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June 6, 2014

DRC-2014-003821

Sent VIA OVERNIGHT DELIVERY

Mr. Rusty Lundberg Director Division of Radiation Control Utah Department of Environmental Quality 195 North 1950 West P.O. Box 144850 Salt Lake City, UT 84114-4820

Re: Transmittal of Hydrogeology Report for the White Mesa Uranium Mill, Blanding Utah In Response to the Request for Information ("RFI"), dated March 26, 2014, regarding the DRC review of the August 27, 2009 Hydrogeologic Report

Dear Mr. Lundberg:

Enclosed are two copies of the White Mesa Uranium Mill Hydrogeology Report, which was revised in response to the Division of Radiation Control ("DRC") Request for Information ("RFI"), dated March 26, 2014.

The revised Hydrogeology Report incorporates the relevant information from studies conducted at the White Mesa Mill since the submission of the original Hydrogeology Report in 2009.

If you should have any questions regarding this report please contact me.

Yours very truly,

ENERGY FUELS RESOURCES (USA) INC. Kathy Weinel Quality Assurance Manager

CC: David C. Frydenlund Harold R. Roberts David E. Turk Dan Hillsten Frank Filas



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HYDROGEOLOGY OF THE WHITE MESA URANIUM MILL

BLANDING, UTAH

June 6, 2014

Prepared for:

ENERGY FUELS RESOURCES (USA) INC. 225 Union Boulevard, Suite 600 Lakewood, Colorado 80228

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Project Number 7180000.00-02.0





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June 6, 2014

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1. INTRODUCTION

In response to the Utah Department of Environmental Quality Division of Radiation Control (DRC) letter to Energy Fuels Resources (USA) Inc. (EFRI) dated March 26, 2014 (RFI letter), an updated site hydrogeological report has been prepared which discusses the hydrogeology of the White Mesa Uranium Mill, (the Mill or the site) located south of Blanding, Utah as per Part 1.F.10 of the amended Utah Department of Environmental Quality (UDEQ) Ground Water Quality Discharge Permit UGW370004 (the Permit).

Part I.F.10 of the Permit describes requirements for the report which consist of:

a) Local hydrogeologic conditions in the shallow aquifer, including, but not limited to: local geologic conditions; time relationships and distribution of shallow aquifer head measurements from facility wells and piezometers; local groundwater flow directions; and distribution of aquifer permeability and average linear groundwater velocity across the site, and

b) Well specific groundwater quality conditions measured at facility monitoring wells for all groundwater monitoring parameters required by this Permit, including, but not limited to: temporal contaminant concentrations and trends from each monitoring well; statistical tests for normality of each contaminant and well, including univariate or equivalent tests; calculation of the mean concentration and standard deviation for each well and contaminant.

As per the RFI letter the hydrogeologic report is to focus on part a). Part b) is covered by INTERA site 'background' reports (INTERA, 2007a; INTERA 2007b; INTERA, 2008), and more recent reports (including INTERA, 2008; INTERA, 2009; INTERA, 2010; INTERA, 2012a; INTERA 2012b; INTERA, 2013a; INTERA, 2013b; INTERA, 2014a; INTERA, 2014b; and INTERA, 2014c) that are updates to the background reports.

Specifically, DRC requests that a site hydrogeological report submitted in August, 2009 (HGC, 2009), be updated with relevant hydrogeological information provided in the following:

- 1. Southwest Investigation Report (November 7, 2012) describing work to better characterize the perched groundwater zone downgradient (southwest) of the tailings cells,
- 2. EFR Nitrate contamination investigation activities (through September 2011) that included installation of soil borings and upgradient perched groundwater monitoring wells,

- 3. Implementation of a Nitrate Corrective Action Plan (May 7, 2012) and ongoing activities to address a perched nitrate groundwater plume,
- 4. Continued implementation of corrective actions related to the chloroform plume that were initiated in 2003,
- 5. October 12, 2012 Source Assessment Report for groundwater monitoring wells in Out of Compliance (OOC) status,
- 6. November 9, 2012 pH Report which included proposed revised GWCL's for all MWseries wells after determination that OOC status for pH in certain wells was not due to cell leakage,
- 7. December 7, 2012 Pyrite Investigation Report which included analysis of core samples for pyrite content and modeling to demonstrate that pH trends were plausibly the result of aeration of the formation due to wildlife pond recharge and/or monitoring well development, overpumping, and sampling,
- 8. Infiltration and Contaminant Transport Modeling to assess contaminant transport times from tailings cells to local receptors,
- 9. Ongoing collection and analysis of groundwater samples and water level data, and
- 10. Discontinuance of recharge to the two upper (northern) wildlife ponds to dissipate the associated perched groundwater mound.

2. BACKGROUND AND OVERVIEW

Figure 1A is a site map showing general site features and the locations of wells, piezometers, springs, and lithologic cross-sections. Hydrogeologic investigation of the site has been ongoing since the initial investigation in 1977-1978 (Dames and Moore, 1978). Major hydrogeologic and groundwater investigations include UMETCO (1993); UMETCO (1994); TITAN (1994); International Uranium (USA) Corporation (IUSA) and Hydro Geo Chem, Inc. (HGC) [2000]; IUSA and HGC (2001); HGC (2004); HGC (2007); INTERA (2007a); INTERA (2007b); INTERA (2007b); INTERA (2008); Hurst and Solomon (2008); INTERA (2009); HGC (2010e); INTERA (2012a); INTERA (2012b); HGC (2012b); HGC (2012c); and HGC (2014).

Investigations to date and more than 30 years of perched groundwater monitoring indicate that tailings cell operation has not impacted perched groundwater. The lack of tailing cell impact is detailed in Hurst and Solomon (2008) and various INTERA documents (INTERA, 2007a; INTERA 2007b; INTERA, 2008; INTERA, 2010; INTERA, 2012a; INTERA 2012b; INTERA, 2013a; INTERA, 2013b; INTERA, 2014a; INTERA, 2014b; and INTERA, 2014c).

Perched groundwater was impacted by disposal of laboratory wastes to two (now abandoned) sanitary leach fields in the early years of Mill operation (prior to about 1980) before tailings cells were operational (HGC, 2007). Disposal of laboratory wastes to the abandoned scale house and former office leach fields (HGC, 2007) is considered the source of a chloroform plume (defined by concentrations greater than 70 micrograms per liter $[\mu g/L]$) located upgradient to cross-gradient (northeast to east) of the tailings cells (Figure 1B). The eastern portion of the chloroform plume likely originated from the abandoned scale house leach field (located immediately north-northwest of TW4-18 [Figure 1B]), and the western portion from the former office leach field (located in the immediate vicinity of TW4-19 [Figure 1B]).

Perched groundwater has also been impacted by nitrate (INTERA, 2009). A nitrate plume (defined by concentrations greater than 10 milligrams per liter [mg/L]) that contains elevated chloride extends from upgradient (northeast) of the tailings cells to a portion of the area beneath the tailings cells as described in the Nitrate Corrective Action Plan (nitrate CAP)[HGC, 2012a]. The precise source(s) of the nitrate plume are not well defined. However, the footprint of a former agricultural/stock watering pond referred to as the 'historical pond' is located beneath the upgradient portion of the nitrate plume and extends to the north of the plume (1B). This pond was active from the early part of the 20th century until the area was regraded as part of Mill construction circa 1980 (HGC, 2012a). This pond is considered one of the likely historical sources of nitrate and chloride to the nitrate plume. Ammonium sulfate handling in the vicinity of the ammonium sulfate crystal tanks (southeast of TWN-2 [Figure 1B]) is considered the only

potential current source of nitrate to the nitrate plume and is being addressed through implementation of Phase 1 of the nitrate CAP [HGC (2012a) and EFRI (2013)].

Both the chloroform and nitrate plumes are under remediation by pumping and are discussed in more detail in Section 3.

Appendix A contains copies of lithologic logs from site perched monitoring wells and piezometers. Appendix B contains copies of perched well construction schematics. Appendix C contains logs of borings installed by INTERA as part of the nitrate investigation that supported the nitrate CAP. Logs of soil borings installed as part of Phase I of the nitrate CAP implementation are provided in EFRI (2013).

2.1 Overview of Site Hydrogeology

TITAN (1994) provides a detailed description of site hydrogeology based on information available at that time. A brief summary of site hydrogeology that is based in part on TITAN (1994) and updated with information from the literature and more recent site investigations listed in Section 1 is provided below.

2.1.1 Geology/Stratigraphy

The White Mesa Uranium Mill is located within the Blanding Basin (the Basin) of the Colorado Plateau physiographic province. Bedrock units exposed in the Basin include Upper Jurassic through Cretaceous sedimentary rocks (Figure 2, from Doelling, 2004). The general succession, in ascending order, is the Upper Jurassic Brushy Basin Member of the Morrison Formation, the Lower Cretaceous Burro Canyon Formation, and the Upper Cretaceous Dakota Sandstone and Mancos Shale. Typical of large portions of the Colorado Plateau province, the rocks within the Basin are relatively undeformed.

The Mill has an average elevation of approximately 5,600 feet above mean sea level (ft amsl) and is underlain by unconsolidated alluvium and indurated sedimentary rocks. Indurated rocks include those exposed within the Basin (described above), and consist primarily of sandstone and shale. The indurated rocks are relatively flat lying with dips generally less than 3°. The alluvial materials consist primarily of aeolian silts and fine-grained aeolian sands with a thickness varying from a few feet to as much as 25 to 30 feet across the site. The alluvium is underlain by the Dakota Sandstone and Burro Canyon Formation, and where present, the Mancos Shale. The Dakota and Burro Canyon are sandstones having a total thickness ranging from approximately 55 to 140 feet. Beneath the Burro Canyon Formation lies the Morrison Formation, consisting, in descending order, of the Brushy Basin Member, the Westwater Canyon Member, the Recapture

Member, and the Salt Wash Member. The Brushy Basin and Recapture Members of the Morrison Formation, classified as shales, are very fine-grained, have a very low permeability, and are considered aquicludes. The Brushy Basin Member is primarily composed of bentonitic mudstones, siltstones, and claystones. The Westwater Canyon and Salt Wash Members also have a low average vertical permeability due to the presence of interbedded shales.

Beneath the Morrison Formation lie the Summerville Formation, an argillaceous sandstone with interbedded shales, and the Entrada Sandstone. Beneath the Entrada lies the Navajo Sandstone. The Navajo and Entrada Sandstones constitute the primary aquifer in the area of the site. The Entrada and Navajo Sandstones are separated from the Burro Canyon Formation by approximately 1,000 to 1,100 feet of materials having a low average vertical permeability. Groundwater within this system is under artesian pressure in the vicinity of the site, is of generally good quality, and is used as a secondary source of water at the site. Stratigraphic relationships beneath the site are summarized in Figure 3 (adapted from TITAN, 1994 and based on the lithology of water supply well WW-3, located just northwest of TWN-2 [Figure 1B]).

The Upper Jurassic Morrison Formation is the youngest Jurassic unit in the Basin. In many places an unconformity separates the Morrison Formation from underlying Middle Jurassic strata. The Morrison was deposited in a variety of depositional environments, ranging from eolian to fluvial and lacustrine. Much of the Morrison is composed of fluvial sandstone and mudstone that have sources to the west and southwest of the Basin (Peterson and Turner-Peterson, 1987). The upper Brushy Basin Member (typically described as a bentonitic shale), was deposited in a combination of lacustrine and marginal lacustrine environments (Turner and Fishman, 1991).

The contact between the Morrison Formation and overlying strata has been the subject of much discussion. In the southeastern part of the Basin, the Lower Cretaceous Burro Canyon Formation overlies the Morrison Formation. The contact between the Burro Canyon Formation and the Morrison Formation has been interpreted as a disconformity (Young, 1960); however, Tschudy *et al.*, (1984) indicated that the Burro Canyon Formation may be a continuation of deposition of the Morrison Formation. Recent studies by Aubrey (1992) also suggest interfingering between the Morrison Formation and overlying units.

Kirby (2008) indicates that the contact between the Morrison Formation and the Burro Canyon Formation (between the Brushy Basin Member of the Morrison and the Burro Canyon Formation) near Blanding, Utah is disconformable with "local erosional relief of several feet". Data collected from perched borings at the site that penetrate the Brushy Basin are consistent with a disconformable, erosional contact in agreement with Kirby (2008).

2.1.2 Hydrogeologic Setting

The site and vicinity has a dry to arid continental climate, with an average annual precipitation of approximately 13.3 inches, and an average annual lake evaporation rate of approximately 47.6 inches. Recharge to major aquifers (such as the Entrada/Navajo) occurs primarily along the mountain fronts (for example, the Henry, Abajo, and La Sal Mountains), and along the flanks of folds such as Comb Ridge Monocline.

Although the water quality and productivity of the Navajo/Entrada aquifer are generally good, the depth (approximately 1,200 feet below land surface [ft bls]) makes access difficult. The Navajo/Entrada aquifer is capable of yielding significant quantities of water to wells (hundreds of gallons per minute [gpm]). Water in WW-series supply wells completed across these units at the site rises approximately 800 feet above the base of the overlying Summerville Formation (TITAN, 1994).

2.1.3 Perched Water Zone

Perched groundwater occurs within the Dakota Sandstone and Burro Canyon Formation beneath the site and is used on a limited basis to the north (upgradient) of the site because it is more easily accessible than the Navajo/Entrada aquifer. Perched groundwater originates mainly from precipitation and local recharge sources such as unlined reservoirs (Kirby, 2008) and is supported within the Burro Canyon Formation by the underlying, fine-grained Brushy Basin Member of the Morrison Formation.

Water quality of the Dakota Sandstone and Burro Canyon Formation is generally poor due to high total dissolved solids (TDS) in the range of approximately 1,100 to 7,900 milligrams per liter (mg/L), and is used primarily for stock watering and irrigation. The saturated thickness of the perched water zone generally increases to the north of the site, increasing the yield of the perched zone to wells installed north of the site. The generally low permeability of the perched zones limits well yields. Although sustainable yields of as much as 4 gallons per minute (gpm) have been achieved in site wells penetrating higher transmissivity zones near wildlife ponds, yields are typically low ($<^{1}/_{2}$ gpm) due to the generally low permeability of the perched zone. Many of the perched monitoring wells purge dry and take several hours to more than a day to recover sufficiently for groundwater samples to be collected. During redevelopment (HGC, 2011b) many of the wells went dry during surging and bailing and required several sessions on subsequent days to remove the proper volumes of water.

Although in areas having greater saturated thicknesses perched groundwater extends into the overlying Dakota Sandstone, perched groundwater at the site is hosted primarily by the Burro

Canyon Formation, which consists of a relatively hard to hard, fine- to medium-grained sandstone containing siltstone, shale and conglomeratic materials. As discussed above, the Burro Canyon Formation is separated from the underlying regional Navajo/Entrada aquifer by approximately 1,000 to 1,100 feet of Morrison Formation and Summerville Formation materials having a low average vertical permeability. As discussed above, the Brushy Basin Member of the Morrison Formation (a bentonitic shale), lying immediately beneath the Burro Canyon Formation, forms the base of the perched water zone at the site. Figure 4 is a photograph of the contact between the Burro Canyon Formation and the underlying Brushy Basin Member taken from a location along Highway 95 north of the Mill. This photograph illustrates the transition from the cliff-forming sandstone of the Burro Canyon Formation to the slope-forming Brushy Basin Member.

Figure 5 is a perched groundwater elevation contour map generated from first quarter, 2014 data. Historic water level maps based on data from 1990, 1994 and 2002 are provided in Appendix D.

As shown in Figure 5 and Appendix D, perched water flow across the site is generally from northeast to southwest. Beneath and south of the tailings cells, in the west central portion of the site, perched water flow is south-southwest to southwest. Flow on the western margin of the mesa is also south, approximately parallel to the rim (where the Burro Canyon Formation is terminated by erosion). On the eastern side of the site perched water flow is also generally southerly. Because of mounding near wildlife ponds, flow direction ranges locally from westerly (west of the ponds) to easterly (east of the ponds). Perched water discharges in seeps and springs located to the west, south, east, and southeast of the site.

In general, perched groundwater elevations have not changed significantly at most of the site monitoring wells since installation, except in the vicinity of the wildlife ponds and pumping wells. For example, relatively large increases in water levels occurred between 1994 and 2002 at MW-4 and MW-19, located in the east and northeast portions of the site, as discussed in HGC (2007). These water level increases in the northeastern and eastern portions of the site are the result of seepage from wildlife ponds. Piezometers PIEZ-1 through PIEZ-5, shown in Figure 5, were installed in 2001 for the purpose of investigating these changes. The mounding associated with the wildlife ponds and the general increase in water levels in the northeastern portion of the site. Conversely, pumping of chloroform wells MW-4, TW4-4, TW4-19, TW4-20, and MW-26, and nitrate wells TW4-22, TW4-24, TW4-25, and TWN-2 has depressed the perched water table locally and reduced average hydraulic gradients to the south and southwest of these wells. Pumping is designed to remove chloroform and nitrate associated with the chloroform and nitrate plumes shown on Figure 1B.

Hydraulic testing of perched zone wells yields a hydraulic conductivity range of approximately 2 x 10^{-8} to 0.01 centimeters per second (cm/s) as discussed in HGC (2012b). Hydraulic conductivity estimates are summarized in Tables 1 through 4. Table1 provides estimates of hydraulic conductivity from slug test data analyzed using the KGS and Bouwer-Rice solutions available in AQTESOLVE (HydroSOLVE, 2000). Table 2 summarizes recovery and slug test data analyzed using the Moench solutions in WHIP (HGC, 1988) and AQTESOLVE. The estimates provided in Tables 1 and 2 are based on HGC (2002); HGC (2005); HGC (2010a); HGC (2010b); HGC (2010c); HGC (2010d); HGC (2011a); HGC (2011c); HGC (2013a); and HGC (2013b). Table 3 summarizes analyses of test data collected during long-term pumping within the chloroform plume area using the Theis solutions available in AQTESOLVE (HGC, 2004). Table 4 (from TITAN, 1994) summarizes hydraulic conductivity estimates based on testing prior to 1994.

In general, the highest permeabilities and well yields are in the area of the site immediately northeast and east (upgradient to cross gradient) of the tailings cells. A relatively continuous, higher permeability zone associated with the chloroform plume and consisting of poorly indurated coarser-grained materials has been inferred to exist in this portion of the site (HGC, 2007).

Permeabilities downgradient (southwest) of the tailings cells are generally low. The low permeabilities and shallow hydraulic gradients downgradient of the tailings cells result in average perched groundwater pore velocity estimates that are among the lowest on site.

2.1.4 Seeps and Springs in Relation to Perched Zone Hydrogeology

Hydro Geo Chem (2010e) discusses the relationships between the perched water zone and seeps and springs at the margins of White Mesa. The relationships between seeps and springs and site geology/stratigraphy are provided in Figure E.1 and Figure E.2 of Appendix E. Key findings of HGC (2010e) include the following:

 Incorporating the seep and spring elevations in perched water elevation contour maps produces little change with regard to perched water flow directions except in the area west of the tailings cells and near Entrance Spring. West of the tailings cells, incorporation of Westwater Seep creates a more westerly hydraulic gradient. Westwater Seep appears to be nearly downgradient of the western portion of the cell complex (Figure 5). Ruin Spring is downgradient of the eastern portion of the cell complex (Figure 5). Westwater Seep is the closest apparent discharge point west of the tailings cells and Ruin Spring is the closest discharge point south-southwest of the tailings cells. Including the Entrance Spring elevation on the east side of the site creates a more easterly gradient in the perched water contours, and places Entrance Spring more directly downgradient of the northern wildlife ponds. Seeps and springs on the east side of the mesa are either cross-gradient of the tailings cells or are separated from the tailings cells by a groundwater divide

- 2. Ruin Spring and Westwater Seep are interpreted to occur at the contact between the Burro Canyon Formation and the Brushy Basin Member. Corral Canyon Seep, Entrance Spring, and Corral Springs are interpreted to occur at elevations within the Burro Canyon Formation at their respective locations but above the contact with the Brushy Basin Member. All seeps and springs (except Cottonwood Seep which is located near the Brushy Basin Member/Westwater Canyon Member contact) are associated with conglomeratic portions of the Burro Canyon Formation. Provided they are poorly indurated the more conglomeratic portions of the Burro Canyon Formation are likely to have higher permeabilities and the ability to transmit water more readily than finer-grained portions. This behavior is consistent with on-site drilling and hydraulic test data that associates higher permeability with the poorly indurated coarser-grained horizons detected east and northeast of the tailing cells associated with the chloroform plume)
- 3. Cottonwood Seep is located more than 1,500 feet west of the mesa rim in an area where the Dakota Sandstone and Burro Canyon Formation (which hosts the perched water system) are absent due to erosion. Cottonwood Seep occurs near a transition from slope-forming to bench-forming morphology (indicating a change in lithology). Cottonwood Seep (and 2nd Seep located immediately to the north) are interpreted to originate from coarser-grained materials within the lower portion of the Brushy Basin Member (or upper portion of the Westwater Canyon Member) and are therefore not (directly) connected to the perched water system at the site.
- 4. Only Ruin Spring appears to receive a predominant and relatively consistent proportion of its flow from perched water. Ruin Spring originates from conglomeratic Burro Canyon Formation sandstone where it contacts the underlying Brushy Basin Member, at an elevation above the alluvium in the associated drainage. Westwater Seep, which also originates at the contact between the Burro Canyon Formation and the Brushy Basin Member, likely receives a significant contribution from perched water. All seeps and springs other than Ruin Spring (and 2nd Seep just north of Cottonwood Seep) are located within alluvium occupying the basal portions of small drainages and canyons. The relative contribution of flow to these features from bedrock and from alluvium is indeterminate.
- 5. All seeps and springs are reported to have enhanced flow during wet periods. For seeps and springs associated with alluvium, this behavior is consistent with an alluvial contribution to flow. Enhanced flow during wet periods at Ruin Spring, which originates from bedrock above the level of the alluvium, likely results from direct recharge of Burro Canyon Formation and Dakota Sandstone outcropping near the mesa margin in the vicinity of Ruin Spring. This recharge would be expected to temporarily increase the flow at Ruin Spring (as well as other seeps and springs where associated bedrock is directly recharged) after precipitation events.
- 6. The assumption that the seep or spring elevation is representative of the perched water elevation is likely to be correct only in cases where the feature receives most or all of its flow from perched water and where the supply is relatively continuous (for example at Ruin Spring). The perched water elevation at the location of a seep or spring that receives

a significant proportion of water from a source other than perched water may be different from the elevation of the seep or spring. The elevations of seeps that are dry for at least part of the year will not be representative of the perched water elevation when dry. The uncertainty that results from including seeps and springs in the contouring of perched water levels must be considered.

Although there are uncertainties associated with incorporation of seep and spring elevations into maps depicting perched water elevations or maps depicting the Burro Canyon Formation/Brushy Basin Member contact elevations, perched water elevation maps now incorporate seep and spring elevations other than Cottonwood Seep, and contact elevation maps now incorporate Westwater Seep and Ruin Spring elevations.

As discussed in item c), Cottonwood Seep was interpreted in HGC (2010e) to be associated with coarser-grained materials within the lower portion of the Brushy Basin Member. The justification for this interpretation is based primarily on 1) the rate of flow at Cottonwood Seep, which is estimated to be between 1 and 10 gpm (consistent with Dames and Moore, 1978), 2) the need for relatively permeable materials to transmit this rate of flow, and 3) the change in morphology near Cottonwood Seep indicating a change in lithology. The change in morphology from slope-former to bench-former just east of Cottonwood Seep can be seen in the topographic map included in Appendix E (Figure E1) and the annotated photograph provided in Figure 6.

The upper portion of the Brushy Basin Member, which hydraulically isolates the perched zone from underlying materials, is composed primarily of bentonitic mudstone, claystone, and shale. The rate of flow at Cottonwood Seep is inconsistent with the materials found within the upper portion of the Brushy Basin but is consistent with coarser-grained materials expected either within the lower portion of the Brushy Basin Member or within the upper portion of the underlying Westwater Canyon (sandstone) Member. The relationship between Cottonwood Seep and lithology is shown on the geologic map provided in Appendix E (Figure E.2) and Figure 6.

As shown in Figures 6 and E.1, Cottonwood Seep is located approximately 230 feet below the base of the perched zone defined by the contact between the cliff-forming Burro Canyon Formation and the underlying slope-forming Brushy Basin Member. The change in morphology from slope-former to bench-former occurs within the lower portion of the Brushy Basin Member (or the upper portion of the Westwater Canyon Member), between the termination of the perched zone at the mesa rim and Cottonwood Seep. The bench-like area hosting Cottonwood Seep begins at the change in morphology east of Cottonwood Seep and terminates west of Cottonwood Seep where a cliff-forming sandstone, interpreted to be within the Westwater Canyon Member, is exposed. The contact between the Westwater Canyon Member and the Brushy Basin Member is interpreted to be located between this sandstone outcrop and the change in morphology from slope-former to bench-former. This places Cottonwood Seep at the

transition between the Brushy Basin Member and the underlying Westwater Canyon Member. This is consistent with the stratigraphy provided in Figure 3 which places the contact between the Brushy Basin Member and the Westwater Canyon Member at elevations between approximately 5,220 and 5,230 ft amsl in this portion of the site, within 5 to 15 feet of the elevation of Cottonwood Seep (5234 ft amsl).

Details of the coarse-grained nature of the lower portion of the Brushy Basin Member are consistent with Shawe (2005) as will be discussed in Section 3.1.1.

2.1.5 Tailings Cells

Details of the construction of tailings cells 2 though 4A are provided in UMETCO (1993). Mill tailings are disposed in lined cells excavated below grade into the upper Dakota Sandstone. Cells 2 and 3 are underlain by a synthetic liner placed over compacted bedding material. The bedding material serves as a drain layer. The drain layer and a sand drain on the downstream embankment are connected to a leak detection lateral. Slime drains were installed above the liner in each cell within the area having the lowest topographic elevation.

Cell 4A and cell 4B have a clayey liner overlain by geotextile and a synthetic liner. Leak detection laterals drain to the southwest and southeast corners of cells 4A and 4B, respectively.

Although the cells are equipped with leak detection systems, and monitoring activities have not detected impacts to the perched aquifer from tailings cell disposal (as discussed in Section 2), the Mill installed additional perched monitoring wells between existing wells on the downgradient margin of the cell complex and between existing cells to function as an 'early warning system' for any potential impacts to perched water. These additional wells, MW-23 through MW-25, and MW-27 through MW-31, were installed and tested in 2005 (HGC 2005). At this time, temporary wells TW4-15 and TW4-17, located at the eastern edge of the cell complex and installed in 2002 (HGC, 2002), were converted to permanent status and renamed MW-26 and MW-32, respectively. Subsequently, upon installation of tailings cell 4B, MW-33 through MW-37 were added to the west and south (downgradient) edges of the cell.

3. DETAILED SITE HYDROGEOLOGY

A detailed description of site hydrogeology is provided in the following Sections.

3.1 Stratigraphy and Formation Characteristics

The site stratigraphy is summarized in Figure 3. Details of formations underlying the site that are stratigraphically above the Westwater Canyon Member of the Morrison Formation are provided in the following Sections.

3.1.1 Brushy Basin Member

As discussed in Sections 2.1.1 and 2.1.3, the upper portion of the Brushy Basin Member is composed of bentonitic mudstone, claystone, and shale, which hydraulically supports the perched zone and isolates it from underlying materials.

The upper portion of the Brushy Basin Member is described by Shawe (2005) as "principally mudstone; it contains only minor amounts of sandstone, conglomeratic sandstone, and conglomerate as discontinuous lenses". Shawe (2005) describes the lower portion of the Brushy Basin as coarser-grained, having "mudstone layers which contain, near their base, lenses lithologically similar to sandstone of the Salt Wash Member, and near their top, conglomeratic sandstone lenses".

With regard to the vicinity of Cottonwood Seep (discussed in Section 2.1.4), the expectation of coarser-grained materials is consistent with its location near the transition from the lower coarser-grained portion of the Brushy Basin Member into the underlying Westwater Canyon Member. As discussed in Craig *et al.* (1955), and Flesch (1974), the Westwater Canyon Member intertongues with the Brushy Basin Member. Craig *et al.* (1955) state "The Westwater Canyon Member forms the lower portion of the upper part of the Morrison in northeastern Arizona, northwestern New Mexico, and places in southeastern Utah and southwestern Colorado near the Four Corners, and it intertongues and intergrades northward into the Brushy Basin Member".

3.1.2 Burro Canyon Formation/Dakota Sandstone

Although the Dakota Sandstone and Burro Canyon Formations are often described as a single unit due to their similarity, previous investigators at the site have distinguished between them. The Dakota Sandstone is a relatively hard to hard, generally fine-to-medium grained sandstone cemented by kaolinite clays. The Dakota Sandstone locally contains discontinuous interbeds of siltstone, shale, and conglomeratic materials. Porosity is primarily intergranular. The underlying Burro Canyon Formation is the primary host of the perched groundwater at the site. The Burro Canyon Formation is similar to the Dakota Sandstone but is generally more poorly sorted, contains more conglomeratic materials, and becomes argillaceous near its contact with the underlying Brushy Basin Member (TITAN, 1994). The permeabilities of the Dakota Sandstone and Burro Canyon Formations at the site are generally low. Porosities and water contents measured in samples of Dakota Sandstone and Burro Canyon Formation collected from borings MW-16 and MW-17 are described in Sections 3.1.2.1 and 3.1.2.2 below. Porosity estimates from these borings agree with measurements reported by MWH (MWH, 2010) for archived samples collected from borings MW-30.

No significant joints or fractures within the Dakota Sandstone or Burro Canyon Formation have been documented in any wells or borings installed across the site (Knight-Piésold, 1998). Any fractures observed in cores collected from site borings are typically cemented, showing no open space.

3.1.2.1 Dakota Sandstone

The Dakota Sandstone, named by Meek and Hayden (1862) for exposures in northeastern Nebraska, is exposed in the Blanding Basin. Where the Burro Canyon Formation is present the Dakota Sandstone rests disconformably upon it. In many localities a three-fold lithologic sequence is present, consisting of a basal conglomeratic sandstone with an underlying disconformity, a middle unit of carbonaceous shale and coal, and an upper unit of evenly-bedded sandstone which intertongues with the overlying Mancos Shale. These strata have been described as deposits of transitional environments which accompanied the westward transgressing Mancos Sea (Young, 1973).

The basal conglomerate represents floodplain braided channel deposits which continue into the adjacent paludal environment. The carbonaceous shales are partly marshy but most formed in lagoon ponds, tidal flats and tidal channels of the lagoonal environment just seaward of the marsh belt. The evenly-bedded sandstone was formed at the shoreline as a mainland or barrier beach deposit of the littoral marine environment. Faunal evidence summarized by O'Sullivan *et al.*, (1972) indicates that the lower part of the Dakota Sandstone is of Early Cretaceous age and the upper part is of Late Cretaceous age.

Based on samples collected during installation of wells MW-16 (abandoned) and MW-17, located beneath and immediately downgradient of the tailings cells at the site (Figure 1B), porosities of the Dakota Sandstone range from 13.4% to 26%, and average 20% (Table 5) which is nearly the same as the average porosity of 19% reported by MWH (MWH, 2010) for archived sandstone samples collected from MW-23 and MW-30.

Water saturations from MW-16 and MW-17 range from 3.7% to 27.2%, averaging 13.5%, and the average volumetric water content is approximately 3% (Table 5). The permeability of the Dakota Sandstone based on packer tests in borings installed at the site ranges from 2.71 x 10^{-6} cm/s to 9.12 x 10^{-4} cm/s, with a geometric average of 3.89 x 10^{-5} cm/s (TITAN, 1994).

3.1.2.2 Burro Canyon Formation

As defined by Stokes and Phoenix (1948), the Burro Canyon Formation at its type locality near Slick Rock, Colorado, consists of alternating conglomerate, sandstone, shale, limestone and chert ranging in thickness from 150 to 260 feet. In the Blanding Basin the Burro Canyon Formation consists of deposits of alluvial and floodplain materials up to about 100 feet thick consisting of medium to coarse grained sandstone, conglomerate, pebbly sandstone, and claystone. At several horizons in the formation are persistent, widely traceable, conglomeratic sandstones interpreted as deposits of a braided channel subenvironment. Sandwiched between these sandstones are variegated mudstone units with some sandstone and siltstone lenses, the products of interchannel and meandering channel subenvironments. Fossils collected from the Burro Canyon Formation at various localities include freshwater invertebrates, dinosaur bones and plants. None are truly diagnostic but all suggest an Early Cretaceous (Aptian) age.

The average porosity of the Burro Canyon Formation is similar to that of the Dakota Sandstone. Based on samples collected from the Burro Canyon Formation at MW-16 (abandoned, located beneath tailings cell #4B as shown in Figure 1B), porosity ranges from 2% to 29.1%, averaging 18.3%, similar to the average porosity of 19% reported by MWH (MWH, 2010) for archived sandstone samples collected from MW-23 and MW-30. Water saturations of unsaturated materials collected from MW-16 range from 0.6% to 77.2%, and average 23.4% (Table 5).

TITAN (1994), reported that the hydraulic conductivity of the Burro Canyon Formation ranges from 1.9×10^{-7} to 1.6×10^{-3} cm/s, with a geometric mean of 1.01×10^{-5} cm/s, based on the results of 12 pumping/recovery tests performed in monitoring wells and 30 packer tests performed in borings prior to 1994 (Table 4). As discussed in Section 2, subsequent testing of wells by HGC yields a hydraulic conductivity range of approximately 2 x 10^{-8} to 0.01 cm/s (HGC, 2012b).

In general (as discussed in Section 2.1.3), the highest permeabilities and well yields are in the area of the site immediately northeast and east (upgradient to cross gradient) of the tailings cells. A relatively continuous, higher permeability zone (associated with poorly indurated coarsergrained materials in the general area of the chloroform plume) has been inferred to exist in this portion of the site (HGC, 2007). As discussed in HGC (2004), analysis of drawdown data collected from this zone during long-term pumping of MW-4, MW-26 (TW4-15), and TW4-19 (Figure 1B) yielded estimates of hydraulic conductivity ranging from approximately 4×10^{-5} to 1×10^{-3} cm/s (Table 3). The decrease in perched zone permeability south to southwest of this area (south of TW4-4), based on tests at TW4-6, TW4-26, TW4-27, TW4-29 through TW4-31, and TW4-33 and TW4-34 (Table 1), indicates that this higher permeability zone "pinches out", consistent with the interpretation provided in HGC (2007).

Relatively high conductivities measured at MW-11, located on the southeastern margin of the downgradient edge of tailings cell 3, and at MW-14, located on the downgradient edge of tailings cell 4A, of 1.4×10^{-3} cm/s and 7.5×10^{-4} cm/s, respectively (UMETCO, 1993 and Table 4), may indicate that this higher permeability zone extends beneath the southeastern portion of the tailings cell complex. However, based on hydraulic tests south and southwest of these wells, this zone of higher permeability does not appear to exist within the saturated zone downgradient (south-southwest) of the tailings cells

Slug tests performed at groups of wells and piezometers located northeast (upgradient) of, in the immediate vicinity of, and southwest (downgradient) of the tailings cells indicate generally lower permeabilities compared with the area of the chloroform plume. The following results are based on analysis of automatically logged slug test data using the KGS solution available in AQTESOLVE (HydroSOLVE, 2000).

Testing of TWN-series wells installed in the northeast portion of the site as part of nitrate investigation activities (HGC, 2009) yielded a hydraulic conductivity range of approximately 3.6 x 10^{-7} to 0.01 cm/s with a geometric average of approximately 6 x 10^{-5} cm/s. The value of 0.01 cm/s estimated for TWN-16 is the highest measured at the site, and the value of 3.6 x 10^{-7} cm/s estimated for TWN-7 is one of the lowest measured at the site. Testing of MW-series wells MW-23 through MW-32 (HGC, 2005) installed between and at the margins of the tailings cells in 2005 (and using the higher estimate for MW-23) yielded a hydraulic conductivity range of approximately 2 x 10^{-7} to 1 x 10^{-4} cm/s with a geometric average of approximately 2 x 10^{-5} cm/s. Hydraulic tests conducted at DR-series piezometers installed as part of the southwest area investigation (HGC 2012b) downgradient of the tailings cells yielded hydraulic conductivities ranging from approximately 2 x 10^{-8} to 4 x 10^{-4} cm/s with a geometric average of 9.6 x 10^{-6} cm/s. The low permeabilities and shallow hydraulic gradients downgradient of the tailings cells result in average perched groundwater pore velocity estimates that are among the lowest on site (approximately 0.26 feet per year (ft/yr) to 0.91 ft/yr based on calculations presented in HGC, 2012b).

The extensive hydraulic testing of perched zone wells at the site indicates that perched zone permeabilities are generally low with the exception of the apparently isolated zone of higher

permeability associated with the chloroform plume east to northeast (cross-gradient to upgradient) of the tailings cells. The geometric average hydraulic conductivity (less than 1 x 10^{-5} cm/s) of the DR-series piezometers which cover an area nearly half the size of the total monitored area at White Mesa (excluding MW-22), is nearly identical to the geometric average hydraulic conductivity of 1.01 x 10^{-5} cm/s reported by TITAN (1994), and is within the range of 5 to 10 feet per year (ft/yr) [approximately 5 x 10^{-6} cm/s to 1 x 10^{-5} cm/s] reported by Dames and Moore (1978) for the (saturated) perched zone during the initial site investigation.

3.1.3 Mancos Shale

Conformably overlying the Dakota Sandstone is the Upper Cretaceous Mancos Shale. The Mancos Shale was deposited in the Western Interior Cretaceous seaway (Figure 7) and is primarily composed of uniform, dark-gray mudstone, shale, and siltstone. It was deposited in nearshore and offshore neritic subenvironments of the Late Cretaceous Sea during its overall southwestern transgression and subsequent northeastward regression.

The Mancos Shale was named by Cross and Purington (1899) from exposures near Mancos, Colorado. Outcrops of the Upper Cretaceous Mancos Shale occur as hills and slopes generally near or directly beneath overlying Quaternary pediment remnants across portions of the Blanding Basin. Mancos Shale is absent in most of the Blanding Basin (due to erosion) where rocks of the Dakota Sandstone and Burro Canyon Formation are either exposed or mantled by thin unconsolidated deposits.

The Mancos Shale in the Blanding Basin consists of marine shale and interbeds of thin (less than 2 feet) sandstone and siltstone beds. Various pelecypod fossils are common in Mancos Shale outcrop areas (Huff and Lesure, 1965; Haynes *et al.*, 1972). Total thickness is estimated at 30 to 40 feet, but is generally negligible to 20 feet, a small erosional remnant of its original thickness of approximately 2,000 feet. The Mancos Shale was deposited during transgression and highstand of the Cretaceous Interior Seaway during the Late Cretaceous (Elder and Kirkland, 1994). Where present, the Mancos Shale may act as an important impermeable layer reducing the amount of potential infiltration and recharge to the underlying Dakota-Burro Canyon perched aquifer (Avery, 1986; Goodknight and Smith, 1996).

The Mancos Shale belongs to the group of thick marine organic muds (or black shales) generally thought of as deposited in geosynclinal areas. Bentonitic volcanic ash layers are abundant in the Mancos Shale (Shawe, 1968). An abundance of pyrite in the layers may indicate that iron was an important constituent of the ash, possibly being liberated by devitrification of glass and redeposited with the diagenetic development of pyrite. Hydrogen sulfide was abundant in the organic rich sediments accumulating at the bottom of the Mancos Sea, if it was a typical

sapropelic marine environment, as seems likely, and may have been especially abundant in the volcanic ash (Fenner, 1933).

Trapped sea water that is buried in the mud of the Mancos Shale likely had a high content of organic material consistent with the abundance of diagenetic pyrite. Chemical reduction resulting from hydrogen sulfide generated in carbon-rich sediments is characteristic of stagnant sea bottoms.

In the Early Tertiary, the original clay and silt deposited in the Mancos Shale became compacted to about a third to a tenth of its original water saturated volume by the time it was buried to a depth of about 10,000 feet (Shawe, 1976). Pore water throughout the Colorado Plateau, driven from compacting mud, moved largely upward into younger sediments (Yoder, 1955), but much water must have moved into the lower more porous strata because of local conditions of rock structure (Hedberg, 1936), because of the relatively high water density, and because of abnormally high fluid pressures. Expulsion of water likely occurred throughout the deposition of the Mancos Shale in the Late Cretaceous and during deposition of younger sediments in the Early Tertiary. Therefore expulsion occurred during a period of many millions of years and at depths ranging from near- surface to nearly maximum depths of burial.

Faulting occurred in many places on the Colorado Plateau, including the Blanding Basin during the Late Cretaceous and Early Tertiary when the Mancos was being deeply buried by younger strata, and this provided numerous avenues to allow water movement into underlying porous strata. It seems likely therefore that the Dakota Sandstone at the base of the Mancos Shale and the dominantly sandy underlying Burro Canyon Formation contained pore water which was expelled from the Mancos and was under abnormally high fluid pressures (Shawe, 1976).

Compaction of bedding around pyrite crystals shows the early development of part of the diagenetic pyrite, and indicates that pore fluids were being squeezed out of the Mancos Shale during the period of diagenesis. As pore fluids became trapped in the Mancos Shale following deposition of sediment in the Late Cretaceous, they immediately began to react with black opaque minerals, with magnetite deposited with the abundant ash fall material and possibly with volcanic glass and other iron-bearing material to form pyrite. Faulting that occurred on the Colorado Plateau in the Late Cretaceous and Early Tertiary facilitated movement of the Mancos pore water into underlying beds, causing removal of hematite coating on sand grains, destruction of detrital black opaque minerals, and growth of iron sulfide minerals (Shawe, 1976).

3.1.4 Pyrite Occurrence in the Dakota Sandstone and Burro Canyon Formation

As discussed above, downward movement of the Mancos Shale pore water into underlying beds of the Dakota Sandstone and Burro Canyon Formations caused removal of hematite coatings on sand grains, destruction of detrital black opaque minerals, and the growth of iron sulfide minerals. Shawe (1976) classifies the Dakota Sandstone and Burro Canyon Formations as "altered-facies" rocks primarily as a result of the invasion of pore waters expelled from the overlying Mancos Shale during compaction. Shawe states that "altered facies rocks that developed by solution attack are notable for their almost complete loss of black opaque minerals and gain of significant pyrite." Shawe further states that "altered-facies rocks contain only sparse black opaque minerals but appreciable pyrite" and that "alteration caused destruction of most detrital back opaque minerals, precipitation of substantial pyrite, and recrystallization of carbonate minerals that took up much of the iron liberated from the solution of black opaque minerals."

According to Shawe (1976), "altered-facies sandstone is light gray or, where weathered, also light buff to light brown. It contains only a small amount of black opaque heavy minerals and may or may not contain carbonaceous material. The light buff to light brown colors are imparted by limonite formed from oxidation of pyrite in weathered rock."

Furthermore Shawe (1976) states "In weathered rocks as observed in thin sections pyrite has been replaced by 'limonite', but preservation of original pyrite crystal forms and lack of abundant limonite 'wash' or dustlike limonite suggest that the forms of most limonite are indicative of the original forms of pyrite before oxidation. Pyrite (or limonite) in sandstone occurs as isolated interstitial patches as much as 2 millimeters (mm) in diameter enclosing many detrital grains, or as cubes 1 mm across and smaller that are mainly interstitial but that also partially replace detrital grains." Also "limonite pseudomorphs after marcasite have been recognized in vugs in altered-facies sandstone of the Burro Canyon Formation." Shawe (1976) also notes that pyrite is more common below the water table and iron oxides (likely formed by oxidation of pyrite) are more common in the vadose zone. These observations are consistent with the occurrence of and oxidation of pyrite in the formations hosting the perched water at the site as will be discussed in Section 4.

3.2 Contact Descriptions

Lithologic contacts between the Brushy Basin Member of the Morrison Formation, and between the Dakota Sandstone and the overlying soils and/or the Mancos Shale, are described in the Sections 3.2.1 and 3.2.2. Cross-sections through soils based on soil borings installed as part of implementing Phase I of the nitrate CAP are presented and discussed in Section 3.2.3.

3.2.1 Brushy Basin Member/Burro Canyon Formation Contact Elevations

Figure 8 is a contour map of the Burro Canyon Formation/Brushy Basin Member contact generated from perched well, piezometer, DR-series boring data and the locations and elevations of Westwater Seep and Ruin Spring. Figure 8 was generated based on data indicating that only Westwater Seep and Ruin Spring are located at the contact between the Burro Canyon Formation and the Brushy Basin Member (HGC, 2012b). As discussed in HGC (2012b) examination of the area near Cottonwood Seep in July 2010 and re-examination in October 2011 revealed no evidence for a hydraulic connection with the perched zone. The absence of any visible seeps or anomalous vegetation in the Brushy Basin Member east and northeast of Cottonwood Seep is consistent with dry conditions in the upper portion of the Brushy Basin Member.

Figure 8 shows that the erosional Brushy Basin/Burro Canyon contact surface dips generally to the south-southwest and is very irregular in the northeast portion of the site. A paleoridge in the Brushy Basin erosional paleosurface extends from beneath cell 4B to the southwest near abandoned boring DR-18. To the east of this paleoridge, a paleovalley extends from south of cell 4A to the northeast, extending into the vicinity of the northern wildlife ponds. A paleovalley subparallel to the cell 4B paleoridge is also present on the west side of the paleoridge, between the paleoridge and the western mesa margin.

