____
County San Juan State Utah Location ____ Elev. ≈5571

PAGE 1 OF 1
T.D. PROBE ____
T.D. DRILL 100.0 T.D
FLUID LEVEL ____

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
2.5						mdst	rdbn											S			Surface Soil - unconsolidated - sandy lean clay CL
5.0						mdst	rdbn											S			Surface Soil - unconsolidated " " " CL
7.5						sh	ltpktn											VS			Mancos sh sandy fat clay CH
10.0						sndy sh	ywgy	f-m	f	a								S			mancos sh
12.5						qtzss, sh	vltbn	f	w	r								W			Upper Dakota Ct. @ 11.0'
15.0						qtz ss	ltywbn	vf-c	m	r								N			
17.5						qtzss	ltywbn	f-m	m	r		L						N			
20.0						qtzss	gytn	f	w	r								N			
22.5						qtzss	ltywbn	f	w	r		L						N			
25.0						qtzss	lttn	m	w	r								N			
27.5						qtzss	tn	m	w	r								N			
30.0						qtz ss	tn	m-c	m	r								N			some chert frags. and grains
32.5						qtzss	ltortn	f-m	m	r		L						N			
35.0						qtz ss	tn	f	w	r								N			
37.5						qtzss	tn	m	w	a								N			
40.0						qtzss	tn	m-c	m	a								N			
42.5						qtzss	tn	m-c	m	r								N			
45.0						qtzss	tn	m-c	m	r								N			
47.5						qtzss	tn	m-c	m	r								N			some chertfrags and grains
50.0						qtzss, sh	ltbn, gn	m-peb	m	r								N			some gn shale frags.
52.5						sh	ywgygn											N			
55.0						sh, qtzss, cgl	ltgygn	m-peb	p	a								N			abund chert frags and grains.
57.5						qtzss	tn	m-vc	p	a								N			" " " " "
60.0						qtz ss	tn	m	w	r								N			
62.5						qtzss	tn	m	w	R		L						N			
65.0						qtz ss	ltortn	m	w	R		L						N			
67.5						qtzss	ltortn	m-vc	m	r		L						N			abund chert frags and grains
70.0						qtzss, cgl	dkgyortn	m-peb	f	r								N			50% chert frags, grains, and pebbles.
72.5						qtz ss	lttn	m-vc	f	a								N			some " " "
75.0						qtzss	vlttn	m	w	r								N			
77.5						qtz ss	ltgytn	m-peb	m	a								N			10% chert frags, grains.
80.0						qtz ss, cgl	gy-dkgy	m-peb	m	a								N			50% chert frags grains and pebbles.
82.5						qtzss	tn	m	w	R								N			
85.0						qtz ss	tn-gy	m-peb	f	a								N			some chert
87.5						qtzss, cgl	gy	m-peb	f	a								N			60% chert frags, grains and pebbles.
90.0						qtzss, cgl	gy	m-peb	f	a								N			note: some material is a qtzite-hard drilling!
92.5						qtzss	ltpktn	m	w	r								N			qtzite - hard drilling.
95.0						qtz ss	lttn-wh	m	w	r								N			
97.5						qtz ss, sh, cgl	gn-wh	m-peb	p	a			tr.	C				N			Brushy Basin Ct @ 96.0 pyrite assoc. w/qtz.
100.0						sh,	gn											N			T.D
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



DAKOTA Cr. to 9.5 from 10.0

Date 28 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR16

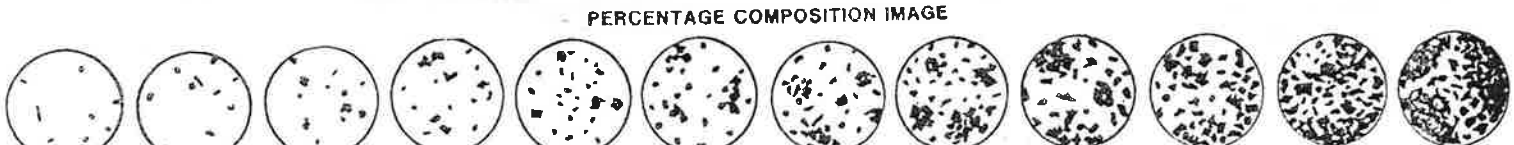
Property White Mesa mill Project Cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____