The approximate axes of these and other paleoridges and paleovalleys in the southwest portion of the site are indicated on Figure 8. These features are especially important in this portion of the site due to the generally small saturated thicknesses and the consequently relatively large impacts these features are expected to have on perched water flow in this area.

Other notable features include a paleoridge surrounded by paleovalleys that trend northwest – southeast (rather than northeast – southwest) in the area northeast of the millsite, a paleovalley extending from the area of cell 4B to Westwater Seep, and paleovalleys converging on Ruin Spring.

3.2.2 Mancos Shale/Dakota Contact Elevations

Figures 9 through 11 are elevation contour maps of the top of bedrock (top of the Dakota Sandstone or Mancos Shale [where present]), the top of the Dakota Sandstone, and the top of bedrock showing Mancos thickness. Based on these maps, the top of Dakota and top of bedrock surfaces dip generally to the south-southwest consistent with the general dip of the top of Brushy Basin surface. In the northeast portion of the site these surfaces are generally less irregular than the top of the Brushy Basin surface.

Notable features include a structural high in the top of Dakota and top of bedrock surfaces near tailing cell 4B, and a north-south trending structural high in the top of bedrock surface east to northeast of the tailing cell complex. The latter feature is primarily the result of a ridge-like remnant of the Mancos Shale that reaches thicknesses greater than 30 feet along the axis of the feature.

Structural highs near cell 4B are present in the top of Brushy Basin surface (Figure 8), the top of bedrock (Figure 9), and the top of Dakota (Figure 10) surface. These features are ridge-like in all three surfaces but the paleoridge in the top of Brushy Basin is not coincident with the paleoridge in the top of bedrock and top of Dakota surfaces except in the vicinity of cell 4B. The primary axis of the paleoridge in the Brushy Basin surface extends from MW-33 at the southwest corner of cell 4B through DR-10, MW-21 and DR-18. The axis of the paleoridge in the top of bedrock surface appears to extend from the vicinity of MW-24 (at the southwest corner of cell 1) through MW-33, DR-11, and possibly DR-15 (but is less well-defined near DR-15).

3.2.3 Soils Above Dakota and /or Mancos

Figure 12 depicts the locations of soil borings installed near the ammonium sulfate crystal tanks as part of implementing Phase I of the nitrate CAP (HGC, 2012a). Borings were installed to depths of refusal using a drive-point rig as described in EFRI (2013). The depth of refusal is assumed to represent competent bedrock. Figure 13 depicts soils cross-sections developed from these borings.

Unconsolidated soils consist primarily of silts with interbedded sands and clays. Weathered Mancos Shale was encountered in many of the borings. Detailed logs of all soil borings are provided in EFRI (2013).

Soils present above the Mancos Shale in this portion of the site are dominated by the same finegrained materials typical of other portions of the site. Soil types encountered in borings installed by INTERA (Appendix C) are generally consistent with those found in the vicinity of the ammonium sulfate crystal tanks and other portions of the site.

3.3 Perched Water Elevations, Saturated Thicknesses, and Depths to Water

As discussed in Section 2.1.3, Figure 5 is a contour map of perched water elevations generated from first quarter, 2014 water level data. Figure 5 contains perched well and piezometer water level data, and the elevations of all seeps and springs except Cottonwood Seep (for which there

is no evidence to establish a connection to the perched water system and which is located near the Brushy Basin Member/Westwater Canyon Member contact, indicating that its elevation is not representative of the perched potentiometric surface). Fill-in contours between the 10-foot elevation contours are provided over portions of the site, including the area immediately westsouthwest of the tailings cells to allow detail in an area having relatively flat hydraulic gradients.

Figure 5 was generated assuming that each seep or spring (except Cottonwood Seep) is a known discharge point for perched water and that the elevation of the seep or spring is representative of the elevation of perched water at that location (HGC, 2010e). As discussed in Section 2.1.4 this may not be appropriate for seeps/springs that are dry for portions of the year. Figure 14 shows the saturated thicknesses of the perched zone based on first quarter, 2014 water level data.

Figure 15 shows depths to water as of the first quarter of 2014. Depths to perched water range from approximately 29 feet below top of casing (btoc) northeast of the tailings cells (at TWN-2) to approximately 117 feet btoc at the southwestern margin of tailings cell 3. Prior to cessation of water delivery to the northern wildlife ponds the shallowest depths to water were encountered in piezometers and wells near these ponds. Saturated thicknesses range from approximately 86 feet at MW-19 near the northern wildlife ponds to less than 5 feet in the southwest portion of the site, downgradient of the tailings cells. A saturated thickness of approximately 2 feet occurs in well MW-34 along the south dike of tailings cell 4B, and the perched zone has been consistently dry at MW-33 located at the southwest corner of cell 4B, and at MW-21 located south-southwest of cell 4B. Both are located on a structural high in the top of Brushy Basin Member surface (Figure 8).

3.4 Interpretation of Cross-Sections

Lithologic and soils cross-sections prepared for various portions of the site are discussed in the following Sections. In general, the lithologies encountered in the borings used to construct the cross-sections are consistent with the literature and with past investigations at the site (prior to TITAN, 1994).

3.4.1 Central and Northeast Areas

Figures 16A, 16B and 17 are lithologic cross-sections in the central to northeast portions of the site, as shown on Figure 1A. Figure 16A is a northeast-southwest oriented cross-section (NE-SW) extending from MW-3 to TWN-12. Figure 16B is a parallel cross section (NE2-SW2) extending from TWN-18 to TWN-19. Figure 17 is a northwest-southeast cross-section (NW-SE) extending from TWN-7 to Piez-3. Figures 16A, 16B, and 17 indicate site features located near the cross-sections.

These cross-sections indicate that the top of Brushy Basin surface is irregular in the northeast portion of the site and that, as discussed in Sections 3.1.2.1 and 3.1.2.2, the Burro Canyon Formation and Dakota Sandstone contain shale/claystone and conglomerate interbeds of varying thickness and continuity. Where poorly indurated, coarser sand and conglomeratic horizons are expected to be relatively permeable, shale/claystone horizons are expected to be at least partial barriers to perched groundwater flow, and where present in the vadose zone, to represent at least partial barriers to downward percolation of recharge. That local saturated conditions have not been encountered above shale/claystone horizons during drilling within the Dakota Sandstone and Burro Canyon Formations suggests that recharge rates over most of the site are generally low, except near unlined ponds or surface depressions, or other areas having enhanced recharge due to their locations within drainages or due to relatively flat, poorly drainable topography.

The perched water table surface is relatively elevated in the vicinities of the wildlife ponds and in the vicinity of the historical pond near TWN-2 (Figure 1B). As will be discussed in Section 3.5.2, the persistently high water level at TWN-2 likely results from low permeability and possibly enhanced recharge in the vicinity of TWN-2 due to graded areas of the millsite having relatively flat topography and poor runoff.

3.4.2 Southwest Area

Figures 18 and 19 are cross-sections showing the hydrogeology of the perched zone in the area southwest of the tailings cells located as shown in Figure 1A. Figure 18 provides west-east cross-sections (W-E and W2-E2) across the area immediately west and southwest of cell 4B. Figure 19 is a south-north cross-section (S-N) from the south dike of cell 4B to Ruin Spring. Cross-sections W-E and S-N are oriented approximately parallel to perched water flow and W2-E2 is oriented roughly perpendicular to perched water flow. Except for abandoned DR-series borings, water levels in the cross sections are based on first quarter, 2014 data. Water levels for abandoned DR-series piezometers have not changed significantly between the third quarter of 2011 and the first quarter of 2014 (as shown in Figure 20) suggesting that second quarter, 2011 water levels for abandoned borings are likely representative of current conditions.

As shown in cross-section W-E in Figure 18 (and in Figure 14) the saturated thickness of the perched zone in the southwest area of the site varies from negligible to more than 20 feet. The variable saturated thickness has implications regarding the flow of perched water to known discharge points Westwater Seep and Ruin Spring. Perched water moving downgradient from the area of the tailings cells westward toward abandoned boring DR-2 must pass through a region of low saturated thickness occupied by DR-6 and DR-7 (Figures 5, 14 and 18). This implies (by

Darcy's Law) that some downgradient areas having larger saturated thicknesses must receive local recharge from precipitation because the water supplied by lateral perched flow is inadequate to maintain the large saturated thicknesses in areas near sinks such as Westwater Seep and Ruin Spring.

Two areas of relatively large saturated thickness that are downgradient of areas of small saturated thickness are of particular interest: the area near DR-2 (abandoned) and DR-5 located west of the area near DR-6 and DR-7 as shown in Figure 18 (cross-section W-E), and the area near DR-25 located south of the area near MW-20 as shown in Figure 19 (cross-section S-N). Each of the above areas of larger saturated thickness is downgradient of the corresponding area of small saturated thickness, and each downgradient area of larger saturated thickness is near a perched water sink. The primary known perched groundwater sinks downgradient of DR-2 abandoned) and DR-5 are Westwater Seep to the northeast and the paleovalley leading south to Ruin Spring (Figures 8 and 14). The primary sink near abandoned boring DR-25 is Ruin Spring. Lateral flow from areas of larger saturated thickness that may exist to the east of cross-section S-N may supply the water needed to maintain the relatively large saturated thickness near DR-25. However, the reported temporary increases in flow from Ruin Spring (and Westwater Seep) after precipitation events (HGC, 2010e) are problematic unless flow is temporarily enhanced by local recharge.

As discussed in HGC (2010e), enhanced local recharge is likely near the mesa margins where weathered Dakota Sandstone and Burro Canyon Formation are exposed by erosion (Figure E.2, Appendix E). Logs at DR-2 and DR-5 show only a few feet of unconsolidated material above the Dakota Sandstone and visual inspection of the mesa near DR-2 (abandoned) and DR-5 shows that weathered Dakota is often exposed (consistent with the geology presented in Dames and Moore (1978). Due to the thin veneer of alluvium overlying the Dakota Sandstone, and thin or absent Mancos Shale, recharge near DR-2 and DR-5 (cross-section W-E, Figure 18) will be facilitated. Similarly, in the area near abandoned boring DR-25 and Ruin Spring, recharge will be facilitated by the thinness or absence of the Mancos Shale and the surface exposure of the Dakota Sandstone and Burro Canyon Formation between DR-25 and Ruin Spring (cross-section S-N, Figure 19).

3.5 Perched Water Occurrence and Flow

Description of the occurrence and flow of perched water at the site focuses on three general areas: 1) the nitrate investigation area, 2) the area of the chloroform plume, and 3) areas beneath and downgradient of the tailing cells, as per Sections 3.5.2, 3.5.3, and 3.5.4 respectively.

3.5.1 Overview

As discussed in Section 2.1.3, perched groundwater at the site occurs primarily within the Burro Canyon Formation as well as the overlying Dakota sandstone where saturated thicknesses are greater. Flow onto the site occurs as underflow from areas northeast of the millsite where perched zone saturated thicknesses are generally greater. Flow exits the Mill property in seeps and springs to the east, west, southwest and southeast. Any flow that does not discharge in seeps or springs presumably exits as underflow to the southeast. Perched water flow is generally from northeast to south-southwest across the site.

3.5.1.1 General Site Flow Pattern

First quarter 2014 perched water elevations (Figure 5) show the typical south-southwesterly flow pattern at the site. The historic water level contour maps in Appendix D demonstrate the persistence of the generally southwesterly perched flow pattern

As discussed in Section 2.1.3, beneath and downgradient of the tailings cells, on the west side of the site, perched water flow is south-southwest to southwest. On the eastern side of the site perched water flow is more southerly. Perched zone hydraulic gradients currently range from a maximum of approximately 0.075 feet per foot (ft/ft) east of tailings cell 2 (near the eastern portion of the chloroform plume) to approximately 0.0022 ft/ft in the northeast corner of the site (between TWN-19 and TWN-16. Hydraulic gradients in the southwest portion of the site are typically close to 0.01 ft/ft, but the gradient is less than 0.005 ft/ft west/southwest of tailings Cell 4B, between Cell 4B and DR-8. The overall average site hydraulic gradient, between TWN-19 in the extreme northeast to Ruin Spring in the extreme southwest, is approximately 0.011 ft/ft.

Perched groundwater discharges in springs and seeps along the mesa margins. These features are located along Westwater Creek Canyon and Cottonwood Canyon to the west-southwest of the site, and along Corral Canyon to the east of the site, where the Burro Canyon Formation is exposed. Based on the data presented in Figure 5, the discharge points located most directly downgradient of the tailings cells are Westwater Seep and Ruin Spring. Westwater Seep is located approximately 2,200 feet west of the tailings cell complex at the site; Ruin Spring is located approximately 9,400 feet south-southwest of the tailings cell complex at the site (Figure 1B).

Dry areas beneath cell 4B and southwest of cell 4B (south of MW-21) affect perched water flow and are defined in Figure 5 by areas where the kriged contact between the Burro Canyon Formation and the Brushy Basin Member is higher in elevation than the kriged perched water elevation. The dry areas shown in Figure 5 encompass abandoned dry well MW-16, dry well MW-21, dry well MW-33, and abandoned dry boring DR-18. The areas defined by the heavy yellow dashed contour lines have saturated thicknesses less than 5 feet. As shown in Figure 5 and southwest area cross-sections (Figures 18 and 19), a large portion of the perched zone west and southwest (downgradient) of the tailings cells has a saturated thickness less than 5 feet. This zone has been persistent based on measurements since the third quarter of 2011. An apparent perched water divide exists in the vicinity of DR-2 (abandoned) and DR-5 (Figure 5). Perched water north of this apparent divide is expected to flow primarily northeast toward Westwater Seep and perched water south of this apparent divide is expected to flow primarily south toward Ruin Spring (as will be discussed in Section 3.5.4).

Figure 14 shows the axes of paleoridges and paleovalleys in the Brushy Basin Member erosional paleosurface and posted first quarter, 2014 saturated thicknesses. As indicated, paleoridges in the southwest area of the site are associated with dry areas and with areas of low saturated thicknesses; paleovalleys are associated with areas of higher saturated thicknesses. Westwater Seep and Ruin Spring are located in paleovalleys. The average saturated thickness based on measurements at MW-35, DR-7, and DR-6, which are the points closest to a line between the southeast portion of tailings Cell 3 and Westwater Seep, is approximately 5 feet. The average saturated thickness based on measurements at MW-37, DR-13, MW-3, MW-20, and DR-21, which lay close to a line between the southeast portion of tailings cell 4B and Ruin Spring, is approximately 9 feet.

Perched water mounding associated with the wildlife ponds locally changes the generally southerly perched water flow patterns. For example, northeast of the Mill site, mounding associated with the northern wildlife ponds results in locally northerly flow near PIEZ-1. Mounding also causes the hydraulic gradient to be more westerly west of the ponds and more easterly east of the ponds. The impact of the mounding associated with the northern ponds, to which water has not been delivered since March 2012, is diminishing and is expected to continue to diminish as the mound decays due to reduced recharge.

3.5.1.2 Influence of Pumping and Wildlife Pond Seepage on Flow and Dissolved Constituent Concentrations

Figures 1A and 1B show the locations of chloroform and nitrate pumping wells at the site. MW-4, MW-26, TW4-4, TW4-19, and TW4-20 are chloroform pumping wells, and TWN-2, TW4-22, TW4-24, and TW4-25 are nitrate pumping wells. Figure 21 is a map showing kriged first quarter 2014 perched water levels, the extents of the nitrate and chloroform plumes at the site, and inferred perched water flow paths. Figure 22 is a detail map showing the locations of pumping

wells, first quarter, 2014 kriged water levels, and inferred capture zones associated with the pumping wells.

As described in HGC (2012a) the nitrate pumping system, which became operational in the first quarter of 2013, is designed to (eventually) establish hydraulic capture of the nitrate plume upgradient (north of) TW4-22 and TW4-24. MW-30 and MW-31, located at the downgradient edge of the plume, are not pumped to minimize the potential for downgradient chloroform migration As described in HGC (2007), the chloroform pumping system, which became operational in 2003 with the pumping of MW-4, TW4-19, and MW-26 (TW4-15), and later enhanced by the addition of TW4-20 in 2005 and TW4-4 in 2010, is designed primarily to reduce mass in upgradient portions of the plume where saturated thicknesses, concentrations, and well productivities are higher. Mass reduction is thereby maximized, the source of chloroform to downgradient areas cut off, and natural attenuation facilitated.

Local depression of the perched water table occurs near chloroform pumping wells MW-4, TW4-4, TW4-19, TW4-20, and MW-26 (Figure 22). Pumping of chloroform wells MW-4 and TW4-19 began in 2003 (HGC, 2004). Well-defined cones of depression are evident near all chloroform pumping wells except TW4-4, which began pumping in the first quarter of 2010, and was the last chloroform well to be brought on-line. Although operation of chloroform pumping well TW4-4 has depressed the water table in the vicinity of TW4-4, a well-defined cone of depression is not clearly evident. The lack of a well-defined cone of depression near TW4-4 likely results from 1) variable permeability conditions in the vicinity of TW4-4, and 2) persistent relatively low water levels at adjacent well TW4-14, as will be discussed in Section 3.5.3.

Local depression of the perched water table also occurs near nitrate pumping wells TW4-22, TW4-24, TW4-25, and TWN-2 (Figure 22), which are operated to reduce nitrate mass in the perched groundwater as per the nitrate CAP (HGC, 2012a). Cones of depression are in the process of development in the vicinities of nitrate pumping wells which were brought on-line in the first quarter of 2013. Relatively slow development of capture zones is expected due to generally low permeability within the nitrate plume.

The hydraulic effects of the chloroform and nitrate pumping systems overlap. Figure 22 shows the inferred capture of both chloroform and nitrate pumping systems as of the first quarter, 2014. Capture zones are calculated by hand based on the kriged water level contours following the rules for flow nets. From each pumping well, stream tubes that bound the capture zone are reverse-tracked, and perpendicularity is maintained between each stream tube and the intersected kriged water level contours.

Recharge from the wildlife ponds has impacted perched water elevations and flow directions at the site by creating perched groundwater mounds as discussed in Section 3.5.1. Furthermore, the March 2012 cessation of water delivery to the northern ponds, which are generally upgradient of the nitrate and chloroform plumes at the site, has resulted in changing conditions that are expected to impact constituent concentrations and migration rates within the plumes. Specifically, past recharge from the ponds has helped limit many constituent concentrations within the plumes by dilution while the associated groundwater mounding has increased hydraulic gradients and contributed to plume migration. Since use of the northern wildlife ponds ceased in March 2012, the reduction in recharge and decay of the associated groundwater mound are expected to increase many constituent concentrations within the plumes while reducing hydraulic gradients and rates of plume migration.

The impacts associated with cessation of water delivery to the northern ponds are expected to propagate downgradient (south and southwest) over time. Wells close to the ponds are generally expected to be impacted sooner than wells farther downgradient of the ponds. Therefore, constituent concentrations are generally expected to increase in downgradient wells close to the ponds before increases are detected in wells farther downgradient of the ponds. Although such increases are anticipated to result from reduced dilution, the magnitude and timing of the increases are difficult to predict due to the complex permeability distribution at the site and factors such as pumping and the rate of decay of the perched groundwater mound. The potential exists for some wells completed in higher permeability materials to be impacted sooner than some wells completed in lower permeability materials even though the latter may be closer to the ponds.

Localized increases in concentrations of constituents such as chloroform and nitrate within and near the chloroform plume, and of nitrate and chloride within and near the nitrate plume, may occur even when these plumes are under control. Ongoing mechanisms that can be expected to increase constituent concentrations locally as a result of reduced wildlife pond recharge include but are not limited to:

- 1. Reduced dilution the mixing of low constituent concentration pond recharge into existing perched groundwater will be reduced over time.
- 2. Reduced saturated thicknesses dewatering of any higher permeability layers receiving primarily low constituent concentration pond water will result in wells intercepting these layers receiving a smaller proportion of the low constituent concentration water.

The combined impact of the above two mechanisms may be especially evident at chloroform pumping wells MW-4, MW-26, TW4-4, TW4-19, and TW4-20; nitrate pumping wells TW4-22, TW4-24, TW4-25, and TWN-2; and non-pumped wells adjacent to the pumped wells. The
overall impact is expected to be generally higher constituent concentrations in these wells over time until mass reduction resulting from pumping and natural attenuation eventually reduces concentrations. Short-term changes in concentrations at pumping wells and wells adjacent to pumping wells are also expected to result from changes in pumping conditions.

3.5.2 Nitrate Investigation Area

The extent of the nitrate plume addressed by the nitrate CAP (HGC, 2012a) and referred to as the 'nitrate plume' is shown in Figure 21. Figure 21 also displays kriged first quarter, 2014 perched water level contours and inferred flow paths and shows the extent of the chloroform plume which overlaps the nitrate plume in the vicinity of TW4-22. Nitrate exceeding 10 mg/L also occurs to the southeast of the plume in relatively isolated pockets (near TW4-10, TW4-12, TW4-18, and TW4-27). As discussed in HGC (2014), this southeastern nitrate is attributed to sanitary leach field discharge associated with the chloroform plume and/or with former cattle ranching operations at the site. Nitrate exceeding 10 mg/L at far down gradient location MW-20 is also likely associated with former cattle ranching operations. The potential for cattle to contribute nitrate to soil is discussed in McFarland *et al* (2006). Elevated nitrate in soil can then act as a source to groundwater.

Perched groundwater flow within the area of the nitrate plume varies from southwest to westsouthwest. The generally southwesterly gradient typical of the majority of the site is influenced by past recharge from the northern wildlife ponds, and elevated water levels in the vicinities of wells TWN-2 and TWN-3. TWN-2 is within the footprint of the historical pond and TWN-3 is immediately east of the footprint of the pond, as shown in Figure 1B. Recharge from the northern wildlife ponds, located immediately northeast of the nitrate plume, caused a shift in gradient in the northern portion of the plume from southwesterly to west-southwesterly (compare Appendix D 1990 and 1994 water level maps with Figure 21). The persistently high water level at TWN-2, which has functioned as a nitrate pumping well since the first quarter of 2013, likely results from low permeability and possibly enhanced recharge in the vicinity of TWN-2 due to graded areas of the millsite having relatively flat topography and poor runoff.

Cones of depression associated with nitrate pumping wells TW4-22, TW4-24, TW4-25, and TWN-2, have been developing since initiation of pumping during the first quarter of 2013. Hydraulic capture associated with these wells is developing slowly due to low permeability conditions. That sufficient capture will eventually develop is indicated by calculations presented in EFRI (2014a) showing that nitrate pumping exceeds pre-pumping flow through the nitrate plume by a factor between approximately 1.2 and 2.5.

Water level patterns near nitrate pumping wells are expected to be influenced by the presence of, and the decay of, the groundwater mound associated with the northern wildlife ponds, and by the persistently low water level elevation at TWN-7. Chloroform and nitrate pumping wells interact. The long term interaction between nitrate and chloroform pumping systems will require more data to be collected as part of routine monitoring.

Criteria regarding control and potential migration of the nitrate plume are detailed in the nitrate CAP (HGC, 2012a). As stated in the CAP, MW-5, MW-11, MW-30, and MW-31 are located downgradient of TW4-22 and TW4-24. MW-30 and MW-31 are within the nitrate plume near its downgradient edge and MW-5 and MW-11 are outside and downgradient of the plume. Per the CAP, hydraulic control based on concentration data is considered successful if the concentrations of nitrate in MW-30 and MW-31 remain stable or decline, and concentrations of nitrate in downgradient wells MW-5 and MW-11 do not exceed the 10 mg/L standard. Based on these criteria, the nitrate plume is under control.

The plume has not migrated downgradient to MW-5 or MW-11 because nitrate has not been detected at MW-11 and has been detected at concentrations less than 1 mg/L at MW-5. Nitrate concentrations in both MW-30 and MW-31 at the downgradient edge of the plume have been relatively stable, demonstrating that plume migration is minimal or absent (EFRI, 2014a).

Chloride has been relatively stable at MW-30 but appears to be increasing at MW-31 (EFRI 2014a). The apparent increase in chloride and stable nitrate at MW-31 suggests a natural attenuation process that is affecting nitrate but not chloride. A likely process that would degrade nitrate but leave chloride unaffected is reduction of nitrate by pyrite. The likelihood of this process in the perched zone is discussed in HGC (2012c).

Understanding of perched water level behavior in the area northeast of the millsite was enhanced by the installation of TWN-series wells northeast of the nitrate plume in 2009. Prior to the installation of these wells, upgradient information was limited to that provided by MW-1, MW-18, MW-19, PIEZ-1, and PIEZ-2. As shown in Figure 1B, nitrate wells TWN-5, TWN-8, TWN-9, TWN-10, TWN-11, TWN-12, TWN-13, TWN-15, and TWN-17 have been abandoned as per the nitrate CAP.

In general, water level data provided by these wells and existing wells and piezometers in the northeast portion of the Mill property indicated that perched water flow is to the southwest. Data from many of these wells helped to better define the extent of the perched groundwater mound resulting from former recharge at the northern wildlife ponds. Figure 23 is a water level contour map from the fourth quarter, 2011 constructed prior to both TWN well abandonment and cessation of water delivery to the northern wildlife ponds.

3.5.3 Area of Chloroform Plume

As noted in Section 3.5.1.2, the area of the chloroform plume is shown in Figure 21. Water level and concentration data presented in this Section are from EFRI (2014b) unless otherwise indicated.

Perched groundwater flow within the area of the chloroform plume has been generally southerly to southwesterly. As discussed in HGC (2007) the chloroform plume resulted from disposal of laboratory wastes to the abandoned scale house and former office sanitary leach fields. Disposal took place in the early years of Mill operation before the tailings cells were functional. Laboratory wastes have been disposed to tailings cells since cells became operational circa 1980.

As discussed in HGC (2007), the abandoned scale house leach field accepted laboratory wastes prior to the former office leach field. The abandoned scale house leach field was located immediately north-northwest of well TW4-18 (Figure 1B). Historic perched water flow in this area was to the south or south-southeast (Appendix D). Chloroform disposed in the abandoned scale house leach field migrated primarily southerly to the vicinity of well MW-4 where it was detected in 1999. Hydraulic gradients in this area were enhanced by recharge from the northern wildlife ponds located north of MW-4.

The former office leach field is located in the immediate vicinity of well TW4-19 (a chloroform pumping well) and immediately northeast of tailings cell 2 (and chloroform pumping well TW4-20) [Figure 1B]. Perched water flow in this area was historically southwest (Appendix D), and hydraulic gradients have been enhanced by recharge from the northern wildlife ponds (located to the northeast).

Once chloroform pumping began in 2003 and nitrate pumping began in 2013, changes to the flow regime formerly dominated by wildlife pond recharge in the vicinity of the chloroform plume began to change locally under the influence of the pumping. Well defined cones of depression are evident in the vicinity of all chloroform pumping wells except TW4-4, which began pumping in the first quarter of 2010. Although operation of chloroform pumping well TW4-4 has depressed the water table in the vicinity of TW4-4, a well-defined cone of depression is not clearly evident.

As discussed in Section 3.5.1.2 variable permeability conditions likely contribute to the lack of a well-defined cone of depression near chloroform pumping well TW4-4. Changes in water levels at wells immediately south of TW4-4 resulting from TW4-4 pumping are expected to be muted because TW4-4 is located at a transition from relatively high to relatively low permeability conditions south (downgradient) of TW4-4. The permeability of the perched zone at TW4-6 and

TW4-26 (and recently installed well TW4-29) is approximately two orders of magnitude lower than at TW4-4 (Table 1). Any drawdown of water levels at wells immediately south of TW4-4 resulting from TW4-4 pumping is also difficult to determine because of the general, long-term increase in water levels in this area due to recharge from the wildlife ponds.

Water levels at TW4-4 and TW4-6 increased by nearly 2.7 and 2.9 feet, respectively, between the fourth quarter of 2007 and the fourth quarter of 2009 (just prior to the start of TW4-4 pumping) at rates of approximately 1.2 feet/year and 1.3 feet/year, respectively. However, the increase in water level at TW4-6 has been reduced since the start of pumping at TW4-4 (first quarter of 2010) to approximately 0.5 feet/year suggesting that TW4-6 is within the hydraulic influence of TW4-4 (Figure 24). Water level elevations at these wells are eventually expected to be influenced by cessation of water delivery to the northern wildlife ponds as discussed above. Recharge from the southern wildlife pond is expected to continue to have an effect on water levels near TW4-4, but the effects related to recharge from the northern ponds are expected to diminish over time as water is no longer delivered to the northern ponds.

The lack of a well-defined cone of depression at TW4-4 is also influenced by the persistent, relatively low water level at non-pumping well TW4-14, located east of TW4-4 and TW4-6. For the first quarter of 2014, the water level at TW4-14 (approximately 5528.8 feet ft amsl) is approximately 11 feet lower than the water level at TW4-6 (approximately 5539.7 ft amsl) and 15 feet lower than at TW4-4 (approximately 5544.1 ft amsl) even though TW4-4 is pumping.

Well TW4-27 (installed south of TW4-14 in the fourth quarter of 2011) has a static water level of approximately 5527.6 ft amsl, similar to TW4-14 (approximately 5528.8 ft amsl). TW4-27 was positioned at a location considered likely to detect any chloroform present and/or to bound the chloroform plume to the southeast and east (respectively) of TW4-4 and TW4-6. Groundwater data collected since installation indicates that TW4-27 does indeed bound the chloroform plume to the southeast and east of TW4-4 and TW4-6 (respectively), however chloroform exceeding 70 μ g/L has been detected at recently installed temporary perched well TW4-29 (located south of TW4-27) since the second quarter of 2013.

Prior to the installation of TW4-27, the persistently low water level at TW4-14 was considered anomalous because it appeared to be downgradient of all three wells TW4-4, TW4-6, and TW4-26, yet chloroform was not detected at TW4-14. Chloroform had apparently migrated from TW4-4 to TW4-6 and from TW4-6 to TW4-26, which suggested that TW4-26 was actually downgradient of TW4-6, and TW4-6 was actually downgradient of TW4-4, regardless of the flow direction implied by the low water level at TW4-14. The water level at TW4-26 (5538.5

feet amsl) is, however, lower than water levels at adjacent wells TW4-6 (5539.7 feet amsl), and TW4-23 (5542.4 feet amsl).

Hydraulic tests indicate that the permeability at TW4-27 is an order of magnitude lower than at TW4-6 and three orders of magnitude lower than at TW4-4 (Table 1). The similar water levels at TW4-14 and TW4-27, and the low permeability estimate at TW4-27 suggest that both wells are completed in materials having lower permeability than nearby wells. The low permeability condition likely reduces the rate of long-term water level increase at TW4-14 and TW4-27 compared to nearby wells, yielding water levels that appear anomalously low as will be discussed in Section 3.8. This behavior is consistent with hydraulic test data collected from recently installed wells TW4-29, TW4-30, TW4-31, and new wells TW4-33 and TW4-34, which indicate that the permeability of these wells is one to two orders of magnitude higher than the permeability of TW4-27 (HGC, 2014). The low permeability at TW4-14 and TW4-27 is expected to retard the transport of chloroform to these wells (compared to nearby wells). First quarter, 2014 chloroform concentrations at TW4-26 and TW4-27 are 1.4 ug/L and non-detect, respectively and both wells are outside the chloroform plume.

Although chloroform exceeding 70 µg/L was detected at recently installed well TW4-29 (located south of TW4-27) and at new well TW4-33 (located between TW4-4 and TW4-29), chloroform was not detected at recently installed well TW4-30, located east and downgradient of TW4-29, nor at recently installed well TW4-31, located east of TW4-27, nor at new well TW4-34, located south and cross-gradient of TW4-29. The detections at TW4-29 and TW4-33 suggest that chloroform migrated southeast from the vicinity of TW4-4 to TW4-33 then TW4-29 in a direction nearly cross-gradient with respect to the direction of groundwater flow implied by the groundwater elevations. Such migration is possible because the water level at TW4-29, TW4-30, and TW4-31 are one to two orders of magnitude lower than the conductivity of TW4-27 (Table 1). The permeability and water level distributions are generally consistent with the apparent nearly cross-gradient migration of chloroform around the low permeability zone defined by TW4-14 and TW4-27.

Data from existing, recently installed and new wells indicate that:

- Chloroform exceeding 70 µg/L at TW4-29 is bounded by concentrations below 70 µg/L at wells TW4-26, TW4-27, TW4-30 and TW4-34. TW4-30 is downgradient of TW4-29; TW4-26 is upgradient of TW4-29; and TW4-27 and TW4-34 are cross-gradient of TW4-29.
- 2. Chloroform concentrations at TW4-33 that are lower than concentrations at TW4-29, and the likelihood that a pathway exists from TW4-4 to TW4-33 to TW4-29, suggests that

concentrations in the vicinity of TW4-33 were likely higher prior to initiation of TW4-4 pumping, and that lower concentrations currently detected at TW4-33 are due to its closer proximity to TW4-4.

Furthermore, TW4-4 pumping is likely to reduce chloroform at both TW4-33 and TW4-29 by cutting off the source. The decrease at TW4-33 is expected to be faster than at TW4-29 because TW4-33 is in closer proximity to TW4-4 pumping. Such behavior is expected by analogy with the decreases in chloroform concentrations that occurred at TW4-6 and TW4-26 once TW4-4 pumping began (HGC, 2014).

Chloroform exceeding 70 ug/L was detected at TW4-8 during the first quarter, 2014 sampling event. A new well (shown in Figure 1B) is therefore planned immediately to the east of TW4-8. To ensure that chloroform in the vicinity of TW4-29 is completely bounded, a new well is also planned to the south of TW4-30 (Figure 1B).

3.5.4 Beneath and Downgradient of Tailings Cells

More than 30 years of groundwater monitoring beneath and downgradient of the tailings cells indicates that the tailings cells have not impacted groundwater as discussed in Section 2. In the event that seepage from tailings cells should impact groundwater at a future date, the likely pathways to known discharge points Westwater Seep and Ruin Spring are calculated in Section 3.5.4.1. Perched zone water balances within the areas near DR-2 (abandoned) and DR-5, and flow within the vicinities of Westwater Seep and Ruin Spring are calculated in Sections 3.5.4.2 and 3.5.4.3.

3.5.4.1 Overview

Figure 25 is a water level contour map showing inferered pathlines from various locations on the west or south (downgradient) dikes of the tailings cells toward known discharge points Westwater Seep and Ruin Spring. These pathlines show the primary expected directions of perched water flow. As indicated, perched water passing beneath the west dike of cell 4B has the potential to travel to either of known discharge points Westwater Seep or to Ruin Spring because of an apparent groundwater divide in the vicinity of DR-2 (abandoned) and DR-5. Perched water north of this apparent divide is expected to flow primarily northeast to Westwater Seep and perched water south of this apparent divide is expected to flow primarily south toward Ruin Spring. The presence of this apparent divide is consistent with enhanced local recharge.

The path to Ruin Spring from the area south of the apparent divide is sub-parallel to the western rim of the mesa. The path is generally along a paleovalley between the mesa rim and the dry portion of the Brushy Basin Member paleoridge defined by MW-21 and abandoned boring DR- 18. Perched water passing beneath the south dike of Cell 4B is expected to travel southsouthwest to Ruin Spring, to the east of the dry paleoridge defined by MW-21 and abandoned boring DR-18.

As discussed previously, the data suggest that flow in the southwest portion of the site is influenced by paleotopography to a greater extent than in other areas of the site due to the prevalence of small saturated thicknesses.

As discussed in Section 2.1.4, there is no evidence to hydraulically connect Cottonwood Seep to the perched water system; therefore no inferred flow pathway depicted in Figure 25 leads to Cottonwood Seep. Section 3.6.3 posits a potential pathway that may hypothetically exist between the perched zone near DR-8 and Cottonwood Seep for purposes of travel time calculations, and to allow for the possibility that an as yet unidentified pathway may exist.

3.5.4.2 Water Balance Near DR-2 and DR-5

Enhanced recharge south/southwest of Westwater Seep near DR-2 (abandoned) and DR-5 is likely needed to maintain the relatively large saturated thicknesses there, considering the slow rate of perched water flow into that area via the zone of small saturated thickness and the presence of known sinks to the northeast (Westwater Seep) and to the south (paleovalley leading to Ruin Spring).

Because the water columns in most piezometers penetrating the area of low saturated thicknesses were inadequate for hydraulic testing, only one estimate of hydraulic conductivity was obtained, at DR-10. As shown in Table 1, the KGS method hydraulic conductivity estimates at DR-10 (located within the area of low saturated thickness) were one to two orders of magnitude lower than at DR-5 and DR-9, located west of the area of low saturated thickness. Assuming the estimate at DR-10 is representative of the area of low saturated thickness, the transmissivity (the product of hydraulic conductivity and saturated thickness) of the area of low saturated thickness is two to three orders of magnitude lower than for the area of larger saturated thickness to the west (near DR-2, DR-5, and DR-9). Figures 5 and 25 show that the hydraulic gradient in this area is relatively flat, and the gradient does not change significantly across the area of low saturated thickness.

Water flows westward from the area of the tailings cells through the area of low saturated thickness between DR-6 and DR-10 (Figure 25). Using Darcy's Law, and assuming a hydraulic conductivity of 3 x 10^{-6} cm/s (0.0084 feet per day [ft/day], based on the KGS estimate provided for DR-10 in Table 1), an average hydraulic gradient of 0.0057 ft/ft, an average saturated thickness of 2.4 ft, and a width of approximately 1,600 feet (the approximate distance between

DR-6 and DR-10), the rate of perched water flow westward through the area of low saturated thickness is approximately 0.18 cubic feet per day (ft^3/day) or 0.001 gpm.

Water flows out of the area of larger saturated thickness (near DR-2 [abandoned] and DR-5) to the northeast toward known discharge point Westwater Seep and to the south through the paleovalley leading towards known discharge point Ruin Spring. The rate of flow out of this area northeast to Westwater Seep is expected to be smaller than the discharge rate at Westwater Seep which also receives water from the east and northeast. The discharge rate at Westwater Seep is too small for a reliable estimate. However, the rate of flow south through the paleovalley leading towards Ruin Spring can be calculated using the geometric average hydraulic conductivity of 0.0089 ft/day (based on KGS estimates for DR-8, DR-9, and DR-10 in Table 1), an approximate hydraulic gradient of 0.0088 ft/ft, an average saturated thickness of 12 ft, and a width of approximately 2,250 ft (between DR-8 and DR-10), as 2.1 ft³/day, or 0.011 gpm, an order of magnitude larger than the calculated flow into the area. The difference between calculated inflow and outflow is approximately 0.01 gpm.

These calculations indicate that an additional water source is needed to maintain the relatively large saturated thicknesses west of the area of low saturated thickness between DR-6 and DR-10; otherwise Westwater Seep and the paleovalley to the south would drain the area of larger saturated thickness more quickly than water was supplied. The most likely source of additional water is infiltration of precipitation enhanced by the direct exposure of weathered Dakota Sandstone and Burro Canyon Formation, and the thinness or absence of any overlying low permeability materials such as the Mancos Shale. Assuming uniform recharge over an area of approximately 175 acres (the portion of the mesa west of Westwater Seep and north of DR-8 and DR-9), the calculated difference of 0.01 gpm implies a conservatively low recharge rate of 0.0011 inches per year (in/yr). Most of the recharge likely occurs near the mesa rim where the Dakota and Burro Canyon are exposed (Figure E.1 and Figure E.2, Appendix E). Such recharge is expected to be enhanced within drainages where they cross weathered Dakota Sandstone and Burro Canyon Formation.

Furthermore, these calculations indicate that perched water flow in the portion of the site south of Westwater Seep is inadequate as a primary supply to Cottonwood Seep. Perched water flow from the area of the tailings cells through the area of low saturated thickness towards Cottonwood Seep would have to be more than three orders of magnitude higher than calculated above to provide a supply of between 1 and 10 gpm. The required flow would have to be even larger considering that some of the incoming flow is diverted to known discharge point Westwater Seep and to the paleovalley that leads south to known discharge point Ruin Spring. Even if this calculation were performed using the geometric average of the KGS hydraulic

conductivity estimates for all tested DR-series piezometers (approximately 1×10^{-5} cm/s or 0.028 ft/day) rather than the estimate for DR-10 (3×10^{-6} cm/s or 0.0084 ft/day), the calculated rate of flow through the area of low saturated thickness would be approximately 0.0032 gpm, which is still approximately three orders of magnitude lower than the estimated discharge rate of Cottonwood Seep. The inadequacy of the perched zone as the primary supply to Cottonwood Seep lie elsewhere.

3.5.4.3 Water Balance Near Ruin Spring and Westwater Seep

Figure 26 is a map showing inferred perched water pathlines in the immediate vicinities of Ruin Spring and Westwater Seep. These pathlines were used to estimate expected flow rates to these features based on Darcy's Law using local hydraulic gradients, saturated thicknesses, and hydraulic conductivity estimates. Saturated thicknesses posted on Figure 26 were calculated as the difference between kriged first quarter, 2014 water level and top of Brushy Basin Member surfaces.

The area of the perched zone providing flow to Ruin Spring was estimated by assuming the flow is divided between Ruin Spring to the west and Corral Spring to the east. This division coincides approximately with a groundwater divide that extends southwest from the southern wildlife pond toward Ruin Spring, approximately parallel to the southeasternmost flow path depicted on Figure 21. Using the geometric average hydraulic conductivity based on estimates at DR-21, DR-23, and DR-24 (2.2×10^{-5} cm/s or 0.06 ft/day based on KGS analysis of automatically logged slug test data [Table 6]), which are closest to Ruin Spring, an average hydraulic gradient of 0.01 ft/ft, and an average saturated thickness of approximately 18 feet over a width of approximately 7,700 feet (along the 5420 foot elevation contour), yields a rate of perched flow of approximately 83 ft³/day or 0.43 gpm.

The calculated value of 0.43 gpm is slightly less than the estimated average flow for Ruin Spring of 0.5 gpm. Assuming that the difference between the calculated perched water flow and the estimated flow at Ruin Spring (0.07 gpm or 13 ft³/day) is due to local recharge over the area of Figure 26 covered by the inferred flow paths (approximately 420 acres or 18.3 x 10^6 ft²), then the local recharge rate needed to make up the difference is approximately 7.1x 10^{-7} ft/day or 0.0031 in/yr.

Flow to Westwater Seep was estimated in a similar fashion. Hydraulic conductivities used in the calculations are summarized in Table 6. Hydraulic conductivity estimates at DR-5, DR-8, DR-9, DR-10, and DR-11 are based on automatically logged slug test data analyzed using the KGS solution method; estimates at MW-12, MW-14, and MW-15 are based on pumping test analyses reported in TITAN (1994) [Table 4]. Estimates from DR-2, DR-16, and DR-17 are not available

as hydraulic tests could not be performed because these borings were abandoned after surveying and water level collection based on the criteria presented in HGC (2012b). Tests also could not be performed at DR-6 nor DR-7 due to an insufficient water column.

Using a geometric average hydraulic conductivity of 9.8×10^{-6} cm/s (0.027 ft/day), an average hydraulic gradient of 0.013 ft/ft, and an average saturated thickness of 4.5 feet over a width of approximately 3,300 feet, yields a rate of perched flow of approximately 5.2 ft³/day or 0.027 gpm. If the geometric average of the hydraulic conductivities estimated at the four closest wells (MW-23, MW-24, MW-35, and DR-5) is substituted (1.8 x 10^{-5} cm/s [0.05 ft/day]), the calculated rate of perched flow is 9.6 ft³/day or 0.05 gpm. In calculating the latter average, the highest estimate from the MW-24 test was used. Because the flow to Westwater Seep is too small to be reliably measured (as discussed in Section 3.7), either result is considered reasonable.

3.6 Perched Water Migration Rates and Travel Times

Perched water pore velocities and travel times along selected pathlines shown in Figure 27 were calculated using Darcy's Law. The calculated pore velocities and travel times are representative of the movement of a conservative solute assuming no hydrodynamic dispersion. Hydraulic conductivity estimates used for pathlines 1, 2A, and 2B are summarized in Table 7, and for pathlines 3 through 6 in Table 8. Pore velocity estimates are summarized in Table 9.

3.6.1 Nitrate Investigation Area

Perched water pore velocities and travel times were calculated along Path 1 (Figure 27) located within the nitrate plume. Path 1 is approximately 1,250 feet long. Under current conditions, a particle migrating along Path1 would be captured by nitrate pumping well TW4-24.

The average hydraulic conductivity along Path 1 is assumed to be the geometric average of the conductivities of wells located within and immediately upgradient and downgradient of the nitrate plume (wells TWN-2, TWN-3, TWN-18, TW4-21, TW4-22, TW4-24, MW-11, MW-30, and MW-31) as estimated by analyzing automatically logged slug test data using the KGS solution (Table 7). Using a geometric average conductivity of 1.31×10^{-4} cm/s (0.37 ft/day), a hydraulic gradient of 0.028 ft/ft, and a porosity of 0.18, the estimated average pore velocity along Path 1 is approximately 21 ft/yr. This implies that approximately 60 years would be required to traverse Path 1.