County San Juan State Utah Location ____ Elev. ≈ 5555

PAGE 1 OF 1
T.D. PROBE ____
T.D. DRILL 105.0
FLUID LEVEL ____

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
2.5						mdst	rdbn										W				Surface Soil-unconsolidated - sandy lean clay CL
5.0						mdst	rdbn										W				Surface Soil-unconsolidated-sandy lean clay CL
7.5						mdst limysh	rdbn-pktn										VS				Mancos Shale @ 6.0 ft.
10.0						limysh-qtzss	pktn-wh	m	w	r							VS				Mancos Shale ss is qtzitic
12.5						qtz ss	ortn	m	w	r		V					S				Upper Dakota Fm Ct @ 9.5'
15.0						qtzss	tn	m	w	R							N				
17.5						qtzss	tn	f-m	m	r							N				
20.0						qtzss	tn	f-m	m	r							N				
22.5						qtzss	tn	f	w	r							N				
25.0						qtz ss	tn	m	w	R							N				
27.5						qtzss	tn	vf-f	m	R							N				
30.0						qtzss	tn	m	w	R							N				
32.5						qtzss	tn	m	w	R							N				
35.0						qtzss	tn	vf	w	R							N				
37.5						qtz ss	ltgytn	m-c	m	a							N				
40.0						qtz ss	tn	m	w	a							N				
42.5						qtzss	tn	m	w	a							N				
45.0						qtzss	tn	m-peb	p	a							N				
47.5						sh-qtz ss	ywgygn	m-vc	p	a							N				
50.0						qtzss, sh	ywgy-tn	m-peb	p	a							N				abund, multi colored chert frags, grains + pebbles
52.5						qtzss	gytn	m-peb	p	a							N				" " " " " " "
55.0						qtzss	ltortn	m-c	m	a		L					N				
57.5						qtzss	ltortn	m-c	m	a		L					N				
60.0						qtzss	tn	m	w	r							N				
62.5						qtzss	tn	m	w	r							N				
65.0						qtzss, sh	ltgytn	m c	m	a							N				
67.5						qtz ss	ltgytn	m c	m	r							N				
70.0						qtz ss	tn	f-m	m	r							N				
72.5						qtz ss	tn	m-vc	p	a							N				chert grains
75.0						qtz ss	ltortn	m-c	m	r							N				
77.5						qtzss, cgl	ltbn	m-peb	p	a							N				50% chert grains + frags.
80.0						qtzss	ltgytn	m-vc	p	a							N				
82.5						qtz ss	ltgytn	m-vc	p	a							N				
85.0						qtzss	ltgytn	m-vc	p	a							N				
87.5						qtzss, cgl	gybn	m-peb	p	a							N				50%+ chert grains, fragments + grains
90.0						qtzss	tn	m	w	r							N				
92.5						qtzss, cgl	gybn	m-peb	p	a							N				50%+ chert grains, frags. + grains
95.0						qtz ss, cgl	gybn	m-peb	p	a							N				75% chert grains, frags + grains
97.5						qtzss	tn	m	w	r							N				
100.0						qtzss	tn-gn	m-c	m	a			tr	C			W				Brushy Basin Ct @ 100.0, pyrite assoc. w/qtz
102.5						sh	gn-vltgn										N				
105.0						sh	gn-ppbn										N				telltale small red chert grains T.D.

PERCENTAGE COMPOSITION IMAGE



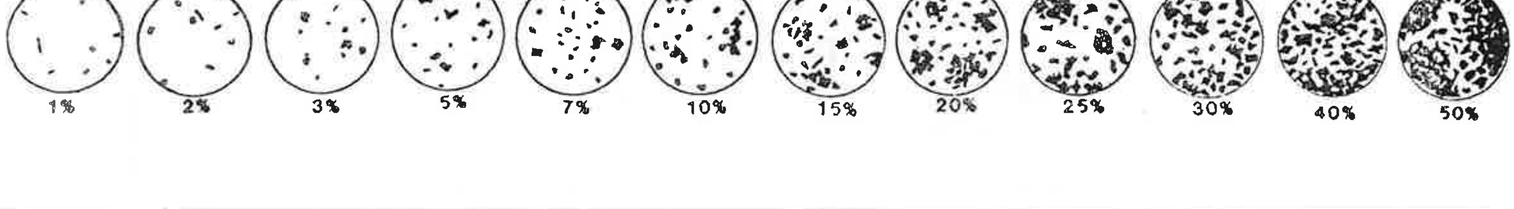
1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Date 29 APR 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Co. Hole No. DR17
Property White Mesa Mill Project CELL 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______
County San Juan State Utah Location ______ Elev. ______

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL 85.0
FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rdbn											N			Surface Soil - unconsolidated - lean sandy clay CL
5.0						mdst	rdbn											W			Surface Soil - unconsolidated - lean sandy clay CL
7.5						qtz ss	ortn	m	w	r		L						N			Upper Dakota Fm Ct @ 5.0'
10.0						qtz ss	tn	m-c	m	r								N			
12.5						qtz ss	tn	m	w	r								N			
15.0						qtz ss	lt gy tn	m	w	R								N			
17.5						qtz ss	lt gy tn	m-c	m	r								N			Some dk chert frags.
20.0						qtz ss	lt gy tn	f-c	f	a								N			
22.5						qtz ss	tn	m	w	a								N			
25.0						qtz ss	tn	m-c	m	a								N			
27.5						qtz ss, sh	vlt tn	f-vc	p	a								N			
30.0						cgl, qtz ss	tn-dkgybn	m-peb	p	a								N			dkgy chert pebbles & frags 75%
32.5						sh, qtz ss	ltgygrtn	m-vc	f	a								N			
35.0						sndy sltst	lt or tn	vf-m	f	a								N			
37.5						sndy sh	lt gy tn	vf-m	p	a								N			
40.0						sndy sh	lt gy tn	vf-f	f	a								N			
42.5						sndy sh, ss	lt gy-lt or tn	vf-f	f	a								N			
45.0						qtz ss	tn	m-c	m	r								N			
47.5						qtz ss	vlt gy	vf-f	m	r								N			
50.0						qtz ss, sltst	v lt gy	vf-m	f	r								N			
52.5						qtz ss	tn	f-c	f	a								N			
55.0						qtz ss	tn	f-m	m	a								N			
57.5						qtz ss	lt tn	m-peb	p	a								N			Some light colored chert frags and pebbles
60.0						qtz ss, cgl	lt gy tn	m-peb	p	a								N			" " " " " " "
62.5						qtz ss	lt gy tn	m-vc	p	a								N			
65.0						qtz ss	lt gy tn	f-m	m	a								N			
67.5						qtz ss	tn	f-m	w	r								N			
70.0						qtz ss	tn	f-m	w	r								W			Brushy Basin Ct @ 70.0'
72.5						sh cgl	gn	peb										N			some dk chert pebbles.
75.0						sh cgl	gn	peb										N			" " " " tell tale red chert frags.
77.5						sh	gn											N			
80.0						sh	gn											N			red chert frags.
82.5						Sh	gn-ltgy											N			
85.0						sh	gn						tr	A				N			T.D. red chert frags, pyrite as small aggre.
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 4 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Inc. Hole No. DR 18