Historic hydraulic gradients within the area of the nitrate plume were likely much larger than 0.028 ft/ft during the time prior to Mill construction when the historical pond was active (Figure 1B). The depth to water at TWN-2, located within the former footprint of the historical pond

(Figure 1B), was approximately 16 feet bls prior to its conversion to a nitrate pumping well. The relatively small depth to water is interpreted to result from the relatively low perched zone permeability at TWN-2 (approximately 1.5×10^{-5} cm/s) and slightly elevated recharge by precipitation resulting from the relatively flat topography in that portion of the site. When the historical pond was active and ponded water was present in the vicinity of TWN-2, depths to water were likely negligible as the associated groundwater mound likely reached an elevation just beneath the pond bottom.

Historic water level maps (Appendix D) show that water levels in the vicinities of MW-30 and MW-31, located along the downgradient margin of tailings cell 2, and at the downgradient margin of the nitrate plume, were approximately 5,520 feet amsl. Assuming that the perched water level beneath the historical pond was close to the pond bottom (approximately 5,625 feet amsl), the perched water level at the downgradient edge of cell 2 was approximately 5,520 feet amsl, and the distance between the southern edge of the historical pond and the downgradient edge of cell 2 was approximately 2,200 feet, the historic hydraulic gradient is calculated as approximately 0.048 ft/ft. This estimate is more than four times the overall average site hydraulic gradient of approximately 0.011 ft/ft (calculated between TWN-19 and Ruin Spring).

Using the geometric average hydraulic conductivity of 0.36 ft/day (as discussed above), an historic hydraulic gradient of 0.048 ft/ft, and a porosity of 0.18, the estimated historic pore velocity downgradient of the historical pond is approximately 35 ft/yr, implying that nitrate originating from the historical pond could have migrated to the downgradient edge of cell 2 within 63 years. Assuming the historical pond was active circa 1920, that nitrate was conservative, and ignoring hydrodynamic dispersion, nitrate originating from the historical pond could have reached the vicinities of MW-30 and MW-31 by 1983.

3.6.2 Area of Chloroform Plume

Perched water pore velocities and travel times along Paths 2A and 2B (Figure 27), located within the chloroform plume area, were calculated. Path 2A is approximately 1,200 feet long and path 2B is approximately 1,450 feet long. Under current conditions, a particle migrating along Path 2A would be captured by chloroform pumping well MW-26, and. a particle migrating along Path 2B would be captured by chloroform pumping well MW-4. In evaluating average hydraulic conductivities along these paths, estimates assuming both confined and unconfined conditions were used. This methodology is considered appropriate for this area of the site because of the potential for semi-confined conditions to exist at least locally (HGC, 2004).

The average hydraulic conductivity along Path 2A is assumed to be the geometric average of the conductivities of nearby wells MW-26, TW4-5, TW4-9, TW4-10, and TW4-18 (Table 7). Using

a geometric average conductivity of 4.88×10^{-4} cm/s (1.4 ft/day), a hydraulic gradient of 0.0275 ft/ft, and a porosity of 0.18, the estimated average pore velocity along Path 2A is approximately 76 ft/yr. This pore velocity implies that approximately 16 years would be required to traverse Path 2A.

The average hydraulic conductivity along Path 2B is assumed to be the geometric average of the conductivities of nearby wells MW-4A, TW4-2, TW4-5, TW4-9, and TW4-32 (Table 7) (no data are available for nearby wells TW4-3 or TW4-11.) Estimates based on the early time data for MW-4A (formerly located 10 feet south of MW-4) were used in calculating the averages because these data are considered more representative of conditions in the immediate vicinity of MW-4. Using a geometric average conductivity of 2.53×10^{-4} cm/s (0.71 ft/day), a hydraulic gradient of 0.026 ft/ft, and a porosity of 0.18, the estimated average pore velocity along Path 2B is approximately 38 ft/yr. This pore velocity implies that approximately 38 years would be required to traverse Path 2B.

Historic hydraulic gradients within the northern (upgradient) areas of the eastern portion of the chloroform plume (prior to about 1990) were likely larger and contributed to relatively rapid movement of chloroform from the abandoned scale house leach field (located immediately north of TW4-18) to MW-4 where chloroform was detected in 1999. The assumptions are made that water levels near the abandoned scale house leach field were affected relatively early by wildlife pond seepage (owing to the close proximity of the northern wildlife ponds) and that the water level at TW4-18, which has been relatively stable since installation in 2002, is representative of the water level at the leach field circa 1980. Based on these assumptions and the historic water level maps provided in Appendix D, the hydraulic gradient between the abandoned scale house leach field and MW-4 was approximately 0.048 ft/ft in 1990 and approximately 0.029 ft/ft in 1999, averaging 0.038 ft/ft. This is more than three times the overall average site hydraulic gradient of approximately 0.011 ft/ft (calculated between TWN-19 and Ruin Spring) and is approximately the same as the current hydraulic gradients at the leading edge of the southeastern portion of the chloroform plume.

Using a geometric average hydraulic conductivity of 1.1 ft/day (Table 3) based on estimates from wells MW-4A, TW4-5, TW4-9, TW4-10, and TW4-18 (located near a line connecting MW-4 with the abandoned scale house leach field), a hydraulic gradient of 0.038 ft/ft, and a porosity of 0.18, and ignoring hydrodynamic dispersion, the calculated average pore velocity prior to 1999 was approximately 84 ft/yr. This is sufficient for chloroform to have migrated from the abandoned scale house leach field to MW-4 between 1978 and 1999. This calculation implies that chloroform could have migrated nearly to TW4-4 by 1999.

3.6.3 Beneath and Downgradient of Tailings Cells

Estimated times for a hypothetical conservative solute originating from the tailings cells and migrating downgradient to known discharge points Westwater Seep and Ruin Spring are calculated in the following Sections. Because the hypothetical conservative solute is assumed to originate from the tailings cells, the time for the solute to migrate downward from the base of a tailings cell to the perched water must be taken into account. Vadose zone travel times are estimated in Section 3.6.3.1. Total travel times are estimated in Section 3.6.3.2.

3.6.3.1 Vadose Zone

Depths to perched water near tailings cell 2 vary from approximately 60 feet bloc near the northeast (upgradient) corner of the cell to approximately 114 feet bloc at the northwest corner of the cell. Depths to water near tailings cell 3 vary from approximately 67 feet bloc near the northeast (upgradient) corner of the cell to approximately 117 feet bloc at the southwest (downgradient) corner of the cell. Depths to water near tailings cells 4A and 4B vary from approximately 73 feet bloc near the northeast (upgradient) corner of the cell. Depths to water near tailings cells 4A and 4B vary from approximately 73 feet bloc near the northeast (upgradient) corner of cell 4A to approximately 114 feet bloc at the southern (downgradient) margin of cell 4B. The average depth to water near cell 2 is approximately 73 feet bloc; near cell 3 approximately 90 feet bloc; and near cells 4A and 4B approximately 94 feet bloc. Because the cells are installed a maximum of approximately 25 feet below grade, the average depth to perched water from the base of cell 2 is approximately 48 feet; beneath cell 3 approximately 65 feet; and beneath cells 4A and 4B approximately 69 feet.

Any seepage from the cell liners would have to travel downward through approximately 48 feet of vadose materials to impact perched water beneath cell 2; through approximately 65 feet to impact perched water beneath cell 3; and through approximately 69 feet to impact perched water beneath cells 4A and 4B.

Knight-Piésold (1998) estimated a maximum volumetric seepage rate for tailings cell 3 based on cell construction and liner characteristics, of approximately 80 cubic feet per day (ft/day) or 0.42 gpm over the entire cell. Most of this seepage was estimated to be via diffusion through the liner. This rate was estimated to decrease over time as the cell desaturates once the final cover is emplaced. Assuming a cell footprint of 3.38×10^6 ft², this maximum rate is equivalent to 2.37 x 10^{-5} ft/day or 0.0086 ft/yr.

The average saturation expected in vadose bedrock beneath the tailings cells is approximately 20% based on saturations measured in bedrock samples presented in Table 5 (from TITAN, 1994).

Assuming that the Knight-Piesold estimates from cell 3 are also representative of cell 2 and cells 4A and 4B, and assuming that this rate of seepage would not significantly raise the average saturation of the underlying vadose zone materials, the average rate of downward movement of a conservative solute dissolved in the seepage, assuming 1) no hydrodynamic dispersion, 2) an average water saturation of 0.20, and 3) an average porosity of 0.18, can be approximated as:

$$\frac{0.0086 \, ft \, / \, yr}{(.20)(.18)} = 0.24 \, ft \, / \, yr$$

The average times to travel from cell liners to the perched water zone would then be approximately 200 years beneath cell 2; 270 years beneath cell 3; and 288 years beneath cells 4A and 4B. These are conservative estimates because the maximum estimated seepage rate is used, and the average vadose zone water saturations would be likely to increase, thereby reducing the downward rates of travel, and increasing the travel times.

Numerical modeling of potential tailings cell seepage and rates of downward migration of solutes are provided in MWH (2010). Based on Figure A-3 from MWH (2010), the simulated seepage rates beneath tailings cells 2 and 3 would reach a maximum of approximately 7.7 millimeters per year (mm/yr) [0.025 ft/yr] by year 25, then drop to approximately 0.7 mm/yr (0.0023 ft/yr) by year 70. The average seepage rate over the 240 year simulation period is approximately 0.0043 ft/yr, half the estimate used in the above calculations. Using this rate with the above assumptions would double the travel times estimated for seepage to reach perched water beneath cells 2, 3, and 4A and 4B. However, the MWH analyses used smaller initial water saturations for the vadose zone which correspondingly reduced travel time estimates. Based on personal communication with MWH personnel, a 200+ year vadose zone travel time estimate for cells 2 and 3 is considered reasonable.

The estimates calculated above for cell 2 (200 years), cell 3 (270 years) and cells 4A and 4B (288 years) will be used in subsequent calculations. Because cells 2 and 3 are at least 30 years old, the travel times starting from the present time will be 170 years for cell 2, and 240 years for cell 3. Cell 4B was installed in 2010 and cell 4A refurbished and put into use shortly thereafter so the effective travel time will be assumed to be 255 years for these cells. Furthermore, the estimates for cells 4A and 4B are considered even more conservative because of improvements in tailings cell design and liner quality that were incorporated in these cells but were not available during construction of cells 2 and 3.

3.6.3.2 Perched Water Zone Downgradient of Tailings Cells

Perched water pore velocities and travel times along selected paths between the tailings cells and perched water discharge points were calculated for pathlines 3 through 6 shown in Figure 27.

The Figure 27 pathlines were selected as the shortest Figure 25 paths from the tailings cells to a) Westwater Seep (Path 3), b) Ruin Spring via the west side of the Brushy Basin paleoridge (Path 5), and c) Ruin Spring via the east side of the Brushy Basin paleoridge (Path 6). A pathline from the tailings cells to the vicinity of DR-8 (Path 4) is also shown in Figure 27. From the vicinity of DR-8 perched water is expected to flow primarily south (within a paleovalley) toward Ruin Spring. However, a potential pathline from the vicinity of DR-8 is also shown in Figure 27 that posits a hypothetical connection between the perched zone and Cottonwood Seep. Path 4 provides the shortest pathline between the tailings cells and the western edge of the perched zone near DR-8, and the potential path provides the shortest hypothetical connection between the western edge of Path 4 and Cottonwood Seep.

Hydraulic conductivities used in the calculations are summarized in Table 8. Hydraulic conductivity estimates are based on automatically logged slug test data analyzed using the KGS solution method, except for MW-12, MW-14, and MW-15. Hydraulic conductivity estimates at MW-12, MW-14, and MW-15 are based on pumping test analyses reported in Table 4 (from TITAN, 1994). Hydraulic tests could not be performed at DR-2, DR-16, DR-18, nor DR-25. These borings were abandoned after surveying and water level collection based on the criteria presented in HGC (2012b). Tests also could not be performed at DR-6 nor DR-7 due to insufficient water column height. Pore velocity calculations for pathlines 3 through 6 are summarized in Table 9.

Path 3 is approximately 2,200 feet long with an average hydraulic gradient of 0.0123 feet per foot (ft/ft) based on the first quarter, 2014 water level at MW-23 (5,495 ft amsl) and the elevation of Westwater Seep (5,468 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 3 (based on data from DR-5, DR-8, DR-9, DR-10, DR-11, MW-12, MW-23, MW-24, and MW-36) is 9.8 x 10⁻⁶ cm/s (0.027 ft/day). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 3 is 0.68 feet per year (ft/yr), yielding a travel time of approximately 3,230 years. Including a vadose zone travel time of approximately 240 years for cell 3, the total travel time is approximately 3,470 years.

Path 4 is approximately 4,125 feet long with an average hydraulic gradient of 0.0046 ft/ft based on the first quarter, 2014 water level at MW-36 (5,493 ft amsl) and the water level at DR-8 (5,474 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 4 (based on data from DR-5, DR-8, DR-9, DR-10, DR-11, MW-12, MW-23, MW-24,

and MW-36) is 9.8 x 10^{-6} cm/s (0.027 ft/day). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 4 is 0.26 feet per year (ft/yr), yielding a travel time of approximately 15,850 years. Including a vadose zone travel time of approximately 250 years for cell 4A, the total travel time is approximately 16,100 years. The additional time to travel along the hypothetical pathway to Cottonwood Seep is not calculated because of the hypothetical nature of the pathway and because the hypothetical pathway is through the Brushy Basin Member which is considered an aquiclude. If such a pathway exists, the combined travel time along Path 4 and the hypothetical pathway (which adds approximately 2,150 horizontal feet to the total path length), would be significantly greater than 16,100 years.

Path 5 is approximately 11,800 feet long with an average hydraulic gradient of 0.0096 ft/ft based on the first quarter, 2014 water level at MW-36 (5,493 ft amsl) and the elevation of Ruin Spring (5,380 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 5 (based on test data from DR-5, DR-8, DR-9, DR-10, DR-11, DR-14, DR-17, DR-19, DR-20, DR-21, DR-23, DR-24, MW-23, MW-24, and MW-36) is 1.1×10^{-5} cm/s (0.031 ft/day). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 5 is 0.60 ft/yr, yielding a travel time of approximately 19,650 years. Including a vadose zone travel time of approximately 250 years for cell 4A, the total travel time is approximately 19,900 years.

Path 6 is approximately 9,685 feet long with an average hydraulic gradient of 0.0116 ft/ft based on the first quarter, 2014 water level at MW-34 of 5,492 ft amsl and the elevation of Ruin Spring (5,380 ft amsl). The geometric average hydraulic conductivity of the perched zone in the vicinity of Path 6 (based on test data from DR-11, DR-13, DR-21, DR-23, DR-24, MW-3, MW-14, MW-15, MW-20 and MW-37) is 1.38 x 10⁻⁵ cm/s (0.039 ft/day). Assuming an effective porosity of 0.18, the average perched water pore velocity along Path 6 is 0.91 ft/yr, yielding a travel time of approximately 10,650 years. Including a vadose zone travel time of approximately 250 years for cell 4B, the total travel time is approximately 10,900 years.

3.7 Implications For Seeps and Springs

The lithologic and hydraulic data collected from the southwest area investigation (HGC 2012b) allow a more comprehensive assessment of the hydrogeology of the site and have implications with regard to seeps and springs southwest of the site. The data indicate that dilution of perched water by local recharge is expected to occur in the vicinities of Westwater Seep and Ruin Spring, and that perched zone permeabilities and flow rates in the southwestern portion of the site are too low (by several orders of magnitude) for the perched zone to serve as the primary source of water for Cottonwood Seep

3.7.1 Westwater Seep and Ruin Spring

As discussed in HGC (2010e) the water source for both Westwater Seep and Ruin Spring is lateral flow from upgradient portions of the perched zone enhanced by local recharge near the edge of the mesa. Most of this recharge likely occurs near the mesa rim where weathered Dakota Sandstone and Burro Canyon Formation are exposed. Such recharge is likely to be enhanced within drainages where they cross weathered Dakota Sandstone and Burro Canyon Formation. The results of the southwest area investigation (HGC, 2012b) indicate that the permeability of the perched zone in the southwest area of the site is on average lower than previously estimated (as in HGC, 2009) and that the contribution to flow at Westwater Seep and Ruin Spring by local recharge may be more significant than previously thought.

3.7.2 Cottonwood Seep

The low perched zone permeabilities and small saturated thicknesses in the southwest area of the site are consistent with low rates of perched water flow, as shown by the calculated flow through the area of small saturated thickness southwest of the tailings cells (between DR-6 and DR-10) provided in Section 3.5.4.2. This low rate of perched water flow (approximately 0.001 gpm) is inadequate (by more than three orders of magnitude) to function as the primary supply to Cottonwood Seep which has flows estimated to be between 1 and 10 gpm. As discussed in Section 3.5.4.2, the estimated flow of between 1 and 10 gpm at Cottonwood Seep is consistent with Dames and Moore (1978).

In summary, the perched zone cannot be the primary source of water to Cottonwood Seep for the following reasons:

1. Cottonwood Seep occurs in the lower third of Brushy Basin Member, approximately 230 feet below the contact between the Burro Canyon Formation and the Brushy Basin Member, more than 1,500 ft west of the termination of the perched zone, and just west of a change in morphology from slope-former to bench-former. The change in morphology is indicative of a change in lithology. As discussed in HGC (2010e) Cottonwood Seep likely originates from coarser-grained materials within the lower portion of the Brushy Basin Member. Alternatively, Cottonwood Seep may originate from coarser-grained materials of the Westwater Canyon (sandstone) Member intertongueing with the overlying Brushy Basin Member at the transition between the two Members. The presence of coarser-grained materials similar to the Salt Wash (sandstone) Member within the lower portion of the Brushy Basin member is discussed in Shawe (2005). The intertongueing of the Westwater Canyon and Brushy Basin Members is discussed in Craig et al. (1955) and Flesch (1974). Based on lithologic cross sections provided in TITAN (1994), the elevation of Cottonwood Seep (5,234 ft amsl) is within 5 to 15 feet of the elevation of the contact between the Brushy Basin Member and the underlying Westwater Canyon Member (5,220 to 5,230 ft amsl). This is also shown in Figure 3.

- 2. The flow at Cottonwood Seep exceeds the flow in the perched zone in the area southwest of the tailings cells by several orders of magnitude. Flows at Cottonwood Seep are also relatively large compared to seeps and springs known to originate from the perched zone, consistent with a primary source other than perched water.
- 3. There is no evidence to establish a direct hydraulic connection between the perched zone and Cottonwood Seep, located more than 1,500 ft west of the termination of the Burro Canyon Formation which hosts the perched water zone. Examination of the area between Cottonwood Seep and mesa rim (the edge of the perched zone) reveals that the upper portion of the Brushy Basin Member appears dry and no previously undiscovered seeps originating from the Burro Canyon Formation near Cottonwood Seep were identified.

Because the results of the southwest area investigation do not provide evidence that Cottonwood Seep is hydraulically connected to the perched water system at the site, and because the perched zone near Cottonwood Seep is inadequate as a primary supply, the primary source (or sources) of water to Cottonwood Seep must lie elsewhere. The primary source(s) must be significant to supply consistent flows at rates between 1 and 10 gpm. By contrast, flows at Ruin Spring (estimated at approximately 1/2 gpm, consistent with Dames and Moore, 1978) are lower than at Cottonwood Seep (between 1 and 10 gpm), and flows at Westwater Seep are too small to measure reliably. Westwater Seep generally consists of damp soil that can be sampled only by excavating and waiting for enough water to seep in for sample collection (see Figures 28 and 29 taken from HGC, 2010e).

Although no evidence of a direct hydraulic connection between the perched zone and Cottonwood Seep was provided by the southwest area investigation, the possibility of a hypothetical, as yet unknown, connection was postulated for the purpose of calculating a travel time from the tailings cells to the western edge of the perched zone (near DR-8), and thence along a potential pathway to Cottonwood Seep. The total travel time from the tailings cells to DR-8 was calculated as approximately 16,100 years. Should a potential pathline such as that shown in Figure 27 exist, the total time needed to travel from the tailings cells to Cottonwood Seep would be significantly larger than 16,100 years.

3.7.3 <u>Potential Dilution of Perched Water Resulting From Local Recharge of the</u> <u>Dakota and Burro Canyon Near Seeps and Springs</u>

As discussed in Section 3.5.4.2, the rate of flow in the perched water zone in the southwest area of the site is small and a contribution from local recharge is needed to explain many areas of relatively high saturated thickness near sinks such as Westwater Seep and Ruin Spring that are downgradient of areas of relatively low saturated thickness. The presence of local recharge is expected to affect the water quality of seeps and springs and has the potential to dilute any dissolved constituents that may migrate from upgradient areas.

3.8 Implications For Transport of Chloroform and Nitrate

Chloroform and nitrate plumes are under remediation by pumping. Pumping systems are designed to remove chloroform and nitrate mass from the perched zone as quickly as is practical to allow natural attenuation in the far downgradient portions of the plumes to be more effective. Furthermore, nitrate pumping is designed to capture approximately the northern $^2/_3$ of the nitrate plume. Pumping at the downgradient margin of the chloroform plume is impractical primarily due to low permeability and low productivity conditions. Pumping at the downgradient margin of the nitrate plume is also impractical primarily because of the potential to draw chloroform downgradient.

In the absence of remedial pumping, the western portion of the nitrate plume would eventually migrate towards Westwater Seep and the eastern portion toward Ruin Spring (Figure 30). In the absence of remedial pumping, the western portion of the chloroform plume would eventually migrate towards Ruin Spring and the eastern portion toward the perched groundwater low centered on TW4-31 (near the southeastern tip of the plume [Figure 30]). Should the low at TW4-31 eventually disappear, chloroform within the eastern portion of the plume would be expected to migrate towards Corral Springs. As indicated by calculations in Section 3.6, thousands of years would be required for either constituent to reach a discharge point. That is sufficient time for either constituent to degrade naturally prior to reaching a discharge point as will be discussed in Section 4.4.

The groundwater low at TW4-31 (located immediately east of TW4-27) is interpreted to result from partial hydraulic isolation from upgradient and cross-gradient areas that were more strongly affected by wildlife pond seepage. Wildlife pond seepage resulted in increases in water levels at wells in the vicinity of TW4-27 as shown in Figure 31. Water levels in wells TW4-6, TW4-26, and TW4-13 rose relatively rapidly compared with water levels at TW4-14. The permeabilities of TW4-6 and TW4-26 are similar (Table 1) and both exhibit similar water level behavior. The permeability at TW4-27 is low (Table 1) and the similarity in water level behavior at TW4-14 and TW4-27 indicates that TW4-14 is also installed in low permeability materials. These low permeability materials are the likely cause of the partial hydraulic isolation of TW4-31. Because the groundwater low at TW4-31 is interpreted to result from variable permeability and from transient hydraulic conditions brought on by wildlife pond seepage, water levels in this area are expected to 'catch up' eventually with water levels in less hydraulically isolated areas. One result of these conditions is the development of relatively steep hydraulic gradients at the leading edge of the chloroform plume in this area.

Water balance calculations near Westwater Seep and Ruin Spring (Section 3.5.4.3) indicate that local recharge is needed to maintain areas having relatively large saturated thicknesses that

supply water to known discharge points Westwater Seep and Ruin Spring but that are isolated from other portions of the perched zone by areas of relatively low saturated thickness. The presence of local recharge near these discharge points at least in part explains increased flow at these features after precipitation events (HGC, 2010e). In the unlikely event that nitrate or chloroform not removed by pumping did not degrade within the thousands of years needed to reach a discharge point, local recharge would act to reduce concentrations prior to discharge.

4. COMPOSITION OF DAKOTA SANDSTONE AND BURRO CANYON FORMATION

As discussed in HGC (2012c), samples of selected archived drill core and drill cuttings were analyzed visually and quantitatively by an analytical laboratory. Table 10 summarizes the mineralogy of samples submitted to the contract laboratory for quantitative analysis. Table 11 summarizes the occurrence of pyrite, iron oxides, and carbonaceous material in site drilling logs having sufficient detail. Table 12 summarizes the results of laboratory visual (microscopic) analyses for sulfides. Table 13 and Figure 32 summarize the occurrence of pyrite in site borings based on both lithologic logs and laboratory analyses.

4.1 Mineralogy

As discussed in Section 3.1.2, the Dakota Sandstone is a relatively hard to hard, generally fineto-medium grained sandstone cemented by kaolinite clays. The underlying Burro Canyon Formation is similar to the Dakota Sandstone but is generally more poorly sorted, contains more conglomeratic materials, and becomes argillaceous near its contact with the underlying Brushy Basin Member of the Morrison Formation.

Based on quantitative analysis of samples for major and minor mineralogy (Table 10), the primary mineral occurring in the Burro Canyon Formation is quartz (greater than or equal to 80% in all analyzed samples except SS-26 which consisted of 'play sand'). Other detected minerals (not necessarily present in all the samples) include potassium feldspar, plagioclase, mica, kaolinite, calcite, dolomite, anhydrite, gypsum, pyrite, hematite, and magnetite. Because of their relatively high reactivity, pyrite, calcite and dolomite are expected to have the most potential to impact perched water chemistry. The presence of carbonaceous matter (Table 11) is also expected to impact perched water chemistry.

4.2 Pyrite Occurrence

As discussed in Section 3.1.4 pyrite occurs within the Dakota Sandstone and Burro Canyon Formations which host the perched water at the site. Table 11 summarizes the occurrence of pyrite, iron oxides, and carbonaceous material in site boring logs. Pyrite has been noted in approximately $^{2}/_{3}$ of site borings having detailed lithologic logs. These borings are located upgradient, cross-gradient and downgradient of the millsite and tailings cells. In addition, carbonaceous material has been noted at many locations which is consistent with at least locally reducing conditions and the existence of pyrite (Table 11).

As discussed in HGC (2012c), samples of selected archived drill core and drill cuttings were analyzed visually and quantitatively by a contract analytical laboratory. Table 13 and Figure 32 summarize the occurrence of pyrite in site borings based on lithologic logs and laboratory analyses.

The results of the visual and quantitative analysis verify the site-wide, apparently ubiquitous existence of pyrite in the perched zone at the site. The existence of pyrite is confirmed at locations upgradient, cross-gradient, and downgradient of the millsite and tailings cells. The results are consistent with Shawe's (1976) description of the Dakota Sandstone and Burro Canyon Formations as "altered-facies" rocks within which pyrite formed as a result of invasion by pore waters originating from compaction of the overlying Mancos Shale.

Pyrite and/or marcasite were detected in all samples submitted for visual (microscopic) analysis (Table 12) having pyrite noted in their respective lithologic logs. Pyrite occurs primarily as individual grains and as a cementing material, and more rarely as inclusions in quartz grains. Pyrite and/or marcasite were detected at volume percents ranging from approximately 0.05 to 25. Grain sizes ranged from approximately one micrometer to nearly 2,000 micrometers. Small grain sizes suggest that much of the pyrite present in the formation may not be detectable during lithologic logging of boreholes and that the actual abundance of pyrite is larger than indicated by the lithologic logs. The detection of marcasite (orthorhombic crystalline FeS₂), which is more reactive than pyrite (cubic crystalline FeS₂), is an important result of the investigation because its reaction rate with either oxygen or nitrate will likely be higher. The laboratory visual (microscopic) analysis confirms the visual observations made during initial well logging.

Pyrite was detected by quantitative x-ray diffraction (XRD) analysis in samples from MW-3A, MW-24, MW-26, MW-27, MW-28, and MW-32 at concentrations ranging from 0.1% to 0.8% by weight (Table 10). Based on the iron content via XRD analysis and the total sulfur analysis, pyrite may also be present in samples from MW-23, MW-25, and MW-29 at concentrations ranging from 0.1% to 0.3%. The presence of pyrite is not indicated in MW-30 or MW-31 by either method of analysis, although it was noted in the lithologic logs. This suggests that the samples submitted for analysis from these borings may not have been representative, or that pyrite degraded over time during storage. Except for MW-30 and MW-31, the quantitative analysis confirms the visual observations made during initial well logging.

Although pyrite was not directly detected by XRD in samples from MW-23, MW-25, or MW-29, the detected iron and sulfur in these samples is consistent with the presence of pyrite. While at least a portion of the detected sulfur may result from the gypsum or anhydrite detected in some of these samples (Table 10), iron not in the form of pyrite would be expected to exist primarily in

the form of iron oxides or perhaps iron carbonates. The absence of detected iron oxides or carbonates in samples from these borings suggests iron in the form of pyrite.

Furthermore, pyrite was either directly detected or possibly detected based on the presence of iron and sulfur in samples from MW-3A, MW-23, MW-24, MW-28, and MW-29, which did not have pyrite noted in the associated lithologic logs. These results are consistent with the small grain sizes noted via the laboratory visual (microscopic) analysis indicating the absence of pyrite in a lithologic log does not necessarily mean pyrite is not present in the associated boring, and that pyrite occurrence at the site has likely been underestimated based on the lithologic logs.

4.3 Expected Influence of Transient Conditions, Oxygen Introduction, and the Mancos and Brushy Basin Shales on Dakota/Burro Canyon Chemistry

Current conditions within the perched groundwater system hosted by the Burro Canyon Formation and Dakota Sandstone do not approach steady state over much of the monitored area. A large part of the site perched water system is transient and affected by long-term changes in water levels due to past and current activities unrelated to the disposal of materials to the site tailings cells. Changes in water levels have historically been related to seepage from the wildlife ponds; however past impacts related to the historical pond, and to a lesser extent the sanitary leach fields, are also expected. Water levels have decreased at some locations due to chloroform and nitrate pumping and cessation of water delivery to the northern wildlife ponds.

The transient nature of a large portion of the perched water system, manifested in long-term changes in saturated thicknesses and rates of groundwater flow, is expected to result in trends in pH and concentrations of many dissolved constituents that are unrelated to site operations. Changes in saturated thicknesses and rates of groundwater flow can result in changes in concentrations of dissolved constituents (or pH) for many reasons. For example, as discussed in HGC (2012c), groundwater rising into a vadose zone having a different chemistry than the saturated zone can result in changes in pH and groundwater constituent concentrations. If the rise in groundwater represents a long-term trend, long-term changes in groundwater constituent constituent constituent constituent.

Under conditions where vadose zone chemistry is not markedly different from saturated zone chemistry, changing groundwater flow rates may result in changing constituent concentrations due to changes in dilution. For example, relatively constant flux of a particular solute into the groundwater zone that results in a relatively constant groundwater concentration under conditions of steady groundwater flow, will likely result in changing concentrations should groundwater flow become unsteady. If the change in flow rate is in one direction over a long

period of time, a long-term trend in the solute concentration is expected to result. Examples include oxygen dissolved in recharge or a constituent present in vadose zone materials overlying perched groundwater that dissolves in recharge and leaches into perched water at a steady rate. An increase in perched flow may cause an increase in dilution and a reduction in constituent concentration and vice-versa. For example, a decrease in dilution related to cessation of water delivery to the northern wildlife ponds is expected to result in increases in dissolved constituent concentrations within chloroform and nitrate plumes as discussed in Section 3.4.1.2.

Furthermore, the mere presence of the tailings cells as barriers to natural recharge and exchange of gas with the atmosphere may result in changes in perched water chemistry. Any such changes are likely to be relatively slow and in one direction, potentially yielding long term trends in parameter values.

The perched groundwater chemistry at the Mill is also expected to be impacted by the following factors:

- 1. The relatively low permeability of the perched zone. This condition increases groundwater residence times and the time available for groundwater to react with the formation.
- 2. The location of the perched system between two shales, the underlying Brushy Basin Member of the Morrison Formation and the overlying Mancos Shale. Both are potential sources of numerous dissolved constituents. Potential interaction between the Brushy Basin Member and perched water are discussed in TITAN (1994).
- 3. The rate of interaction between the shales and the perched water. Interaction with the Mancos Shale at any particular location will depend on the presence, thickness, and composition of the Mancos, the rate of recharge through the Mancos into the perched zone, and the saturated thickness and rate of groundwater flow in the perched zone. Interaction with the Brushy Basin Member at any particular location will depend on the composition of the Brushy Basin, and the saturated thickness and rate of flow in the perched zone. Oxygen introduced into site monitoring wells may also react with the Brushy Basin and affect overlying perched water chemistry.
- 4. The rate of oxygen introduction into the perched zone via recharge or via site groundwater monitoring wells. Introduced oxygen is available to oxidize constituents such as pyrite, which impacts the local groundwater chemistry near each recharge source and near each well by releasing acid and sulfate. The resulting increased acidity can also destabilize various mineral phases in the aquifer matrix. The degree of impact on groundwater chemistry will depend on the amount of pyrite, the rate of oxygen transfer, the neutralization capacity and saturated thickness of the perched zone, and the rate of groundwater flow.
- 5. Elements other than iron and sulfur as contaminants in pyrite. Pyrite reacting with oxygen introduced into the formation will release these elements, potentially altering both the

vadose zone and the groundwater chemistry. The potential for pyrite to have significant contaminants (such as selenium) is enhanced by its origin from fluids expelled from the Mancos Shale.

Changes in perched zone constituent concentrations and pH are therefore expected to result from the introduction of oxygen into the subsurface, the oxidation of pyrite and other constituents, changes in recharge rates, and past and current recharge passing through the Mancos Shale.

For example, the Mancos Shale is a significant source of selenium (Baker, 2007; Colorado Department of Health and Environment, 2011; Tuttle, 2005). Because the Mancos overlies the perched zone over much of the site (Figure 11) it could represent a past and ongoing source of selenium. Selenium originating from the Mancos Shale could potentially increase concentrations in the perched zone by three mechanisms: 1) Ongoing leaching from the Mancos Shale via recharge; 2) oxidation of Mancos-derived selenium in the Burro Canyon Formation and Dakota Sandstone by dissolved nitrate in the perched water and/or oxygen introduced into the perched zone via perched well casings; and 3) oxidation of pyrite containing Mancos-derived selenium by dissolved perched zone nitrate and /or oxygen introduced into the perched well casings. Selenium already present in the Dakota Sandstone and Burro Canyon Formation (including as a constituent in pyrite) could have originated from the Mancos in the past, and could affect the entire formation rather than just the areas beneath the current erosional remnants of the Mancos.

Precipitation percolating downward from the land surface is expected to leach selenium from the Mancos Shale and carry it downward into the perched zone. Beneath the tailings cells, any such leaching is expected to have occurred for the most part prior to the installation of the cells which represent a barrier to infiltration of precipitation. Vadose pore waters in the Dakota Sandstone and Burro Canyon Formation beneath the cells may thus be expected to contain selenium leached from the Mancos in the past. Perched water rising into vadose pore waters containing selenium may enhance mass transfer and result in increased selenium concentrations in the perched water.

Potentially increasing selenium concentrations may also result from the oxidation of selenium already present in the Dakota Sandstone and Burro Canyon Formation. Oxidation of selenium by nitrate present in perched water and/or by oxygen introduced into the formation via the well casings may result in increasing dissolved selenium concentrations. The possibility of nitrate oxidation of selenium is presented in Potoroff (2005).

A third potential source for increasing dissolved selenium concentrations in perched water is oxidation of pyrite by nitrate and/or oxygen introduced into the formation via well casings. Pyrite typically contains trace elements including selenium. Selenium has been measured at concentrations as high as 0.2% by weight in pyrite (Deditius, 2011). As discussed in HGC

(2012c), pyrite oxidation is expected to result in other changes that include an increase in dissolved sulfate (unless a sink for sulfate is present). Oxidation of pyrite by dissolved oxygen is expected to result in a decrease in pH as acid is released in the reaction:

$$\text{FeS}_2 + 3^3/_4\text{O}_2 + 3^1/_2\text{H}_2\text{O} = \text{Fe}(\text{OH})_3 + 2\text{SO}_4^{2-} + 4\text{H}^+$$

Oxidation of pyrite by nitrate may also occur as discussed in HGC (2012c). This process may result in either an increase or decrease in pH depending on the reaction pathway:

5
$$\text{FeS}_2 + 14\text{NO}_3^- + 4\text{H}^+ = 7\text{N}_2 + 10\text{SO}_4^{2-} + 5\text{Fe}^{2+} + 2\text{H}_2\text{O}$$
; or
2 $\text{FeS}_2 + 6\text{NO}_3^- + 2\text{H}_2\text{O} = 3\text{N}_2 + 4\text{SO}_4^{2-} + 2\text{FeOOH} + 2\text{H}^+$

The interaction between nitrate and pyrite will be discussed in more detail in the following Section.

4.4 Implications For Perched Water Chemistry and Natural Attenuation of Nitrate and Chloroform

As discussed above, past, current, and future interaction of the perched water zone with the overlying Mancos Shale and underlying Brushy Basin Member can be expected to affect perched water chemistry at the site. Changes in perched water chemistry related to oxidation of pyrite by oxygen introduced into the subsurface dissolved in recharge and via well casings is also expected to occur.

Concentrations of chloroform and nitrate already present in the perched zone will be affected over time by various processes, including direct mass removal by pumping. Natural attenuation of both constituents is expected to result from physical processes that include dilution by recharge and hydrodynamic dispersion. Volatilization into the vadose zone is another physical process that is expected to lower chloroform concentrations in perched water. Mass reduction processes expected to lower both nitrate and chloroform concentrations include chemical and biologically-mediated processes. The impacts of pyrite degradation by oxygen, degradation of nitrate by pyrite, and reductive dechlorination of chloroform are discussed in Sections 4.4.1 through 4.4.3.

4.4.1 Pyrite Degradation by Oxygen

As discussed in HGC (2012c), the pH values measured in many site groundwater monitoring wells located upgradient, within the vicinity of, and downgradient of the millsite and tailings cells displayed decreasing trends. pH decreases in many of these wells were accompanied by

increases in sulfate concentrations. Ten of the MW-series groundwater monitoring wells were out of compliance (OOC) with respect to pH due to a decreasing trend.

As discussed in INTERA (2012a and 2102b) and Section 5 below, changes in pH were determined to result from natural causes unrelated to the operation of the tailings cells. Based on work described in HGC (2012c), the decreases in pH and increases in sulfate in OOC wells were explainable by oxidation of pyrite, which releases acid and sulfate as described above. Screening-level calculations and geochemical modeling using PHREEQC (Parkhurst and Appelo, 1999) indicated that pyrite measured in samples from the perched zone existed in more than sufficient quantity to have resulted in the measured changes in pH and sulfate at three representative wells located immediately upgradient (MW-27), immediately downgradient (MW-24), and far downgradient (MW-3A) of the tailings cells. The calculations also indicated that pyrite existed in sufficient quantity to maintain these trends provided sufficient oxygen was available. Continued release of any contaminants within site pyrite is expected as is release of pH sensitive constituents present in the Burro Canyon Formation and Dakota Sandstone.

4.4.2 Nitrate Degradation by Pyrite

As discussed in HGC (2012c), nitrate will degrade in the presence of pyrite. Nitrate will also degrade, and more readily, in the presence of organic matter. Both pyrite and organic material in the form of carbonaceous matter have been logged in drill cuttings from the perched zone.

As discussed in (Korom, 1992), the thermodynamically favored electron donor for reduction of nitrate in groundwater is typically organic matter. This process under neutral conditions is represented via the following generalized reaction (e.g. van Beek, 1999; Rivett *et al.*, 2008; Tesoriero and Puckett, 2011; Zhang, 2012):

$$5CH_2O + 4NO_3^- = 2N_2 + 4HCO_3^- + H_2CO_3 + 2H_2O$$
 (Reaction 1);

In acidic (pH<6.4) aquifer conditions, reduction of nitrate by organic matter can be generalized by the following pathway:

$$5CH_2O + 4NO_3^- + 4H^+ = 2N_2 + 5H_2CO_3 + 2H_2O$$
 (Reaction 2).

In both cases, five moles of organic matter are required to reduce four moles of nitrate. Under acidic conditions the alkalinity generated by denitrification by organic matter consumes acid.

In the absence of dissolved oxygen, pyrite can also be oxidized by nitrate. Denitrification by pyrite may occur via two primary reaction pathways. The pathway most commonly applied in

geochemical studies (Kolle *et al.*, 1983, 1985; Postma *et al.*, 1991; Korom, 1992; Robertson *et al.*, 1996; Pauwels *et al.*, 1998; Hartog *et al.*, 2001, 2004; Spiteri *et al.*, 2008) is a bacteriamediated reaction that yields ferrous iron, sulfate, water, and nitrogen gas as follows:

$$5FeS_2 + 14NO_3^- + 4H^+ = 7N_2 + 10SO_4^{2-} + 5Fe^{2+} + 2H_2O$$
 (Reaction 3).

By Reaction 3, five moles of pyrite reduce 14 moles of nitrate, consuming four moles of acid. Reaction 3 is considered applicable when pyrite concentrations exceed nitrate concentrations (van Beek,1999). Where nitrate concentrations exceed pyrite concentrations, Reaction 4 is a more likely mechanism (Kolle *et al.*, 1987; van Beek, 1999; Schlippers and Jorgensen, 2002):

$$2FeS_2 + 6NO_3^- + 4H_2O = 3N_2 + 4SO_4^{2-} + 2Fe(OH)_3 + 2H^+$$
 (Reaction 4).

By Reaction 4, two moles of pyrite reduce six moles of nitrate, yielding iron hydroxide, sulfate, acid, and nitrogen gas. Therefore, when nitrate concentrations exceed pyrite concentrations (Reaction 4), denitrification by pyrite is more efficient than when pyrite is in excess (Reaction 3). Additionally, Reaction 4 produces acid, while Reaction 3 consumes acid, indicating that the impact of denitrification by pyrite on aquifer geochemistry is controlled by the relative abundance of pyrite and nitrate.

Reaction 4 is an overall reaction that combines Reaction 3 and a second step whereby ferrous iron is oxidized by nitrate. This second step is more likely to occur when excess nitrate is present and available to oxidize ferrous iron (Kolle *et al.*, 1987; Rivett *et al.*, 2008; Zhang 2012).

Stoichiometric calculations were used to determine the weight percent of perched zone pyrite that would be required to reduce 43,700 lbs of nitrate via reaction mechanisms 3 and 4 (assuming each was the only denitrification reaction occurring). 43,700 lbs of nitrate is the baseline nitrate mass calculated as specified in the nitrate CAP (HGC, 2012a). 43,700 lbs of nitrate corresponds to 19,822 kg and 319,684 moles. Although noted in lithologic logs the organic matter content of the perched zone has not been quantified so calculations regarding nitrate degradation by reactions 1 and 2 are not presented, even though significant nitrate reduction via these mechanisms is likely to occur.

Nitrate can either migrate towards Ruin Spring to the south-southwest or to Westwater Seep to the west. Assuming the entire nitrate plume migrated south towards Ruin Spring, the volume of the perched zone through which the nitrate plume would migrate was assumed to be on average 20 feet thick, 1,200 feet wide, and 10,000 feet long, representing a total saturated formation volume of 2.4×10^8 ft³ or 6.8×10^9 liters. Assuming the entire nitrate plume migrated west

toward Westwater Seep, the volume of the perched zone through which the nitrate plume would migrate was assumed to be on average 18 feet thick, 2,800 feet wide, and 4,950 feet long, representing a total saturated formation volume of 2.5 x 10^8 ft³ or 7 x 10^9 liters. To be conservative, the following calculations are based on the smaller volume of 6.8 x 10^9 liters.

Using these estimates, reaction 3 would require 114,173 moles of pyrite to consume 43,700 lbs of nitrate, and would consume 91,338 moles of acid (1.34×10^{-5} moles H⁺ per liter of formation). Reaction 4 would require 106,561 moles of pyrite to degrade the nitrate, producing 106,561 moles of acid or 1.57×10^{-5} moles H⁺ per liter of formation.

Assuming a conservatively large porosity of 0.2 for the perched zone (HGC, 2012c), the total volume of water is 1.36×10^9 liters; and assuming a solids density of 2.6 kg L⁻¹, yields a total solid mass of 1.4×10^{10} kg.

Using this solid mass, both Reactions 3 and 4 would require pyrite formation weight percents of 0.000098% (9.8 x 10^{-5} %) and 0.000091% (9.1 x 10^{-5} %), respectively, to degrade 43,700 lbs of nitrate.

These calculated pyrite weight percents are orders of magnitude less than conservative estimates of pyrite content based on samples analyzed during the pyrite investigation (HGC, 2012c), which ranged from 0.0056% to 0.08% (5.6 x 10^{-3} % to 8 x 10^{-2} %). These results suggest that the available pyrite content in the path of the nitrate plume is two to three orders of magnitude greater than needed to degrade the total mass (43,700 lbs) of nitrate. These calculations are conservative in that they assume the degradation of the entire mass of nitrate and not just the mass needed to reduce concentrations below 10 mg/L. Whether or not pyrite oxidation by nitrate at the site is generating or consuming acid depends largely on whether oxidation of ferrous iron by nitrate is occurring (i.e. whether pyrite denitrification is occurring by Reaction 3 or Reaction 4; whether nitrate exists in excess).

The preferred mechanism for denitrification by pyrite is likely to vary spatially. If pyrite is assumed to be relatively evenly distributed throughout the formation, while nitrate occurs in a discrete plume, Reaction 3 may dominate on the plume edges while Reaction 4 may dominate the core of the plume.

4.4.3 Chloroform Reduction

As discussed in HGC (2007), the presence of chloroform daughter products indicates that chloroform is degrading naturally via reductive dechlorination. Calculations presented in HGC (2007) based on daughter product concentrations indicated that the entire chloroform plume

would be reduced to concentrations below 70 ug/L within approximately 190 years. Reductive dechlorination takes place under anaerobic conditions which were inferred to exist only locally within the perched zone. The low rates of degradation and the persistence of nitrate associated with the chloroform plume are consistent with primarily aerobic conditions.

However, the presence of widespread pyrite in the perched zone is consistent with at least locally anaerobic conditions, and with the low calculated rates of chloroform degradation presented in HGC (2007). Continued reductive dechlorination is expected within locally anaerobic portions of the perched zone.

5. SUMMARY OF INTERA WORK AND FINDINGS

Background groundwater quality evaluations have been performed for each MW-series groundwater monitoring well. Groundwater compliance limits (GWCLs) have been established for each permit constituent on an intra-well basis.

A Revised Background Groundwater Quality Report (INTERA, 2007a) evaluated groundwater analytical data collected since the initiation of groundwater sampling. The revisions included a Flow Sheet that was approved by the DRC and contained steps for analyzing data and setting GWCLs. INTERA (2007a) identified naturally occurring elevated, increasing, and decreasing concentrations of various constituents in monitoring wells located far upgradient, far downgradient, and in the vicinity of the Mill Site. This report also presented a thorough discussion and identification of the most appropriate indicator parameters (chloride, fluoride, sulfate, and uranium) based on constituents in tailings solutions and their behavior in groundwater. Analysis of the indicator parameters in monitoring wells, including monitoring wells that contained increasing trends in other constituents, provided no evidence of tailings cell seepage. Since INTERA (2007a), three additional Background Reports (INTERA 2007b, 2008, and 2014c) evaluate available data and determine GWCLs for each permit constituent in each well based on the DRC-approved Flow Sheet.

Upon approval of the GWDP in 2010, constituents with two consecutive GWCL exceedances are subject to a Source Assessment Report (SAR) as defined in the GWDP. The initial SAR was submitted in October of 2012 (INTERA 2012a) and covered all of the constituents in wells with consecutive exceedances since the approval of the GWDP in 2010. The October 2012 SAR (INTERA 2012a) presented a geochemical analysis of parameters that exhibited exceedances as well as an analysis of the indicator parameters in each of those wells to determine if the exceedance could be related to potential tailings seepage or Mill-related activities. Since then, four additional SARs, (INTERA 2013a, 2013b, 2014a, qne 2014b) cover additional consecutive exceedances. In all cases the exceedances for which the SARs were performed were determined to result from naturally occurring conditions in the groundwater at the site or from other factors that are affecting groundwater but are unrelated to tailings cell operation. These other factors include the chloride and nitrate plume that is addressed by the nitrate CAP and a sitewide decline in pH that was identified at the time of the Background Report.

At the time of the Background Report, an overall decline in pH across the site was observed. Background analysis and determination of GWCLs for pH were performed using laboratory pH measurements rather than using measurements that are collected in the field at the time of sampling by using a pH probe. Since the latter of these two methods of measuring pH is more reliable, an additional pH analysis was performed in 2012 using only field data. GWCLs for pH were recalculated at this time using the field measurements. As discussed in Section 4.4.1, HGC (2012c) determined that pH decreases resulted from pyrite oxidation enhanced by oxygen delivery to the perched zone. Oxygen delivery mechanisms included advective transport to the perched zone dissolved in wildlife pond seepage, and diffusive transport to perched water in the vicinities of perched wells via perched well casings. pH decreases were therefore determined to be unrelated to tailings cell operation.

6. SUMMARY AND CONCLUSIONS

The Mill is is situated on White Mesa and is located within the Blanding Basin physiographic province. The Mill has an average elevation of approximately 5,600 feet above mean sea level (ft amsl) and is underlain by unconsolidated alluvium and indurated sedimentary rocks.

Indurated rocks include those exposed within the Blanding Basin, and consist primarily of sandstone and shale. The indurated rocks are relatively flat lying with dips generally less than 3°. The alluvial materials overlying the indurated rocks consist primarily of aeolian silts and finegrained aeolian sands with a thickness varying from a few feet to as much as 25 to 30 feet across the site. The alluvium is underlain by the Dakota Sandstone and Burro Canyon Formation, and where present, the Mancos Shale. The Dakota Sandstone and Burro Canyon Formation are sandstones having a total thickness ranging from approximately 55 to 140 feet. Beneath the Burro Canyon Formation lies the Morrison Formation, consisting, in descending order, of the Brushy Basin Member, the Westwater Canyon Member, the Recapture Member, and the Salt Wash Member. The Brushy Basin and Recapture Members of the Morrison Formation, classified as shales, are very fine-grained and have a very low permeability. The Brushy Basin Member is primarily composed of bentonitic mudstones, siltstones, and claystones. The Westwater Canyon and Salt Wash Members also have a low average vertical permeability due to the presence of interbedded shales.

Beneath the Morrison Formation lie the Summerville Formation, an argillaceous sandstone with interbedded shales, and the Entrada Sandstone. Beneath the Entrada lies the Navajo Sandstone. The Navajo and Entrada Sandstones constitute the primary aquifer in the area of the site. The Entrada and Navajo Sandstones are separated from the Burro Canyon Formation (and the perched water system monitored at the site) by approximately 1,000 to 1,100 feet of materials having a low average vertical permeability. Groundwater within this system is under artesian pressure in the vicinity of the site, is of generally good quality, and is used as a secondary source of water at the site. Stratigraphic relationships beneath the site are summarized in Figure 3.

The site and vicinity has a dry to arid continental climate, with an average annual precipitation of approximately 13.3 inches, and an average annual lake evaporation rate of approximately 47.6 inches. Recharge to major aquifers (such as the Entrada/Navajo) occurs primarily along the mountain fronts (for example, the Henry, Abajo, and La Sal Mountains), and along the flanks of folds such as Comb Ridge Monocline.

Perched groundwater occurs in the Dakota Sandstone and Burro Canyon Formation beneath the site and is used on a limited basis to the north (upgradient) of the site because it is more easily

accessible than the Navajo/Entrada aquifer. Perched groundwater originates mainly from precipitation and local recharge sources such as unlined reservoirs (Kirby, 2008) and is supported within the Burro Canyon Formation by the underlying, fine-grained Brushy Basin Member, considered an aquiclude.

Water quality of the Dakota Sandstone and Burro Canyon Formation is generally poor due to high total dissolved solids (TDS) in the range of approximately 1,100 to 7,900 milligrams per liter (mg/L) and is used primarily for stock watering and irrigation. Nitrate and chloroform plumes occur in site perched water as shown in Figure 1B. The nitrate plume extends from upgradient (north-northeast) of the tailings cells to beneath the cells. The chloroform plume is located primarily upgradient to cross-gradient of the cells. Sources of the nitrate plume are not well-defined but a historical pond shown on Figure 1B is considered a source of nitrate and chloride to the plume. The only potentially active source of nitrate to the plume is related to ammonium sulfate crystal handling near the ammonium sulfate crystal tanks located southeast of TWN-2 (Figure 1B) and is being addresses through implementation of Phase I of the nitrate CAP. Past sources of the chloroform plume are two abandoned sanitary leach fields (located near TW4-18 and TW4-19) that received laboratory wastes prior to tailings cells becoming operational circa 1980. Both plumes are under remediation by pumping.

The saturated thickness of the perched water zone generally increases to the north of the site, increasing the yield of the perched zone to wells installed north of the site. The generally low permeability of the perched zones limits well yields. Although sustainable yields of as much as 4 gallons per minute (gpm) have been achieved in site wells penetrating higher transmissivity zones near wildlife ponds, yields are typically low ($<^1/_2$ gpm) due to the generally low permeability of the perched zone. Many of the perched monitoring wells purge dry and take several hours to more than a day to recover sufficiently for groundwater samples to be collected. During redevelopment (HGC, 2011b) many of the wells went dry during surging and bailing and required several sessions on subsequent days to remove the proper volumes of water.

As shown in Figure 5 and Appendix D, perched water flow across the site is generally (and historically) from northeast to southwest. Beneath and south of the tailings cells, in the west central portion of the site, perched water flow is south-southwest to southwest. Flow on the western margin of White Mesa is also south, approximately parallel to the rim (where the Burro Canyon Formation is terminated by erosion). On the eastern side of the site perched water flow is also generally southerly. Hydraulic gradients at the site currently range from approximately 0.002 ft/ft in the northeastern corner of the site to approximately 0.075 ft/ft east of tailings cell 2 (in the vicinity of the chloroform plume).

Because of mounding near wildlife ponds, flow direction ranges locally from westerly (west of the ponds) to easterly (east of the ponds). The March 2012 cessation of water delivery to the northern ponds, which are generally upgradient of the nitrate and chloroform plumes at the site, has resulted in changing conditions that are expected to impact constituent concentrations and migration rates within these plumes. Specifically, past recharge from the ponds has helped limit many constituent concentrations within these plumes by dilution while the associated groundwater mounding has increased hydraulic gradients and contributed to plume migration. Since use of the northern wildlife ponds ceased in March 2012, the reduction in recharge and decay of the associated groundwater mound are expected to increase many constituent concentrations within the plumes while reducing hydraulic gradients and acting to reduce rates of plume migration. The impacts associated with cessation of water delivery to the northern ponds are expected to propagate downgradient (south and southwest) over time.

Perched water discharges in seeps and springs located to the west, south, east, and southeast of the site (Figure 1B). Flow onto the site occurs as underflow from areas northeast of the millsite where perched zone saturated thicknesses are generally greater. Flow exits the Mill property in seeps and springs to the east, west, southwest and southeast. Any flow that does not discharge in seeps or springs presumably exits as underflow to the southeast. Darcy's Law calculations of perched water flow to Ruin Spring and Westwater Seep yield reasonable results and suggest that local recharge contributes to seep/spring flow.

Hydraulic testing of perched zone wells yields a hydraulic conductivity range of approximately 2 x 10^{-8} to 0.01 cm/s (Tables 1- 4). In general, the highest permeabilities and well yields are in the area of the site immediately northeast and east (upgradient to cross gradient) of the tailings cells. A relatively continuous, higher permeability zone associated with the chloroform plume and consisting of poorly inducated coarser-grained materials has been inferred to exist in this portion of the site (HGC, 2007).

Permeabilities downgradient (southwest) of the tailings cells are generally low. The low permeabilities and shallow hydraulic gradients downgradient of the tailings cells result in average perched groundwater pore velocity estimates that are among the lowest on site. Furthermore, more than 30 years of groundwater monitoring indicate no impacts to perched water from tailings cell operation (based on various work by INTERA and Hurst and Solomon [2008]).

As discussed above, perched groundwater discharges in seeps and springs located along the mesa margins. The relationships between seeps and springs and site geology/stratigraphy are provided

in Figure E.1 and Figure E.2_. Seep and spring investigation (HGC, 2010e) and investigation of the southwest portion of the site (HGC, 2012b) indicate the following:

- 1. Incorporating the seep and spring elevations in perched water elevation contour maps produces little change with regard to perched water flow directions except in the area west of the tailings cells and near Entrance Spring. West of the tailings cells, incorporation of Westwater Seep creates a more westerly hydraulic gradient. Westwater Seep appears to be nearly downgradient of the western portion of the cell complex (Figure 25). Ruin Spring is downgradient of the eastern portion of the cell complex (Figure 25). Westwater Seep is the closest apparent discharge point west of the tailings cells. Including the Entrance Spring elevation on the east side of the site creates a more easterly gradient in the perched water contours, and places Entrance Spring more directly downgradient of the northern wildlife ponds. Seeps and springs on the east side of the tailings cells by a groundwater divide
- 2. Ruin Spring and Westwater Seep are interpreted to occur at the contact between the Burro Canyon Formation and the Brushy Basin Member. Corral Canyon Seep, Entrance Spring, and Corral Springs are interpreted to occur at elevations within the Burro Canyon Formation at their respective locations but above the contact with the Brushy Basin Member. All seeps and springs (except Cottonwood Seep which is located near the Brushy Basin Member/Westwater Canyon Member contact) are associated with conglomeratic portions of the Burro Canyon Formation. Provided they are poorly indurated the more conglomeratic portions of the Burro Canyon Formation are likely to have higher permeabilities and the ability to transmit water more readily than finer-grained portions. This behavior is consistent with on-site drilling and hydraulic test data that associates higher permeability with the poorly indurated coarser-grained horizons detected east and northeast of the tailing cells associated with the chloroform plume.
- 3. Cottonwood Seep is located more than 1,500 feet west of the mesa rim in an area where the Dakota Sandstone and Burro Canyon Formation (which hosts the perched water system) are absent due to erosion (Figures E.1 and E.2). Cottonwood Seep occurs near a transition from slope-forming to bench-forming morphology (indicating a change in lithology). Cottonwood Seep (and 2nd Seep located immediately to the north [Figure 8]) is interpreted to originate from coarser-grained materials within the lower portion of the Brushy Basin Member (or upper portion of the Westwater Canyon Member). Alternatively, Cottonwood Seep may originate from coarser-grained materials of the Westwater Canyon (sandstone) Member intertongueing with the overlying Brushy Basin Member at the transition between the two Members. The presence of coarser-grained materials similar to the Salt Wash (sandstone) Member within the lower portion of the Brushy Basin member is discussed in Shawe (2005). The intertongueing of the Westwater Canyon and Brushy Basin Members is discussed in Craig et al. (1955) and Flesch (1974). Based on lithologic cross sections provided in TITAN (1994), the elevation of Cottonwood Seep (5234 ft amsl) is within 5 to 15 feet of the elevation of the contact between the Brushy Basin Member and the underlying Westwater Canyon
Member (5220 to 5230 ft amsl). This is also shown in Figure 3. Cottonwood Seep is therefore not (directly) connected to the perched water system at the site.

- 4. Only Ruin Spring appears to receive a predominant and relatively consistent proportion of its flow from perched water. Ruin Spring originates from conglomeratic Burro Canyon Formation sandstone where it contacts the underlying Brushy Basin Member, at an elevation above the alluvium in the associated drainage. Westwater Seep, which also originates at the contact between the Burro Canyon Formation and the Brushy Basin Member, likely receives a significant contribution from perched water. All seeps and springs other than Ruin Spring (and 2nd Seep just north of Cottonwood Seep) are located within alluvium occupying the basal portions of small drainages and canyons. The relative contribution of flow to these features from bedrock and from alluvium is indeterminate.
- 5. All seeps and springs are reported to have enhanced flow during wet periods. For seeps and springs associated with alluvium, this behavior is consistent with an alluvial contribution to flow. Enhanced flow during wet periods at Ruin Spring, which originates from bedrock above the level of the alluvium, likely results from direct recharge of Burro Canyon Formation and Dakota Sandstone exposed near the mesa margin in the vicinity of Ruin Spring. This recharge would be expected to temporarily increase the flow at Ruin Spring (as well as other seeps and springs where associated bedrock is directly recharged) after precipitation events. As discussed previously, local recharge is consistent with Darcy's law calculations of perched water flow to Ruin Spring and Westwater Seep.

The assumption that the seep or spring elevation is representative of the perched water elevation is likely to be correct only where the feature receives most or all of its flow from perched water and where the supply is relatively continuous (for example at Ruin Spring). The perched water elevation at the location of a seep or spring that receives a significant proportion of water from a source other than perched water may be different from the elevation of the seep or spring. The elevations of seeps that are dry for at least part of the year will not be representative of the perched water elevation when dry. The uncertainty that results from including seeps and springs in the contouring of perched water levels must be considered.

The rate of flow in the perched water zone in the southwest area of the site (downgradient of the tailings cells) is small and contributions from local recharge are needed to explain many areas of higher saturated thickness near sinks such as Westwater Seep and Ruin Spring that are downgradient of areas of low saturated thickness (HGC, 2012b). The presence of local recharge is expected to affect the water quality of seeps and springs and has the potential to dilute any dissolved constituents that may migrate from upgradient areas.

As discussed in HGC (2012c), samples of selected archived drill core and drill cuttings were analyzed visually and quantitatively by a contract analytical laboratory. Table 13 and Figure 32 summarize the occurrence of pyrite in site borings based on lithologic logs and laboratory analyses. The results verify the site-wide, apparently ubiquitous existence of pyrite in the

perched zone at the site. The existence of pyrite is confirmed at locations upgradient, crossgradient, and downgradient of the millsite and tailings cells. The results are consistent with Shawe's (1976) description of the Dakota Sandstone and Burro Canyon Formations as "alteredfacies" rocks within which pyrite formed as a result of invasion by pore waters originating from compaction of the overlying Mancos Shale.

A large portion of the perched water system at the site is in a transient state, manifested in longterm changes in saturated thicknesses and rates of groundwater flow. This condition is expected to result in trends in pH and concentrations of many dissolved constituents that are unrelated to site operations. Changes in saturated thicknesses and rates of groundwater flow can result in changes in concentrations of dissolved constituents (or pH) for many reasons. For example, as discussed in HGC (2012c), groundwater rising into a vadose zone having a different chemistry than the saturated zone can result in changes in pH and groundwater constituent concentrations. If the rise in groundwater represents a long-term trend, long-term changes in groundwater constituent concentrations (or pH) may result.

Under conditions where vadose zone chemistry is not markedly different from saturated zone chemistry, changing groundwater flow rates may result in changing constituent concentrations due to changes in dilution. For example, relatively constant flux of a particular solute into the groundwater zone that results in a relatively constant groundwater concentration under conditions of steady groundwater flow, will likely result in changing concentrations should groundwater flow become unsteady. If the change in flow rate is in one direction over a long period of time, a long-term trend in the solute concentration is expected to result. Examples include oxygen dissolved in recharge or a constituent present in vadose zone materials overlying perched groundwater that dissolves in recharge and leaches into perched water at a steady rate. An increase in perched flow may cause an increase in dilution and a reduction in constituent concentration and vice-versa. For example, a decrease in dilution related to cessation of water delivery to the northern wildlife ponds is expected to result in increases in dissolved constituent concentrations within chloroform and nitrate plumes.

Furthermore, the mere presence of the lined tailings cells as barriers to natural recharge and exchange of gas with the atmosphere may result in changes in perched water chemistry. Any such changes are likely to be relatively slow and in one direction, potentially yielding long term trends in parameter values.

The perched groundwater chemistry at the Mill is also expected to be impacted by the following factors:

- 1. The relatively low permeability of the perched zone. This condition increases groundwater residence times and the time available for groundwater to react with the formation.
- 2. The location of the perched system between two shales, the underlying Brushy Basin Member of the Morrison Formation and the overlying Mancos Shale. Both are potential sources of numerous dissolved constituents.
- 3. The rate of interaction between the shales and the perched water. Interaction with the Mancos Shale at any particular location will depend on the presence, thickness, and composition of the Mancos, the rate of recharge through the Mancos into the perched zone, and the saturated thickness and rate of groundwater flow in the perched zone. Interaction with the Brushy Basin Member at any particular location will depend on the composition of the Brushy Basin, and the saturated thickness and rate of flow in the perched zone. Oxygen introduced into site monitoring wells may also react with the Brushy Basin and affect overlying perched water chemistry.
- 4. The rate of oxygen introduction into the perched zone via recharge or via site groundwater monitoring wells. Introduced oxygen is available to oxidize constituents such as pyrite, which impacts the local groundwater chemistry near each recharge source and near each well by releasing acid and sulfate. The resulting increased acidity can also destabilize various mineral phases in the aquifer matrix. The degree of impact on groundwater chemistry will depend on the amount of pyrite, the rate of oxygen transfer, the neutralization capacity and saturated thickness of the perched zone, and the rate of groundwater flow.
- 5. Elements other than iron and sulfur as contaminants in pyrite. Pyrite reacting with oxygen introduced into the formation will release these elements, potentially altering both the vadose zone and the groundwater chemistry. The potential for pyrite to have significant contaminants (such as selenium) is enhanced by it's origin from fluids expelled from the Mancos.

Changes in perched zone constituent concentrations and pH are therefore expected to result from the introduction of oxygen into the subsurface, the oxidation of pyrite and other constituents, changes in recharge rates, and past and current recharge passing through the Mancos Shale.

Decreasing trends in pH accompanied by increasing sulfate concentrations in MW-series wells that were OOC for pH were determined to result from oxidation of pyrite based on screening-level calculations and geochemical modeling presented in HGC (2012c). The calculations also indicated that pyrite existed in sufficient quantity to maintain these trends provided sufficient oxygen was available.

6.1 Perched Water Pore Velocities in the Nitrate Plume Area

Perched water pore velocities and travel times calculated within the nitrate plume along Path 1 (Figure 27) yield an estimated average pore velocity of approximately 21 ft/yr and a travel time of approximately 60 years, based on a first quarter, 2014 hydraulic gradient of 0.028 ft/ft.

Historic hydraulic gradients within the area of the nitrate plume were likely much larger than 0.028 ft/ft during the time prior to Mill construction when the historical pond was active (Figure 1B). Based on historic water levels in the vicinities of MW-30 and MW-31, located along the downgradient margin of tailings cell 2 (Appendix D), and at the downgradient margin of the nitrate plume, an historic hydraulic gradient is estimated as approximately 0.048 ft/ft. This is more than four times the overall average site hydraulic gradient of approximately 0.011 ft/ft (calculated between TWN-19 and Ruin Spring).

Using the historic hydraulic gradient of 0.048 ft/ft, the estimated historic pore velocity downgradient of the historical pond is approximately 35 ft/yr, implying that nitrate originating from the historical pond could have migrated to the downgradient edge of cell 2 within 63 years. Assuming the historical pond was active by 1920, that nitrate was conservative, and ignoring hydrodynamic dispersion, nitrate originating from the historical pond could have reached the vicinities of MW-30 and MW-31 by 1983.

6.2 Perched Water Pore Velocities in the Chloroform Plume Area

Perched water pore velocities and travel times within the chloroform plume area along Paths 2A and 2B (Figure 27) were calculated based on first quarter, 2014 hydraulic gradients of 0.0275 ft/ft and 0.0262 ft/ft, respectively. The estimated average pore velocity along Path 2A is approximately 76 ft/yr, implying that approximately 16 years would be required to traverse Path 2A. The estimated average pore velocity along Path 2B is approximately 38 ft/yr, implying that approximately 2B is approximately 38 ft/yr, implying that provide the traverse Path 2B.

Historic hydraulic gradients within the northern (upgradient) areas of the eastern portion of the chloroform plume (prior to about 1990) were likely larger and contributed to relatively rapid movement of chloroform from the abandoned scale house leach field (located immediately north of TW4-18) to MW-4 where chloroform was detected in 1999. Based on historic water levels (Appendix D) the hydraulic gradient between the abandoned scale house leach field and MW-4 is estimated as approximately 0.048 ft/ft in 1990 and approximately 0.029 ft/ft in 1999, averaging 0.038 ft/ft. This is more than three times the overall average site hydraulic gradient of approximately 0.011 ft/ft (calculated between TWN-19 and Ruin Spring) and is approximately

the same as current hydraulic gradients at the leading edge of the southeastern portion of the chloroform plume.

The historic hydraulic gradient implies an average pore velocity prior to 1999 of approximately 84 ft/yr, sufficient for chloroform to have migrated from the abandoned scale house leach field to MW-4 between 1978 and 1999. This calculation implies that chloroform could have migrated nearly to TW4-4 by 1999.

6.3 Hydrogeology and Perched Water Pore Velocities in the Southwest Area

Investigation of the southwest area of the site, including seeps and springs (HGC, 2012b), indicates that permeabilities in the southwest portion of the site are on average lower than previously estimated (as for example in HGC, 2009), and that perched water discharges to Westwater Seep and Ruin Spring, but there is no evidence for a direct hydraulic connection between the perched water zone and Cottonwood Seep. The hydraulic test and water level data also demonstrate that the perched zone southwest of cell 4B is inadequate as a primary supply to Cottonwood Seep by several orders of magnitude and that that the primary source of Cottonwood Seep lies elsewhere. However, a hypothetical connection between the perched zone near piezometer DR-8 and Cottonwood Seep is postulated for the purposes of calculating perched water travel times and to allow for the possibility that an as yet unidentified connection may exist

Important results of the southwest area investigation are:

- 1. The Brushy Basin Member erosional paleosurface in the southwest area of the Mill site is dominated by a paleoridge extending from beneath Cell 4B to abandoned boring DR-18 (Figure 8). The paleoridge is flanked to the west by a north-south trending paleovalley oriented roughly parallel to the western mesa rim (Figure 8).
- 2. The southwest area of the Mill site is characterized by generally low saturated thicknesses, low permeabilities, and relatively shallow hydraulic gradients. This is illustrated in Table 1 and Figure 14. Hydraulic gradients in the southwest portion of the site are typically close to 0.1 ft/ft, but are less than approximately 0.005 ft/ft west/southwest of tailings Cell 4B, between Cell 4B and DR-8.
- 3. The paleotopography of the Brushy Basin Member erosional surface has a greater influence on perched water flow in the southwest portion of the site than other areas because of the low saturated thicknesses and dry areas associated with the paleoridge extending south-southwest from the tailings cells (Figures 8, 14, 18, and 19).
- 4. The low transmissivities implied by the low permeabilities and low saturated thicknesses combined with the shallow hydraulic gradients imply low rates of perched water flow in the southwest portion of the site. Calculated average pore velocities along Pathlines 3, 5,

and 6 (Figure 27) from tailings cells to known discharge points Westwater Seep and Ruin Spring range from 0.60 ft/yr to 0.91 ft/yr, and travel times from 3,230 to 19,650 years based on first quarter, 2014 water level data. If vadose zone travel times from the base of the tailings cells to the perched water are included, the range of calculated travel times is 3,470 to 19,900 years.

- 5. The estimated travel time from the tailings cells to the vicinity of DR-8 (Path 4) is approximately 15,850 years based on first quarter, 2014 water level data and a calculated pore velocity of 0.26 ft/yr. Including the vadose travel time of approximately 250 years yields a total travel time of 16,100 years. Assuming a hypothetical pathway to Cottonwood Seep, the time to travel along Path 4 and thence along the potential pathway from the edge of Path 4 to Cottonwood Seep (which adds approximately 2,150 horizontal feet) is expected to be significantly greater than 16,100 years.
- 6. Brushy Basin Member paleotopography influences the locations of Westwater Seep and Ruin Spring; both are located in paleovalleys within the Brushy Basin Member paleosurface (Figure 8).
- 7. Local recharge is needed to explain areas of relatively large saturated thickness that supply Westwater Seep and Ruin Spring, because lateral flow into these areas from upgradient low saturated thickness portions of the perched zone is inadequate. The calculated perched zone recharge rate in the approximate 175 acre area southwest of Westwater Seep (near DR-2 [abandoned] and DR-5) is approximately 0.0011 in/yr.
- 8. The perched water system in the southwestern portion of the site is inadequate as the primary supply to Cottonwood Seep by several orders of magnitude. Therefore the primary source(s) of Cottonwood Seep must lie elsewhere.

6.4 Fate of Chloroform and Nitrate

Natural attenuation of nitrate and chloroform in the perched water is expected to result from physical processes that include dilution by recharge and hydrodynamic dispersion. Volatilization is another physical process that is expected to lower chloroform concentrations in perched water. Mass reduction processes expected to lower both nitrate and chloroform concentrations include chemical and biologically-mediated processes. These processes include reduction of nitrate by pyrite, and anaerobic reductive dechlorination of chloroform.

Both nitrate and chloroform plumes are under remediation by pumping. Pumping acts to reduce nitrate and chloroform mass as rapidly as is practical, allowing natural attenuation to be more effective.

The nearest potential discharge points for nitrate originating from the nitrate plume are Westwater Seep and Ruin Spring, both located downgradient of the tailings cell complex at the site. The nearest potential discharge points for chloroform are Ruin Spring and ultimately Corral Springs for the southeastern portion of the plume. Corral Springs is located downgradient of the eastern portion of the chloroform plume and cross-gradient of the tailings cell complex. Calculations of perched water flow rates indicate that thousands of years will be required for perched water at the downgradient margins of the tailings cells to reach a discharge point. Because both chloroform and nitrate plumes are more distant from discharge points than the tailings cell complex, even more time would be required for chloroform or nitrate to reach a discharge point. This is more than sufficient time for any residual chloroform or nitrate within the respective plumes to be attenuated through physical, chemical, and/or biological processes.

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8. LIMITATIONS STATEMENT

The opinions and recommendations presented in this report are based upon the scope of services and information obtained through the performance of the services, as agreed upon by HGC and the party for whom this report was originally prepared. Results of any investigations, tests, or findings presented in this report apply solely to conditions existing at the time HGC's investigative work was performed and are inherently based on and limited to the available data and the extent of the investigation activities. No representation, warranty, or guarantee, express or implied, is intended or given. HGC makes no representation as to the accuracy or completeness of any information provided by other parties not under contract to HGC to the extent that HGC relied upon that information. This report is expressly for the sole and exclusive use of the party for whom this report was originally prepared and for the particular purpose that it was intended. Reuse of this report, or any portion thereof, for other than its intended purpose, or if modified, or if used by third parties, shall be at the sole risk of the user.

TABLES

TABLE 1	
Results of Slug test Analyses Using KGS and Bouwer-Rice Solutions	

		Aut	omatically Logged	Data	Hand Collected Data				
		К	GS	Bouwer-Rice	K	GS	Bouwer-Rice		
Test	Saturated	К	Ss	К	К	Ss	К		
	Thickness	(cm/s)	(1/ft)	(cm/s)	(cm/s)	(1/ft)	(cm/s)		
TWN-1	54	1.70E-04	2.22E-03	NI	1.97E-04	1.25E-03	1.36E-04		
TWN-3	60	8.56E-06	8.73E-06	2.23E-05 8.97E-06	2.04E-05	1.10E-04	2.73E-05		
TWN-4	85	1.76E-03	3.43E-04	2.79E-05	1.25E-03	1.84E-06	NI		
TWN-5	77	4.88E-04	3.88E-07	4.06E-04	4.88E-04	3.88E-07	3.70E-04		
TWN-6	79	1.74E-04	2.22E-03	NI	3.50E-04	2.22E-12	3.36E-04		
TWN-7	11	3.57E-07	2.22E-03	4.59E-07	3.57E-07	2.21E-03	NI		
TWN-8	80	1.51E-04	3.66E-04	7.55E-05	4.73E-04	1.41E-06	2.48E-04		
TWN-9	29	2.99E-05	6.92E-03	2.86E-05	6.02E-05	5.59E-03	7.93E-05		
TWN-10	20	3.83E-05	0.1	2.31E-05	8.71E-05	8.12E-03	1.10E-04		
TWN-11	68	1.18E-04	1.08E-05	9.83E-05	9.34E-05	7.18E-05	9.78E-05		
TWN-12	67	8.05E-05	4.65E-05	7.69E-05	1.28E-04	1.27E-07	7.39E-05		
TWN-13	68 57	2.62E-06	0.1	4.77E-06	2.09E-06	0.1	5.93E-06		
TWN-14	58	4.75E-05	0.39E-03	2.74E-00	5.96E-05	3.17E-03	7.93E-00		
TWN-16	41	0.0142	8.02E-04	6.47E-03	0.00E-03	0.45E-04	0.42E-03		
TWN-17	69	3.73E-06	0.033	6.18E-06	1.41E-06	0.061	1.96E-06		
TWN-18	83	2.27E-03	2.44E-06	1.14E-03	2.67E-03	2.22E-12	NI		
TWN-19	50	2.69E-05	2.49E-03	1.81E-05	3.83E-05	3.34E-03	NI		
MW-03 (mlt; pssc)	5.2	4.00E-07	1.92E-02	1.50E-05					
MW-05 (It; pssc)	10	3.50E-06	4.40E-03	3.90E-06	3.20E-06		4.30E-06		
MW-17	18	2.60E-05	1.71E-04	2.40E-05	2.20E-05		3.00E-05		
MW-18	58	2.90E-04	4.60E-07	2.40E-04	3.20E-04		2.50E-04		
MW-19	80	1.70E-05	1.44E-06	1.30E-05	1.20E-05		1.50E-05		
MW-19, commed MW-20 (mlt: pssc)	4/	1.00E-05	3.∠4⊑-06	9.30E-05					
MW-20 (mlt)	12			<u>5.90E-0</u> 6			2.50E-06		
MW-22 (pscc)	51	1.00E-06	2.00E-03	7.90E-06	9.00E-07				
MW-22	10		0.1	4.40E-06	KU .	N II	3.40E-06		
IVIVV-23 MW/-23h	12	3.20E-08		1.00E-06		NI NI			
WW-230	34	2.30E-07	2.30E-03	2.50E-07 3.15E-05	3.03E-05	0.0152	2.00E-07		
MW-25	33	1.10E-04	3.00E-04	7.40E-05	1.70E-04	2.00E-04	1.00E-04		
MW-27	36	8.20E-05	5.30E-04	3.60E-05	1.40E-04	8.70E-05	3.10E-05		
MW-28	23	1.70E-06	0.02	1.70E-06	1.70E-06	0.02	2.00E-06		
MW-29	18	1.10E-04	1.90E-04	9.30E-05	1.30E-04	2.10E-04	1.00E-04		
MW-30 MW-31	24 53	1.00E-04 7.10E-05	2.90E-04	6.40E-05	1.10E-04 7.40E-05	1.40E-04 7.20E-06	5.10E-05		
MW-32	46	3.00E-05	8.80E-05	2.60E-05	2.80E-05	2.50E-04	3.00E-05		
MW-35	12	3.48E-04	1.95E-05	2.18E-04	2.59E-04	1.78E-05	1.65E-04		
MW-36	6.2	4.51E-04	4.29E-04	NA	7.73E-04	2.66E-04	6.52E-04		
MW-36 (It) MW-36 (et)	6.2	NA NA	NA	1.84E-04 5.07E-04	NA NA	NA NA	NA NA		
MW-30 (et) MW-37	2.9	1.28E-05	2.22E-12	1.21E-05	NA	NA	NA		
TW4-4 (et)	22	NA	NA	1.26E-03	NA	NA	NA		
TW4-4 (lt)	22	1.66E-03	6.21E-05	2.89E-04	1.63E-03	3.01E-04	7.91E-04		
TW4-6 TW4-20	24 43	1.15E-05 5.90E-05	3.67E-05	1.00E-05 4.20E-05	7.00E-05	1.49E-04 1.20E-05	1.32E-05 5.30E-05		
TW4-21	63	1.90E-04	1.10E-04	3.20E-05	1.90E-04	3.20E-05	9.40E-06		
TW4-22	55	1.30E-04	6.80E-06	1.10E-04	1.30E-04	4.50E-06	1.10E-04		
TW4-23	43	3.80E-05	7.40E-03	2.90E-05	3.40E-01	6.40E-04	7.90E-05		
TW4-24	53	1.60E-04	1.10E-03	1.00E-04	1.20E-04	1.70E-03	5.20E-05		
TW4-25	89 18	5.80E-05	0.001 3.23E-04	3.70E-05	7.40E-05	1.10E-03	5.00E-05		
TW4-20 TW4-27 (uncorrected)	10	2.40E-03	5.23E-04 NA	2.16E-05 NA	2.13E-05	1.51E-04	1.59E-06		
TW4-27 (100% correction)	9	7.01E-07	2.22E-03	1.99E-06	NA	NA	NA		
TW4-27(60% correction)		1.35E-06	1.27E-03	1.15E-06	NA	NA	NA		
TW4-28	67.9	3.52E-04	1.22E-06	3.92E-04	3.29E-04	7.49E-06	4.07E-04		
TW4-29	17.7	4.24E-05 NA	1.19E-03 NA	2.00E-05	4.52E-05	9.62E-04 NA	3.80E-05		
TW4-30	9.6	1.44E-04	1.00E-02	6.22E-05	1.34E-04	1.00E-02	1.38E-04		
TW4-30 (et)	9.6	NA	NA	1.63E-04	NA	NA	2.91E-04		
TW4-30 (lt)	9.6	NA	NA	1.12E-05	NA	NA	1.41E-05		
TW4-31	18.1	4.18E-05	2.54E-05	3.87E-05	3.24E-05	9.65E-05	4.01E-05		
TW4-32(et)	64.8	9.03E-05 NA	NA	1.09F-04	0.34E-05 NA	7.97E-04 NA	1.34F-04		
TW4-32(lt)	64.8	NA	NA	2.51E-05	NA	NA	1.17E-05		
TW4-33	13.1	5.51E-05	3.73E-04	5.78E-05	5.25E-05	5.32E-04	5.76E-05		
TW4-34	25.2	9.98E-05	1.13E-03	1.54E-04	9.39E-05	1.54E-03	1.25E-04		
TW4-34 (lt)	25.2	NA 0.055.05	NA	1.17E-04	NA	NA	NA 0 705 05		
	12.3	2.95E-05	4.21E-05	3.80E-05	2.80E-05	2.05E-03	3.76E-05		
DR-6, OCI 2012	7.0	2.40E-00 3.40E-08	1.00E-02	3.36E-07	4.40E-00	0.0011	4.45E-07		
DR-9	24.5	4 49F-04	4.30E-06	3 41F-04	4 73E-04	1.21E-05	4 73E-04		
DR-10	3	2.92E-06	6.54E-03	5.56E-06	9.71E-06	8.41E-04	9.71E-06		
DR-11	8.9	8.88E-06	8.88E-04	1.54E-05	5.83E-06	2.22E-03	1.11E-05		
DR-13	11.2	5.90E-06	7.33E-05	5.38E-06	4.93E-06	1.57E-04	1.49E-06		
DR-13(et)	11.2	NA	NA	NA	NA	NA	6.81E-06		
DR-14	18.8	1.26E-05	7.34E-05	1.66E-05	7.78E-06	4.84E-04	6.18E-06		
DR-14(et)	18.8	NA	NA	NA	NA	NA	1.23E-05		
DR-17	6.5	1.24E-05	1.53E-04	1.43E-05	3.17E-06	5.00E-03	2.19E-06		
DR 10	6.5	NA 0.005.05	NA DE4E 00	NA	NA	NA	8.35E-06		
DR-19	3.5	3.29E-05	2.54E-03	3.78E-05	3.39E-05	1.86E-03	4.08E-05		
טבירום DR-21	13.5	2.14E-Ub	1.91E-05 7 17E-06	2.09E-00 3.60E-05	2 21F-05	1.90E-05	1.09E-UD		
DR-23	7.5	1.96F-05	3.85F-04	2.35F-05	7.49F-06	5.00F-03	4.51F-06		
DR-23(et)	7.5	NA	NA	NA	NA	NA	2.16E-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:

 $\textit{Bouwer-Rice} = \textit{Unconfined Bouwer-Rice solution method in Aqtesolv} ~^{\mathsf{TM}} \textit{ unless otherwise noted}$

cm/s = centimeters per second

ft = feet

K = hydraulic conductivity $KGS = Unconfined KGS solution method in Aqtesolv^{TM} unless otherwise noted$

Ss= specific storage

NI= Not Interpretable .

et= early time data mlt=middle to late time data

lt=late time data

pssc=partially submerged screen correction used for Bouwer-Rice solution NA=not applicable

TABLE 2Results of Recovery and Slug Test Analyses Using Moench Solution

				Automatically	/-Logged Data		Hand Data
Well ID	Interpretation Method	Туре	Hydraulic Conductivity (cm/sec)	Storativity	Saturated Thickness (feet)	Skin	Hydraulic Conductivity (cm/sec)
	WHIP	pump/recovery	7.70E-07	0.0082	20	none	7.70E-07
MW-01	AQTESOLV (Moench, Leaky)	pump/recovery	7.70E-07	0.0082	20	none	7.70E-07
	AQTESOLV (Moench, Unconfined)	pump/recovery	8.90E-07	0.01	40	none	
MW-03	WHIP	slug	4.30E-05	0.01	5.2	none	
MW-05	WHIP	slug	1.10E-05	0.1	10	none	
MW-17	WHIP	slug	2.90E-05	0.01	18	none	
MW-18	WHIP	slug	4.40E-04	2.20E-05	45	none	
10100-10	WHIP	slug	5.30E-04	0.02	45	6.54	
	WHIP	slug	7.10E-06	0.032	47	none	
MW-19	WHIP	slug	1.70E-05	0.027	47	2.24	
	AQTESOLV (Moench, Leaky)	slug	1.70E-05	0.027	47	2.24	
MW-20	WHIP	slug	8.20E-06	0.02	12	none	
MW-22	WHIP	slug	4.20E-06	0.014	51	none	

Notes:

cm/sec = Centimeters per second

WHIP analyses via modfied Moench Leaky Solution

TABLE 3Estimated Perched Zone Hydraulic Properties Based onAnalysis of Observation Wells Near MW-4 and TW4-19 During Long Term Pumping of MW-4 and TW4-19

Observation Well	Theis Solution (Confined or Unconfined)	Transmissivity (ft ² /day)	Storage Coefficient	Water Bearing Zone Thickness (feet)	Average Hydraulic Conductivity (ft/day)	Average Hydraulic Conductivity (cm/sec)	
TW/4_1	Unconfined	8.9	0.023	39	0.23	8.20E-05	
1 00 4-1	Confined	8.4	0.023	24	0.35	1.30E-04	
TW/4-2	Unconfined	4.6	0.0065	39	0.12	4.30E-05	
1004-2	Confined	3.8	0.0063	24	0.16	5.70E-05	
TW/4-7	Unconfined	4.7	0.011	39	0.12	4.30E-05	
1 1 1 4-7	Confined	3.3	0.011	24	0.14	5.00E-05	
	Unconfined	4.5	0.010	39	0.12	4.30E-05	
1 1 1 4-0	Confined	3.9	0.010	24	0.16	5.70E-05	
	Unconfined	5.8	0.019	39	0.15	5.40E-05	
10100-475	Confined	3.5	0.019	24	0.15	5.40E-05	
MW-4A	Unconfined	12.4	0.0029	39	0.32	1.10E-04	
(early time)	Confined	9.1	0.0031	24	0.38	1.40E-04	
TW/4_5	Unconfined	89	0.0043	67	1.3	4.60E-04	
1004-5	Confined	87	0.0043	31	2.8	1.00E-03	
	Unconfined	72	0.0043	67	1.1	3.90E-04	
1 1 1 4-9	Confined	71	0.0043	31	2.3	8.20E-04	
TW/4 10	Unconfined	48	0.0077	67	0.72	2.60E-04	
1004-10	Confined	46	0.0076	31	1.5	5.40E-04	
TW/4 15	Unconfined	15	0.0037	67	0.22	7.90E-05	
1004-15	Confined	12	0.0037	31	0.39	1.40E-04	
TW/4 16	Unconfined	19	0.0036	67	0.28	1.00E-04	
1 1 1 4-10	Confined	18	0.0035	31	0.58	2.10E-04	

TABLE 3Estimated Perched Zone Hydraulic Properties Based onAnalysis of Observation Wells Near MW-4 and TW4-19 During Long Term Pumping of MW-4 and TW4-19

Observation Well	Theis Solution (Confined or Unconfined)	Transmissivity (ft ² /day)	Storage Coefficient	Water Bearing Zone Thickness (feet)	Average Hydraulic Conductivity (ft/day)	Average Hydraulic Conductivity (cm/sec)
TW4-18	Unconfined	76	0.0046	67	1.1	3.90E-04
	Confined	74	0.0046	31	2.4	8.60E-04
TW/4-19	Unconfined	44	0.12	67	0.66	2.40E-04
1004-19	Confined	39	0.12	31	1.3	4.60E-04

Notes:

cm/sec = Centimeters per secondft/day = Feet per day $ft^2/day = Feet squared per day$

TABLE 4 Summary of Hydraulic Properties White Mesa Uranium Mill from TITAN (1994)

Boring/ Well Location	Test Type	Interval (ft-ft)	Document Referenced	Hydraulic Conductivity (ft/yr)	Hydraulic Conductivity (cm/sec)
Soils					
6	Laboratory Test	9	D&M	1.20E+01	1.20E-05
7	Laboratory Test	4.5	D&M	1.00E+01	1.00E-05
10	Laboratory Test	4	D&M	1.20E+01	1.20E-05
12	Laboratory Test	9	D&M	1.40E+02	1.40E-04
16	Laboratory Test	4.5	D&M	2.20E+01	2.10E-05
17	Laboratory Test	4.5		9.30E+01	9.00E-05
19	Laboratory Test	4	Daivi	7.00E+01	0.00E-00
22	Laboratory rest	4	Geometric Mean	2 45E+01	2.37E-05
Dakota Sandstone				2.102101	2.07 2 00
No. 3	Injection Test	28-33	D&M (1)	5.68E+02	5.49E-04
No. 3	Injection Test	33-42.5	D&M	2.80E+00	2.71E-06
No. 12	Injection Test	16-22.5	D&M	5.10E+00	4.93E-06
No. 12	Injection Test	22.5-37.5	D&M	7.92E+01	7.66E-05
No. 19	Injection Test	26-37.5	D&M	7.00E+00	6.77E-06
No. 19	Injection Test	37.5-52.5	D&M	9.44E+02	9.12E-04
			Geometric Mean	4.03E+01	3.89E-05
Burro Canyon Formation	Injection Test				
NO. 3	Injection Test	42.0-02.0	Daivi	3.60E+00	3.01E-06 1.57E.05
No. 3	Injection Test	63-72 5	D&M	5 30E+00	1.57E-05 5.13E-06
No. 3	Injection Test	72 5-92 5		3 20E+00	3.09E-06
No. 3	Injection Test	92 5-107 5	D&M	4 90E+00	4 74E-06
No. 3	Injection Test	122.5-142	D&M	6.00E-01	5.80E-07
No. 9	Injection Test	27.5-42.5	D&M	2.70E+00	2.61E-06
No. 9	Injection Test	42.5-59	D&M	2.00E+00	1.93E-06
No. 9	Injection Test	59-82.5	D&M	7.00E-01	6.77E-07
No. 9	Injection Test	82.5-107.5	D&M	1.10E+00	1.06E-06
No. 9	Injection Test	107.5-132	D&M	3.00E-01	2.90E-07
No. 12	Injection Test	37.5-57.5	D&M	9.01E-01	8.70E-07
No. 12	Injection Test	57.5-82.5	D&M	1.40E+00	1.35E-06
No. 12	Injection Test	82.5-102.5	D&M	1.07E+01	1.03E-05
No. 28	Injection Lest	76-87.5	D&M	4.30E+00	4.16E-06
No. 28	Injection Test	87.5-107.5	D&M	3.00E-01	2.90E-06
NO. 28	Injection Test	107.5-132.5	D&IVI Deel (2)	2.00E-01	1.93E-07
	(7) Recovery (7) Recovery	92-112		3.00E+00	2.900-06
WMMW5	(7) Recovery	95 5-133 5	H-F	2.97 L+00	2.07 E-00 1 27E-05
WMMW5	(7) Recovery	95 5-133 5	Peel	2 10F+01	2.03E-05
WMMW11	(7) Recovery	90.7-130.4	H-E (3)	1.23E+03	1.19E-03
WMMW11	(7) Single Well Drawdown	90.7-130.4	Peel	1.63E+03	1.58E-03
WMMW12	(7) Recovery	84-124	H-E	6.84E+01	6.61E-05
WMMW12	(7) Recovery	84-124	Peel	6.84E+01	6.61E-05
WMMW14	Single Well Drawdown	90-120	(5) H-E	1.21E+03	1.16E-03
WMMW14	Single Well Drawdown	90-120	(6) H-E	4.02E+02	3.88E-04
WMMW15	Single Well Drawdown	99-129	H-E	3.65E+01	3.53E-05
WMMW15	(7) Recovery	99-129	Peel	2.58E+01	2.49E-05
WMMW16	Injection Test	28.5-31.5	Peel	9.42E+02	9.10E-04
WMMW16	Injection Test	45.5-51.5	Peel	5.28E+01	5.10E-05
	Injection Test	65.5-71.5	Peel	8.07E+01	7.80E-05
	Injection Test	85.5-91.5	Peel	3.00E+01	2.90E-05
	Injection Test	40-00	Peel	3.10E+00	3.00E-06
	Injection Test	90-95 100-105	Pool	5.02E+00	5.50E-06
WMMW18	Injection Test	27-32	Peel	1 14F±02	1 10E-04
WMMW18	Injection Test	85-90	Peel	2 59E+01	2 50E-05
WMMW18	Injection Test	85-90	Peel	2.69E+01	2.60E-05
WMMW18	Injection Test	120-125	Peel	4.66E+00	4.50E-06
WMMW19	Injection Test	55-60	Peel	8.69E+00	8.40E-06
WMMW19	Injection Test	95-100	Peel	1.45E+00	1.40E-06
			Geometric Mean	1.05E+01	1.01E-05
Entrada/Navaio Sandstones					
WW-1	Recoverv		D'Appolonia (4)	3.80F+02	3.67F-04
WW-1	Multi-well drawdown		D'Appolonia	4.66E+02	4.50E-04
WW-1,2,3	Multi-well drawdown		D'Appolonia	4.24E+02	4.10E-04
			Geometric Mean	4.22E+02	4.08E-04

Notes

(1) D&M = Dames & Moore, Environmental Report, White Mesa Uranium Project, January 1978.