Property White Mesa Mill Project Cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____

County San Juan State Utah Location ____ Elev. ≃ 5536

PAGE 1 OF 1

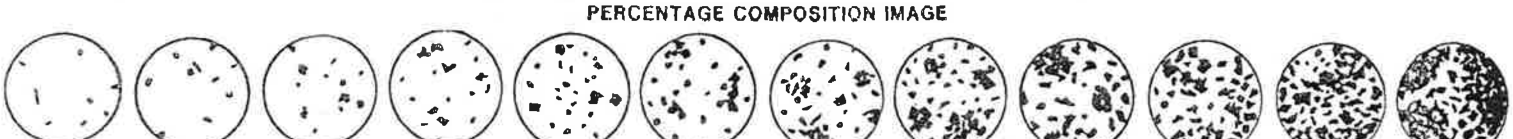
T.D. PROBE ____

T.D. DRILL 70.0

FLUID LEVEL ____

Depth	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCl	Carbon Amount	Carbon Type	Remarks
0–2.5	mdst	rdbn											W			Surface Soil- unconsolidated - sndy slt ML
5.0	mdst	rdbn											m			Surface soil- unconsolidated - sndy slt ML
7.5	qtz ss	bn	m-vc	p	A								N			Upper Dakota Fm Ct. @ 5.0' wh-gy chert frags.
10.0	qtz ss	wh-gybn	m-vc	p	A								N			abund chert frags.
12.5	cgl, qtz ss	gybn	m-peb	p	a								N			75% multi colored chert frags. + grains
15.0	qtz ss	dkgy	m	w	a								N			
17.5	qtz ss	tn	f	w	r								N			
20.0	qtz ss	lt or tn	m	w	r								N			
22.5	qtz ss	tn	m-c	m	r								N			
25.0	qtz ss	tn	m-vc	f	r								N			
27.5	Cgl, qtz ss	gytnbn	m-peb	p	a								N			
30.0	qtz ss	tn	m	w	R								N			moisture first noticed @ 30.0'
32.5	qtz ss	tn	m	w	R								N			
35.0	qtz ss	tn	m c	m	R								N			
37.5	qtz ss	tn	m c	m	R								N			
40.0	qtz ss	lt or bn	m-vc	f	r								N			abund chert frags. + grains
42.5	qtz ss	vltgytn	m	w	a								N			
45.0	qtz ss	vltgytn	m-c	m	a								N			
47.5	qtz ss, qtzite	wh	m-c	m	a		L						N			very hard drilling some small chert grains
50.0	qtz ss, qtzite	wh	m-c	m	a		L						N			" " "
52.5	qtzite	wh-vlttn	m-vc	p	a								N			" " "
55.0	qtzite	wh-vlttn	m-vc	p	a								N			" " "
57.5	qtzite, sh	rdgybn-ltgn	m-peb	p	A			tr					N			Brushy Basin Ct. @ 57.0' chert breccia.
60.0	sh	ywgygn					H						N			
62.5	sh	blgy					L						N			some chert grains
65.0	sh	blgy											N			telltale red chert grains
67.5	sh	blgy											N			
70.0	sh	blgy											N			T.D.
72.5																
75.0																
77.5																
80.0																
82.5																
85.0																
87.5																
90.0																
92.5																
95.0																
97.5																
100.0																
102.5																
105.0																
107.5																
110.0																
112.5																
115.0																
117.5																
120.0																
122.5																
125.0																

PERCENTAGE COMPOSITION IMAGE

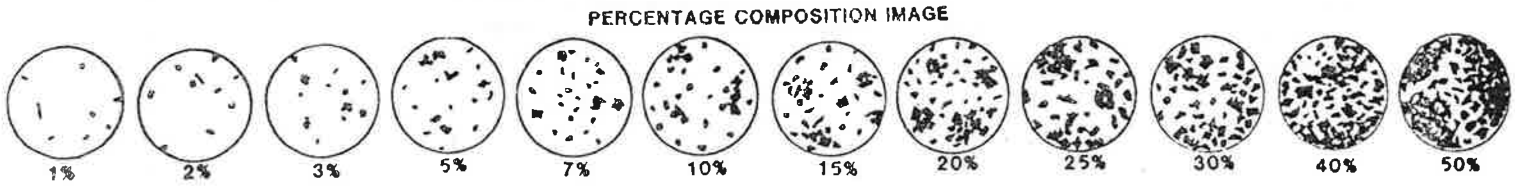


Date 3 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR19
Property White Mesa Mill Project Cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____
County San Juan State Utah Location ____ Elev. ≈ 5513