(2) Peel = Peel Environmental Services, UMETCO Minerals Corp., Ground Water Study, White Mesa Facility, June 1994.

(3) H-E = Hydro-Engineering, Ground-Water Hydrology at the White Mesa Tailings Facility, July 1991.

(4) D'Appolonia, Assessment of the Water Supply System, White Mesa Project, Feb. 1981.

(5) Early test data.

(6) Late test data.

(7) Test data reanalyzed by TEC.

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TABLE 5 Properties of the Dakota/Burro Canyon Formation White Mesa Uranium Mill from TITAN (1994)

Formation	Well No. and Sample Interval	% Moisture Content	Moisture Content, Volumetric	Dry Unit Weight (Ibs/cu ft)	% Porosity	Particle Specific Gravity	% Saturation	% Retained Moisture	% Liquid Limit	% Plastic Limit	% Plasticity Index	Rock Type
Dakota	WMMW-16 26.4' - 38.4'	1.50	3.30	135.20	17.90	2.64	18.20	5.10				Sandstone
	WMMW-16 37.8' - 38.4'	0.40	0.80	127.40	22.40	2.63	3.70	6.30				Sandstone
	WMMW-17 27.0' - 27.5'	0.30	0.60	138.80	13.40	2.57	4.80	5.10				Sandstone
	WMMW-17 49.0' - 49.5'	3.60	7.10	121.90	26.00	2.64	27.20	9.60				Sandstone
	Formation Average:	1.45	2.95	130.83	19.93	2.62	13.48	6.53				
Burro Canyon	WMMW-16 45.0' - 45.5'	5.60	12.60	140.90	16.40	2.70	77.20		29.60	15.40	14.20	Sandy Mudstone
	WMMW-16 47.5' - 48.0'	2.60	5.90	142.80	12.00	2.60	48.90	4.40				Sandstone
	WMMW-16 53.5' - 54.1'	0.70	1.40	129.00	19.90	2.58	7.10	6.40				Sandstone
	WMMW-16 60.5' - 61.0'	0.10	0.20	117.90	27.30	2.61	0.80	9.90				Sandstone
	WMMW-16 65.5' - 66.0'	2.60	5.50	131.50	19.30	2.62	28.20	7.10				Sandstone
	WMMW-16 73.0' - 73.5'	0.10	0.30	130.30	20.60	2.63	1.30	5.50				Sandstone
	WMMW-16 82.0' - 82.4'	0.10	0.10	134.30	18.50	2.64	0.60	4.80				Sandstone
	WMMW-16 90.0' - 90.7'	0.10	0.30	161.50	2.00	2.64	12.80	0.90				Sandstone
	WMMW-16 91.1' - 91.4'	5.20	9.80	118.10	29.10	2.67	33.80		33.70	16.20	17.50	Claystone
	WMMW-17 104.0' - 104.5	0.20	0.40	161.40	1.70	2.67	26.60	0.80				Sandstone*
	Formation Average:	1.90	4.01	134.03	18.34	2.63	23.41	5.57				

Note:

*Data from this interval is actually from the Brushy Basin and is not included in the averages.

TABLE 6 Hydraulic Conductivity Estimates For Spring Flow Calculations

Ruin S	Spring	Westwat	ter Seep	Westwate	r Seep (2)
location	k (cm/s)	location	k (cm/s)	location	k (cm/s)
DR-21	3.29E-05	DR-5	2.95E-05	DR-5	2.95E-05
DR-23	1.96E-05	DR-8	2.46E-08	MW-23	2.30E-07
DR-24	1.64E-05	DR-9	4.49E-04	MW-24	4.16E-05
		DR-10	2.92E-06	MW-35	3.48E-04
		DR-11	8.88E-06		
		MW-12	2.20E-05		
		MW-23	2.30E-07		
		MW-24	4.16E-05		
		MW-36	4.51E-04		
geomean:	2.19E-05	geomean:	9.76E-06	geomean:	1.77E-05

Notes:

k = hydraulic conductivity

cm/s = centimeters per second

TABLE 7Hydraulic Conductivity Estimates For Travel Time CalculationsPaths 1, 2A, and 2B

PAT	FH 1	PAT	H 2A	PAT	H 2B
location	k (cm/s)	location	k (cm/s)	location	k (cm/s)
TWN-2 TWN-3 TWN-18 TW4-21 TW4-22 TW4-24 MW-11 MW-30 MW-31	1.49E-05 8.56E-06 2.27E-03 1.90E-04 1.30E-04 1.60E-04 1.40E-03 1.00E-04 7.10E-05	TW4-5 u TW4-5 c TW4-9 u TW4-9 c TW4-10 u TW4-10 c TW4-18 u TW4-18 c TW4-19 u TW4-19 c	4.60E-04 1.00E-03 3.90E-04 8.20E-04 2.60E-04 5.40E-04 3.90E-04 8.60E-04 2.40E-04 4.60E-04	TW4-2 u TW4-2 c MW-4A u MW-4A c TW4-5 u TW4-5 c TW4-9 u TW4-9 c TW4-10 u TW4-10 c	4.30E-05 5.70E-05 1.10E-04 1.40E-04 4.60E-04 1.00E-03 3.90E-04 8.20E-04 2.60E-04 5.40E-04
				I W4-28	3.52E-04
geomean:	1.31E-04	geomean:	4.88E-04	geomean:	2.53E-04

Notes:

k = hydraulic conductivity

cm/s = centimeters per second

c = *confined solution*

 $u = unconfined \ solution$

TABLE 8 Hydraulic Conductivity Estimates for Travel Time Calculations Paths 3-6

PATHS	3 and 4	PAT	TH 5	PAT	TH 6
location	k (cm/s)	location	k (cm/s)	location	k (cm/s)
DR-5	2.95E-05	DR-5	2.95E-05	DR-11	8.88E-06
DR-8	2.46E-08	DR-8	2.46E-08	DR-13	5.89E-06
DR-9	4.49E-04	DR-9	4.49E-04	DR-21	3.29E-05
DR-10	2.92E-06	DR-10	2.92E-06	DR-23	1.54E-05
DR-11	8.88E-06	DR-11	8.88E-06	MW-3	4.00E-07
MW-12	2.20E-05	DR-14	1.26E-05	MW-14	7.50E-04
MW-23	2.30E-07	DR-17	1.24E-05	MW-15	1.90E-05
MW-24	4.16E-05	DR-19	3.29E-05	MW-20	9.30E-06
MW-36	4.51E-04	DR-20	2.14E-06	MW-37	1.28E-05
		DR-21	3.29E-05		
		DR-23	1.96E-05		
		DR-24	1.64E-05		
		MW-23	2.30E-07		
		MW-24	4.16E-05		
		MW-36	4.51E-04		
	0.765.06	400 m c	1 105 05	#00 mc	1 295 05
geomean:	9.760-06	geomean:	1.10E-05	geomean:	1.38E-05

Notes:

k = hydraulic conductivity *cm/s* = centimeters per second

Path	Hydraulic C	onductivity ^a	Path Length	Head Change	Hydraulic Gradient	Pore Velocity
Falli	(cm/s)	(ft/yr)	(ft)	(ft)	ft/ft	ft/yr
1	1.31E-04	134	1,250	35	0.0280	21
2A	4.88E-04	499	1,200	33	0.0275	76
2B	2.53E-04	259	1,450	38	0.0262	38
3	9.76E-06	10.0	2,200	27	0.0123	0.68
4	9.76E-06	10.0	4,125	19	0.0046	0.26
5	1.10E-05	11.3	11,800	113	0.0096	0.60
6	1.38E-05	14.1	9,685	112	0.0116	0.91

 TABLE 9

 Estimated Perched Zone Pore Velocities Along Path Lines

Notes:

^a Geometric average (from Tables 7 and 8) Assumes effective porosity of 0.18 cm/s = centimeters per second ft/ft = feet per foot ft/yr = feet per year

TABLE 10 Results of XRD and Sulfur Analysis in Weight Percent

Mineral	Formula	MW-34	MW-23	MW-24	MW-25	MW-26	MW-27	MW-28	MW-29	MW-30	MW-31	MW-32 (TW4-17)	SS-26*
Mineral	i ornidia	MW-0A	11111-20	10100-24	10110-25	11111-20	Depth	(feet)	11111-25	11111-00	11111-01	(,	00-20
		89.5	108	118.5	65 - 67.5	90 - 92.5	80 - 82.5	88.5	102	65 - 67.5	95 - 97.5	105-107.5	NA
quartz	SiO ₂	79.7	96.2	88.4	90	86.9	95.4	90.1	95.8	87	91.7	94.1	39.2
K-feldspar	KAISi ₃ O ₈	ND	0.2	0.6	2.4	2.4	0.7	1.5	0.5	1.4	2	0.8	21.6
plagioclase	(Na,Ca)(Si,Al) ₄ O ₈	ND	ND	ND	1.4	1.6	1.5	1.8	1.5	1.5	0.5	0.2	29
mica	KAI ₂ (Si ₃ AI)O ₁₀ (OH) ₂	0.3	1.2	4.5	2.2	2	0.2	3	0.2	5.9	3.1	1.2	5.2
kaolinite	Al ₂ Si ₂ O ₅ (OH) ₄	1.1	1	4.3	3.2	2.5	1.4	2.9	1.7	3.6	2.4	1.6	0.8
calcite	CaCO ₃	14	ND	ND	ND	3.9	ND	ND	ND	ND	ND	1.2	0.6
dolomite	CaMg(CO ₃) ₂	4.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
anhydrite	CaSO ₄	0.4	0.8	0.4	0.4	ND	ND	ND	ND	ND	ND	ND	ND
gypsum	CaSO ₄ ·2H ₂ O	ND	0.2	0.8	ND	ND	ND	0.3	ND	0.3	ND	ND	ND
iron	Fe	0.3	0.4	0.2	0.4	0.4	0.4	0.2	0.3	0.3	0.3	0.4	0.2
pyrite	FeS ₂	0.1	ND	0.8	ND	0.3	0.4	0.2	ND	ND	ND	0.5	ND
hematite	Fe ₂ O ₃	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.4
magnetite	Fe ₃ O ₄	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2
					Sulfur	Determinati	on						
Total S	S	0.14	0.14	0.63	0.05	0.13	0.15	0.04	0.03	0.02	0.02	0.26	0.02
equivalent FeS ₂	FeS ₂	0.3	0.3	1.2	0.1	0.2	0.3	0.1	0.1	<0.1	<0.1	0.5	<0.1

Notes:

NA = Not applicable: quality control sample ND = Not Detected

* = 'play sand'

TABLE 11Tabulation of Presence ofPyrite, Iron Oxide, and Carbonaceous Fragments in Drill Logs

Well	Pyrite	C Fragments	Iron Oxide
MW-3A			Х
^a MW-16			Х
^a MW-17			Х
^a MW-18			X
^a MW-19			Х
^a MW-20			Х
^a MW-21	Х		Х
^a MW-22			Х
MW-23			Х
MW-24			Х
MW-25	Х		Х
MW-26	Х		Х
MW-27	Х		Х
MW-28			Х
MW-29			Х
MW-30	X		X
MW-31	X		X
MW-32	X		X
MW-33			X
MW-34	X	X	X
MW-35	X	X	X
MW-36	X		X
MW-37	X		X
Piez-2			X
Piez-4	X		X
Piez-5	X		X
DB-2	X		X
DB-5	X		X
DR-6	X		X
DR-7			X
DB-8			X
DR-9	X		X
DR-10	~~~~~		X
DR-11	X		X
DR-12	X		X
DR-13	X		X
DR-14	X		X
DB-15	x x		X
DR-16	X		X
DR-17			^
DB-18	x		X
DB-19	~ ~		X
DR-20	x		X
DR-21	~ ~		X
DR-22	1		~ ~
DR-23	Y		Y
DR-24	Y Y		Y X
DR-25	A Y		× Y
	^		^ Y
TW/4-1	v		^
T\N/4 2	v v	v	• • • • • • • • • • • • • • • • • • •
T\N/4 4	^	^	^
T\\// 5	v	v	
TW4-5	v v	N V	v
1 1 1 4 - 0	∧	^	^

TABLE 11Tabulation of Presence ofPyrite, Iron Oxide, and Carbonaceous Fragments in Drill Logs

Well	Pyrite	C Fragments	Iron Oxide
TW4-7	Х	Х	X
TW4-8			X
TW4-9	Х	Х	X
TW4-10	Х	Х	
TW4-11		Х	
TW4-12	Х	Х	X
TW4-13	Х	Х	X
TW4-14			X
TW4-15	Х		X
TW4-16	Х		X
TW4-17	Х		X
TW4-18		Х	X
TW4-19			X
TW4-20			X
TW4-21	X		X
TW4-22	Х		
TW4-23	Х	Х	X
TW4-24			X
TW4-25	Х		X
TW4-26			X
TW4-27	Х		X
TW4-28	Х	X	
TW4-29	Х	X	X
TW4-30	Х	X	X
TW4-31	Х	X	X
TW4-32	X	X	X
TW4-33	X		X
TW4-34		Х	X
TWN-1			X
TWN-2	X		X
TWN-3	X		X
TWN-4			X
TWN-5	X		X
TWN-6	X		X
TWN-7			X
TWN-8	X		X
TWN-9			X
TWN-10			X
TWN-11	X		X
TWN-12	X		X
I WN-13	X		X
I WN-14	X		X
TWN-15	X		X
TWN-16	X		X
TWN-17			X
TWN-18	X		X
TWN-19	Х		X

Notes:

C Fragments = particles of carbonaceous material (plant remains, etc)

^a = only moderately detailed log available

TABLE 12 Sulfide Analysis by Optical Microscopy

				Gra	in size (microme	ters)
Sample	Depth (feet)	Mineral	Volume%	Minimum	Maximum	Mean
MW-26 (TW4-15) ¹	92.5' - 97.5'	pyrite	4.30	5.6	44.4	128.9
MW-34	67.5' - 70'	pyrite	0.30	1.1	177.8	71.1
MW-36	87.5' - 90'	pyrite	5.20	5.6	88.9	52.2
MW-36	87.5' - 90'	marcasite	0.50	22.2	488.8	121.2
MW-36	112.5' - 115'	pyrite	2.20	16.7	577.7	188.9
MW-36	112.5' - 115'	marcasite	0.20	22.2	333.3	177.8
MW-37	110' - 112.5'	pyrite	9.80	11.1	1666.5	131.1
TW4-16 ²	92.5' - 95'	pyrite	0.10	11.1	105.5	47.8
TW4-22	90' - 92.5'	pyrite	0.30	5.6	66.7	26.7
TWN-5	110' - 112.5'	pyrite	15.80	5.6	1377.6	208.9
TWN-5	112.5' - 115'	pyrite	0.50	5.6	266.6	70
TWN-5	112.5' - 115'	marcasite	0.50	22.2	55.6	36.7
TWN-5	112.5' - 115'	chalcopyrite	0.02	ND	ND	6
TWN-8	117.5' - 120'	pyrite	12.00	5.6	455.1	137.8
TWN-8	117.5' - 120'	marcasite	0.60	66.6	288.9	155.5
AWN-X2 ³	87.5' - 90'	pyrite	2.40	5.6	33.3	17.8
AWN-X2 ³	87.5' - 90'	marcasite	0.60	66.6	288.9	155.5
TWN-16 ⁴	82.5' - 85'	pyrite	0.10	1.1	11.1	6.1
TWN-16 ⁴	87.5' - 90'	pyrite	0.16	7	168	35.5
TWN-16 ⁴	87.5' - 90'	marcasite	0.05	ND	129.5	ND
TWN-19 ⁵	82.5 ' - 85'	pyrite	1.18	3.5	434	42.1
TWN-19 ⁵	82.5 ' - 85'	marcasite	0.06	21	42	36.4
DR-9	105' - 107.5'	pyrite	17.00	2.2	677.7	136.7
DR-12	87.5' - 90'	pyrite	0.30	11.1	111.1	52.2
DR-12	87.5' - 90'	marcasite	0.10	22.2	111.1	72.2
DR-16	97.5' - 100'	pyrite	2.40	5.6	33.3	17.8
DR-16	97.5' - 100'	marcasite	0.60	66.6	288.9	155.5
DR-25	75' - 77.5'	pyrite	25.00	1.1	1955	22
DR-25	75' - 77.5'	marcasite	2.50	55.6	621.6	265.5
SS-31*	NA	chalcopyrite	0.01	ND	ND	10
SS-37*	NA	pyrite	0.02	7	14	11.7

Notes:

¹ Samples from 92.5' - 95' and 95' - 97.5' combined due to small sample volume

² Sample from 92.5' - 95' submitted instead of sample from 95' - 97.5' because no sample material available

³ Originally TWN-16

⁴ Originally TWN-19

⁵ Originally TWN-22

NA = *Not* applicable: quality control sample

ND = Not determined

* = 'play sand'

Well	Pyrite Noted in Drill Logs	Pyrite Detected by Laboratory
MW-3A		X (Q)
^a MW-16		NA
^a MW-17		NA
^a MW-18		NA
^a MW-19		NA
^a MW-20	X	NA
^a MW-21	X	NA
<u>"MW-22</u>		
MW-24	Y	
MW-26	X	
MW-27	X	X (Q)
MW-28		X (Q)
MW-29		possible ^b (Q)
MW-30	Х	ND (Q)
MW-31	Х	ND (Q)
MW-32	Х	X (Q)
MW-33		NA
MW-34	Х	X (V)
MW-35	X	NA
MW-36	<u>X</u>	X (V)
<u>MW-37</u>	X	X (V)
Piez-2	X	NA
Piez-4	<u>X</u>	NA
Plez-5	<u> </u>	NA NA
DR-2	<u> </u>	NA NA
	A Y	NA NA
DR-7	A	ΝΔ
DB-8		NA
DR-9	Х	X (V)
DR-10		ŇĂ
DR-11	Х	NA
DR-12	Х	X (V)
DR-13		NA
DR-14	Х	NA
DR-15	X	NA
DR-16	X	X (V)
DR-17		NA
DR-18	Х	NA
DK-19	v	
	Α	
DR-22	Y	ΝΔ
DR-24	Ŷ	ΝΔ
DR-25	X	X (V)
TW4-1		NA
TW4-2	Х	NA
TW4-3	Х	NA
TW4-4		NA
TW4-5	Х	NA
TW4-6	X	NA
TW4-7	X	NA
TW4-8		NA
TW4-9	X	NA
TW4-10	Х	NA
TW4-11		NA

TABLE 13Summary ofPyrite in Drill Cuttings and Core

Well	Pyrite Noted in Drill Logs	Pyrite Detected by Laboratory
TW4-12	Х	NA
TW4-13	Х	NA
TW4-14		NA
TW4-15	Х	NA
TW4-16	Х	X (V)
TW4-17	Х	NA
TW4-18		NA
TW4-19		NA
TW4-20		NA
TW4-21	Х	NA
TW4-22	Х	X (V)
TW4-23	Х	NA
TW4-24		NA
TW4-25	Х	NA
TW4-26		NA
TW4-27		NA
TW4-28	Х	NA
TW4-29	Х	NA
TW4-30	Х	NA
TW4-31	Х	NA
TW4-32	Х	NA
TW4-33	Х	NA
TW4-34		NA
TWN-1		NA
TWN-2	Х	NA
TWN-3	Х	NA
TWN-4		NA
TWN-5	Х	X (V)
TWN-6	Х	NA
TWN-7		NA
TWN-8	Х	X (V)
TWN-9		NA
TWN-10		NA
TWN-11	X	NA
TWN-12	X	NA
TWN-13	Х	NA
TWN-14	X	NA
TWN-15	X	NA
TWN-16	X	X (V)
TWN-17		NA
TWN-18	Х	NA
TWN-19	X	X (V)
AWN-X1		NA
AWN-X2	Х	X (V)
AWN-X3		NA

TABLE 13 Summary of Pyrite in Drill Cuttings and Core

Notes: ^a = only moderately detailed log available ^v = detected iron and sulfur may indicate the presence of pyrite Q = quantiative analysis by XRD

V = visual (microscopic) analysisND = not detected by laboratory

NA = not analyzed by laboratory

FIGURES






approximate extent of historical pond



proposed temporary perched monitoring well



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 θ

TW4-32

temporary perched monitoring well installed September, 2013 Ж

RUIN SPRING የ seep or spring



R

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

CORRAL SPRINGS

REFERENCE H:/718000/hydrpt14/maps/Uwellocxs14.srf







perched piezometer

TW4-32 ☆

temporary perched monitoring well installed September, 2013

WW-3 Δ

water supply well WW-3 (completed in Navajo Sandstone)

RUIN SPRING

6 seep or spring



APPROVED

WHITE MESA SITE PLAN SHOWING LOCATIONS OF PERCHED WELLS, PIEZOMETERS, AND KRIGED NITRATE AND CHLOROFORM PLUME BOUNDARIES

DATE REFERENCE H:/718000/hydrpt14/maps/UwellocNchl.srf

GURE

1 B

SYSTEM	SERIES	F	ORMATION D MEMBERS	SYMBOL	THICKNESS Meters (Feet)	LITHOLOGY
QUAT.		Su	ufficial deposits	Q	<12 (<40)	A CONTRACT OF A
CRET.	Upper	Mancos Shale		Km	0-9 (0-30)	Gray marine shale
		Dakota Sandstone		Kd	5-15 (15-50)	Thin discontinuous coal beds
	L.	Burro Canyon Formation		Kbc	24-36 (80-120)	Pebble conglomerate and sandstone
JURASSIC	Upper	Morrison Fm.	Brushy Basin Member	Jmbb	>60 (>200)	Variegated mudstone, claystone, and sandstone Commonly covered by landslides beneath canyon rims

Modified from Doelling (2004).

HYDRO GEO	LITHOLOGIC COLUMN					
🛫 CHEM, INC.	Approved	Date	Author	Date	File Name	Fiaure
	SJS	11/9/12	SJS	11/9/12	F2 litho clmn	2





APPROVED	DATE	BEFEBENCE	FIGURE
SJS		hvdrot14/mans/contact2 srf	4
		nyaipt 14/maps/contact2.5m	· ·





NOTES: adapted from HGC (2010); "2nd Seep" and "Dry Seep" are described in HGC (2010)



EXPLANATION



ANNOTATED PHOTOGRAPH SHOWING
EAST SIDE OF COTTONWOOD CANYON
(looking east toward White Mesa
from west side of Cottonwood Canyon)

DATE	re reference	
	H:/718000/hydrpt14/maps/cottonwood2.srf	6





EXPLANATION kriged top of Brushy Basin elevation contour and label



TW4-12 05521 temporary perched monitoring well showing elevation in feet amsl

perched monitoring well showing elevation in feet amsl

approximate axis of Brushy Basin

approximate axis of Brushy Basin paleovalley

abandoned boring showing elevation in feet amsl

temporary perched nitrate monitoring ♦ 5545 well showing elevation in feet amsl

paleoridge

PIEZ-1 perched piezometer showing ● 5551 elevation in feet amsl



TW4-32 \$5499 temporary perched monitoring well installed September, 2013 showing elevation in feet amsl

RUIN SPRING

5380 seep or spring showing elevation in feet amsl











EXPLANATION

- approximate 1st sampling event geoprobe boring location
- approximate 2nd sampling event geoprobe boring location
- approximate 3rd sampling event geoprobe boring location
- 🕀 ammonium sulfate crystal tank





northeast - southwest (NE-SW) cross-section

APPROXIMATE GEOPROBE BORING AND CROSS-SECTION LOCATIONS WHITE MESA SITE

DATE

APPROVED

REFERENCE H:/718000/hydrpt14/ xsection/soilxs/soilxsloc_rev.srf IGURE 12









GEO

CHEM, INC.

₩64

temporary perched monitoring well installed September, 2013 showing saturated thickness in feet

RUIN SPRING

seep or spring δ

BRUSHY BASIN PALEORIDGES AND PALEOVALLEYS WHITE MESA SITE

APPROVED DATE FIGURE REFERENCE H:/718000/hydrpt14/maps/Usat0314rv.srf

14



EXPLANATION



estimated area having saturated thickness less than 5 feet



estimated dry area



perched monitoring well showing depth to water in feet



temporary perched monitoring well showing depth to water in feet

TWN-7

temporary perched nitrate monitoring well showing depth to water in feet



perched piezometer showing depth to water in feet

TW4-32 ☆ <mark>4</mark>9

temporary perched monitoring well
installed September, 2013 showing
depth to water in feet

RUIN SPRING

l seep or spring



NOTE: MW-4, MW-26, TW4-4, TW4-19, and TW4-20 are chloroform pumping wells; TW4-22, TW4-24, TW4-25, and TWN-2 are nitrate pumping wells

HYDRO GEO CHEM, INC.		1st QUARTER, 2014 DEPTHS TO PERCHED WATER WHITE MESA SITE					
0111111, 11 (0)	APPROVED	DATE	REFERENCE	FIGURE			
, ,			H:/718000/hydrpt14/maps/Udtw0314.srf				









xsection/ewxsne/ewxsneb.srf





vertical exaggeration = 5:1

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

APPROVED

DATE	REFERENCE	H:/718000/hydrpt14/ xsection/ewxssw/ewxsswb.srf	FIGURE 18
------	-----------	--	--------------













NOTE: MW-4, MW-26, TW4-4, TW4-19, and TW4-20 are chloroform pumping wells; TW4-22, TW4-24, TW4-25, and TWN-2 are nitrate pumping wells

• 5551

O 5553

● 5595

TW4-1

PIEZ-2

TW4-32 **₩ 5563** elevation in feet amsl

elevation in feet amsl

elevation in feet amsl

temporary perched monitoring well

temporary perched monitoring well installed September, 2013 showing

showing elevation in feet amsl

perched piezometer showing

	HYDRO GEO CHEM, INC.	ŀ	KRIGED 1st QUARTER, 2014 WATER LEVELS AND ESTIMATED CAPTURE ZONES WHITE MESA SITE (detail map)					
		APPROVED	DATE	REFERENCE	H:/718000/hydrpt14/ maps/Ucap0314.srf	FIGURE 22		



elevation in feet amsl























perched piezometer showing ● 5592 elevation in feet amsl

W4-32temporary perched monitoring well☆ 5563installed September, 2013 showing TW4-32 elevation in feet amsl

RUIN SPRING

₿ 5380 seep or spring showing elevation in feet amsl

NOTE: MW-4, MW-26, TW4-4, TW4-19, and TW4-20 are chloroform pumping wells; TW4-22, TW4-24, TW4-25, and TWN-2 are nitrate pumping wells



KRIGED 1st QUARTER, 2014 WATER LEVELS SHOWING INFERRED PERCHED WATER FLOW PATHLINES NEAR RUIN SPRING AND WESTWATER SEEP

DATE REFERENCE H:/718000/ hydrpt4/springs/Uspgfl14.srf























PHOTOGRAPH OF THE WESTWATER SEEP SAMPLING LOCATION JULY, 2010

APPROVED	DATE	REFERENCE	11/710000/	FIGURE	
0.10			H://18000/		00
515		hvdrpt14/maps/v	vestsmpl2.srf	28	28
		······································			

Burro Canyon Formation

Westwater Seep (immediately downgradient from sampling location)

Brushy Basin Member



PHOTOGRAPH OF THE CONTACT BETWEEN THE **BURRO CANYON FORMATION AND THE BRUSHY BASIN MEMBER** AT WESTWATER SEEP

H:/718000/

DATE SJS

APPROVED

REFERENCE hydrpt14/maps/westcontact2.srf FIGURE 29

























EXPLANATION

MW-5 〇

perched boring (pyrite status unknown)

MW-33



perched boring having detailed log showing no pyrite

MW-25

perched boring showing pyrite in log and having a laboratory detection (if analyzed)

MW-24



perched boring having pyrite detected via laboratory analysis only (not shown in log)

MW-29



MW-30



perched boring showing pyrite in log and having no laboratory detection



WHITE MESA SITE PLAN SHOWING PYRITE OCCURRENCE IN PERCHED BORINGS

32

APPROVED DATE REFERENCE H:/718000/hydrpt14/ FIGURE H:/718000/hydrpt14/



APPENDIX A

LITHOLOGIC LOGS
APPENDIX A.1

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52 F	1	vitto i	MCMT			N		• •
E DE	at.55	11th m	n-vefr	L		N		
575	a12.55	litta	mwr			N		
200	972.55	lttn t	2-cfr			N		
2.5 E	atzss	ltokto	MWR			Ň		
65.0	atz ss	vitay t	2-mfr			N		
375	972.55	v 1494	MWR			N	-	N 5
72.4	gtzss	vitau	mwr			N		
2.5	atzss	vitgu	fwr			N		
5.0	gtz SS	vitav	fwr			N		
72.5	<u>qtz:55</u>	th m	-vcmr			N	chert frag + gra	10 S
0.0-	atz \$5	Itayta	MWR			N		
32.5	atzss	Itgytn)	ncmr	+++-		N	Mositure ist notice	ul e 80.0'
5.0	912.3S	Itauta r	A-CMV	+++-		2		
7.5-	atz 35	Itanta m	- People			0	chert publies + fr	sgr.
0.0		to P	- NO A			0		
2.5	atess	Itarta a	mbo	200				
	Sh	noha-a-	- million				Rectorio	R Acti
	Sh	ppon-gn				N	Drushy Basin U	2 95.0 good contact
25 H		The ga					1.0.	
75								
25-1								
5.0								
25-								
0.0								
2257								
DE H								

A REPORT OF A



Date 27 APR 2011 Ge	nlogist L. CASERDER	- r	: Drilling Co. F	RAYLES EXPL	VRATION CO HOLONO DR 7
Property WHITE MESAMILL	Project <u>CELLAR</u>	ales.	Unit	No	Sec Twp Rge
County SAN JUAN	State UTAH		Location		Elev <u>5594</u>
			///	1/0/5/	PAGE OF
L' L S S L A	à a e	1/2/	A S O PYRI	TE JOR S	T.D. PROBE
S 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	00 00 00 00 00 00 00 00 00 00 00 00 00	15 1 0 1S	5/2/0/2/2/2/	2/2/2/2/2/	T.D. DRILL 100.6
1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		4/0 ×	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	10 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2	REMARKS
		\mathcal{H}	11111	WI TO	
25 mdst	raba			W	Au Sol-unconsolidated CH
5.0 97255	orba M-C	ma	L	K Upi	M Diceta Ct & G.O.
1.5 at 2.55	orta m-c	AM		Ň	
12.5 atzs	Itbn m	6 14		Ŋ	
15.0 atzss	Hbn m	wa		N	
17.5 - qtzss	orth M-C	mà	+ + + + + + + + + + + + + + + + + + +	N	
20.0	th M	WA	╞╌┼╍╋╌┥┥┥	N	
22.5	to m	wr		N C	1 10 m
250-	1+6/1 /1-0	wr	╏╺┝╋ ╋╋╋	N 20	me chertfinggs
27.5	The from	mr		N	
30.0	Itauto m	wr		N	
32.5 - 415.55	Itayon m-C	mr		N	
35.0 gtz 55	vitauta f	WR		N	
40.0 To 1 95.55 C	i light m-per	fr		Ň	
42.5 sh, atza	s Ityway vf-f	mr	L	N	СН
45.0 ATZ 55	lttn f-m	mr	L	N	
47.5 atzss	Hextn m-C	FR		N	
500 - 972.55	HOKTO M-C	+ R	┥╄╋╋┥┤	N	111 A
52.5	Horita m-per	4 3		N 50	me multi colored chent grows
55.0 97255	vitekta m	WE		N	
57.5-1 0tzss	VITPKTN F-M			N	
60,0 - at ss	It pkth M-per	+ 0		N	
Give at ss	Itayin M-C	ma		N	
60	bn Cvc	ma		N db	und chevel fordas
07.5	Itayon m-ve	md		N	
725 Tr. atzss. C.	albn C-pek	ma		N	
75.0 0 072.95	ayth m-c	mr		N	
77.5	Itayin M	wr		NM	pisture first noted , some chert grains
80.0 97255	orth m-c	mr		N	
82.5 atzs	orpkin M	WK		4	
85.0 - 97255		W R			
B7.5-	1+th VM	WD			
90.0-	auto m-c	mr		N N N N N N N N N N N N N N N N N N N	
92.5	ally the le blan mod	mr		100 2	meshin Risin For PLR 92 D' the Lachhles
95.0 E	a with the biomer			N m	withed frags.
9735 TE Sh at a	an-vitay vf.c	Pr	Jr A	N TI),
170 ET					
107.5-					
110.0					et 12
112.5					
1/5.0-					
//2.5-					
120.0					
1225					
/25.01111					and the second



County San Ju	. <u>0n</u> S	state <u>Utsk</u>	0			L	.o c	ati	ion	Un I	T N	0	-		Sec Twp Rge Elev. ~ ⁵⁵³ 7
4	1/3/1	/			1	17	7	7	47	7	-		7	7	
1 2 8	* / * / * / * /		~	· .	1.	/ ,	A	12	14	PY	R/T	E/	1	She	T.D. PROBE
\$ 6 × 5	\$ x x	o.	4	1	5/2	0/0	E/A	*/	1	1.1	./	(\$)	21	10/	T.D. DRILL 70.0
1 2 2 1 2 1 M	Vel X		, /	No No	(*).	S'	*	3%	5/0	5/4	1	1	10	10	FLUID LEVEL
5 5 8 8	\$ <u>/</u> v	*	/	5/0	1	6	18	10	12	1	*/	2/4	1	\$/*	REMARKS
5-133	Sh. gtzss	ltyway	γf	W	r							v5			Mancos Shale - soil was removed during site or
0 月雲	sh-gtzss	Hywny	vf	w	٢							S			upph Dakots Fin Ct & 4.0'
5	977.55	tn f.	m	M	9		L	_	_			N		 	
0	atzss	ta f-	m	105	5			_	4			N		L	
5-12	972.55	tn	m	W	2			\square				N			
0日室	972.5S	tn m	C	m	9	_		4	4			N		ļ	
5-1-	atess	pkin m-	C	f	r							N			
0 日 3	atzss	tn f-	m	4	r			4	4			N			
5.口题	sh gtass	Hywan f-	m	\$	r		10000	_	4			N			CL
。中國	gtzss sh	Hywgy f-	m	\$	r		_	4	4			N			ML
5	atzss sitst	1ttn vf-	m	f	r		L		_			N			
.6-1-2-1-	97255, sh	It n VF-	m	£	r		4	4	4	<u> </u>		N			
5日第	atz-os, sh	1th- 1tywen	m	W	5			_	4	_		N			very horddrilling
.o. [972.53	Itaria m-	C	M	R	_	L	4	4			N			some dkgy chart grains
5- F (3)	9/253,97217	Itaria m-V	C	£	9			4	4			N			abund 1 . b
0-1-1-1	gTz 35 gtzite	wh m-v	C	4	3			-		-		N			very hard dwilling
5日注意	atzss, atzite	wh m-v	6	f	2			+	+	4		N			extremely hard drilling
	atz SS gtit	wh m-v	C	£	2			4	-	-		N			0 n n
5	gtz SS, gtzite	wh m-	Pe!	2	9		_	4	4			Ń			er 0 h
4日登	gtz ss gtzite	wh-vitta m-1	C	P	à		_	+	-	-		N			31
5-42	atz ssatzile	wh-or-cikgy m	pel	P	A			4		-		N			p is is .
0-円売	sh	Hgybl			_	-	+	4	+	-		N			
5	gtzss gtzite	Haytn f-	m	m	r	-		4	4	-		W			
	sh	gygn-pprobn				-		4	+		-	N			Brushy Dosin CHE 575' cutting and Mot
5-12-1	Sh	gn-pproton			_	-		+	4	-		N			tale tell rd check grains
0日至	sh	0			+	-	-	+	+	4		N			
5日全日11	Sh	-gn		<u>.</u>			ti	r f	1	-		N			
0-7===	sh	34			_		_	4	-	-		N			TD.
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Date <u>4 ma</u>	<u>y 2011</u> Geol	logist_ <u>L.C</u>	asebolt	_ Drilli	ng Co.	Boyles	Exploration Inc.	Hole No. DR9
Property <u>Wn</u>	W. Mesa mill	Project	611.43		Un	it No	Sec	Twp Rge
County <u>San</u>	Tuan T	State	, it	<u> Loca</u>	tion_	,,	7 7 7 7 7	Elev. <u>≈ 55</u>
2		/	1	///	*//	/ /.	5 2 5	PAGE / OF)
5× 15/ 9	0 00 00 00 00	å /	a 94 /4	1 1/2	S/S/P	YRITE	100 3	T.D. PROBE
8 /2/2	2 3 5 0		045 × 15	0/8/2/	5/2/2	4 /3/8/	2/2/	T.D. DRILL _//5-0
1 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1	14/4/ 2	6	1 1 × 0	2 1 / S	0/0/	1/2/0/2	00/00/	
	<u>** `</u>	1	- / %/	<u> </u>	11/	×/ +/ +/	*/*/	CEMARKS
25-	Indst	Irdbn. Itpk				W	Surface soil to 2.	o Mancos Shale to 2.5 C
0-1-2	gtzss, sh	rdbn	f-mmr			5	Unconsolidath	m
5-13-1	gizzs Sh	rdbn	fwr			N	и п	m
0	gtzss sh	Irdon	vffmr			- W		
·5-1-2	atzss	rdbn	mwr			2V		
の日語	shigtz ss	dkgybn	fmma	L		VS	Upper Dakota FM	et e 14.0'
5	gtzss	tn-	mwa	L		N		
0	972.55	Itn	mwa			N		
5	972 55	tr	twwy			N		
	972 55	tn	mwa			N		
5	972 35	to	fwr			N		
	977 55	ta	MWr			N		
5	ATZ 55	to	MWZ			4		
	atz ss	tn	mwa			N		
A	172.55	th	mwa			N		
0.1	atziss	To	m.cma			N		
.5	atzss	tr	mwr			N		
so Harris	417 55	tn	fwr			W		
	atz ss	orau	C-VCPA			N	abund about	Grack
E	atess	orqu	C-VCPD	L		W	in h	n
e Hall	atzss	th	m-cma			N		8 \\s
	a72.95	th	m-cma			N		
	Sh	lunad				N		
	at as sh	JUNEA	PWr			N		
	AT2 55 20		EMMT			N		
HE	late ss sh	JI	fwr			N		
日本	at as al		CWY			N		1.(
	gizss sh	101	VC L m	to		N		^
	atasc		VE E WAR	1		N		
2-11:00	atas	194		11	A	N		
	191255	11+ to	Vit + IVV			N		
	412.55					N		
	90.35	11+	y i v a			-		
5-HEEN	at- ss		mw a					
	412.55	11941A				14	moisture first hot	U. R. 85.0'
5	atzs, sh	IItgy M	IN W K			M		
	gtz SS	11th	MI-CMP			N		
5日33日	Atz SS	1+th	mur			5		
0-1-12	atess	(H Th)	MWT			N		
5-12	gtz ss	If th	MWR			N		
2.F3	gtz ss, sh	Ityway	mwR			N		
5-日藏	972.55	wh	mwr	44		N		
0 TYX	at ss cal	wh-dkay	C-papp a	1%	0	N		
5	gtzss cal	wh-dicay	C-peppo	1%	C	VΒ		
	gtz 35 cg]	dkay-on	C-pelpa			N		
	SD	añ J				N	Beushy Rasin P	@ 110.0
0 HEEL	Ish	an				N	TD	- //···
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				- 100 B	COLUMN 101120	1000000	000000	

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PERCENTAGE COMPOSITION IMAGE



te UMAU	2011 Geol	onist / Ca	e halt	D	- 111		o /-	Barrel	15 E	NOTIO TO THE ALL DR 14
operty Whit	1. Miss mill	Project Cel	14B	_ U	r I I I I	ng C	0 <u>~</u> Init I	No	<u>es c</u>	Sec Two Roe
ounty San Ju	dn	State Utah		L	oca	tion		•0		Ywp Rge.
11	TAT			77	7	1.7	7		77	1.1.8.1
A to o	1 2 00	2	4 /	1	12/2	2/4/	PYRI	TE /	13	PAGE OF
\$ 4 5	2/2/3/		A AN ST	10/0	×/*	\$L	17	7.8/	20	T.D. DRILL 90.0
12 2 × 2	A S S S		019 A 4	10%	10/2	13/0	10/2	×/.	15/0	FLUID LEVEL
15/5/8/0	8	/	* 65	0 9	18/	*/*/	* *	2/2	2/2/	REMARKS
	molst	rdbn				↓ ↓.		W		Surface Soil . Unconsolidated CH
中國	moist	rdbn		\downarrow				W		Surface Soil 11 CH
日回日	ate ss	th	m w 9		L			N	 	Upper Dakota Fm Ct @ 5.0
	gtz ss	tn	mw a			$\left \cdot \right $	+	N N	\vdash	
님씨	9T2 55	1n	+ 000	++						
	ATZ SS	Th	MWO				+	N		
	1917.55 at= 55		C m m c	+			+	N	\vdash	some cherr trags and growns
	072.55	to	f.mmr			\square	\uparrow	N		
	atzss sh	Ityway	FMMT					N		sandy less day Cd.
田岡田	atzse sh	litau	C-MMY	· 1	-			N		" ") CL gome chert pel
	atzss cal si	ndkuwau	f-perm v					N		sandy lean clay CL " "
0.00	atzss cgl	ywgy V	f-permr					N		4
日前二	atz ss sh	ywgy	Vf-CMT					N		Lean clay CL, some chert gro
日際日日	917.55	yuth	fwr					N		
	9T2 55	ywtn	fwr	+	_			N		
	972.35	1pktn	fwr		-			N		
	472-55	ywgy-Th	t-mmx					N B)		
	1712 35 107- C3	to	IT IN Y		-			2		
	ota se	1to	MWC		1			N		• *
Tel I	OFT SS	Hbn	M-PCb m r	· Ti	H			10		anund ablat on is
Est I	atess	Ita	MWR					N		about gians
	1 atz 55	th	MWR	,				Ń		
	atz 55	τ'n	m-cma					10		
山湾	972.55	Horto	m-cmd		L			N		
\square	gtz SS	Vitan	m-cmr		-			N		very hard drilling!
	gtz 35, 691	Itaybn	m-peop a	-				N		very abund chert frogst grains
	gitite, cg1	gyin	m-pebp à		_			N		<u> </u>
	atzite cgi	auta r	n-VCF A	+	-			N		
	gizife	guth-wh	M-VCP A	+			+	1		very abund chert frags a grains
	pilot ou	19410-WN	VIII A					N		But an Algori
亳	sitet en	an					+	N		DEMINY BASIN (A & BO.O
FE	ISN SN	án						N		
HE I	sh	GN.						N		T.D.
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月 []]										
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40%

ounty San Ju	Lan S	State <u>Utah</u>	'w''			Loc	atio	_ 011 2 n)		Sec Twp Rge Flev ≈5582
4	1/3/1		-		7	77	1/+	77	/	1	17	AN SI PAGE OF
IN ANO	2 2 2	é /	¢ ₀∨		4/	A	15/0	4 P	YRITE	1	13/2	T.D. PROBE
& / / × / ×	8 8 8		4	1	5/20/	10/2	10	47	1.1.	1/4	5/0	T.D. DRILL 115.D
AN & S	A CO L	6	. /	2	8/20	1	3 10	10/	4/4×/	\$/4	0 00 M	S/w FLOID LEVEL
15/ 6/8/0	/%/ V		10	5/5	11	0/5	18/	*/*	1 4/4	14	18/	REMARKS
	mdst	rábn						\downarrow		W		Surface Soil (unconsolidated)
「「「「「「」」	Indist, Sh	Irdon Itpk	-							VS		Surface soil (unconsolidated, Mancos shale @
- 月達	sndy sh	Indon	m	ç	r					VS		
	sh, atzss	rabn-ltpk	m	m	r		_			VS		
	sh atz es	Hpk-vltta	m	m	r		_			VS		Upper Dokoto Fm Ct. @ 12.0'
	atzss	Itayion m	-C	M	r					5	_	
日前日日	952.85	Ityw m	-ve	4	3	1-	4			N		abund. It colored chert frags.
	972.33	Ilfayto m	C	t	r		_			N	_	1
	ATZ 53	Itayta	m	W	r					N		
H I	gtz SS	Itgyta f.	m	W	r					N		
- 月三月	atzss	Itgyth	M	W	R					Ň		
	atzss	Hayta	C	W	r					N		
中部	atzss	litta	f	W	r _					N		
	atzss	It to f.	0	P	0					N		some dk chertarains.
	atass	anta m	Y-C	М	r					N		obund dk chertary is
	atzss	1+ tr	M	W	R					N		4
山際	atzss	litin m	- C	m	0					N		
	atzss	Htm	m	ω	R					N		
上》	atzss	Hauth	C	W	R					N		
	atz SS, Sh	th-Itan C-	bet	P	A					N		multicolored chert from & arit
	atz ss	th m	-VC	M	۲.					N		• در در در
	atz ss	th m	-C	M	r					N		
	etz.ss. slts	titbiay m-	oeb	£	0					N		chent neable fores -
日際	sltst at 5	situal f	VC	ρ	a				2	N		Lans pool of
	Sligt AT2 55	s Heblau F.	VC	P	9					N		
	gtzss, slifs-	lthiau-itto M	HC	m	2					N		
	atz ss	th m	-C	m	2					S		
High	atzss cal	Itnbn m-	pelo	8	2					M		will i colored chert Cours
5.2	ATZ SE. CAL	tubu c-	Deb	ρ	2					N	-	Product of the top ago.
Hose II	atz ss	Itauto m-	C	m	2		1	\mathbf{T}		N		
H ALL	ata SS	l'auto M-	IC	Ę	2					N		
\mathbf{H}	127 35	itauto f.	Im	W	r			\dagger		N	1	mitter Carriella and
F.	atz ss	librarita m	C	W	r		1			N	-	THE FIRE FIRST TIPLES & SULL
T III	atz ss	Litauto	m	w	R	+						
Tel I	at- ac	litauto f-	m	m	r			$\uparrow \uparrow$		11		
	Att CS	litauta r	m	m	r					N	+	
	at as	auta in	pela	£	r					N	+	
	1 atrac	Digita M-	whi	m	r	+				2		
4	at- co -	auto a	NU	Da	-	++				N		
1.3	at- se		1	m	r	+						and the second
4.2	at so al	taka m	16 Inala	0		+	+			N		VERY CONTRACTION
P	ate co	to have the	Peg	P	2					1	-	" abund dkgy chert frigs.
古巡回	191255, e.g.		per l	p	-		-			N		" y gy chert frags.
一至	GIZSS SH	wn-ayan +-	100	*	0		15.1			2		Brushy Basia Ct. @ 106.0 good contact chert
古三日	121	gygn	$\left \right $				-varys			3		some masses of sulfide (pyrite?)
出産	Sh	guan	$\left \cdot \right $			+	-			N.		
	120	gygn-ppbn	\vdash	-						N I		T.D. mottled cuttings
			$\left \right $		_							
E00008												
					200		0.52 2021		10000	10		



	Littlefield rome the pres		n - 199	and the state of the
Date 28 APR 2011	Geologist_ <i>L, Caseb</i>	11/14	_ Drilling Co. Bauk	is Exploration Co. Hole No. DR/2
Property White Mess in	111 Project Cell 48		Unit No	Sec Twp Rge
County San Judn	State <u>_U+ah</u>		_ Location	Elev. <u>≯5584</u>
		1		PAGE OF
1 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	ja la	× /4	A S O PYRITE	T.D. PROBE
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Or Norse	\$ 15/3	8/8/2/0/2/2/2/2/2/2	T.D. DRILL 100.0
1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	il Sta	12/0/	0 1 0 10 10 10 10 10 10 10 10 10 10 10 1	S S S
0	× (, (<u>/%/?/`</u>		REMARKS
25 Mast	rdbn		W	Surface Soil unconsolidated fat clay w/soud CH
5.0 mdst	- yrdbA		19 15	Swrfact Soil n n n 4 CH
75 十三 1	I tykin		VS	I A A A A A A A A A A A A A A A A A A A
10.0	itosto		S	4 »
12.0 atz 3	ish Ithn Y	mwr	LN	WORK DAKOTA CT @ 12.5'
atz ss	tn	mar	LNN	The second se
74.5 200	lif orta v	mwr	LN	
22.5	tn r	MWA	N	
25.0-	tn r	NWB	R	
275	i ligyto v	nwr	Ŋ	Some Chevi grains
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- <u>H</u>	atzss	10	mu	r					1	1	-	
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Date <u>29 A</u> Property <u>Wh</u>	<u>P.2.2011</u> Geol ite Mesa M://	Project <u>CELO</u>	e/66/4 4 B	_ Dr	illing	Co. Uni	<i>Bay le</i> t No	s Ex,	<u>oloration Co</u> Hole No. <u>DR17</u> Sec Twp Rge.	
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PERCENTAGE COMPOSITION IMAGE



		國和中國政府											n Statement C
Date 4 May	<u>2011</u> Geolo	gist L.Co	SEbolt	~	_	Dr	illi	ng	Co.	Boli	1105	E.	Exploration Inc. Hole No. DR 18
Property White	e <u>mesa mill</u> F	Project	143						Un	it N	0		Sec Twp Rge
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Date <u>3/14/2</u> Property White	<u>//</u> Geolo Mess mill F	pgist <u>L.C.A.S.C</u> Project <i>Cell</i> 4	60/ 1 3	_ Drilling Co.	<u>Rayles Ex</u>	ploration Inc. Hole No. DR 22
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5	qtz 55	Hautri				Upper Dakots Ct E 5,0
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5 0 40	atz 35 CAL	auto m-	ails f a		N	50% chart grains + frags.
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P.D	atzs cal	auto m	perf a		N	abund light colored chertgrains.
F	atras	Hauto M.	CMR		N	6
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5 4 3 1	atzss	Itgy m.	cmo		M	
。山至二十	sh	Hay-Iton			N	Brushy Basin Ct & 57.5' some chert Gi
5	sh	wh-ltayan			N	
	Sh	auba			N	some red chert grains
5日至1	sh	an-bobn			N	Extremely hard drilling (chert) from 67.5
FE	sh. atz	orth-an			N	to 72.5' cheat pebbles + frags.
	sh atzite	whilten m	pet		N	
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う甘ヨート	1 oh	1 DIGU			N	
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ounty <u>san</u>	11.11	Tate <u>Man</u>	2		-	Lo		7	77	_	-	-	-	Elev. <u>~ 3497</u>
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			Ĥ	4	4		6	7	4	7	14	4		
5-12	mast	volon	2 0	-		-					5	+		Surface soil. Mancos Shale @ 2.0-unconsol
2	snowsn	rabn-Itpktn V	-r	WI		-					VS			Munos Sh
5-822	snolysh, gtzs	pktn-ywbn f.	m	<u> </u>							VS.	+		upper Dokota et @ 7.0
0	atzas	wh-ywin m-	C	<u>n i</u>		1		$\left \right $	-		2	+		
5	atzss	th M-	C	m	-	-		\square			N	+	4	
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开题	972.55	th f-	M	m	2	-					N	4		
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15 P.P.	gtz ss, cg	guto-dkou m.	peb	f	2	_				-	N	_		30% chert pebbles & grains
4	gtz ss	gytn m-	C	m	r		-			-	н	_		ç
「田湾」」	atz SS	gyth M-	C	m	r		-				N	_		some chertfrogs.
2 4 3	at2.55	guta m-	C	m	rļ.	-					N	-		5
5431	97295	Vitan vf-	M	f	r						N			* **
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0 -	atzas	VItan	m	W							И			
5	atz ss	Vitau	m	W	~						N			quite moist @ 675
	at2.95	Vltan	m	N	r						N			
5	atzas	VItan m.	0	m	r						N			some gy chartgrains & frags.
	gtz 55 sh	Wwbn-tubn M	C	m	r	L					N			· · ·
5 <u>1</u> 3	gtzss. sh	wh-th-an m-	-peb	P	2		tr	C			N			Brashy Basin Ct@ 77.0' good contact
	sh	ayan									N			some rod chert grains
-HE	sh	quan									N			3
日至	sh	an									N			T, D.
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Property Whi	te Mesa Mill	Project Cell 4	F B			• 1 + 1		Unif	No.		-xp	Sec Twp Rge
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25	molst	yg/bn	++-	+	-				W		+	Surface Soil-unconsolidated - andy lean clay- CL
5.0	mast	sol bă					$\left \right $		W			Surface soil - un consolidated - andy lean clay - EL
75	Sridul Sh	pkta C-	VCP	r	-	+	+		V.	1	- 	Mancos Sh
0.0	972.55	gyta m-	per +	r		-	$\left \cdot \right $	_	X		+	Upper Dokoto FM Ct @ 7.5 chert peobles.
2,5	1972 SS	gyta m.	-VC +	10			\square				-	light colored chert frags. 4 grains
5.0-	17255	gyta m	-peg+			-	+		N			<u>_h1) * n1)</u>
5	atz ss	Itayta f-	MM	IY		-	$\left \right $		I I I		-	
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7.5	atzss	Hayto	mw	r	_				N	-	4	
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20-H	atzss	Iliyuta m-	.VC f	4		4	11		N	3		
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0	atz35, Cal	pravin M-	per P	9	L	-			N]		30% in a n n n
·5 日	atzss	JUL GUTA M-	VCF	a					V	5		
	AT2.55	lay f-	CF	8		11:			V	3		
25日室	31	Jan							K			Brushy Basin Ct & GO.O' some pobo cherton
の上雲	sh	2n				tr			P	J		some pobn-red chert froms.
5.HE	Sh	an an							A	J		11
	Sh	gyan-opba							N	1		some mottled cuttings
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PERCENTAGE COMPOSITION IMAGE



APPENDIX A.2

MW - SERIES

	o Mini	erais Corpora	tion
Location: San Juan Coun	hy, Utah	Data:	11/24/82
Gamma (Na	i) - Neu	tron Porcelty	
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Cored Interval 70.0 ft. to 95.0 ft. T.D.

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<u>Depth</u> 70.0 - 74.0	Description Core barrel blocked, 75% core recovery, quartz sandstone, very light tan - white, med. to very coarse grained, chert pebble zone at 71.3 ft., sparse chert grains, calcareous cement at 72.3 - 73.0 ft., abund. hematite/limonite disseminated at 73.2 - 73.8 ft., possible replacement of earlier pyrite.
74.0 - 80.0	Core recovery 67%, quartz sandstone from 76.0 ft77.5 ft., white, medium grained, sub rounded, 77.5 ft 78.4 ft., quartz sandstone, very light tan, fine to medium grained, sub rounded, 78.4 ft 80.0 ft., quartz sandstone, very light tan, fine to medium grained, sub rounded, clay cement.
80.0 - 85.2	Quartz sandstone fine grained subrounded to rounded clay cement (non calcareous) occasional chert pebble, grit size zone from 82.5 - 82.8 and from 84.5 - 84.9 ft
85.0 - 87.5	No core recovery.
87.5 - 90.0	Quartz sandstone / grit, calcareous cement white to light gray green, coarser zones contain light green shale fragments and chert pebbles, green clay gall noted from 88.0 - 88.2 ft., conglomerate from 89.5 - 90.0 feet.
90.0 - 95.0	Core recovery 97%, quartz sandstone / conglomerate, light gray green, contains abundant chert pebbles and grit, zone from 90.0 - 92.5 ft. contains numerous low angle partings due to friable character of the core, no weathered or mineralized surfaces noted. Upper Brushy Basin contact at 92.5 ft Conglomerate in direct contact with undisturbed green shale below. End of Core



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PEEL Environmental	24 ryices 122-4116		WMMW-16			
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10-		ganta, lipit lad, vog fan 'n besprind, nån				
20-		یوسند. اولا است اد اولا وجور بسیر شده اد است. او است. این است. این میکند (سیر این مندی است. این این این این این این این این این این	fand Junifellin, official and the second of the PVC			
Aurra Canyon Fm		anguna ana tayanna. Galeta, lafet gray, day ta anafan g davat, adama January, anatanany narat y yanat, adama galeta, lafet gray, lako ta mahan-granad, adam Ni: Bennalda gar, angkar ta adamaya yana da Ni: Bennalda gar, angkar ta adamaya yana da				
		quarti, lipli quadata gray, vary fau guinai yily. Ala gray, filolandala anti, kanandin, marta, lipli kud ta lipli pay, vary kan guinari, u pareta, fanada yanakatan, yana kan guinari, u	Control or			
60- Tree # 3		nenita filitania para la provinsi filitani	1			
70-			e, paret E digite (transition E digite (transition			
80- 2		یستو. گوک و دی , مدالیت و طلاحظ مقصوط او اخذ رویه او وسط آمای و سیاب و محمل رویس اطلاع وسیلیست ده دیکورد، و بری این مطاطع.	Advanced, and Link and Colorada			

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				Bore Hole	No.:
PEEL Environmental S	Servic est		WMMW-17		
Project: White Mass	Surface Flev	5575.06	T. D. = 110"	UMETCO M	Inerais Corporation
Date: 12/07/92	Depth to Water:	86.5	Geologist: F. A. Peel		
		~	Semple Description		Comments Well Costruction
Beneficial (Septh				f	
Soll Dakota Fm			n men er fannen fan sen er fan er Anteren gewere, faste turk fan er er er er fan e	and hashing topic	
20-			labuna : quarta, light guy, rury lina- is lino y draid, mbr saile, hidda.	wani, Lanketti, Yuun	
30-	窑		ه: چیناند تویین میروند و چیناند ویر ملوغی های که پس این چیناند است. او چیناند و پیناند ویر ملوغی های او پس	, berdenslik, soll.	Constitutions
		1	antana : ayara, iyo yay ta iyo yaa ya	u u fes gebeek	
	A Rec 7.5		denne: gundt, provide gray, han in problem grained, funnerski jokort and Mile guldens) folder, dange	adrand,	K-145-8007000
Burro Canyon Fm			desires: quere, fajte proy, fine-grained, submitted, lab in any		
60-		$\left\{ \right\}$			
70-			*		
10-	12074		uldansi: quetta lajdi lajdi, produme la verj metto grif daligi, uni anglestara de, yana basi riski,	net advant.	5 1-2
	Care of 2 Rea Lar Care of 2 Rea Lar		ndramani, aparite, fagle la sene grav, grave grav al lan, fan Ganasani, handreicher unde, antygenerene, podele jan at Gana		K- 156-4 cm/mr
Brushy Basin Member			al gans ang palat pan kang tang tang tang tang tang pan panta ang tang pana ang tang	halle, hard, coarte a conglementin,	K-4 SE-8 corres
110					lR

	Environmental	Services	Bore Hole No. : WMMW-18		
	Protect: White Mesa	Surface Elev. 5657.58	T. D. = 148.5	UMETCO Minerals Corporation	
	Date: 12/07/92	Depth to Water: 92	Geologist: F. A. Peel	Comments Well	
ļ	Gamma (Nat)	Neutron - API	Sample Description		
	Soil Mancos Shaje Dakota Fm	San Sha	d: quartz, red brown, silly. de: black, platy, hard. chilena: quartiz, fight built in fight gray, subround, , maining >>> least toward base, Occ links peeble	Lunderste, taxe	
	- 20-		ана на селото на село		
	40-		datance il al alaren 2.55 very complementali il part besto civit al alfici ingenerat. Alferen: quanta, hufi, fine-grained, subsounded, a attenue, kastiniti, reno iven stahling. Alferen: quanta, light policer gray, fine-gealrent, eu Hallring.	L Ec 1164 annual di Angelang	
	S0- UITO Čanyon Fm 60-		dalland: da abava >>> vory fire-grained, mma: light groenish gray, orgilacsoos, play,		
	70-		- Malamas, qualitz, Egift gally, vary Eris-gradiant, publi Main,		
	00		Mana: quati, light gray, vary lina- la machan-g ngular,uca pablak. Natens: as aleves interbacked with Conglemental 9, light gray, sandy in pael. Islana: as aleves,	pallouel, 9. paible 10. 2 16 1 univer Drownia East	
			siona: quantz, groeniah gray, fina-grained, aukar und, Laudraik, Mobile, brioriteddiad with eoccader reddiah brown, anti,	ngedar, ta nal film shake 16.30 Colorada Siles Gand	
	120	Sanda	daren: quartz, Agris groen is groonish gray, very t ed, eventumi, argitectorea. Inmende: politik, Brit: Ingenerat, very black, a anruh to pol. Name: quartz, Agris groen, very Sna-grahud, argit ed and groen shude aktypen.	fine- to Sine- Larity ID Receives with	
	130-1 mhy Basin Mirrobar 140-		- restillet, bryon play, and,		

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			-	Bore Hole No. :				
	Aress CO	ionial S	iervice s1 16	H	WMMW-19			
	Project, Mikita II		Surf	sca Elaw 5655.05				
	Date: 12/07/92	a: 12/07/92 Depth to Water: 150 Coold				_0/1/2/07	milerais Corporation	
	Dele. Compe		y al	BLID WALT: 150	Geologist:		Comments Well	
	Gamma (Nat)	Depth	31	Neutron - API	Sample Description			
		07		Sard	: quariz, rèddah krown,line-preined, sity,			
	7	1		San	dateme: quarts, fight gray, line-grained, subrou	nd, kaolintic,		
	<u> </u>							
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	2		5					
	-5	20 -	<u>-</u>	+++				
	\leq	Í	Â		alana: quarte, light ball, vary line- 10 macham-g ngular 10 subround, haalinilit, ban staining,	rained,	Commenter and A	
		1						
							C LOUGH HE FYC	
		.07			arm; as above >>> loss iron stained.			
		Į			ne: quartz, mechanigray, sandy hard,			
	S							
		40-	-	+++++++++++++++++++++++++++++++++++++++			881	
					napras: apratoz, ligita dull, vary tina- sa machum-g angular sa autorounal, kasatolik, kun ataloing.	rsheil,		
	1	1	2				881	
		50	3	Care in Sand	term: quarts, light gany to buil, course-grained and, pearly conted, facilitatic, red loss statistics,	and angular to		
		ł	٦Y	Sanda	everalic (creet & liftic poolee), lanat qualit, very line- to five-grained, everal	rd, very kasinik		
		Tent #	1		iren ofsining, est 6hile parting, >>> very hard :	ni ikana,	881	
ŀ	+	60		<u> </u>	many ments field half your first to median	aland sub-sec	K- 84E-6 control	
			÷		while, red and brown from staining.			
		1		<u> </u>				
	Burro Canyon Fm			111111				
ľ		70			terni: quartz, fight gray, vary lina- la Irm-grain	ed, swizzend,	Com dave -	
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		Ì		1 -ran	anat quantz, light gray, lina- le machan-grainne	l, corquismoratic		
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	_ { `		() () () () () () () () () () () () () () ()		uerus: quartz, april grounish gray, vory fine-grab seese to very argitectores, dvin groon shale par h brown shale parting at base.	traja, wary,		
			81					
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	Services		Bore Hole No. : WMMW-20
Arvada, CO (303)422	-5116		
Project; White Mesa	Surface Elev. 5538 Es	T, D, = 114.5	PBTD = 90'
Date: 8/4/94	Depth to Water: 86.4	Geologist: C. Bilgood	
Gamma (Nai)	Neutron - API	Sample Description	
		Sand: quarte, reddish brown, eily, argliaceont, Aec	dian.
			S Lief Strat Surface Crg
$ \langle $			
	TOP DAKOTA (12.5).	Sandstone: quart, ight gray ia cub, very ine ia i angilacoous,subangular, scil.	Cemers Bersonta Cont Cont
2		Sandatone: quarta, light gray, line- to medium gra soft, trace iron staking, trace pinpoint porosty.	ined, argf1208008,
		Sandstone: as above, conglormeratic in part with	dah gay cheri dasis.
a a		Sandstone: quariz, light gray, argiteceous, line Rim.	- la molium grainoù,
6		Sandstone: as above, conglostaratic in part, o clasta.	
		antitone: as above becoming less argiliste	rours, Jight brown gray,
$\left \sum \right $		modum-grained, well sorted, las intergranulat	porosňy.
			- Oardsroo Sea
		Sandstone; quarta, light gray, modium graine	d, occasionally coarse-
		grained, subargular to subrownou buckting clasts from 72.0 to 72 9. Conglomerate: link; petitle, shale and chert	dasis, very sandy, poorly
	至	Shale; ofve green, wasy, soft, lop 0 7 block; Uhalog Core	10 20 Contax Sica 5 0-3
	s	Sandstonet quarte, dark reddish green to gr	sy, five-grained, very
		Becoming dark reddish gray, this bedded an Missing Core	a fur a base
	Original Contract (907)	Sitistione: dark teddish bicwn, sandy in part ol dark ted brown sity shale at lop. Sitistione: preen, wary, britle, occasional w	, argiflaceous, fub etilingen Mobal lanston fohrs, e fly
		In part, iron staining along 2" near versical it	22CTUM P9.
		Claysione: dark greenish gray with reddsh horizontal plaing, wary, fied vertical joints at base.	cast, poorty developed , becarring lighter in color
		Claysione: Right green gray, sity to sandy. Claysione: red, sity to sandy, hard, mode	hard to very hard.
		poorly developed horizontal planng. Claysione: dark reddish purple with occas vertical fracture at base filed with white d	bnal graen finge, block y, ? 47.
		Claysions; earliny red, pourly developed h vestical 210 4" hairline fractures filled and Sandtions; ouariz, Johi gray green, very	artiantal plaing, some thin alward to fight green in cobr fine to medium grahed, thing
		argitacenus, subangtia, sil, poorly son Bohr green gray stritone and bohr green Bohr year argitaceous and eandy.	ed in part grazing openie zig end gray shate, very hard and
		Claysione: dark red brown, measive, harr Claysione: light gray green, poorly develo sharp contact with overlying red shale.	a, sped hortzonial plating. Nard,

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PEEL Environmental Arvada, CO (103)(1)	Services		Bore Hole No. : WMMW-21
Prolect; White Mesa	Surface Elev. 5558 Est	T. D. = 117.0'	PBTD = 90.0'
Dale: 0/12/94	Depth to Water: Dry	Geologist: C. Bilgood	
Gamma (Nal)	Neutron - API	Sample Description	
		Sard; anolian sand, quad;, teddish brown,	- Commufication to Grant
		Sandstone: quantz, bohi gray, Rise- giahned, angutar b rounded, well sonted, argitaceoux, some fight ian to g fine - to modium grained sandstone. Sandstone: quantz, bohi ten, fine- to mecham-grained bronkic staining, abundani chieri tragments (probabili	e subangular ta pray pooly soned
40 50		Sandstona: quart, Ighi tan, fina- to modium-grained, so ied, olive green soli deystone clasis. Sandstone: quart, Ighi gray to greenkb gray, line- to	filable, wet
		Sandulona: to subrevided, poolit anded, angliaceou verkiobied chen lingervests, conglorevalic in part, py Sandulona: quant, gray to light gray, line- to medium subrounded, angliaceous, wall sorted, abundari pyth puthably developed along tractures.	rs, nhundañi rific. •grained, ie and pyrile crystale
70 80		Mining Core Sandtome quant, light grey, medlum-grained, subro angilarnowi, conformatic, chind lagorapit, angular occasional subrounded peoples, black chent lagorapit Maring Core Conglommistic black proble, chert, very sandy, quant subroundd, very sublaccous. Sandstone: quant, congtomeratic grading downward conglomerate. Missing core Conglomerate: chert peoble, argRaccous, sandy, han Surdstone: quant, Jght gray, fine to medium prates subrounded, congtomeratic, argBacecus, hand, light.	undad, vary lo subangular, . modium-grained to sandy d. fight. 8, subangular to
90		Sanstione: quart, light gray, fine to motion galance is ubround at Sight gong market, way hard and tigh a taxous partneri, no visible porosky. Sanstione: as above with large vertical functives files and store: quart, light gray, fine- to medium-gra tounded, very hard and tight, sitceous commit, no vis Sanstione: quart, light gray, fine- to medium-gra and egits, no visible porosky. Sinsione: very fait gary green, pyrible, near vertical functional bedrag painty, which, because wertical in part. Sinsione: very fait gary green, pyrible, near vertical functional bedrag painty, hard, becaming more Sanst Claystone: tight gary green, sandy, near vertical fractu- in part. Missing Core Sanstione: quart, light gray green, way fine-grabed functives, accordance find pathing and provide and bedrage	1. rounded to 4. weil anded, with pyrke. 1. whoreved to bide porcety. Inded, poorty bideding takes. pyrke. very fland actures. some area. pyrke. biochy rea. pyrke. biochy werkel bide porcet
110		Shaja: grey-green, slightly sandy, bedding plane and v lactores Claysboa: gray green, wary, solt, Missing Core Straine: Upht grey green with very Ben-grahed sand Christ hagmonts, avgilaceous, very aandy. Shaja: brownish prev, bocorring grey green, solt very emision fractureg. Shaja: biyl green bit grey to green grey, very sandy, v including.	rentcal lons lon

											Bore Hole I	10.:		
Arvede, CO (303/472-3116										·····	WMN	IW-2	2	
Prolect:	White N	638	Surface Elev. 5516 Es				Surface Elev. 5516 Est T, D, = 140' PBTD = 120'							
Date: B/	4/94		Depth to Water: 76			76	Т	Geologist: C. Bilgood	<u> </u>					
Gamma	(Nat) 25		Neutron - API			2000		Sample Description		4	74	•		
$\sum_{i=1}^{n}$										Sandsione: aeoEan aand, quanta, reddish brown.		ALCONTRACTOR	The second second	·
		0 20	္ စံစံစံစံစံစံစံစံစံ စံစံစံစံစံစံ		7				-	Conglomerate: chen, fight gray to dah gray, occas interbodded with light gray quant sandstone, roun Conglomerate: sandstone and conglomerate as ab	danal translucent, ded, shin bedded. 2004.		and the second	- 1/4° Steel Surface Ceg
\{ \ \ \ 			6000000000000000000000000000000000000							Sandstone; quaro, while to very light gray, fine-te asplaceous	9 miclium-grained,		SUSSIAN AND DURING PROPERTY OF	Cement:Bertank Gravi
		40		-		-				,			A COLOR OF A	4° schedual 40 PV
\ . . .	-	50	-							Sandslone: quanz, while to very light tan, line-gr haid, light	ained, wait comented,	AUGUNO AND	 Attendententententen	Contraktor
		60	_			$\left \right\rangle$		_ _		Sanchiore as slove, very hard, ediceous cemer	a 	MICCOCC	- #	
						-	-	\rightarrow		Sandatone as above with trace light gray charts waining	regmens, trace bon			- Berstanile Seut
) () (70								Sandstone, quante, fipfalgray to light lan, vary fi chen (classi la 1/2", alficeous campari, walf camp salning, occasionally fight green in color. Aandatone: as above with increase in chent class laboring. Comp	se greined, subenguise, rised, hand, kon 18.		an an ann an Staire	
$\left \right\rangle$		80								Lectury core Surchiser querz, ight tan ta ight gray, fra-te subargular to subcountied, elacous camert, ig congitimeratic at base, hard, well camerited. Sandstone: sa abors becoming congitimeratic probables sub a ngular te subcround, varicolored	medium-prained, fit, becoming very at base. Conglomerate			
ζ [2								Conglomerate: variablend as above, chen and Sandstone: ouertz, way fight gray, way fire-gra subteurded, occasional rock clasts, uses are horizonal bedding parting, some cross bedding Maxing Core	claysione tragments. Ined, argiteceous, yanutar porosay, some			- 10-20 Colori 55ca Sara
· ·		0				ß				Sandstone: quartz, kpit gara ta fojis gara gara graha du shanpula in a mundich poorty ported, claystone ctass, fait te good integranular poro Sandstone: quartz, way lipit gray, fina- te med to subrounded, very linkits, good integranular well sonted.	r, fine- to very coarse- arge 1° green gray aky, very stable. Wm-grained, subangular porceky, maawve,	-		
; ;)		100								Sandutuna quarta, foli pren gray. Die grahe bair integranular pomity, Keble	d, angilian wous, souralmit,	-		
)		110	_	-						Mosing Care		-		
		120			0.00	1000	EAS	51141 (12	5	Sindstone quarts, fore green grey, fine-to co al base, conditionentle, varicoberd, with great Rick Jagners Claptione green, wasy Musing Core	arne-grained, argitaceour n claysione, chert and oav			
	-	0E1	-111111111				- -			City time ted brown, motified green, some ho City time grey green to bright green, some n Statine, light grity green, bard, way argituce I gritding into byth grien daysbox.	rigonial parting of motifing and banding ous, slightly sandy, lower			
			1111							Clin stores light gray monthed, with red brown play way, came 3' to 10" verificationes, or relate	claystone, hard, some ome skaled, some lettson			

	http://www.aug		
Date <u>4</u> -	<u>L-05</u> Geologist & Casebo		ч.
Property	White Mesa Project Mul-23	Drilling Co. <u>Bayles E</u>	Hole No. <u>MW-23</u>
County	State <u>Utsh</u>	Location	Sec. <u>32</u> Twp Rge
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52.5	19tzss Htm Vf-fW	6	very clean sand.
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PERCENTAGE COMPOSITION IMAGE

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Coun	ty <u>San</u>	Juan TIT	State/	(tah	Lo	cation			Sec. <u>S</u> [wp	Rge Elev	·
4			,0 ⁵	A 194		******	PYRITE		E PAGE	2 OF 2	
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PERCENTAGE COMPOSITION IMAGE



Core Log of Well No. MW-23

Cored Interval 49.0 ft. to 132.0 ft. T.D.

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<u>Depth</u> 49.0 - 59.5	Description Core recovery 100%, 49.0 - 59.5 ft., quartz sandstone, fine - medium grained, tan, non calcareous cement, cross-bedded, very uniform, most partings occur along cross beds and are mechanical (broken during drilling), no mineralized or weathered surfaces.
59.5 - 70.0	 Core recovery 95%, 59.5 - 61.5 ft., quartz sandstone, fine - medium grained, tan, non calcareous, cross-bedded as above, lower contact is 45 degree angle erosional surface. 61.5 - 64.0 ft., quartz sandstone, very light gray, medium grained, very clean sandstone, no mineralized partings, grades downward into conglomerate. 64.0 - 69.5 ft., quartz sandstone, medium - grit sized grains, very coarse chert pebble conglomerate from 67.0 - 69.5 ft 69.5 - 70.0 ft., quartz sandstone, medium - coarse grained, very light gray.
70.0 - 80.0	Core recovery 90%, 70.0 - 70.5 ft., no core recovered, 70.5 - 73.5 ft., siltstone, very light gray- green, soft core, low angle parting with limonite at 73.0 ft 73.5 - 80.0 ft., quartz sandstone, light gray-tan to light pink-tan, limonite stained low angle parting at 73.7 ft., grit zone at 75.0 ft., and from 75.5 - 76.5 ft., small limonite blebs after sulfides at 77.5 - 78.0 ft., some manganese dendrites from 78.5 - 79.5 ft., calcareous zone from 78.5 to 79.5 ft
80.0 - 90.0	Core recovery 87%, 80.0 - 84.5 ft., quartz sandstone, light gray-tan, fine - medium grained, non calcareous cement, no mineralized partings. 84.5 - 85.7 ft., quartz sandstone, pink-tan to yellow orange, medium - grit sized grains, abundant disseminated limonite at 85.5 - 85.7 ft 85.7 - 87.0 ft., core not recovered. 87.0 - 89.0 ft., quartz sandstone, pink-tan, medium - grit sized grains. 89.0 - 90.0 ft., quartz sandstone / gritstone, some disseminated limonite.
90.0 - 100.0	Core recovery 40%, 90.0 - 96.0 ft., no core recovered. 96.0 - 100.0 ft., quartz sandstone / gritstone, medium - very coarse, light tan - yellow-orange, abundant disseminated limonite from 97.8 - 98.2 and from 99.5 - 100.0 ft., mechanical partings along un- mineralized bedding planes, non calcareous.
100.0 - 110.0	Core recovery 100%, 100.0 - 102.3 ft., quartz sandstone, fine - medium grained, light yellow-orange to pink-tan, abundant limonite from 100.0 - 101.0, hematite from 101.5 - 102.3. 102.3 - 105.5 ft., quartz sandstone, fine - medium grained, light gray,

Core log of well MW- 23 Cont.

unmineralized mechanical partings. 105.5 - 106.0 ft., disseminated limonite zone, yellow-orange. 106.0 - 110.0 ft., quartz sandstone, fine - coarse grained, light gray to orange-yellow.

11.0 - 120.0
Core recovery 100%, 110.0 - 111.2 ft., no core recovered.
111.2 - 113.5 ft., quartz sandstone / conglomerate, fine - grit size grains, light gray to light gray-green, green clay blebs plus dark chert fragments and pebbles.
113.5 - 114.5 ft., quartz sandstone / gritstone, abundant hematite mineralization, yellow-orange.

114.5 - 120.0 ft., quartz sandstone / gritstone, cross-bedded, graytan, chert fragments and pebbles at 115.0 - 116.5, 117.5 - 118.5, and 119.0 - 120.0 ft., non calcareous.

120.0 - 130.0 Core recovery 91%, 120.0 - 120.9.0 ft., no core recovered. 120.9 - 126.8 ft., quartz sandstone / gritstone, gray-tan to dark gray, dark gray chert fragments and pebbles, no mineralized partings observed, calcareous zone from 124.2 - 126.8 ft., upper Brushy Basin Mbr. contact at 126.8 ft. 126.8 - 129.7 ft., shale, green.

129.7 - 129.8 ft., gritstone as above.

130.0 - 132.0 Core recovery 100%, shale, green, non calcareous, T.D.

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Cored Interval 20.0 ft. to 120.0 ft. T.D.

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<u>Depth</u> 20.0 - 29.0	Description Quartz sandstone, very fine - fine grained, non calcareous cement, some chert pebbles from 20.0 - 20.5 ft 20.5 - 23.5 quartz sandstone, very fine - fine grained, gray to light tan brown, weathered contact at 23.5 ft. with hematite/limonite. 23.5 - 27.5 siltstone/shale, very light gray, high angle parting with slickensides at 25.5 ft. 27.5 - 29.0 quartz sandstone, very fine grained, light gray tan, some low angle parting with hematite/limonite coatings.
29.0 - 38.0	Quartz sandstone, very fine - fine grained, light gray with disseminated hematite/limonite staining from 29.0 - 29.2 ft. and from 29.0 - 29.2 and 29.3 - 29.4 ft., also some low angle partings with hematite staining. 30.0 - 34.0 quartz sandstone, very fine - fine grained, light gray tan, non calcareous. 34.0 - 34.5 quartz sandstone, fine - medium grain, abundant disseminated limonite. 34.5 - 38.0 quartz sandstone, fine - medium grained, very light gray tan, non calcareous cement, some low angle partings.
38.0 - 48.0	Core recovery 100%, 38.0 - 39.9 ft., quartz sandstone, very fine grained, very light gray, well sorted. Non calcareous cement. 39.9 - 48.0 quartz sandstone, very light gray - white, medium grained, well sorted, some disseminated limonite patches from 47.0 - 47.5 ft., non calcareous cement. No mineralized partings.
48.0 - 58.0	Core recovery 88%, 48.0 - 51.5 ft., quartz sandstone, light gray, fine - coarse grained, non calcareous cement, disseminated limonite at 48.5 and 50.5 - 51.2 ft. 51.5 - 56.0 ft., quartz sandstone / conglomerate, medium - grit sized grains, consists of chert fragments and pebbles, conglomerate zones at 51.5 - 52.0 ft., 53.7 - 54.0 ft., 55.5 - 56.0 ft., non calcareous. 56.0 - 58.0 ft., siltstone / shale, light gray-green.
58.0 - 69.0	Core recovery 93%, 58.0 - 69.0 ft., quartz sandstone / siltstone, very fine grained, light tan, rounded grains, disseminated limonite from 58.9 - 59.5 ft., and 60.5 - 61.0 ft., low angle partings with hematite / limonite coatings at 62.7 ft., and 66.0 ft., grain size increases to fine from 67.0 - 69.0 ft., two small 2 - 4 cm patches of limonite after pyrite with remnant pyrite in center of patchs at 68.5 ft.
69.0 - 80.0	Core recovery 73%, 69.0 - 70.0 ft., quartz sandstone, fine - medium grained, light tan, very clean sandstone, non calcareous cement. 70.0 - 72.0 ft. core not recovered.

Core log of well MW- 24 Cont.

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	 72.0 - 72.2 ft., green shale. 72.2 - 76.0 ft., quartz sandstone / conglomerate, fine - medium grained, grading downward into conglomerate from 75.0 - 76.0 ft., light gray-tan to tan. 76.0 - 78.0 ft., quartz sandstone, very fine grained, light purple-pink to yellow-tan. 78.0 - 79.5 ft., shale, gray-green, poor recovery. 79.5 - 80.0 ft., quartz sandstone, fine - medium grained, gray, abundant disseminated limonite, some manganese dendrites.
80.0 - 90.0	Core recovery 100%, 80.0 - 80.2 ft., shale, gray-green. 80.2 - 90.0 ft., quartz sandstone, medium - grit size grains, light gray- tan, abundant 2 - 3 cm diameter spherical patches of disseminated black mineral from 80.2 - 83.0 ft., no mineralized partings observed. conlomerate zones at 84.0 - 84.3 ft., 84.5 - 85.0 ft., and 87.7 - 88.2 ft., non calcareous cement.
90.0 - 100.0	Core recovery 90%, 90.0 - 95.0 ft., quartz sandstone, fine - grit sized grains, light gray-tan, conglomerate zones at 90.2 - 91.0 ft., 92.3 - 95.0 ft., non calcareous cement, some disseminated limonite. 95.0 - 97.0 ft., quartz sandstone, fine - medium grained, light gray. 97.0 - 98.0 ft., quartz sandstone, medium - grit sized grains, light yellow-gray, some conglomerate zones. 98.0 - 99.0 ft., core not recovered. 99.0 - 100.0 ft., quartz sandstone, medium grained, light gray-tan, very friable.
100.0 - 110.0	Core recovery 70%, 100.0 - 105.0 ft., quartz sandstone / conglomerate, fine - grit sized grains, light gray to tan, conglomerate zones from 100.0 - 100.2 ft., 102.5 - 103.5 ft., 103.5 - 105.0 ft., quartz sandstone, medium grained, non calcareous cement. 105.0 - 110.0 ft., quartz sandstone, medium grained, some disseminated limonite, very soft and friable.
110.0 - 120.0	Core recovery 100%, 110.0 - 114.5 ft., quartz sandstone, yellow-tan to gray-pink, medium grained, abundant disseminated limonite in this zone. 114.5 - 116.7 ft., quartz sandstone, medium grained, light gray. 116.7 - 117.5 ft., abundant disseminated limonite. 117.5 - 118.5 ft., quartz sandstone, fine - medium grained, gray, calcareous cement. 118.5 - 118.6 ft., conglomerate / shale, green, upper Brushy Basin Mbr. contact at 118.5 ft., contact is high angle. 118.6 - 120.0 ft., shale, green. T.D.

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PERCENTAGE COMPOSITION IMAGE









Core Log of Well No. MW-28

Cored Interval 49.0 ft. to 110.0 ft. T.D.

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<u>Depth</u> 49.0 - 60.0	Description Core recovery 55%, 49.0 - 54.0 ft., no core recovered. 54.0 - 54.3 ft., conglomerate, non calcareous. 54.3 - 60.0 ft., quartz sandstone, fine - medium grained, yellow- orange to tan, no mineralized or weathered surfaces, disseminated limonite zones from 55.0 - 56.0 ft., and 57.8 - 59.8 ft
60.0 - 70.0	No core recovered from this interval.
70.0 - 80.0	Core recovery 22%, 70.0 - 77.8 ft., no core recovered, 77.8 - 80.0 ft., quartz sandstone, fine - medium grained, yellow-tan, cross-bedded with some grit sized grains occuring along bedding planes, very friable, non calcareous.
80.0 - 90.0	Core recovery 63%, 80.0 - 83.8 ft., no core recovered. 83.8 - 86.3 ft., quartz sandstone, medium - grit sized grains, yellow- tan, sharp contact with underlying shale. 86.3 - 86.5 ft., shale, yellow-gray. 86.5 - 90.0 ft., quartz sandstone, medium grained, yellow-tan to gray, non calcareous, very friable.
90.0 - 100.0	Core recovery 82%, 90.0 - 91.7 ft., no core recovered. 91.7 - 93.5 ft., quartz sandstone, fine - medium grained, gray-tan to light tan, several nonmineralized mechanical partings, non calcareous. 93.5 - 100.0 ft., quartz sandstone / gritstone, yellow-gray, grit zone from 95.5 - 97.5 ft., conglomerate zone from 99.9 - 100.0 ft., non calcareous, core becomes almost unconsolidated from 91.7 - 100.0 ft
100.0 - 110.0	Core recovery 67%, 100.0 - 103.3 ft., no core recovered. 103.3 - 103.5 ft., conglomerate with chert pebbles up to 1 1/2 inch diameter. 103.5 - 104.0 ft., quartz sandstone, fine - medium grained, yellow- gray, some limonite on contact at 104.0 ft., upper Brushy Basin Mbr. contact. 104.0 - 110.0 ft., shale, green to purple-brown, some carbonaceous patches at 105.0 - 105.4 ft., purple -brown mottling from 106.5 - 108.5 ft. End of core at 110.0 ft., T.D.

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PERCENTAGE COMPOSITION IMAGE



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PERCENTAGE COMPOSITION IMAGE



Cored Interval 20.0 ft. to 60.0 ft.

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<u>Depth</u> 20.0 - 30.0	<u>Description</u> Core recovery 36%, 20.0 - 20.3 ft., quartz sandstone / siltstone, very fine grained, yellow-pink- tan, calcareous cement. 20.3 - 27.0 ft., no core recovered. 27.0 - 30.0 ft., quartz sandstone, medium grained, pink-tan to tan- brown, disseminated limonite from 27.0 - 28.0 ft
30.0 - 40.0	Core recovery 100%, 30.0 - 40.0 ft., quartz sandstone, cross-bedded, medium - grit sized grains, tan, non calcareous, grit zone from 31.3 - 31.7, dark gray clay galls from 32.1 - 33.0 ft., no mineralized partings.
40.0 - 50.0	Core recovery 67%, 40.0 - 40.7 ft., quartz sandstone, tan, medium - grit sized grains, grit zone from 40.7 - 41.0 ft., contact with weathered surface at 41.0 ft., manganese dendrites. 41.0 - 45.2 ft., quartz sandstone, light gray, fine - medium grained. 45.2 - 46.6 ft., quartz sandstone, yellow-gray to yellow-tan, low angle limonite mineralized parting at 46.3 ft. 46.6 - 50.0 ft., no core recovered.
50.0 - 60.0	Core recovery 95%, 50.0 - 51.0 ft., siltstone, yellow-gray-tan. 51.0 - 52.5 ft., quartz sandstone / siltstone, dark gray-brown. 52.5 - 55.5 ft., shale, purple-red. 55.5 - 60.0 ft., siltstone, yellow-brown, very soft, lower contact is low angle parting, grades into quartz sandstone to 60.0 ft., tan to yellow-orange conglomerate zones at 57.0 - 57.3 ft., 58.0 - 58.7 ft., and 59.8 - 60.0 ft., end of core.