PAGE 1 OF 1
T.D. PROBE ____
T.D. DRILL 75.0
FLUID LEVEL ____

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React. - 10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rdbn											N			Surface soil - unconsolidated
5.0						mdst	rdbn											S			Surface soil - unconsolidated
7.5						sndysltst	rdbn-pk	vf f	m	r								VS			Mancos Sh @ 6.0'
10.0						sndysltst	rdbn-pk	vf m	f	r								VS			" "
12.5						qtz ss	ywtn	f-m	m	r								N			Upper Dakota Fm Ct @ 10.0'
15.0						qtz ss	lt or bn	m	w	a		L						N			
17.5						qtz ss, sh	gytn-vdkgy	m-c	m	a								N			
20.0						qtz ss	ltgytn	m	w	a								N			sparse gy chert grains
22.5						qtz ss	tn	m	w	r		L						N			" " " "
25.0						qtz ss, cgl, qtzite	gy-wh	m peb	f	r								N			25% lt-dkgy chert pebbles & frags.
27.5						qtz ss	wh-gybn	m peb	f	a								N			abund chert frags. & pebbles.
30.0						qtz ss	ltgytn	m	w	r								N			
32.5						qtz ss, sh	wh-ltgytn	m-peb	m	a								N			
35.0						qtz ss	ltgytn	m-vc	f	a								N			
37.5						qtz ss	ltgytn	m-c	m	a								N			
40.0						qtz ss	vltgytn	m	w	r								N			
42.5						qtz ss	vltgytn	f-m	m	r								N			
45.0						qtz ss	vltgytn	f	w	r								N			
47.5						qtz ss	vltgytn	m	w	r								N			
50.0						qtz ss	lt pk tn	m-vc	m	r		H						N			abund chert frags.
52.5						qtz ss	ltgytn	m-c	f	a								N			
55.0						qtz ss	ltgytn	m-c	f	a								N			
57.5						qtz ss	wh-ltgytn	m-vc	f	a								N			
60.0						qtz ss, cgl	dkgytn	c peb	p	a								N			50% lt & dk gy chert pebbles & frags.
62.5						qtz ss	tn-dkgy	m-peb	p	a								N			
65.0						cgl, qtz ss	tn bn	c-peb	p	a								N			75% multicolored chert pebbles & frags.
67.5						sh, qtz ss	bn-gy	m-c	m	r								N			Brushy Basin Ct @ 66.0'
70.0						sh	ltgygn											N			
72.5						sndy sh	blgn											N			
75.0						sh	blgn											N			T.D. some red chert grains
77.5																					
80.0																					
82.5																					
85.0																					
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE

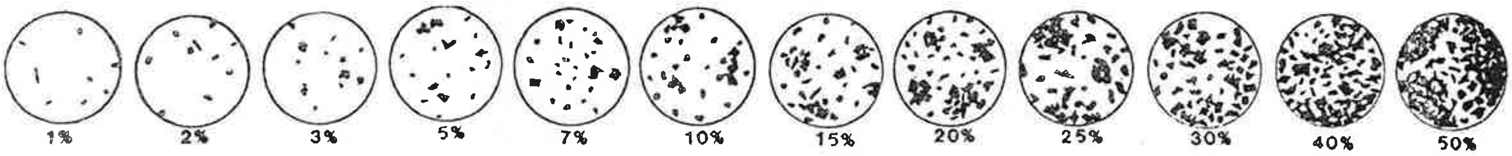


Date 2 MAY 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration Inc. Hole No. DR 20
Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______
County San Juan State Utah Location ______ Elev. ≈5499

PAGE 1 OF 1
T.D. PROBE ______
T.D. DRILL ______
FLUID LEVEL ______

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
0																					
2.5						mdst	rdbn											N			Surface Soil-unconsolidated sndy lean clay CL
5.0						mdst	rdbn											N			Surface soil-unconsolidated- sndy lean clay CL
7.5						qtzss, sh	pktn	m-peb				L						VS			upper Dakota Fm Ct. @ 6.0' some chert frags.
10.0						qtzss	ltrdbn	m-c	m	r		H						N			
12.5						qtzss	vltgytn	m-c	m	a								N			
15.0						qtzss	vltgytn	m	w	a								N			
17.5						qtzss	ltgytn	m	w	a								N			
20.0						qtzss	tn	m	w	a								N			
22.5						qtzss	tn	m-c	m	a								N			
25.0						qtzss	lttn	f	w	a								N			
27.5						qtzss	tn	m-c	m	a								N			some chert frags
30.0						qtzss	ltgy	m-c	m	a		H						N			" " "
32.5						qtzss	ltgytn	m-c	m	a								N			
35.0						qtzss-sh	ywgnbn	f-m	m	r		L						N			
37.5						sndy sh	ltblgy	m	w	r								N			sparse chert grains
40.0						sndy sh	ltblgy	f-m	m	r								N			
42.5						sh	ltblgy											N			
45.0						sh	blgy-bn											N			sparse chert frags.
47.5						qtzss, sh	gybn	vf-m	f	a								N			
50.0						sh, qtzite	gybn	vf-m	f	a								N			
52.5						sndy sh	gygn	m-peb	f	a								N			sparse chert pebbles + grains
55.0						sh, qtzss	ltgngy	m	w	a		L						N			
57.5						sndy sh	ltgytn	f-m	m	r			tr					N			
60.0						qtzss, sh	ywgybn	f-m	m	r								N			
62.5						sndy sh	ltblgy	f-m	m	r								N			
65.0						sh	gygn											N			sparse red-bn chert frags.
67.5						sh	gygn											N			
70.0						qtzite, sh	wh-gy	f-m	m	r								N			some red-bn chert grains + frags.
72.5						qtzss, sh	wh-gy	f-c	p	a								N			
75.0						qtzss, sh	wh-gygn	f-m	m	a								N			Brushy Basin Ct @ 73.0' abund. rd-gy chert pebbles
77.5						sh	gygn											N			
80.0						sh	gygn-ppbn											N			mottled shale frags.
82.5						sh	gygn											N			
85.0						qtzss, sh	wh-gygn	m-c	m	a								N			micaceous ss, (muscovite?)
87.5						sndy sh	gy-gygn	f-m	m	r								N			
90.0						sh	ltgy						tr					N			T.D.
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 2 May 2011 Geologist L. Casebolt Drilling Co. Baylas Exploration Inc Hole No. DR21