Date <u>4-5-05</u> Geologist <u>L. Case</u>	bolf Drilling Co. Boyles Exa	protion Co. Hole No MM-31
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PERCENTAGE COMPOSITION IMAGE









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	412.55			- - -	- 12			<u> </u>			
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¹⁵ H	1412-55- 1 at-2 80	144ba	morial		200 						
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5日ぶ圖 🛛	atzss	Hay	mwr	· 📓		<u>ac</u>				<u>i</u>	•••
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	Przss, cgi	dkywgy i	m- <u>brpr</u>					N	ШĨ.	<u> </u>	abund dk chert frags & grains
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Date <u>26 APE 2011</u> Geo	logist_L.Caseboit	Drilling Co	ayles Exploration, Inc.	Hole No. 111 310
Property white Mess Mill	Project <u>Cell4B</u>	Unit M	No Sec	Twp Rge
County San Juan	Stote Litah	Location		Elev. ~ <u>3013</u>
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	S Styler St	2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 / 2 /		T.D. DRILL <u>220,0</u>
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25 THI MAST	rdbn-ltok		VS MANCES Sh	CL
8.0	rdbn		vs	CL
10.0	rdbn		5	······································
/2.5	Irdbn	╺╆╍┝╴┝╸╠╍╠╸┝╴┥╸	S	
15.0	It or		V5	······
	Huwth		VS	
22.5 Ht-	1+pktn		S	
25.0- qTZ 55	youth MW r		N Upper Dakota C	@ 22.5 ft.
275			N	
30.0	th mwa	L	N	•
35.0	ta mw 3			
37.5 qt2.55	th m W a			·
40.0	the matter of the second secon		N	
43.5 012 53, St	$\frac{1}{1}$		N	
45.0	th f. mm r		N	
500- gtz 35_	th MUR			· · · · · · · · · · · · · · · · · · ·
52.5	th m-c m r		N	
55.0	to MWF		N	
57.5-1-1-1-1 (a)	Hbn m-cmr	·	N some wh-gy	chert grains and frags.
972-55	th M-VCFY	- <u> </u>	N	17
65.0 Sh, sitst	<u>gy-1+tn</u>			
37.5-1-3h	Itay The reference		N	Ch
72.0	It www.bn mw	-	N	
75.0 atz 95	1+tn-1+ywbn mw		S	
77.5-H at2.95	wh-lttn musi			¢ H
30.0-1==	11694			
92.5 Sh	pproun		N mottled cut	tings
	Holyy pprobin		N	
90.0 Sh	itblgy		VW	
92.5	vitta vi w	╶┾┽╾┥╋╞╏┼		
95.0	Vita F-m M		VW 1	
975	vitto f-mmi	-	Ń	
12 5 ATZ 53	wh mwr	-	N	
25.0	vittin mw		N	
07.5 97258	vitta mixer			
10.0-1-1- and at- ac	Vitto f-MM		W MDISTUre First	nulid
72.3 4 35 15 0 1 2 35	ultin f.mm	- ma	S Brushy Basin	ct. @ 115.0
(25日三) Sh	blgn			
20.0 === Sh	blgn		N LiDi	
287.5-1				



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	한 김 영화 방법을 받을 것을 수 없다.	1.41.545444-54				·		· · · · · · ·	n an
Date <u>25 A</u> A	DE 2011 Geolo	gist L. Casebo	1+	_ Dri	lling Co	Bayl	es Ex	ploration, Inc.	- Hole No. MW-37
Property Whi	te mesa mill 1	Project <u>Cell</u> 4	B			it No.	<u> </u>	Sec	Twp Rge
County Son	Juan s	slole Utah		<u> </u>	cation <u>C</u>	ELL 4B	DIKE		Elev_ <u>56/8 ×</u>
	\$.		/	/ / /	[*]		Γ.	1 5 1 5 1	PAGE OF
× 1.	8 / 3 / 3 / 8 / _	5	4 /4	[š	\ <u>*</u> &	YRITE	13/4		T.D. PROBE
& /&/ ×	[\$]\$[\$]	Sec.	at 15/3	\$/\$/	5/8/5/	[o: [3].	\$. 	\$77	T.D. DRILL <u>120-0</u>
No star	ÿ/¥/\$Z ×	Contraction of the second	18/8/	NO (N)	[\$ \$ \$ \$	\$`/\$`\\$	18/\$	S/24/	
0-6-6-	<u>``\`\</u>	· · · · ·	/ // //		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	<u>/*/*/</u>	*/ */	×7	REMARKS
25-12-2	mdst	rdbn		-				Cumpacted Taili	ngs Cell Dike Material
5.0	melst	rdbn				vs		· · · · · · · · · · · · · · · · · · ·	<u>1)</u>
75-1:5	mast	rdbn				- 100			11
10.0	malst	rabn				114			
12.5-1 靈	und st	rdbn ·							h
15.0 [] []	maist	raon				V-		š	17
17.5	mast	raph				VS		8))
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25.0日到	sh	uwbn				VS		Mancos Sh	
30,日主	Sh-mdst.	rdbn-Hpk				×۷		mands Sh.	
375	atzss, sh	th. f.	mmr			vs		upon Dakota Ct.	@ 300'
35 0	972.95	tn f-	mmr			Vu			
375	gtz SS Sh	to ct	mmr			N			
40.0	97259 3h	gybn	mmr			<u>[1</u>			
42.5	gizes, sh	wh-Harbo-digy	mmr			- N			
45.0	gtzss	wh-ltorba f-	MMr	<u> </u>					
47.5-173	912.55	vitto	MWR	노		- VW			
500	gtz 35, gtzite	wh	MINK					Very hard drilling	*al. 4 a
52.5-	atzss-atzitz	wh f-	mw r			1		extremely hord dr	illing
55.0-	atres.grzite	$\frac{\omega n - 1t To}{\tau}$						MDISTURE FIRST N	5112 C 59
575		11+2	ogb O D			<u>и 100 г</u>		Very shund a har	tarrive and perbles
60.0 1 1.4	191275, Cgi	Hunadara Mar	DUL R A			N		Some chart ack	ble Codes
Gives	Sh-Cal	11 que gy gr	abp a			N			A
65.0-HEE	allet at as	H + p $Vf -$	peb P a			Ň			
	at 20	$1+t_0$ $VE-$	DED P T			N			
Das History	atz- 55	14th f-	WAN P r			10			· · · · · · · · · · · · · · · · · · ·
72.3	ate 55	litin m-	pet PT			5			
775日三日	at2 59	vitta m-	pull r	- L		VN		abund chert (rdgs.
Bao E	atz. 59	vitbn .	mwr			N		· · · · · · · · · · · · · · · · · · ·	•
82.5	gt2 35, cg1	wh-vokgy M	peb p r	2		2		Abund unter e BO	o' abund chert frags a penoles
85.0 HEE	sti, gtz sz.Cg	1+tn-gn f-	peb P T	<u> </u>		N		abund chert fro	gs and pebble.
875-HE	sh, gtzss	gn·wh f-	Sed P T			N			
90.0-	qt2 55	wh m-	permit						
92.5	<u>qtz ss</u>	Haybn M-	PLO FIN Y					· ·	
95.0-	972 SS	vitta	MWR						
975-1838	9Tt 55	vitta m-	peb 12 r					2 ·	
1221-2-1-100	gte ss	littn m-	c # r			N			
12.5-日本	9tz 55	$1+tn$ t^{-}	mmr						
v50日恋!	972 55	$\frac{1+t_n}{1+1}$	M M					· · · · · · · · · · · · · · · · · · ·	
07.5	glzss, sh_	ITM-gn f-	man in o			- <u>N</u>		· ·	
10.0	9TZ 55	wh-in	m la la		222				
72.5-日 滚	141255	virin -	mmr		12 0	ω			
75.0-1 認識	412 20	white black				N		Brushy Brain P.4	@ 117.0' (apodeen Tact)
175日21	1 412 55, en	blev- sobo				И		1200 T.D.	
20.04									
									·
300 CM 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		• • • • • • • • • • • • • • • • • • •							····

PERCENTAGE COMPOSITION IMAGE

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APPENDIX A.3

PIEZ - SERIES

nere /	18-2001		
Property	<u>18-2001</u> Geologist <u>L.Caseboli</u>	Drilling Co. Bayles	Exploration, Inc. Hole No. PIEZONDER WELL #/
County _	an Juan Slote Utah	Unit No	Sec Twp Rge
	1/1/1/		Elev
A A A A A A A A A A A A A A A A A A A		L A Sh PYRITE	US PAGE OF
St and			T.D. DRILL 107.5 TD.
			S/S/ FLUID LEVEL
2-1		/%/*/\`/\`/\`/*/*/*/*/*/*/*/*/*/*/*/*/*/*/	REMARKS
F の日本	Sitst, sh Ird ha		
7.5	3Hst.sh rdbg-1ttn		2011
10.0	slist, sh_ lipktn	2Y	
12.5日三	slist sh lipk-ligy	R I	
15.0-	Siter, qtess lite P-m f	<u>sr</u> N	Upper Burro Cyn Fm. Contacte 14.5 ft.
775 日 3	at se lite - vc c		24
22.5	$\frac{1}{9tz}$ s to $f-mf$		
25.0	atzss th f.mf	M	
27.5	alzss th f-mm	1r N	
30.0-	$\frac{qtzs}{th}$ $\frac{f}{t}$	SQ W	
25 11 11	$\frac{q_{12}}{q_{12}}$ $\frac{Tn}{t}$ $\frac{1}{t}$ $\frac{p_{12}}{q_{12}}$	Sa VII	
325	atzss 1+th f-mif	Sr. VW	
40.0	atzss lith fmf	Sr. N	
425-	atzss th fmf	Sr N	
45.0-1	Atzss gy fmp	Sr N	
47.5	1912 SS Hayta Fimm		
525	gtzss Hto MW	r N	· · ·
55.0	atzss Hayta MCM	- N	
575-	qtzss Itgytn fvcp	sr N	
60.0	qtzSs $ltgn$ $vf-ff$	Sr N	
	at s with the		
475 H	atzss viten vfm f	sr N	
700	atz SS VItto VFME	SF N	
72.5	qtzss vitta f.M.w	Sr N	
75.0	etzss vitte fm	Sr N	
	at se with finite	Sr N N	
67.5- H	172 SS Have pullicater C. 10 m		
85.0日3	atz SS Hay-multi-color m-vC f 1		about. chert frags.
875 4	gtz ss Itgy-multi-colorm vcfr	r III III III N I 🔅	b
90.0	gtz 35, cgl multi-color much	r N	<u>i</u> i ii ii
92.5	ptz.ss.cgl wh-multicolornive + 1		high_
47.0 H	gress cal multicolog multiPress		2but chert frags } perm
, po. 0 Her	912 SS cal multicolar MVCP 1		
102.5	92 ss wh-vitgn mycpsv	r N N R	Jurro Cum / Brushy Rasin Fra Pt @ 1025
105.0-1-2	sh, sitst gn	N	
107.5 -===	Sh - 190-pp		<u>гр</u>
110.0-1			,
1/5.0日			

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Date <u>12-17-2001</u> Ge	ologist L. Casebolt	Drilling Co. Bay	les Exploration Inc Hole No presonater 19/142
Property White Mesa Mill	_ Project	Unit No	Sec Twp Rge
County <u>San Juan</u>	Slate <u>Utah</u>	Location	Elev
	D ^{ot} C ^{Ot} ors ^w		C C
2.5-	Ind bn		ALMARKS BIT DIA. 4.75
5.0	rdbn	S	
7.5	ywbn-rdbn frm f sv	W	Hoper Burn Cup Contact 0. 6 0 Get
10.0-1	ywbn-rdbn fim psr	W	
12.5 4 gtz.ss	to ufff sr		
15.0-1- 15.0-1 atz ss	tn f p sr		
17.5	vitgy fwsr		
20.0	Itgy F-MMSr		
	<u>626-1794</u>	Hern N	Encounterwater @ 21 feet, begin injection
225			Nosample
300	104 ALL 14-6 4 15-		
32.5	wh-multicolor MAC D ST		about allow t Creations
350	multi-color f-VC 0 Sr		13 1) 1)
37.5	wulti-color much sr	N	i) i) ii
40.0-1 0: atz.ss.cg/_	multi-color mycp.sr	N	از ۱۹
42.5	multi-color mycp sr		n 1 µ
45.0	multi-color Mrvep sr		* tr. hematien pyrite
	Multi-color MVC p Sr		
	unulti-color mice point		
55 A L C L C L C L C L C L C L C L C L C L	multi-color mych sr		
525 0	multi-rolon mur a sri		
60.0 90. 912.35, C41	wh-multicolon mich 3r		
62.5 - atz 55	HW fmfsr	N	
65.0 atz ss	wh f-mfsr	N	
67.5 - 4tz ss	wh-lton f-mfst		
700	bn Vfc psr		
	un-bn f-mps-		
	m multicalor music a les		
	$f_{\rm m} = f_{\rm m} f_{\rm s}$		about cheut trags
ers ditess	20 f-Mfsc		······································
850	h-lto f-mfsr		
67.5	ih M-crpst	N	
90.0	n mer psr		some chert frag.
92.5	bn-gugn vfmpsr	N	Burro Cyn/Brushy Basin Fm ct @ 92.0 feet
95.0-1-=- SHSASA 9	╉┈────┤╶┤╌┤╴┤┊┥─┤		
17.5	╇┈───┤╌┤╌┤╌┤╶┤		
1020-1-1	╇╌╍╸╸╴╴╎╌┠╍╎╌┠╍╎╶┨	╌╏╌┨╌┨╶┨╴┨	T.D
		╺╂╌┠╌┠╺┨╴┠╼┠╶	
1025		╧╂╍╂╍┨╶┠╼┨╶┠╶┨┈	· · · · · · · · · · · · · · · · · · ·
1100 H		╤╂╧╂╧╂╶┼╧╂╶╂╼╂╧	Note: this well as is to 11 1 11 11
112.5-			Surface casing to a denth of RO R Cal
115.0-			The top & lect of the well clouched every when
1175-7			distribution this material throughout the resultion
120.0			cuttings, Surface casing was installed resulting
/22.5	<u></u>		In improved cutting recovery and quality,



·· v Flit	s, - coldina	•	••••	•
Date 12:15	7-2001 Geologist 1 Casebalt	D-:		1
Property W	Dite Mega Mill_ Project	Drilling Co.	Doyles Explore	tion, Inc. Hole No. presometer well #
County Say	n Juan State Utah	Location	I INO	_ Sec Iwp Rge
		777777	1111	
At at		/ / / × / × / + / PY	NITE Star	PAGE OF
St free a		No X X X A		T.D. DRILL _100.00
A A A				FLUID LEVEL
· •		<u> </u>		REMARKS Bitdia. 4.75
2.5	Sitst, Su rdbn		S Soil	
5.0-1	Sitch sh litch ba	╾┾╉╌┝╋╋┻╂╴	S Soll	
	Silst sh Hak ba			
12.5	sitsh, sh. It nk ba			
15.0-	Slist sh litak bo		VS	
17.5	sltst sh Itin		vs	
200	sltst, sh It ywgy		S	
22.5-	gtzss 1+tm f-cfr		M doper	Burro Cun Fm. Ct. @ 200 Ceet
25.0	atz ss 11m m-cmsr	-	YW	
275	atz ss th mwr		VW	
30.0	$\frac{1}{12}$		N	
323	at s to $Cimer$	┟╼┨┈┠┉┠┈┠┈╽╶╽		
375	atess in finise	┟╍┨╸┟╶┟╴┠╺┨╶┝		· · · · · · · · · · · · · · · · · · ·
40.0	9tzss 1+th fmsr			· · · · · · · · · · · · · · · · · · ·
42.5	9255 Hay F-mfsr		N	
45.0-	atzss 11-in f-c f sr		N	
47.5			Nosam	ple
50.0		┉┨┈┠┉┠┉┠┈┠╸	No Sam	ple
52.5		┿╉╶┠┅┫╍╉╍╂╌┠╴	No Sar	ple
		╤╂╌╂╍╂╼╂╼┼╌┼╍	Nosam	ple
60.0 4	atzs.cgl wh-multicolor f-mfr	╺┥╶┨╌┨╼┨╶┧╴	No San	nple
62.5 0.8	gtz SS cgl multicolor f.m.f.r		N "	N N
5.0	atz SS cg1 multicolor f-vc part		N n	N 11
2.5	ate SS cgl multicolor f-vc par		N r	N 11
0.0-	at ss, cg1 multicolor wcpa		N II	11 J.
2.5	Atz Ss, cg1 multicolor VC pa	╺┼─┼╾┼╍┽╶┼╾╵	N II	4) y
5.0	at s. cgl multicolor five par	┽╾╂╌╂╌┨╶┨╶┥	N	р II
	attal an-multicolor thepr	╅┾╂╌┠╌┨╶┠╸┥	N P	
s ==	sitet cal an	╅╌╁╍╂╍╂╼╂╶╂╶┥	Burroc	un/Brushy Basin Ct.@ 79 feet
5.0	slist gn	┽╌┾╍╫╍┼╌┟╴╢	J	· · · · · · · · · · · · · · · · · · ·
	stistical an-auto			······
2.0_1===	sitst, sh gn			
5-712-11	3ltst, ss gn-tn		. 6	
0	stist,cgl gn-wh			
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20+1-2=	SHCt. cgl gn-mult.color-	┨──┠╦┠──┠╼┨╴┠╾┨╹	Т.	
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5-11				
10 H				
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APPENDIX A.4

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の日間	Sh, slitst	4494									I	VS			Silty, noteable selenite crystals
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	congl,ss	tn vc	-m	Plu	R	-	-			_	1	1	1	_	5% Dark brown-ton chert Gragment first water
	Conglass	ta VC	m	PW	R	+	-				<u> N</u>	-	4		3% Darkbrown-tan chert frigment-first wets
	Congl, Ss	$\frac{t_n}{v}$	m	P I	2	╇	SP			-+	1	4-	+	-	15% Muticolored chert & rock fragments
	Congl. 55, 5h	rabn-gygn-in.	[-m]		- 	+	┼─			_			╇	╇	
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Date 🔟	<u>1-16-99</u> Geo	ologist <u>L.Case</u>	BOLT	Drillin	g Co. B	BAYL	ES L	EXPLORATION, TNC. Hole No #3
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175	Sh	dKauba				VS		Silty, Sparse manganess, dendrites on surfaces
200	sh	dicqueba				VS		
22.5	Sh_	akgybn	┝╌┠╌┨╴┠╸	<u> </u>	+++	15		
25.0	Sh	digyon	┟╌┠╌┠╸	┥┦┥	╉╃┼	۷s		1% gypsum (selenite) crystals
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650	9tz 55	ltto	mGSR		+ + + + + + + + + + + + + + + + + + +	N		
67.5	qtz SS	Itto F	m G SR		┠-┨-┠	IN_	┦┙┦	
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	1412 35, ata 35.	It has ru	m F SR		┢╍╂╶╂╼	IN 5P	P	Sparse carbon from plant transmo
77.5 - 40	atz SI Cal	lt ba F-1	PPD		┠╍╂╌┠╼	10	╉┽	Q to sail (
30.0 7.7	gtz Sz Cal	Itblay F-0	CEPA					Broken FOCK I FRAME T.
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85.0	<u>qtz. Ss.</u>	Htn 1	MGR			N		Commission of Egrand & Poletrag. From 77.5 (let.
87.5	atz Ss_	11+tn h	nGR			N		
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72.5	ata Se	It in ne a	nG K	╶╁╃┤		N.	┟╌╎╴	
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1000	Sh. 972 Ss	It blau FIC	DP SA	╶┾┽╴╽		W	┠━┥┘	Lower contact Burro Cyn Fm.
02.5	SHst, Sh	It blay			-	m		Brushy Basin Mbr. Morrison F.m.
105.0	Sitst Sh	Hblgy-wh				N		
1075	Sh.	It blay-wh				NI		
~~日空	Sh, gtzs;	Hblgy-wh FM	P SA	Я		N		Noteable puiste (<1%)
/12.0	SItst gtzss	Hblgy-wh FM	PSD	SP		N		Spanse pyria
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//7.5	Sh, Sitet	blgy	┼╌┤╌┦		-╂-┠-╏	N		
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PERCENTAGE COMPOSITION IMAGE

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Date <u>5-11-2000</u> Geologist <u>L. CASEBOLT</u> Drilling Co. <u>BAYLES EXPLORATION</u> , INC Hole No. <u>TW4-4</u>
County SANJVAN State //TAH Location Elev.
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D - Sh, It yo ba MT P Sh S
Qtz Ss. It to M-FP SA HUDDEr Durro Cyn Contacte 17.5 noteable color chunge
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5 - Qtz So, It to MF P Sh VW
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Qtz Ss Hauth MG SR N
5 Otz SS Hayto MESR NSPP Soarse carbon frag.
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PERCENTAGE COMPOSITION IMAGE

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. <b>-</b> . '	Property (2)	<u>2000                                  </u>	eologist <u>22</u>	ASEBOLT		_ Dri	lling	Co.	. BAy	<u>ILES</u>	EXPLORATION, INIL Hole No. TW4-6
e.	County SAN	TUAN	L Project A	<u>ТАН</u> ТАН	HASE 2			. Un	it N	0	Sec Twp Rge
-		TIN	7 7				77	n			Elev
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			NO /	0°	14 510/0		**/\$	4	77	<u>{</u> {},	Vier S T.D. PROBE
	A A A		, ¹⁰	0'0'5		<u>``</u> ,	* /3	/~ k		/*/	FLUID LEVEL DRY WELL
	0-55	<u><u></u></u>		* 6	t/5/\$	/ <b>\$</b> \$	/*/*	/*/	/ <b>\$</b> \$/{	\$/\$ 	NA REMARKS
2.	5	Sh, Slts	tss dk rd bn	CM	VP			Í	ŤΤ	s	Soil very source clearate anise -last C.
5.	の中国	Sh, Sits	dkrdbn-1	trdta_				<u></u>	1	VS	, , , , , , , , , , , , , , , , , , ,
7.5	「日三日	Slfst	lter.tn					-800 	8	ر ا	
10.	0	Sh, qtz	3s_ It yurgy_	m	PR	SP		<u> </u>		15	Noteable color change
12.	5 日종	Sh. SH	st It ywg :							15	
15.	0-1	Sh,qtzs	is It ywgy		= SR	SP				S	Hematite as grains, and clusters, gtz grains
17.:	「日三日	Sh,qtz S	s It ywgy_	<u> </u>	= SR	SP	++			5	" some sparse gypsun (selenite x1s.)
2 <i>0</i> .		Sh. Sits	+   l+ ywgy			┥╌┝	+		<u>   </u>	4	
22.	5-日三日	Sh, site	+ Hywgy				$\left  \right ^{\cdot}$		<u> </u>	4-1	Upper Burro Cyn Fm. Contact at 22.5 ft.
25.0		QE SS_	- Iltgyta	9	SR	[ <u>5</u> ]	┼╌┼╴	4-1	V(	<u>" - </u>	Otz grains clear, sparse hematite as grains, ch
27.5	· +1 -	Gta Sa	1194In_	<u> </u>	SA	SP		+		-1	Spense dkgy chent frag, some gy shale.
30.0		Otz Sc	lite to	- Cha	SE	A	┼╌┼╌	┥┦		┼╌╂	
32.5		At Sc	to the		57	c -	┠╍┠╼	╉╼╊		╂┯╂	Abund hematite, abund wh-dkgy chert frag.
35.0	<b>,</b> 日	CH2 SS			[ ² ]	5	┠╼╌┠╼	┽╌┼		╎╌┠	Some hereatile abrind which dkgy chert frag
37.5		Sh Atz Se		C-ml		\$	┝╌┼╍	+		┼╌┼	
40.0	H II	Q12 Ss	to to	mc	2	SP		+	- N	$\uparrow \uparrow$	Neg children same
42.5	H	Qtz Ss	to	m		SP		$\uparrow \uparrow$	N		Nite Office Sala.
47.5	·E=	Qtz Ss Sn	ltayta	F-M+		9 P			N		Sparse shale frag.
50.0		Qtz SS	/ <del>t</del> tn	F G	4	SP _			N		
525		Q12,55	1+tn	F G					И	SP F	Sparse carbon (plant fragments)
55.0		Qtz Ss, St	Itgy	FF					N	SP	Some curbon (plant fragments) which ert frag
57.5		Qtz Ss	gy	FF	51		-		4	VA P	Abundant carbon, some wh chent frag.
60,0	-1	atz SS	94	MFP	SA	╶┼┽				AP	
62.5	$\mathbf{H}$	atz Ss	gytn	M-FF	34	╶┼╌┼			- <u>  N</u>	SP	
65.0	$\Pi$	Qtz SS	<u>gy1n</u>	MFF	84					58	wh-bk chert tragments
67.5		UT2 SS	11+ta	MFF	<u> </u>		╺┼╼┤				wh-bk chert tragment
70.00 ·	$\square$	Qtz SS	<u>  tn=</u>	MFG		┼┼	┽┽				Wh-bk-chert trags
72.5 -		CHIZ SS CAL	1tn		SAL	++	╺┼╼┼		N	- -	COURSE, MULTI COLOREN OTOCA FRAGMENTIA POSSION
75.00		Dta Sc	wit to	EC	5A		++		N		
77.5-		Atz Ss	Vittn	FF	5A SA				N		<u>к</u> и у
80.0-		Qtz Ss	v It to	FF	5A	s			W		Some granular pyrite frag.
82.5 -	Ħ III	Otz Ss	vHauta	FF	A	SP			N		J. J. J. N
85.0-		Sh gtzss	94	MPS	jA	SP			NS	P	
827		Atz SS Sh	94	CMP 5	A	SP_	+ +		NS	P	Carbone pyrite frag. with multi colored chart fre
475-		Qtz Ss	Itorta	MGS	<u>e</u>	++	+		N		nice chan sand
95.0-		Qtz Ss	It or th	MGS	R	$\left  \cdot \right $	╉┽		VW :		Basal Burro Cyn. Fm Conlais @ 45.0 leet.
97.5 -		Sh, Cgl	blgy-tn	CVPS	┦_ _	<u>s</u>	┨╌┽╴	+	N		upper Brushy pasin contact, pyrie grains by
T.D.				-┼-┼┉┼-		┼╌┼─	╉┯╂╸	- <del>   </del>			gy chent fragments. The down of the other of
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Date 🔟	1-17-9	7 <u>9.</u> Geo	ologist <u>Z Casi</u>	<u>e 60</u>		<i>.</i>	_	Dri	llin	g C	Co.	B	AY	ΊĿΕ.	5	EXPLORATION, MC Hole No. +7
Property	Y WHITE SAD	E MESA MILL	Project MN-	4	PH	<u>ASE</u>	2			_ 1	Un	it	No.			Sec Twp Rge
County_	<u></u> 77	JULIN	State <u>UTAH</u>					_0(	cati 7	ion 777	_			-7	_	Elev
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2			°° ,	, p	Ň	24	0/	\$ \$	× /	Š/	7	7	7,4	۶/۲	ž	Xe/ S         T.D. PROBE           T.D. DRILL
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0 5	5 / 8 / 0				6	5	$\sqrt[n]{c}$	i/q			×/	*	/~) ~)	/& */	13	REMARKS
2.5		Sltst, Sh	dkrdbn									_	۱ ۱	J		Soll
5.0		sltst, sh	dkrdbn-ltpk	tn	+	_	-		-	_	_		Υ <u>Υ</u>	S C		noteable color change
75 日暮		Sltsh.Sh		+	╀		+				╉	┢		<u>&gt;</u>		
10.0 日言		Sh	ywyy		╈						+-	+-	W		╈	Noter ble color change, some manganese dend
12.5 日三		Sh	ี นพยน		T			L					Y	;	T	sparse limonite
175 43		Sh	4694										5		Ι	gypsim (selevite) crystals
20.0		qtz Ss, SH	stywgy	V	F P	SA		L		_			S			20% gypsum (seleinte) crystals
225日言		Sltst sh	40034	+	┢	4-		니			-	+	N	-	╀	2.0% gupsum (selenite) Crystals
25.0		Sitst, Sh	<u> </u>		┼─	-	$\left  - \right $	н	+	+	╀	┼─	N	+	╋	103 gypsum (selenite) c-ystale
27.5		012 55	17429	m	F	SA		+	+	╋	╉	┼─	1		┢	Track Burne Con Tra
375		ate 3s	It th	m	F	SA			╈	$\uparrow$		-	IN	┢	$\uparrow$	Topor Durro Lyn, FM.
35.0-		gtz Ss	lt th	m	G	SR		L			1		N		T	Sparse limonity
37.5		gtz SS	1t th	m	4	SR		L		1			N			Sparse linionia
40.0-		gtz SS	It the F	<u>-m</u>	F	SN		_	4-	-	┨		N	-	_	
42.5		gtz SS	$\frac{1}{11}$	- m	F	31		+	_	+	$\vdash$		IN	╞	╞	
45.0		giz ss	1 it to	F		50		-+		+	+	$\vdash$	LU LI		┝	
50.0日		atz 55	lttn F-	. m	F	SR		t			$\mathbf{f}$		(A		$\vdash$	
52.5		gtz SS	vitta	F	G	se							N			
550		gtz ss	VItto VF	F	6	SA				1		ļ	Ν		ļ	
57.5-		gtz Ss	litta VF	- 1-	F	SA		_		-			N	_		
60.0		97255,5h	Thon-gy F.	. m	F	SA		+	+	+-		-	N	-	┝	
			ongy bis			┥╴┦	+	╉	╋			$\square$		-	┝	Last star latter at the second second
675		> NO CW	tings			$\square$		T	1		-				<b>†</b>	LOST Circulation at This depth - no custings
700-			1													
7z.5																در در در د د د
75.0 A.P.		atz Ss	[ltbn	m	<u>6</u>	SA	_	_					Ŋ			Began H2D injection w/ form
77.5		giz SS Cal	It ywth M	CP	P A	SA		4		$\left  - \right $			N	S	ρ	Sparse carbon as plant frag. chert fragments
80.0		912 53, Cg1	11 gy - wh m	CE	P 0	54	┦			$\left  \cdot \right $			N			Chertegtzite rock Gragments sparse hemati
		atz 55 Cal	th-rdbn m	10	ρ		$-\frac{1}{2}$	,	+	┝┤			A			
87.5		gtz SS Cgl.	tn-multicolor	CR	p	A	╧╎╴		1-	╎╴╢			N	-		abundant rale bk chert fragments
90.0		qtz Ss, Sh_	1+tn-1+blgyt	m	F	SA							N			11 bl shall fragments 5%
92.5-		gtzss, Sh	lttnbn-ltblgy	-m	F	SA	_	5	pm				N			Sparse surice as cement/matrix around at arain
75.0-		alz Ss	11th-1torbn F	m	F	SA		1 51	PMIX	┞┤	$\downarrow$	_	N	_		
97.5-1		giz ss Clfst	VITTN F	m	F	SAL	+	+-		$\left  \cdot \right $	_	-	N	_		Base of Burro Cyll Fm.
00.0		sh. sitst	Ithlan		-	+	╉	┿		┞╌┼	+	-+		÷		
105.0		Sh, sitst	dkrdbn-blay		1	+			+	┝┼	╈			-+	-	Challe C
1075		Sh, Sltst	dkppbn-blgy					_ -		+	1.		N			Driace trag, mottled, reduced from rdbn-blgy
110.0 0		Sltst, Cal	Itblgy	$\square$	Ţ								N	1		Dark gray chert frag. 9 non-101
//2.5		9tz. 55, C2 1, 34	It blay m	<u>er</u>	e	A			$\square$		Ţ		Ň	T		Coarse, cleargtenrains, large rock Comments
115.0		Sh, Sltat	VIblgy		4	_	+-	-		$\square$	-	<u> </u>	N	4	4	
17.5日三		Sh	It blgy	+	-	-+	+-	+	$\left  \right $		-	-	N.			
120.0				+	+	+	+	╉	┼┤	$\rightarrow$	+	-	۶J .	+		
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GE COMPOSITION IMAGE









Property 624	99 Geo TF MFSAMIL	logist <u>L. CAS</u>	<u>E</u> 6 0	<u>el</u> 4-	<u>r</u> 56		Dr	illi	ng	Co.	Br	<u>44</u>	ĽĔ	3	<u>LEXPLORATION INC.</u> Hole No. <u>#8</u>
County SANJ	WAN	Slate (ATA)	_ <u>_</u> ;4	179	<u>, 2</u>			<u> </u>	•••	. Un	ITI	N 0.		·····	Sec Iwp Rge
<u> </u>	1111			_		7	7	$\frac{cu}{7}$	7	7	7		7	7	
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		ેં / સ	Ś	ž	1		$\langle \hat{\mathbf{a}} \rangle$	1	<u>`</u> ?`	Ļ	-7	7.		X	e/ S T.D. PROBE
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0-11-1-1		· / · · · · ·	+	7	7	4	7	7	7	74	4	7	7	7	N REMARKS
	SHOF_Sh	rdbn			+-	-	-	2				lS			Soil
5.0	sltst-sh	rdbn-Hokt	4	+	-	<u> </u>	<b> </b>	<u> </u>			_	13	1		
7.5	Sltst-Sh	rdbn-1+pktn		ļ.	1		-				-	Y	5[		
0.0	sltst-sh	Ittn - rdbn				ļ	_					V	<u> </u>		noteable color change
2.5	sh	dkywbn										5			
5.0 1 ==	Sh	dKyw 6n	1									V	\$		manganese dendrites on surfaces
25 日三日	sh	dKywbn					L					YS	; 		trace selenite (gupsum) fragments
00	Sh	drywbn					L					5			3% selenite fragments
2.5 上三十	SItst-Sh	clkywbn				:	L					5			J
5.0	SItst-Sh	dkywbn					L					N			
25 上哥	sitst-sh	ywbn					1/4					N		Τ	
	glzSs	ltauto 1	N-F	P	SR			Π			1	N	1	ſ	Top of BUTTO CUA Em @ 275'
2.5	atz Ss	ltorto	F	G	R						1-	N	T	$\top$	
50	atz Ss	lttn E	V.	P	50		н	$ \uparrow $	-	+	+	N	$\mathbf{T}$	$\uparrow$	
7.5 1 4	atz SS. Cona	dkto uc	Ir.	ŀ			н		-+	-	┢	S	$\vdash$		
	at ss Conal	dk to	r c	1p	A		14		+		+	lvs	┢──		
, <b>H</b>	Sta 55 514++	dkauta E	VE	P	SR		<u>, , , , , , , , , , , , , , , , , , , </u>		+		+	N	┢──		sparse shall tragments
50	ata Se Sitet	det. r	VF	P	SR		1		+			N			
		ll to	VE	G	SD		-	+	+		+	N		$\vdash$	· · · · · · · · · · · · · · · · · · ·
	91235	14 to		4	D		_	-+	+		+	h.			
	gte s	<u> </u>			2			+	+		-	Ni I		$\vdash$	
	412.53		1	+	<u>SR</u>		_	+	+			41			
	gtz Js	It mbn	1 V F	F	<u>SR</u>		-	+	+		$\left  - \right $	11			
	q12 Ss	gybn	VF	r	<u>SR</u>			-	-		-	N	1		
	<u>qt2.)s</u>	gybn	VF	F	SR		-	+	-		+-	N	1%		
	9Tz Ss	gybn F	VF	<u>Р</u>	SR	_	4	$\downarrow$	1	+-	+	N	1		
5.0	qtz.Ss	dktn	VF	F	SR	_	-	-				Ν	T		
7.5	gtzss	gytn F-	VF	F	SR	_				1-		N			
,	gtz Ss	quita M.	VF	F	Se							N			
5-1	gtz Ss	gytn F	VF	F	SR							Ŋ			
5.0 1	gtz Ss	tn	F	W	SR							Ŋ			
15-11-1	gtz Ss	tn	F	W	se			Τ	Т	Τ		N			Trace dk chent for aments
.0	gtz Ss	to m-	F	ρ	se		H I	Т			;	S			3% Holes shale Councit
5日题	sitst	H blan						T				N			To it ough shale fragments
。日際日日	atz ss	1++12	F	ս	se	+	+	$\uparrow$	+	+		M	$\neg$		
25日三日	gtz SS	Itay	F	6	SE	+	+	╈	+-	+	┢┼┤	N	-	+	
	9tzss	ltau	VF	F	SR	+	+	+	╈	1-		N	$\neg$	+	
	sitst	(t blau	<u>+</u> +		*7	+	+	╋	+	+		N	┥		
	07-55 514+1	1t blog	_t		$\frac{1}{2}$	+	╉	╉	+-	+	+	╢	+	+	
	ot- <.	Han DU	<u></u>		×+	+	╋		╉	+	┝╺╀	4	-+		
	to Co Paral	ITgy-ITDIgn	<u>m</u>		<u>~</u>	+	╋	+-	+		4	4	-		5% blgn shall frag. &
	at a	gy ve	다	2	×	╉	╇	╋	+	+		N	4	4	50% multicolored rocks chert fragments
"日影!!	1912.25,	пду ис-	ml		R	-	+	+	1	$\downarrow$	$\square$	N	4	_1	1% dkgy-wh rock fragments. Burrow Cun / Arushu Pr
	Sitst, Congl	gygn	-	_	_	+	ŀ	+	1	$\square$		И			sparse 1ttn-rd chert fragments
	Sitst Congl a	zygn	_	-	4	1	1	1	1	$\square$	. I	N			sparse colored chert fragment people fragment
	DITST, Cong	<u> </u>	4		-	-	_	+	$\bot$	$\square$		N	$\square$		Sparse colored chert fragments
5日韓日	Ditit, Congl	gygn	-	4			⊥	1				М			· · · · · · · · · · · · · · · · · · ·
	Sltst, qtzss	gyan	/F								T	Ķ.	T	2	Sparse Han BS Franciste
ю <u>П</u>	Sitst. gtz Ss.	<u>949n</u>	IF		_[		Γ	Г	Γ	Π	1	N	t		Soarse Hay Se F an oft
20-12-2	slfst, Conal	Hayan	T	T	T	T	T	Т	T	11	+	N	$\uparrow$		survey in gy as frigments
25日至1	Sh J	Kpprd-quan	T		·		1	1	1		-	N)	+	+	eror 10/2 In Cheri tragments 25%
	Ici.	1 313		+	+		+	1	+-	╋╌┨		5	÷		
50 5-1	1211	Koord		· 1	1	1	1	1	E	1 1	- ) i	11/	- L	- 1	



Dale	e <u></u>	<u>2-/5</u>	-9	Geol	ogist <u>, Cho</u> k	<u></u>	201		[	Jri	llir	ng	Co	). <i>E</i>	<u>49</u>	14		ليتك	Sec Two Ree
Prop	perty	<u>1000</u>	<u>17 E</u>	EMESO MUL	Project <u>MU-9</u>	رسم	- <i>P</i>		<u> </u>				ີ ດ	דנח	NIC	3			Set Flev
Cour		220	7		Sidle <u>ATAN</u>				7	7	7	7.	<del>7</del>	7		_	7	7	
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	[3] .	s / .	/3)	18 5		1	\$/	ş7,	*/	چ/ء	$\langle$	×/.	×	/	/*	X	/	:/x	REMARKS
_ º-f	155					ſ	ť-	ſ	Ĺ	ŕ	Ń	<b>.</b>	Í.	ŕ		s	5		soil (plant Gragments)
210 +	177	11		51130	Hok my - Hok	1/F	P		<b>.</b> .	1					: 1	rs			Hok Fragments caliche
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20.0-	133			Sh	Hywar-94							•			ļ	/5			
22.5-	1	: ·	ľ	.56	Uwar-an				ŀ.							5			increasing gyps min (selenite crystal;)
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~~~	물	1.		SH	Itwway-94							·				S			gypsum (selenity, crystals 2%)
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52.0	122			situ sh	HUAN-BY by					Я					-	W			course hematile
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BAYLES EXPLORATION INC. Hole No. 29-09-003-M-09 aa AASERA





DN IMAGE

Property <u>Lan</u> County <u>San</u>	Than	_ Project <u>Mu</u> _ State <u>_ Utah</u>	1_4	Pha	56 3	3 . La		ntic	- U 2n`.	ni	I N	10.		Sec Twp Rge Elev
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	91633	udrau		50		╈	\uparrow	1			N	20		about 20% carbon wood frag.
	atzss. sh	vltta f	ME	Sr				Τ			N		Ι	moisture first noied@ 72.5'
	otzss.sh	ritta f	mf	sr		Γ	Τ				N			
	atz ss. sh	vitto f	mf	sr							N			Water injection begin @ 75.0 feet
4 A	ss.cal	wh-blk mi	VC P	sr							N			multi-colored chertfrag. high perm.
44	sh sHstcal.	Itav	vc p	sr					\square		Ŋ			р К.
	55	wh f	mm	sr.		\bot	1_	\square			N			clean sand
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74	Ss.cgl	wh m	210	<u> s-</u> -		ŀ		┝┥	-	+	N		-	
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Date <u>12-</u> Property 4	<u>19-2001</u> G	eologist <u>L. Ca</u>	sebo	0H	. 2	_ D	ril	ling	g C	ю.	B	ay	de	es Exploration, Inc. Hole No. TW4-11
County _Se	<u>In Juan</u>	State	<u> </u>	7 12.39		1	00	nti	! ^^	וחר	TP	10.		Sec Twp Rge
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io	Sltst.sh	- vakgybn	┼╌┨			┢						N		Dakota/Burro Cyn Fr. Cuntad @ 35.0 feet
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2日	<u>91255</u>	dkgy	<u>+ r</u>		$\left - \right $	┝─╁			╈	┢			╇	Some carbon wood tregmenus
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Date 721-2002									
Property While Mesa Will	Project	. <u>Н</u>	_ Dr	illing	Со	Bay	Ks.	Ey	aloratiun Hole No. TW4-12
County San Juan	_ State _Ulah	•		catio	_ Unii	tNo.			Sec Twp Rge
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50 Liter Steel	rdbn	V4 Vf				<u>9</u>			SurfaceSoil
7.5 SHst	rdbn	Vf				S			
10.0 1= 3Hst	rdbn	vf				S			
12.5	rdbn-lttn	Vf				S			
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17.5	pktn	V C		$\left \right $		VS VS	3	ļ	
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30.0 Sndy Sl	tst bn vf	fpsa				N			
32.5-1 CtzSs	tn vf	mpsa				N			Ct. Topof Dakota F.4 @ 31.0 feet
35.0	$-\frac{t_n}{f}$	mp sa	Н			N			hematite coating of quarts grains
57.5 40.0 E Cta SS		MP 5a	H			4	+		U
42.5 - Ctz SS	tn	fmsa	H			N			
45.0	h gy-pprd	fMsa	Н			N			
47.5 - GHZ SS,	- Vitgy	ffsa				N			
50.0	- VHgy	c c sa				<u>u</u>			
52.5 - CT2_3	VHgy	f f Sa				<u> </u>			
S75	Hay-Vaken 1	$f f s_{\alpha}$					24		
60.0 Qtz Ss	vitay-Itin vi	MP Sa	L				Tr	1 1	Carbonaceous material
62.5 Qtz Ss	Hay-blk vf	mpsa				N	W/	I	j. n
650 Qtz Ss Cg	1 akgy-bik vf	verpa	·			И	5%	Ĩ	abund, while to degray chert frag.
675 - Qtz Sc	Vltgy-blk vf	mf sa		Tr.		<u>N</u>			
70.0 + 4.0	- Kgy-blk Vt	m F SA		1		N	_		diseninated pyrite
723 Cc Ct	segu m	verpa		/0 T-					multicolored chert frags.
775 Vos Cal Ates	BS qy M	veroa	-1-1			Ň	1-		chart Crace
80.0 OTZ SS C	ally in	vcr p Sa				N			chevt Gravi
82.5 Cgl, Qtz	is gy m	ver p Sa		Tr:		N			chert frug
85.0	s gy m	vorpa		_		N	ļ		۲ ۱
87.5 VP	s gy m	ver p or		Ŧ		N			<u>N</u> n
90.0	Jultar vf	ver p a		IF Tr					n ŋ
95.0	Vltgy-Wh vP	cr f Sa		1%		N			discompated dimensione with all + C.
97.5 - P. Qtz 35, C	alwh vf	crf sa				N			anssentinue + Phissive parte, cheat trag
100.0	wh Yf	fmsa		Γr		Ν		1. 1.	
1025	st ywbn-ppbr vf	-ff sa				N	ļ		Upper Brusiny Basin FM. contact @ 101.0 fact.
105,0	wh-Itgn Vf	f f Sa				W			l
102, 2 + (2+2-3, 5h	wn-Itgn ppbn Vt	-+ 12 JA		U 1		· W			
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PERCENTAGE COMPOSITION IMAGE 15% 40%