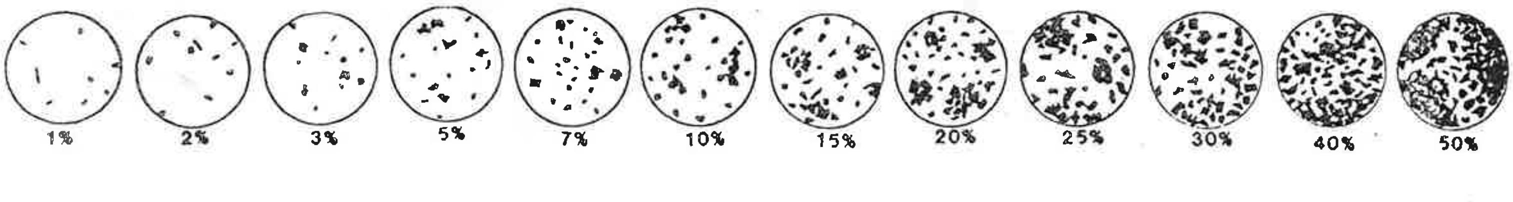
Property White Mesa Mill Project Cell 4B Unit No. ___ Sec. ___ Twp. ___ Rge. ___

County San Juan State Utah Location ___ Elev. ≈5530

PAGE 1 OF 1
T.D. PROBE ___
T.D. DRILL ___
FLUID LEVEL ___

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0–2.5						mdst	rdbn											W			Surface soil-unconsolidated-sndy lean clay CL
5.0						mdst	rdbn											S			Surface soil-unconsolidated-sndy lean clay CL
7.5						sndysh	rdbn-ltpk	m	w	a								VS			Mancos Shale @ 8.0'
10.0						sh	pktn											VS			
12.5						sh	ywgy											VS			
15.0						sh	ywgy											m			
17.5						sh	ywgy											m			
20.0						sndysh	ywgy	f	w	a								M			
22.5						sndy sh	ywgy	m	w	a		L						VW			
25.0						sndy sh, ss	tn	f-m	m	a								VW			Upper Dakota Fm Ct @ 24.0'
27.5						qtz ss	tn	m	w	a								N			
30.0						qtz ss	tn	m	w	a								N			
32.5						qtz ss	tn	m	w	a								N			
35.0						qtz ss	tn	f-m	m	a								N			
37.5						qtz ss	tn	m	w	a								N			
40.0						qtz ss	tn	f	w	a								N			
42.5						qtz ss	tn	m	w	a								N			
45.0						qtz ss, sh	dkbn	m	w	a		L						N			
47.5						qtz ss	tn	m-c	m	a								N			
50.0						qtz ss	gytn	m-vc	p	a								N			abund multicolored chert frags.
52.5						qtz ss	tn	m-vc	p	a								N			" " " " "
55.0						qtz ss	tn	m-c	f	a								N			" " " " "
57.5						sh	ltgy-gybn											N			chert pebbles & frags
60.0						sh	ltgy											N			
62.5						sndy sh	vltgytn	vf-m	f	a								N			
65.0						qtz ss	tn	m	w	a								N			
67.5						qtz ss	tn	m-c	m	a								N			
70.0						qtz ss	tn	c	w	r								N			
72.5						qtz ss, cgl	ltgytn	m-peb	f	r								N			
75.0						qtz ss	ltgytn	c	w	r								N			some gy chert grains
77.5						qtz ss	tn	c	w	r								N			
80.0						qtz ss	tn	m-c	m	a								N			
82.5						qtz ss	tn	m	w	r								N			
85.0						qtz ss	tn	f-m	m	r								N			
87.5						qtz ss	ltpktn	vf	w	r								N			
90.0						qtz ss	tn	f-m	m	r								N			
92.5						qtz ss	tn	m	w	r								N			
95.0						qtz ss, cgl	tn	m-peb	f	a								N			some gy chert frags.
97.5						qtz ss	wh-vlttn	m-vc	m	a								N			abund. wh-lt colored qtzite & chert frags.
100.0						qtz ss	wh-vlttn	m-vc	m	a								N			" " " " " "
102.5						qtz ss	wh-tn	m-peb	f	a								N			" " " " " "
105.0						qtz ss	wh-tn	m-peb	f	a								N			hard drilling, abund rusting steel frags.
107.5						qtz ss, qtzite	wh-tn	m-peb	f	a								N			" " " " " "
110.0						qtz ss, qtzite	wh-tn	m-peb	f	a								N			50% of grains are chert
112.5						qtz ss, cgl	gytn	m-peb	f	a								N			
115.0						qtz ss, cgl - sltysh	ywtn-gygn	m-peb	f	a		L						N			Brushy Basin Ct. @ 114.0
117.5						slty sh	gn-ppbn											N			
120.0						sltysh	gn-ppbn											N			T.D.
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



Date 3 May 2011 Geologist L. Casebolt Drilling Co. Boyles Exploration Inc. Hole No. DR 22

Property White mesa mill Project cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. 5488

PAGE 1 OF 1

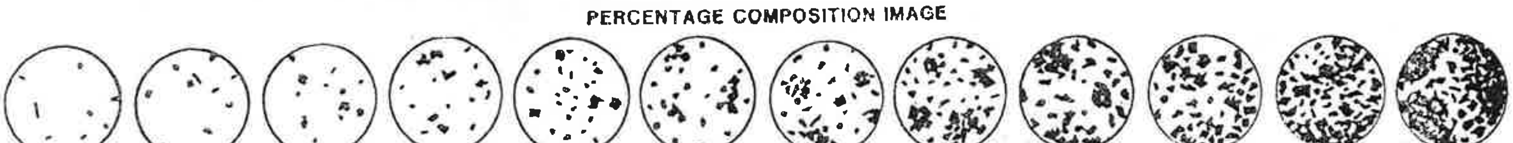
T.D. PROBE ______

T.D. DRILL 85.0

FLUID LEVEL ______

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
2.5						mdst	rdbn											W			Surface Soil - unconsolidated - sndy lean clay CL
5.0						mdst	rdbn											W			Surface Soil - unconsolidated - sndy lean clay CL
7.5						qtz ss	ltgytn											N			Upper Dakota Ct @ 5.0'
10.0						qtz ss cgl	ltgytn	m-peb	f	r								N			abund gray chert frags.
12.5						qtz ss,	ltgytn	m	w	r								N			
15.0						qtz ss, sh	wh-ltgytn	m-c	m	r								N			
17.5						qtz ss	wh-ltgytn	m-vc	m	r								N			some chert frags.
20.0						qtz ss	ltgytn	m-c	m	r								N			
22.5						qtz ss, cgl	gytn	m-peb	f	a								N			50% chert grains & frags.
25.0						qtz ss, cgl	gytn	m-peb	f	a								N			" " " "
27.5						qtz ss,	tn	m	w	a								N			
30.0						qtz ss cgl	gytn	m peb	f	a								N			abund light colored chert grains.
32.5						qtz ss	ltgytn	m-c	m	R								N			
35.0						qtz ss	ltgytn	m	w	R								N			
37.5						qtz ss	ltgytn	m	w	r								N			
40.0						qtz ss	ltgytn	m-c	m	a								N			
42.5						qtz ss	ltgytn	m	w	r								N			
45.0						qtz ss	ltgytn	m-c	m	r								N			
47.5						qtz ss	ltgytn	m	w	r								N			
50.0						qtz ss	ltgytn	m-c	m	r								N			
52.5						qtz ss	ltgytn	m-c	m	a								N			
55.0						qtz ss	ltgy	m-c	m	a								N			
57.5						qtz ss	ltgy	m-c	m	a								M			
60.0						sh	ltgy-ltgn											N			Brushy Basin Ct @ 57.5' some chert grains
62.5						sh	wh-ltgygn											N			
65.0						sh	gybn											N			some red chert grains
67.5						sh	gn-ppbn											N			Extremely hard drilling (chert) from 67.5
70.0						sh, qtz	ortn-gn											N			to 72.5' chert pebbles & frags.
72.5						sh, qtzite	wh-ltgn	m-peb										N			
75.0						sh	blgy											N			red chert frags.
77.5						sh	blgy	peb										N			" " " & pebbles
80.0						sh	blgy											N			
82.5						sh, qtz ss	blgy	f-m	m	a			tr	C				N			
85.0						qtz ss, sh	ltgy	vf-m	f	a								N			TD

PERCENTAGE COMPOSITION IMAGE



1% 2% 3% 5% 7% 10% 15% 20% 25% 30% 40% 50%

Date 4 May 2011 Geologist L. Casebolt Drilling Co. Bayles Exploration, Inc. Hole No. DR 23

Property White Mesa Mill Project Cell 4B Unit No. ______ Sec. ______ Twp. ______ Rge. ______

County San Juan State Utah Location ______ Elev. ≈5491

PAGE 1 OF 1

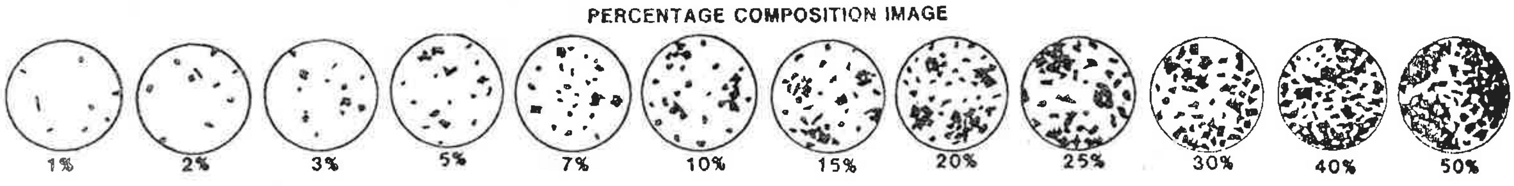
T.D. PROBE ______

T.D. DRILL 85.0

FLUID LEVEL ______

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0																					
2.5						mdst	rdbn											S			Surface soil. Mancos Shale @ 2.0'-unconsolidated
5.0						sndysh	rdbn-ltpktn	vf-f	w	r								VS			Mancos Sh
7.5						sndysh, qtzss	pktn-ywbn	f-m	m	r								VS			Upper Dakota Ct @ 7.0'
10.0						qtz ss	wh-ywtn	m-c	m	r		L						N			
12.5						qtz ss	tn	m-c	m	r		L						N			
15.0						qtz ss	tn	m-c	m	a								N			
17.5						qtz ss	tn	f-m	m	a								N			
20.0						qtz ss	tn	m	w	a		L						N			
22.5						qtz ss	tn	m	w	r								N			
25.0						qtz ss	tn	m c	m	a								N			
27.5						qtz ss	lt	m c	m	r								N			
30.0						qtz ss	ltgytn	m	w	R								N			
32.5						qtz ss	ltgytn	m	w	r								N			
35.0						qtz ss	ltgytn	m	w	r								N			
37.5						qtz ss	ltgytn	m-c	m	r								N			
40.0						qtz ss	ltgytn	m-c	m	a								N			
42.5						qtz ss, cgl	gytn-dkgy	m-peb	f	a								N			30% chert pebbles + grains
45.0						qtz ss	gytn	m-c	m	r								N			
47.5						qtz ss	gytn	m-c	m	r								N			Some chert frags.
50.0						qtz ss	gytn	m-c	m	r								N			
52.5						qtz ss	vltgy	vf-m	f	r								N			
55.0						qtz ss	wh-ortn	f-m	m	r		L						N			
57.5						qtz ss	wh	f	w	a								N			
60.0						qtz ss	wh	m	w	r								N			
62.5						qtz ss	vltgy	m	w	r								N			
65.0						qtz ss	vltgy	m	w	r								N			
67.5						qtz ss	vltgy	m	w	r								N			quite moist @ 67.5
70.0						qtz ss	vltgy	m	w	r								N			
72.5						qtz ss	vltgy	m-c	m	r								N			Some gy chert grains + frags.
75.0						qtz ss, sh	ywbn-tnbn	m-c	m	r		L						N			
77.5						qtz ss, sh	wh-tn-gn	m-peb	p	a			tr	c				N			Brushy Basin Ct @ 77.0' good contact
80.0						sh	gygn											N			some red chert grains
82.5						sh	gygn											N			
85.0						sh	gn											N			T.D.
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE



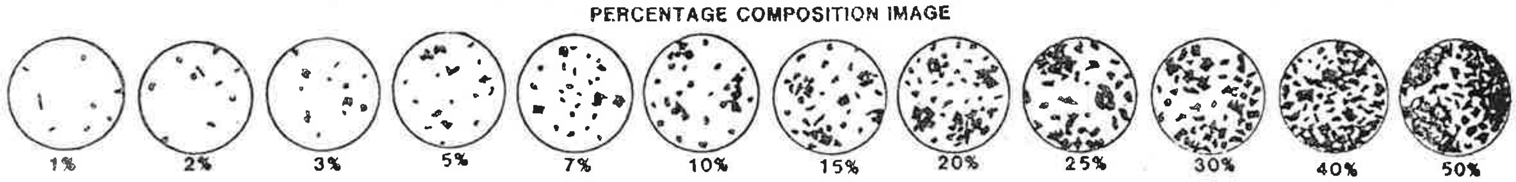
Date 3 MAY 2011 Geologist L. Casebolt Drilling Co. Byles Exploration Inc. Hole No. DR 24
Property White Mesa Mill Project Cell 4B Unit No. ____ Sec. ____ Twp. ____ Rge. ____
County San Juan State Utah Location ____ Elev. ≈5469

PAGE 1 OF 1
T.D. PROBE ____
T.D. DRILL 80.0'
FLUID LEVEL ____

Depth	Sample Taken	Graphic Log	Alteration	Gamma Anomaly	Breccia Pipe	Lithology	Color of Wet Sample	Grain Size	Sorting	Angularity	Cement Matrix	Iron Oxide	Pyrite Amount	Pyrite Habit	Pyrite Alter.	Metallic	Non-Metallic	React.-10% HCL	Carbon Amount	Carbon Type	Remarks
0–2.5						mdst	rdbn											W			Surface Soil-unconsolidated-sndy lean clay-CL
2.5–5.0						mdst	rdbn											W			Surface soil-unconsolidated-sndy lean clay-CL
5.0–7.5						sndy sh	pktn	c-vc	p	r								VS			Mancos Sh
7.5–10.0						qtz ss	gytn	m-peb	f	r								N			Upper Dakota Fm Ct @ 7.5' chert pebbles + grains
10.0–12.5						qtz ss	gytn	m-vc	f	a								N			light colored chert frags. + grains
12.5–15.0						qtz ss	gytn	m-peb	f	a								N			" " " " "
15.0–17.5						qtz ss	ltgytn	f-m	m	r								N			
17.5–20.0						qtz ss	ltgytn	m-c	m	a								N			
20.0–22.5						qtz ss	ltgytn	m	w	r								N			
22.5–25.0						qtz ss	ltgytn	m	w	r								N			
25.0–27.5						qtz ss	gytn	m-c	m	R								N			
27.5–30.0						qtz ss	ywgytn	m-vc	f	a								N			abund white chert frags.
30.0–32.5						qtz ss	ltgytn	m-c	m	r								N			
32.5–35.0						qtz ss	ltgytn	m	w	r								N			moisture 1st noticed 35.0'
35.0–37.5						qtz ss	ltgytn	m	w	r								N			
37.5–40.0						qtz ss	ltgytn	m	w	r								N			
40.0–42.5						qtz ss	ltgytn	f	w	r								N			
42.5–45.0						qtz ss	ltgytn	f-m	m	r								N			
45.0–47.5						qtz ss	gytn	f-c	f	a								N			
47.5–50.0						qtz ss	ltywtn	m-vc	f	a		L						N			
50.0–52.5						qtz ss	ywgytn	m-peb	f	a		L						N			abund light colored chert pebbles + grains
52.5–55.0						qtz ss, cgl	orgytn	m-peb	p	a		L						N			30% " " " " "
55.0–57.5						qtz ss	ywgytn	m-vc	f	a								VS			
57.5–60.0						qtz ss	gy	f-c	f	a			tr.					VS			
60.0–62.5						sh	gn											N			Brushy Basin Ct @ 60.0' some ppbn chert pebbles.
62.5–65.0						sh	gn						tr					N			Some ppbn-red chert frags.
65.0–67.5						Sh	gygn											N			
67.5–70.0						Sh	gygn-ppbn											N			some mottled cuttings
70.0–72.5						sh	gn											N			
72.5–75.0						sh	gn											N			some red chert grains
75.0–77.5						Sh	gn											N			
77.5–80.0						sh	gygn											N			T.D.

Depth scale: 0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5, 25.0, 27.5, 30.0, 32.5, 35.0, 37.5, 40.0, 42.5, 45.0, 47.5, 50.0, 52.5, 55.0, 57.5, 60.0, 62.5, 65.0, 67.5, 70.0, 72.5, 75.0, 77.5, 80.0, 82.5, 85.0, 87.5, 90.0, 92.5, 95.0, 97.5, 100.0, 102.5, 105.0, 107.5, 110.0, 112.5, 115.0, 117.5, 120.0, 122.5, 125.0

PERCENTAGE COMPOSITION IMAGE



Date *2 May 2011* Geologist *L. Casebolt* Drilling Co. *Bayles Exploration, Inc.* Hole No. *DR 25*
Property *White Mesa Mill* Project *Cell 4B* Unit No. ____ Sec. ____ Twp. ____ Rge. ____
County *San Juan* State *Utah* Location ____ Elev. *≈ 5462*

PAGE *1* OF *1*
T.D. PROBE ____
T.D. DRILL *80.0*
FLUID LEVEL ____

DEPTH	SAMPLE TAKEN	GRAPHIC LOG	ALTERATION	GAMMA ANOMALY	BRECCIA PIPE	LITHOLOGY	COLOR OF WET SAMPLE	GRAIN SIZE	SORTING	ANGULARITY	CEMENT MATRIX	IRON OXIDE	PYRITE AMOUNT	PYRITE HABIT	PYRITE ALTER.	METALLIC	NON-METALLIC	REACT.-10% HCL	CARBON AMOUNT	CARBON TYPE	REMARKS
0																					
2.5						qtz ss, mds	lt or bn	m-c	m	a		L						VW			Surface Soil to 1 foot, Upper Dakota Fm Ct @ 1.0'
5.0						qtz ss	or gy bn	c-vc	m	a		L						N			30% chert frags.
7.5						qtz ss	tn	m-c	m	a								N			20% " "
10.0						qtz ss	or tn	m-c	m	a								N			Moisture First noted @ 7.5' 30% chert.
12.5						qtz ss, sh, cgl	yw tn	m-peb	p	a								N			
15.0						qtz ss	tn	m-c	m	r								N			30% chert grains
17.5						qtz ss, cgl	or bn	c-peb	p	a								N			80%+ " " & pebbles
20.0						qtz ss, cgl	or bn	c-peb	p	a		L						N			90%+ " " "
22.5						qtz ss, cgl	or gy bn	c-peb	p	a		L						N			90%+ " " "
25.0						qtz ss, cgl	or gy bn	c-peb	p	a		L						N			90%+ " " "
27.5						qtz ss, cgl	gy bn	c-peb	p	a		L						N			90%+ " " "
30.0						qtz ss, cgl	or gy bn	c-peb	p	a								N			90%+ " " "
32.5						qtz ss, cgl	or bn	c-peb	p	a								N			70%+ " " "
35.0						qtz ss, cgl	gy bn	c-peb	p	a								N			90%+ " " "
37.5						qtz ss	tn	m	w	R								N			
40.0						qtz ss	lt or tn	f-m	m	r		L						N			
42.5						qtz ss	tn	f-m	m	r								N			
45.0						qtz ss	tn	m	w	r								N			
47.5						qtz ss	tn	f-m	m	r								N			Some chert frags.
50.0						qtz ss	tn	m	w	R								N			
52.5						qtz ss	tn	m-c	f	a								VW			some gy chert frags & grains
55.0						qtz ss	lt gy tn	m-vc	f	a								N			abund. " " " "
57.5						qtz ss, cgl	lt gy tn	m-peb	p	a								N			30% wh-gy chert pebbles & frags.
60.0						qtz ss	lt tn	m-peb	p	a			Tr.	A				N			some " " " " "
62.5						qtz ss	lt tn	m	w	R								N			
65.0						qtz ss, cgl	or tn	m-peb	p	a								N			40% multi colored chert pebbles, frags, & grains
67.5						qtz ss, cgl	gy tn	m-peb	p	a								N			80% " " " " " "
70.0						qtz ss	v lt gy	m-c	f	a								N			
72.5						qtz ss	v lt gy	m	w	r								N			
75.0						qtz ss	v lt gy	f-m	m	r								N			Well began producing water @ 72.5'
77.5						qtz ss, cgl, sh	yw tn-bl gn	m-peb	p	a			1%	C				N			Brushy Basin Ct. @ 76.0' (good contact)
80.0						sh	bl gn						Tr.	A				N			T.D. some pp bn chert pebbles
82.5																					
85.0																					
87.5																					
90.0																					
92.5																					
95.0																					
97.5																					
100.0																					
102.5																					
105.0																					
107.5																					
110.0																					
112.5																					
115.0																					
117.5																					
120.0																					
122.5																					
125.0																					

PERCENTAGE COMPOSITION IMAGE