Date <u>7-1-0</u> Property Whit	2 Geo te Mesa M. II	logist <u>L: Casebo</u> Project MINH	17	Drillir	ng C	0 <i>Ba</i>	zy/e	s E	xploration Co Hole No. TW4-13
County SanJ	nan	State Utah			l	Init No	0		Sec Twp Rge
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x 15		*	4	/ / /	<u>)</u>	PYRITE	./	/৽/	ST PAGE OF
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A A A A	\$ /\$ /\$	O' O' S'		Ň.	<u>}</u>		14		T.D. DRILL <u>IDL</u>
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5.0	Sltysh	rdbn-nk vi						+	Soil
75	sttysh	rdbn-pk v4					-7 VS		
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「日三」	Sh. Ota Ss	The set of	0 m	\uparrow		┥┝┥	2	-	Noteable color change sparse hematite
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5.0日三十	Sitush	HUGUDO UC	r	1-1-1		+ + + + + + 2	$\frac{2}{3}$		
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30.0	Sltush	uwayba Vf	╞╼╂╼╊╧			<u> </u>			
32.5	Qtz SS	locto Cim	moo	$\frac{1}{1}$		<u> </u>		13	
35,0	Qtz Sc	orta cim	DISA						Upper Dakota Fm. contact @ 30.0/ linonite coatin
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V50	Atz SS	th C	C QA			++	3	+	
475	Qt2 SS. Sh	to-e VER	T JU D SA				3	-	
52.0-	Atz SS	wh vff	msr				Ĵ	-	
575	Qtz SS	lttn vcf	MSr				1-		Ulean Sandstore
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	Qt- Se	unto ME	C Sa						
	Sh citst	drau-hlk vf	+ JK					-	
	Q47 Sc	Ital Chu	mor			-+	<u>v 3</u>	4	abund. Carbonaceous material
	12+2 SS	$H_{gy} + M$					1/16		sparse carbon material, trace pyrite
	Ato ss	11 JY Cha	with	╏╴┟╴╁╴	+			-	
	Ot- So Sh	Hay + M	mr	┥─┝┶			1 10		
70.6	Qtz SS	IL + VEE	INF	┼╌┼╌┽╴	┥┥		1		
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15.0	12tz Cs	17th mark	fice	┝╼╌┠╴┊	++				some gray chert fragments
	Sh Gt CS	Haven Char	TSA	12	┼╉				multi colored chert frag,
	Sh CH- Cn	Have the	* m		┼╌┨		1		pyrite, Multi Color al chevit (
	CHAT	Hayan-wa VE					<u>* </u>		some chert fragments
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0.0	04- 0-	Han wh	for	20/					
	Sto Sc	Iton when m	t cr	10/	++				abund, pyrill fragmen is
	Sh nt co	an ich in	C SNI	1/d 1/91					some pyrice fragments
025+1===	LUL VIE S	$y_n - w_n \qquad m$	+)1"!"	1/6					<u>Apper contact Brushy Basin Fm. @ 101.5; Some</u>
									pyrile, occurs as cubes and granular
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Date _7	- <u>7-2002</u>	Geol	ogist <u>L.Cas</u>	660	1+-		D	-i Ili	ing		b. <u>8</u>	Ray	les	E	ploration Hole No. TW4-14
County	San Tuc	n	Brogectelain	MW	4					_ U	nit I	No.			Sec Twp Rge
	11	7577	Sidle <u>MTUR</u>				- Lo	200	iti (on _					Elev
*			4		4.			4	$\left\langle \star \right\rangle$.	/	TE /	/	/&/	S PAGE OF
4 /4			S' /	4 . 4	* /	/44/ ex/0		/*		Ĭ		~~ ~~~	/s	×/~	T.D. PROBE
AN AN	A LA M		, o'	045	1 al		3° / 3	\$_ }	$\langle \rangle$	\$\\$		$\langle \rangle$	*/:	<u>;</u> /;	FLUID LEVEL
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5.0 -		sndy Sh-qtz	Hpk-wh	v	þ	sa						٧	3		trace of alert freement.
7.5		Sh-sltysh	Wh-pk	¥	' p	sa.						¥:	s		
		Sndysh_	ywgybn	<u>_vf-f</u>	le	a	ł	<u>c</u>				٧٩	5		limonite/hematite coating on gtz grains
2.5		Slty Sh_	Ywgybn	γ	2p	sa.	+,	r 🏼				<u> </u>			, <u> </u>
50		sity sh	4wgybn	<u> </u> ¥	fp.	Sa	1	<u>را</u>				M	1		hematike coating on atz
7.5		SltySh	ywgybn	V-	<u>}</u>	Sa		<u></u>				٨	<u> </u>		J)
0.0-		31743h-97255	11+gy-orbn	v£lf	P.	sa		-				N			Contact upper Dakota Fm. Capprox, 18.0 feet.
	•	Atz SS	Th	f-m	i f	sr	<u> </u>					N			Clean sandstone
		O_{1-SS}	11+-	m	13	sr	Tr		-			N			
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100 115		Qtz SS-cg	vitto v	f-cr	٥	sa	35	2		t in t		N			Herdenic warring on sand grains, white chert frag.
12.5		Qtz SS	Ittn	f-cr	f	sa	19	24				N	┢─		11-Langy quarit Emay ments.
50		Btz SS	vitta	ç	W	Sr						N	1		very clean sandstone
75		atz ss	14th	f	ω	Sr						N			
50.0- -		Qtz Ss.	It pktn 1	If m	f	Sr						N			
2.5		Qtz.SS	1+pktn	m cr	E	sr						N			sparce chevt frag.
5.0		Qtz Ss.	1+tn	_m	t	r	_					N			4
57.5		Rtz SS	1++n	M	W	r	_					N			very clean sandstone
0.0		Utz SS-Cgl	Htn y	4-1m	P	<u>sa:</u>						N			dkgytown cherta gtz frig.
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75-00.0		Qtz SS-Cal	tn	mcr	n h	sr	+-					N	-		20 % Chart & quarter trag mens
au D.		Qtz SS-GI	multicolor	m ver	D	sa						N			50% and (chard-blk chert Cong.)
25-1		Qtz.Ss	1+tn	m	W	r				\square		N			clean sandstow.
5.0 -		Qtz.SS	14 tr	m	£	sr						N			2% akgy quartz freg.
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Date <u>7-2</u> -	<u>- 2002.</u> Geo	logist L. Caseboit	_ Drilling Co	Ranks Evolpenting	PA Halan TW/ 15
Property W	nite mesa Mill	Project MW4	Unit	No 'Sec	Hole No///9- /5
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22.5	(H- SS	arbo M Cro A		Upper Cont	nut Dakota Fm @ ZB.Ofect.
25.0	Ot SC	arbo makera A		IN limonite, C	chert frags
27.5	Qtz SS Sh				5
40.0	Qt-7 SS	the find for		N	
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875	CH St CL	VHQU-ITSILVETTSU			
90.0	al So Ci	VITGY-1791 VEFF RAL	10/		
12.5	CTESE SO	VItgy-Itgn VIII I Day	///////////////////////////////////////		
95.0	LATZ SS Sh	wh-Hgn Vff & Sa.	TC	N	-
77.5	atz SS, Sh	wh-Itgn vtfff Sa			
00 0-1-2-1	Atz 35 Sh	wh- Itgn vt mt su		N	
107.5	CATZ SS. Sh	wh-Itan FMFSM		N	······································
15.0	Q17 JS	wh + m + sr		N	
1075	Utz SS	the fmfsr			
110.0-1-1:18	Je sc sin	vitan + vorp sa		IN gray-brow	n chert fragments.
12.5	UX IZ SS	Wh-Itgn Vff F Sa			
15.0	AFZ.SS	wh-Itgn vfffsa			
175	Utz SSISh	whiltgn vfmpsr		N	
20.0	Sh, Qtz Ss	gn-wh vfmpsr		N Upper conl	act Brushy Basin Fm. @ 118.0 Peet
22.5-1==	Sh,	gn-ppbn		N	·
Г.Д. []	<u> </u>				

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Date	7 <u>-2-2</u>	002	_ Geol	ogist L.Ca	15660	14			Dri	llir	ng (Co.	B	ay	les	·E	Exploration Hole No. TW4-16
County	y White Sain	<u>Tuais</u>	Mill	Project	<u>14</u>				•			Uni	i'i N	٩o.			Sec Twp Rge
county		- T.	7.77	State <u>Un</u>	<i>k</i>			<u> </u>	Loc	cat	ion	·					Elev
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0 - []-	<u>0 V 0</u>	0/0/	<u> </u>	/	* /	6	5/	r (<u>%</u>		×/×	$\langle \mathbf{x} \rangle$	*	$\langle \langle \rangle \rangle$	(43) */	<u>*</u> /	AS 12/4"61+ to 50 A REMARKS 12/4"61+ to 50'
25		Sh	SHst.	ywgybn_										VS			Surface soil.
5.0		GA CA	zss	Hpkor	<u></u>	? F	SA							s			
		SH	st Sh	Hrdbn		 	_		<u> </u>					S			
		20	, Sitst	ywgybn		-	1_							VS			some chert frag.
12.5		st.)	14wgyion_		+	╀─	-			_			VS			
17.5		Sn	dy Sh	Hay to	VA			-				<u>_</u>	-			-	
20.0	3	St)	liwayba	- 44 13	Ŧ	124	1					+			-	
22.5-1		31)	ywgybn									+	vs	1		aussing on stale (sale site)
25.0 1=		Sh		ywgybn										VS			VERY abund and NIS
27.5-===		Sh	L	ywgybn		-	L.			_				S			
30.0-		Sh		yugybo			-					4		M	ļ		1 9 11 11
32.5		1 St	<u> </u>	ywgybn	- 0 0	-	<u> </u>	. 8.						m			11 J1 J1 J1
35.0-1-		0H	<u>- Co</u>	ywgybn	Vff	<u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	Sa							S			Upper-Contact Dakota Fm. @ 33.0 feet
57.5			- <u>SC</u>	14 br	+		SIL				<u></u>		╉──	W			
475	•	Qtz	. 55	Hullon	f	12	Sa			+	╶┼╴	+-	+	N			
450-		Qtz	Ss	Iltribn	fm	l¢.	3r			\uparrow		-	1	N			some l'anite a ative
475		Qtz	S	tn	m	m	sr		L		T	1-	1	N			some limbrille couling.
50.0-		Qtz	SS	tn	fr	f	sr							W			
52.5		Qt2	2 Ss	tn	f	F	sa							N			
55.0 -		Qt	SS	<u>tn</u>	f	F	Sa		_	_	_			N			
57.5-		Qtz	<u>. Ss</u>	to	-f	<u> </u> f	Sa	_	_	_		_		N			
600-1-		1212	101	th.	$\frac{V+F}{C}$	<u>Ι</u> ρ	30				-		╂	2			
		10th	Sc Sc	gyba	<u>+ m</u>	P C	SA		-+	-		+		W N			gypsum crystals as selen, te
675		CH-	SS Sh	Hauto	vff	m	54 87		-+	╈	+			N			Some chert frag. as sand grains
70.0		Qt2	SS	to	f	W	r			+	+	1		N	1		
72.5	· ·	Qt2	S	94	vfç	m	3r			1	╋	1-		N	12	I	
75.0	9.	Ctr.	Ss Cal	It bn	f kr	D	sa							Ν	÷		white to de army chart framents
175		Qtz	.Ss, Ca	Hautn	fcr	ŀ	sa						·	N			
800		Qtz.	55, 54, 61	Hgytn	fM	P.	Sa					_		N			
825-0	X S	Qtz	SS Cal	th	mk	ĺ₽-	a		_	_	_	_		Ν			chert fragments, while to be to rd
95.0		012	<u>25 () (</u>	th	MYL	ŧr-	a,		-+	+	+-	-		N			multicolored chert frags.
\$7.5 HA		Otz.	S Cal	In Juda	M VC	¢Ρ.	sa sr	\neg	-					N	-		multicolored chert fragi wh-or-blk
		Atz	Ss	vith	VEP	IP P	51 57		-	-		1-		N			Clean sandthan
		CHZ	Ss	ulttn-wh	vff	W	sa			1				N			Creat Survey Store
975		Ah.S	S Cal	multi Color	mvci	p	a		2	2				N			munite desseminated around scale around school
100 V		ates	S.Sh,Ca	Multicolor,	VEVCI	p	a							N			frac.
102.5		Qtz 9	s' a	Wh	fm	m	sr							Ν			Clean white sandston.
105.0		Qtz 9	Ss	wh-vltgn	fm	m	sr							N			
107.5-		Qtz	Ss	wh-VHgn	fin	M	Sr	4	_		-	$\left \right $		N	4		
110.0		Gtz .	20	wh-vitan	f m	+	Sr		1	r				N			
112.5		ATZS AL	SI SIN / CIL	Wh-Vltgn	+ M	F	Sr		-	<u>_</u>		$\left \right $		N			
15.0-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1		1412	s ch Cil	m-11gn_	1 m 1		25	<u>ा</u> ्रा				┥┤		N			
17.)		at.	S. ShCal	wh-Itan	VEIN	P	57				1			N			
1200		Qtz «	SS, Sh	wh-ltsn	f	f	5-				1			N			
125.0 02		-Qt2	SS, Cgil	wh- gy	fvcr	þ	sr							N			





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Control Store Location The second product of the second secon	Da Pro	te <u>2-</u> perty/	2-200 Dhite 1	2 Geol <u>Nesa M.1</u> /	logist Proje	L. Case ct <u>MW4</u>	Ь0 /	1+		_ (Dri	llir	ng	Co Ur	nit	Ba No	141 D	25	<u>s</u> E	<u>xploration</u> Hole No. <u>TW4-16</u> Sec Twp Rge
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(4) 50 (3) <t< td=""><td>142.5-</td><td></td><td></td><td>Sh, Qtz. Ss</td><td>wh-</td><td>าก</td><td>¢</td><td>£</td><td>sr</td><td></td><td></td><td></td><td></td><td></td><td></td><td>1</td><td>N</td><td></td><td></td><td>Under Coulact Brush Rasis En m 1410 Part</td></t<>	142.5-			Sh, Qtz. Ss	wh-	าก	¢	£	sr							1	N			Under Coulact Brush Rasis En m 1410 Part
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Dote <u>7-8-</u> Property Wi County <u>San</u>	<u>. 2002</u> Geo nit <u>e Mesa Mill</u> Juan	logist <u>L.C. ase</u> Project <u>AIW4</u> State 11tch	, <i>o</i> l+	_ Drilli	ng Co. <u>Ba</u> Unit N	o Sec	Hole No. <u>7W4-18</u> Twp Rge
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Date	4-19	-05 Geo	ologist <u>L.Ca</u>	schol	+		Dr	illir	ng	Co.	_[301	μ	50	Exploration Co. Hole No. TW4-21
County	у <u>WAITA</u> San Ti	L MESA MILL	Project	·						Uni	it N	10.			Sec Twp Rge
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5.0		SndysHat	rdbn-1+th	vf-f	P S	<u>ک</u>						٧S		1	mances Sh.
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52.5-		gtzss sitst	VOKgy-1+gy	vf f	f so				-			υ			
55.0		slifst, sh, ss	vdkgy-vltgy	vf-m	f Se	\ <u>`</u>		ľ.	1			N			-
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60.0		Shan sitest	1tgybn	F-VCF	+ 25	-		+	╞	+	-		-	<u>.</u>	
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70.0		atz SS	Hauth	m	wr			+	-			N			
72.5		atzss-grit	It guth m	-VCT	wr			1	1		-)			`
75.0		gtz 35-grit	If gyta n	1-vcr	wr							J			
77.5		gtz ss-cg)	lqybn n	1- peb	p sr			_				U I		ें	Cgl. zone, about chert frag. d peubles
9		19tzss-grit	<u>quin n</u>	-yer	pisa				_	\square)	1			
800-19		<u>qt2.55-cgl</u>	okgytn f	- peb	P 33		_	-	-			N			
85.0		qTZ-SS-SItSt	akgy V+		P SA			-	-		-	<u>, </u>	+		Silly fg 35 @ 84.0 ft
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り」甘園		912 SS -	wh - f	-m	2 Sr		1	0			۱ ۱		4		· · · · · · · · · · · · · · · · · · ·
1150日三		atree al	wh-Itgh f	-m 1	155		-	╞				4	╡	2	parse ansh frag
四十三		sh	00-auan	11									Ŧ		1 pour Brushy Rosen Ct @ approx 117,044. (146 video)
20.0日三		sh	pp-gygn DD-gygn					0							
250 上三		Sh	ppbn-dkayan								K		t		70



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Date <u>4-9-05</u> Geologist <u>L.</u>	Caseboft Drilling	1 Co. Bayles Explorat	ion Co. Hole No TW4-72
County Say Tube State 1/		_ Unit No	Sec Twp Rge
	Location Location	nn	Elev
x to a to a			S PAGE OF
	of an Sho at h		T.D. PROBE
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	* 6 5 8 6 4 7	$\mathbf{x} \mathbf{x} \mathbf{x} \mathbf{x} \mathbf{x} \mathbf{x} \mathbf{x} \mathbf{x} $	REMARKS cored from 20-115.0'
2.5 - Sindysitst or bn	f m p so	M Su	rface soil
5.0 dt sc alldtana	VF-CrPSa	VS	;
(DO LIES) Sitst at s vitedbo	VER E Sa		
12.5 Sltst.otz ss v Hrdbn	At t	VS	
15.0 sitst sh vitrdbn		l vs	
17.5 Sltst 3h It ywgy		AM	
20.0 Sudy sitst It orth	VF-FF SA	W	
22.5 yuth	FM F 32	N yppe	· Dakota Fim. ct @ approx 20.0 ft.
25.0+ 912.55 MWIN	P M F ST	N	
2/5	f m C sr		
Atz ss Http	f-mwsa		
350 gtz 35 litin	fmfsa		
375		N N N D C	
40.0 42.55 th	f-mfsà	N	ungs
42.5 qt2.ss th	f-mfsr	N	
45.0	mwsa	N	· · · · · · · · · · · · · · · · · · ·
47.5 th	+-Mf 52		
one of the second	WEst	N N	
550 - 13	mfsr		
57.5 atzs gutn	m-crf sa		
60.0 at s gyta	fwsr		
62.5 - H 60	M-VCr P S2	N	······································
65.0 - atz 35 gytn	<u> </u>		
67.5 4 gtz ss (16n	MW3r	N	
700-1-1-1 17255 1794bn	m-crif'sr	M	
12.5 de la	M-WUPSA		
775 - 20 Azss cal th	h-VER PSA	Mult	colored chert from ond pubbles
Bag gtzss th	f-crPSr		
82= dtzss th	f-m f sr	M	
8. Hin etz 95 Hin	f-m f sr	N	
87.5 - 4tzss 1/tm	f-mfsr	N	
90.0 Hin 1 4 m	f-mfsr	W W	•
92.5-4-3-4 4/2 55, Sh Th-gybl	t-mtstu rCI	- W Spars	2 Shale frage
15.0	$\frac{1}{2}$ m + Sr		
at ss. With-wh	f-verp sa	N	
1025 gtz ss, cgl vittm-wh	f-a-it P SA	N Some	mult colored about achieve final C
os.o tai letzss, cgi th	f-grit P Sa TrCT	N	the prove of the propies and rock trags.
1075 de la	M-prit P Sa	N abint	multicolored chert we bioles
10.0 - ate SS cgl de outa	m-grit	N	
12.5	<u>NM-Gr</u>	N UP	2er Brushy Basin Ct e approx 111,5ft.
1 === Isnayon blay	66 7 174	N	




		· ·	e e e e e e e e e e e e e e e e e e e
Date <u>5-1-07</u> Ge	ologister Casebolt	Drilling Co. Bauk	s Evolution
Property White Mesa	_ Project	Unit No	Sec. Tue D. 700.4-23
County <u>San Juan</u>	_ State Utah	Location	Elow
	/ /	11/4/1 1	Liev
		A & L. PYRITE	U/S/ 20
	Of an strain	* * * * * * * * * * * * * * * * * * *	T.D. DRILL <u>120.0</u>
			S/4 FLUID LEVEL
		<u> v v × v × v × v × × × v × v × v × v × </u>	REMARKS LORE ZONE 100-120
2.5 Dindy sitts	t Hrdbr t R	5	Surface soil
	Holita		Mancos Sh
	Hekto		
12.5 HE Sh.	HUNAN		
150日三 Sh	Huway-qy	VS	about salarite rule
17.5 1== Sh	It y Jan	VS	Some solutile vic
200 - Sndysh	It.ywgy VFP	S	Very about selevite V/s
22,5	Hywry -	M	sparce selenite x15.
25.0 - Endych	ywgu VEP	W	Very large & abunt selevite frags.
27.5 Snolysh	ywgy-argy vf	N	abunt selenite
30.0 - Sindysh	gy vf P		some selenite
32.5-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1	orgy F-MPr		Upper Dakota Fm contact approx 31.0ft:
35.0-+	au t- cr K F		
40 h dt ss	1+to vf w R		shale lens
47.5 atzss	1+th VEWR		
450	It the VFWR	N	
475 - 475	1+ th VFWR		
50.0-1 qtz ss_	Ittn VFWR	Q	
52.5-	14th VEWR	N	
55.0 ==== 912.55	_ Ittn VFWK	N	
57.5	Vakgy-blk	NS	carbon plant frag-
G0.0	TUN-OKJY E DUNA		Chertpeb/frags.
151 at 155	ltta forpa		No sample
atuss/cal	ltoray fabrica		about multi astrong chart from a set
70.0	th F CTNA		Same must colored check from
725-1 atz ss	tn f-mmR	N	
75.0 Snow sits	Hblay VF-F	Ŋ	
775-1- Sltst/sh	1+ blgy		
Fo.o-	It blgy		
72.5 - SIAST		N	
850	$\frac{1}{1}$ $\frac{1}$		Moisture first noted
$\frac{37.5}{30.5}$	vilto I u WR		
27 5 qtz 35	vilta mwwe		
atz ss	vitta mww		
275	vitta mwww	N N	Trace blau shale snarry chest and in a
00.0	Htn/sh MMWR	(A)	Bezin Cone rug
22.5			No sample.
05.00 atz 45	Hbn f-mMR		
P7.5	VittaE-mm R.		
10.0-1-5- 912.55/sh	1+m-VITblgy f-CR RS		
1/2.5	Th- ywgr- Hbl MC 5		Upper Brushy Basin Ct @ 111,5, from core
13.0++	HANGI-DI-PPDY		
20 AL	pobr-bl wir a		Battan in R. J. n
			<u>2011 - 10 120,0</u>



Core Log of Well No. TW4-23

Cored Interval 100.0 ft. to 120.0 ft. T.D

Depth Description

100.0 - 110.0 Core recovery 26%, 100.0 ft. - 105.5 ft. no recovery.
 105.5 108.5 ft. quartz sandstone / gritstone, very light yellow-tan, fine to grit size quartz grains. Oxidized, some low angle partings occur along crossbeds and concentrations of grit sized grains. Coarse material consists of chert and shale fragments, no high angle fractures or joints observed.

108.5-110.0 ft. quartz sandstone / conglomerate, light gray - reduced, sparse pyrite grains, some low angle partings. Quartz sandstone / gritstone with abundant chert grains and fragments. No high angle fractures or joints observed. Competent core.

110.0 - 120.0 Core recovery 85%, 110.5-111.5 ft. No core recovery, upper Brushy Basin contact selected at 111.5 ft.

111.5-113.5 ft. Mottled green shale, some low angle partings, Brushy Basin Fm.

113.5-120.0 ft. Purple - brown shale, some low angle partings, no high angle fractures or joints observed, core consists of broken fragments and 2 to 4 inch long unbroken pieces. Core began to air slake soon after retrieval.

Date <u>5-2-07</u> Geologist <u>6 Casebol</u>	_ Drilling Co. Bayles Expl	bration Co. Hole No TW4-24
Property Unite Mesa Project	Unit No	Sec Twp Roe
County San Juan State Utah	Location	Elev ≈
	/ /2 /2 /4, /PYRITE / /3/8/	PAGE OF
Ly he is the to a set of the set		
	$\left \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \end{array} \end{array} \right \left \begin{array}{c} \end{array} \right \left \end{array} \right \left \end{array} \right \left \begin{array}{c} \end{array} \right \left \end{array} \right \left \end{array} \right \left \end{array} \right \left \begin{array}{c} \end{array} \right \left \end{array} \left \begin{array}{c} \end{array} \right \left \end{array} \right \left \end{array} \right \left \end{array} \right \left \end{array} \left \left \end{array} \right \left \end{array} \right \left \end{array} \left \left \end{array} \right \left \end{array} \right \left \left \end{array} \right \left \end{array} \left \left \end{array} \right \left \left \end{array} \right \left \left \end{array} \right \left \left \left \end{array} \right \left \left \left \end{array} \right \left \left $	FLUID LEVEL
	$\frac{1}{2} \left \frac{1}{2} \right \frac{1}{2} \left \frac{1}{2} \left$	REMARKS CORE TONE 100' 120'
2.5 SndySHst rdbr vf.cR PA	h	Rurfrice Spil - Some why a prost trans
5.0 Sndy Sltst rdbr yf f m SA	h ys	" to sold it with
7.5 Slitst indian		17. Sejenii L X IS
10.0 Sndustist 11-br VE4 m 5A	n Vs	
12.5 SHUSH HER		
150 TEE Shall It wulker		2022
175 gtz Ss the funder SP		Viancos shou
20.0 Line at Sc Itauto a leenish		Apper Dakota FM COATACT at approx 15.0
22.5 atz Ss to millemise		some whicherf trogs.
25.0 at se 14th Cimins SA		
200 ± 3		
		one It gy shale frags. (2%)
32.3 Mon SA		N (10%)
35.0 172 55 $5h$ 171 $hgu 17 5h$	<u> </u>	s/sh 50%/50%
373 - 453	<u> </u>	s/sh 50%/50%
49.0 gtz Ss, Sh wh-th, gy f-M m Sh	1 N S	s/sh 80%/20%
42.5 Amm SA	1 N 3	15/sh 90% / 10%
45.0 qtz.ss the vfm P SA		lean Ss sparse whichert grains
425 giz Ss wh vf-m P SA	1 N SI	ome white chert grains
500 gtz Ss wh f-mmSR	1 N Su	me whard chart grains surface coding parat
52.5 X. P. qtz. Ss. Callton M- PUD P SA	1 5 w	thite chert frogs, conglomerate zone
55.0 the gtz SS cji to m- peo P SA	1 N w	hite to gray chulf frogs
5725 Th M- CRPR	I N M	ulticolored chert grains
600 9tz SS, Cg tr m- 124 P SR	1	
62.5 0tz 98 th F. MP SA	1 N	p 1) 1)
65.0 Atzss to f. MM SR	N	
67.5 date SS to MWR) N	
70.0	N Ct	hert people frags is to limovite after mente
72.5 Att 98 Htm m- CRIMSR		
75.0 atz ss with m- eemse	N	na si se
725- 92 SS who m-rem SP		
KOUT TE OTS Sh whithin m-rem SP		SISD 654 /14046
SITUS HAR		5/ 511 - 60 /6 / 90 /0
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E75 Charles Ch		
and the second states and the second		
1210-1-1:31 412-35-31731 11-1-1-1-4		
		·
95.0 ATZSS VITIN F- MIMJA		
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100.0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	I N SO	ome rounded chert grains - begin coring
		o cutting recovered below 100.0'
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Core Log of Well No. TW4-24

Cored Interval 100.0 ft. to 120.0 ft. T.D

<u>Depth</u> <u>Description</u>

- 100.0 110.0 Core recovery 54%, 100.0 ft. 104.8 ft. no recovery.
 104.8- 108.4 ft. quartz sandstone / conglomerate, light tan, fine to grit size sub angular quartz and chert grains. Some very low angle crossbeds. Core is oxidized with limonite staining. Non calcareous.
 108.4-110.0 ft. Quartz sandstone / conglomerate, some low angle partings.
- 110.0 120.0 Core recovery 100%, 110.0-110.2 ft. Quartz sandstone / conglomerate, very light tan to white to yellow, oxidized contact, contact is not gradational. Contact is approx. 15 to 20 degrees from horizontal. Chert pebbles to 1/4".
 110.2-115.8 ft. Quartz sandstone / siltstone, some shale fragments, very fine to fine grained with occasional chert grains. Low angle partings.

115.8-118.2 ft. Purple-brown siltstone / shale, mottled appearance, high angle (45 degree) slickensided partings at 116.4 ft. and 118.2 ft. Striations indicate some normal movement.

118.2-120.0 ft. Light green siltstone / shale, some low angle partings.

			en en staar het de gebe
Date <u>4-30-07</u> G	eologist. L. Casebolt	Drilling Co. Boyles Explor	ation Ca. Hole No TW4-25
Property White Mesa Mill	Project	Unit No	Sec Twp Rae
County San Juan	_ Stateh	Location	Elev. 🚈
			PAGE 1 OF 2
	i a en	$\left \begin{array}{c} \mu \\ \mu \\ \mu \end{array} \right \left \begin{array}{c} \lambda \\ \lambda $	T.D. PROBE
Star and the start of the start	NOT NOT STATE	\$\\$\\$\\$\\$\\$\\$\\$\\$\\$\\$\\$\\$\\$\}	T.D. DRILL <u>1400</u> FLUID LEVEL
		8/8/2/2/2/8/9/2/2/2/2/2/2/2/2/2/2/2/2/2/	REMARKS of The Indian
			REMARKS CORE ZONE 110.8-140
2.5	st robr vr		face 501.
5 HI Sthush	1tbr		aces Shale Fin
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o I gtz ss	vitta francis	SR N	
15 <u>972 55</u>	Vitto 2.mm	SR I W	
1.0	VHTO-VHgy frim		
2.5	- Itayin -mk		
<u>- 917 98</u>	Wh-Ifgy frm r	$\frac{5N}{2a}$	e multi colored chert frogs.
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	wh f-m e		y chert trogs
atz ss	wh Vf-CRP	SA I TT N Q.bn	t dk chert frags
5 r.4. atz Ss	wh-lttn vf-laint P	SA I H	It chert froms
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Core Log of Well No. TW4-25

Cored Interval 110.8 ft. to 140.0 ft. T.D.

Depth Description

110.8 - 120.0 Core recovery 100%, 110.8 - 116.0 ft. very light gray quartz sandstone, very fine grained, some low angle partings, mottled appearance, some light green shale fragments. Competent core, no high angle fractures or joints.

116.0-120.0 ft. quartz sandstone, fine to coarse grained, some low angle partings, no high angle fractures or joints. Grit sized material occurs along bedding planes, competent core.

120.0 - 130.0 Core recovery 100%, 120.0-127.8 ft. clean white quartz sandstone, fine to medium grained, well sorted and rounded, competent core. Low angle cross-bedded with gray green shale fragments concentrated at bedding planes.

127.8-128.5 ft. quartz sandstone / grit, coarse, poorly sorted, very light gray, sparse disseminated pyrite, some chert fragments and light green shale fragments.

128.5-130.0 ft. clean quartz sandstone, fine to medium grained, white, no high angle fractures or joints, competent core.

130.0 - 140.0 Core recovery 75%, 130.0-131.9 ft., Dakota sandstone, fine to medium grained quartz, well sorted, rounded grains, low angle cross-bedding, accessory grains include multi colored chert grains and shale fragments. Three inch zone of disseminated pyrite mineralization occurs from 130.7 to 130.9 ft. Core is white with dark gray patch of pyrite. Numerous low angle partings occur at bedding planes. No high angle fractures or joints are observed.

Sandstone / Shale contact occurs at 131.9 ft. Upper Brushy Basin contact.

131.9-134.5 ft., core is missing, no recovery, presumed to be Brushy Basin.

134.5-135.0 ft., core material consists of fragments of light gray green shaly siltstone.

135.0-137.8 ft., light gray green siltstone, with some mottling, competent core.

137.8-139.5 ft., purple brown siltstone / shale, competent core.

139.5-140.0 ft., light gray green siltstone, no high angle fractures or joints. T.D.

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Date <u>5-2</u>	2 <u>5-2010</u> Geo	plogist Case	10/1	Drilling (co. Bayles	Exploration Hole No. TW4-26
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2.5-	<u>XI+S+</u>	ywbn				<i>0 1</i>)
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7.5	972 35	gybn m.	crmr		N	
0.0	gtz ss	gybn m-	Ver P S		N	abundt. dkgr chert grains
2.5-	q12.55	gybo m-	VCT PS		VW	obundt. white chert grains.
5.0	9TZ 55	fn f	MWr		<u> </u>	clean sand
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12.5	912.55	toF	mwr		N	cilean sand ::
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5.0	412-55		+ W K		N	
7.5-1-1	9T2.5.5	Hywin f:	mmr			abundt chart grains
0.0	472 SS	11+10 m-	crma			
25	<u>qtz ss</u>	In-dkgy M-F	UPP A		N	multi colored chert frogs or grains
5.0	ate ss	th-dkgy M	2483		N	Moisture first noted, abuid chertorains
7.5-	atz ss	th-qy m-p	b P r		N	/
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17.5 日孫国	sndy sh-qtzs	ywbn	4 m a	-		W	Detois Ct. @ 17.0'
20.0	<u> 4</u> [±.55	1+m	mwr				
22.5	1912-25	Hauto	mar			N	to have as compart
25.0	atzas, sh	ltauto m	- cr M r			N	
30.6	97.55_	17th	mwr			2	
32.5	atzss_	1+tn	mwr			N	
35.0	gtz ss	tn f.	mmr	·		א	moisture noted @ 35.0ft.
37.5	97235,54	1- 34- pk 1-	<u>crmr</u>				some bright pintered clay min as coment
40.0-	972 55	Vitgy fr	CY M F	· 🔛			
	at ee	to m-	Cr P Y				
	atz 39	tn	mwr			N	
	112 55	to M-	crmr	lim		N	
52.5	atz ss	Hortn	m w r			N	• •
55.0	atz ss	Hypen m	<u>crm</u> r			N	Some light colored chert frogs and grains
- 575- 二 注:	<u>41-55</u>	Itgybo m.	ermr			N	abund light colored chert frags.
60.0-	atz ss	<u>tn</u>	MWR				
	912.55	$\frac{1}{10}$	MAR			N	
63.04	atz 93	to f-	MAR			N	light and dark chert frags
	atz 55	In	MWR			Ы	sparse dKarey chert frous.
72.5	atz ss	orth	mmR			N	some multi colored chert frag.
75.0 7.00	gt258, cg1	th-gybn m-	PED K A			N	abund. chert frogs and peoples. moisture noted.
77.5-1-33	97255	tn m-	Kr m r			P.	······
800	9+2-55	<u>tn</u>	4 Wr			N	
82.5	97255	$\frac{t_n}{m-1}$	cro a				shund shart Course
85.0	912-22 6tz 85	yesto M	Cr m r				ADWIN CHEVIL (1 8435
870-H	atz ss	ywth m-	CTP 2			5	some chert peubles
925-ESE	gtz 55, cgl, sh	orth-61gnm	pet P A		412 C	VW	Brushy Basin Ct @ 91.0ft. sparse sulfides
95.0	sndysh_	<u>blgn</u>	mmr	L		<u>N</u>	sparse chertpeb,
97.5	sndysh	bign	MMT			N	
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475-		972.55	Itanto				+			N		Moisture first notel @ 47.5'
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55.0		atz.55	distro	mwr	•		Ħ	8		N N		Some light a loop of a loop
575-		atzss	Hbn	ç mm≥						9		Some light colored chert indgs.
60.0 - P.V		qtzss/cgl	Hgy-wh n	n-petp A						N	F -	abund chert peobles and frags.
625		Cg1/gtzss	dkgy-tn r	r-perpA				Č.		N		⊾ H B B B
45.0 - P		cg1/9tz 55	to-itgy "	n-peop A						N		<u>нь</u> н _{и в}
675		Cal/gTz SS	th-gy c							N		- ty 14 - 15 - 19
70 - P. P.		Cg1/912 55	th-gy Cr	- peb P A				2		ייי ר		<u>ų y h h n</u>
123-1-1-1-1		at so /cal	<u>in-akgy C</u>	- per A				<u>.</u> 1		N N		
775-11		atzss/cg)	th M	- peb p 2						א		
Rao		atz ss	tn m	-crmr						N		· · · · · · · · · · · · · · · · · · ·
825		912.55	tn m-	- cr m r						Ŋ	Τ	Bagin Hop injection
85.0-		cg1/qtzss	tngy m-	- peb p A		F	I			N		Imonite after purite, rare purite xls in shall fram.
87.5		Cg1/qtzss	th-dkgy M-	peb p A			C			N		
10.0		Sh/qtzss/cg	th-blgn M	- peop A						N		Brushy Basin et & BB.O.A.
125日至		S. J. OL	blan t-	<u>mma</u>				8		<u>1</u>		sparse rd chart pebbles.
95.0 十三		sad ch	$\frac{b}{g}$	mma				8		י גר	-	Some rol chert publics
17.1 国家		Snah Sh	<u>1930 t-</u> Ithlan f-	mma						<u>,</u>	+	$T = A \mapsto S' = \mathcal{A} \setminus \{V_{n}\} \setminus \{V_{n}\} \setminus \{V_{n}\}$
1025												1. U. C 101.3 Small (2-1mm) rd chert publics
												winder drows the wor. 18 of pild 21,
日 日												
		┝────┤										
							4					
											-	General Note: The fractured and fragmented
											-	condition of the caset and quartz peobles may
H II		<u> </u>									-	have resulted from the crushing action of
Η												conside builded of the Iricone ruller b) s
				1 83833	98938 98938		369 B.M	s 1 3	888		<u>1000</u>	Inson in arise states.

PERCENTAGE COMPOSITION IMAGE



Property White Mes	_ Geologist <u>L.Casebolt</u> a Mill Project <u>Nitrate Study</u>	Drilling Co. <u>Bayles Exp</u>	Sec Two Dec
County Son Juan	StateState	Location	Sec Twp Rge Elev
	the state of the s	L L L PYRITE J &	DAGE OF 0 T.D. PROBE 90.0' 0 T.D. DRILL 95.0' FLUID LEVEL 1000000000000000000000000000000000000
	Var l rabo	× 5 × × × × × × × × × × × × × × × × × ×	REMARKS
	W/sind rahn-lttn gitus m		Burface soil
15 31	ysh robn-Hywon st-H	A 15 1	Macos Sh PL & 5.D'
2.0 I = 1 = 0.0	lysh ltywbn slt-vf m2	y VS	
.5	ash ywbn fr		bund. selenite (gypsum xls.)
	ss w/sh uwbn from		ome selenite xis.
	ss u/sh ywbn fmr	· W	
5	ss wish ywbn fr	- W	
	ywbn-gy		
	dysn ywgybo + my		
5 ats	ss/sh ltorth fma	N #F (A	viere The kuster Adrie 21 cc
	235 1 Hay-th f-mmr	4	
5	ss/sh gy-orth fmmr		
	ss Itauta; mered		Disture 1st noted @ 37.5'
at at at at a	ss th mus a	N N B	han (1-0) is the of the of
5 gt	ss ywth-rd M-crm a	N N	an all all all all and a set all a s
at at	ss/sh ywth-gy m-crma	N	
5	ss th-gybik f-mma	N 52	
	SS/CGI TN-DIK-rd M-PEDPA	N ISE AL	ound carbon as plant frags / chart frags.
	ss/calta-rdta m. pebpA	N A	bund chert/gtz peable frags.
5 PA	latess gy-tin cr-peb P A	N N	proz 80% chewtfrogs.
	ss/cgl-tn m-crra	N N	
	ss/cgl-tn m-peopa	N a	bund chart peoble frags
	lates octo-au m-peop a		
HIA CAL	latzss orayth cr. per P a	N N	n n n n
Cal	late 55 orgyth M- pedp A	V V	
	latzs orgin cr-perp A	w 14	ostly chert peobles and frags.
diz at	ssical the member A		
	ss/sh ywth-blan m-crmR	N B	rushu Basia ALA Qr N
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Date <u>3-5-1</u>	3 Geologist <u>L. Czsebolt</u>	Drilling Co. Boyles Ex	plation, Inc. Hole No. TW4-31
Property White	energy Project Nitrole Study	Unit No	Sec Twp Rge
County	State <u>Utoh</u>	_ Location	Elev
			ST ST PAGE OF
and a solution		A S PYRITE	T.D. PROBE 111-0
St at at a	The state of the s	2/5/2/5/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2/2	T.D. DRILL <u>10.D.</u> FLUID LEVEL
St St X		9 / 1 / 0 / 0 / 0 / 1 / 1 / 1 / 0 / 0 / 4 / 0 / 1 / 0 / 0 / 1 / 4 / 0 / 0 / 1 / 1 / 1 / 0 / 0 / 1 / 1 / 1	РЕмарка
	C) where I led be shall be		A CHARKS
	() w/sund withto with sites ma		Surface Shill CL (leon Chy W/ Sand
75	Situst Haybon situation a		Manus ch Pt Q 5 2
	Sudysh Hywbn from a	S	
12,5	Sindysh Hywon vf. m M a	VS	
15.0	gtzssw/shillywon f-mma	5	
17.5	qT255 w/sh Hywbn fm r	N	
20.0	atzss w/sh Hyubn f-mmr	6	
22.5	qtzss (+th f w r	W	upper Dakota et e. 20.0°
25.0	atzss Htn f W T	N	
275	atzss lith f-mm F		
30.6	$\frac{qT_2}{1} \frac{ss}{s} + \frac{1}{s} \frac{ss}{s}$		some muscovite sheets as accessory minerals
32.5	Sh Hay		sparse carbon material
350	strasse ll orbingy tom a		abund limonik as cementing agent.
	at as uto fmma	4	
47.5	at 35 Hauth mcrma	a	
450	atzas Htm mecran r		
475	atess Htm fmma	4	
500	gtzss-sh ltbn-dkgym-ermr	N 52 I	some carbon fragments
52.5	gtzss bn mwr	N~12 I	some carbonaceous material, sparse chart frags.
55.0	gtss bn MWT	N	some chert fings.
57.5	atzss bn mwr		•
60,0	ates by morma	N N	Moisture 1st notel @ 60.0
62.5	gress Itpkon f-mma	N	
65.0	qizss It in t-mina		
67.5	atzs In revolp A		abund. light colored chart frags.
	$\frac{q_{12}s_{2}}{a_{12}s_{2}}$ $\frac{q_{12}s_{2}}{a_{12}}$ $\frac{q_{12}s_{2}}{a_{12}}}$ $\frac{q_{12}s_{2}}{a_{12}}$ $\frac{q_{12}s_{2}}{a_{12}}}$ $\frac{q_{12}s_{2$		a bund mouti colored chert frogs.
72.3	at-ss/al to-dkay M-peb P A		mille od upper of obsert weller and Care
77.5	atzss/cal In-dkay m- peb P A	N N	I II N N II III
800 E	atzss th mmr	N	
82.5	atzss the MMr	N	
85.0	gizzs the m-crmr	N	abund. multicolored chert frags
87.5	atzss tn mwr		
90.0-	atzss/cgitn m-pabpr	N	some chartpebbles and frags.
92.5	gtzss/cgl/sh gnin m- pesp r	N	abund chert and gtz. pebbles and frags.
95.0-日湾	gtzss gytn m-rear a	4	
97.5-日容	$q_{12,55}$ Th (1) 1		<u>Clean source</u>
100.0	at con an then	196/2	Suffides (marcasitic habit)
102.5	ch au ta		ship for a mothed an index to show on that
105.0	sh /cal guan-pobn		Shart chart for a
	sh pobn-blan	N	
//2.5日		N	T.D. C 111.0
1/5.0			
//7.5月			
120.0			
122.5			
/25.0			

PERCENTAGE COMPOSITION IMAGE

15%

10%





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Date _	<u>9-9-2</u>	2 <u>0/3</u> Ge	ologist <u>L. CASEBOL</u>	Γ		Drill	ina	6	B			Evoloption C. Turk 22
Proper	ty <u>Wh</u>	ite Mesa Mil	Project				ing	lin	it N	40	21	Soc. T. T. Soc. T. So
County	Son	Juan	_Stote _Utah				ntin	ייס ח	11 1	U .		Sec Twp Rge
	7	TIT	7 7		7	7.7	7	;			7	Elev
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4º	$\left \frac{k}{k} \right _{c}$		00 8 4	× /1	~/~ ·	/\$`/\$	$\hat{\mathbf{x}}$	<u>/~ </u>		/	/\$`	100 T.D. PROBE 119.5
ST A	18	\$ \ \$	ov of sh	13/	<u>*</u> /,	<u>)</u> [*/.	6 (x)	<u> </u>	<u>k: /</u> .	$\langle \rangle \langle \rangle$		T.D. DRILL 117.5
ST ST	8/8	Stat S	C AR	/ 4 ⁰ / 5	1	L' AN	$\langle \mathbf{x} \rangle \langle \mathbf{x} \rangle$	ૢૢૢૢૺ૾		8	2	SIL FLOID LEVEL 43.4
	₽ſſſ			<u> </u>	¥/0	<u>XX</u>	<u> </u>	<u> </u>		<u>}</u>	2	REMARKS B. 73 AMI 4-11-13
2.3 ++==	3	CL W/SON	o rabn 31+11	f M d						N		Surface soil CL (Lear clay w/ sand)
50 +		CL w/501	<u>d</u> robin sit w	<u>em a</u>						VS		Surface soil CL (Lean clay w/ sand)
7.5	Ξ.	CH W/SON	d rolbn sltv	<u>fmð</u>						٧S		Surface soil CH (Fot Clay W/ Sand)
10.0		CH W/ SA	d 17 robn-ywoonsti	MM 0						<u>ک</u> ا		Mancos Sh fm@ 9.0'
12.5	3	CL W/Som	of Itrdbn-pk sit. f	ma						5		Small Sandstone be while.
15.0-		972.35/8h	Hywbn f-m	ma						VS		
17.5-	5	gtz. SS/ Sh	Ituwon f- cr	- p a						m		
20.0		gizss	th f-c	r P à						Vin		$\lambda = \frac{1}{2} + $
225		atzss	to	ma		in		<u> </u>		งม		appear locate or le 17.5 While chart frag-1 cm
25.0		latz SS	to m-cr	mz		him				N		
275		atz 55	+16 m	- r				×		1		
30.0	:	912 55	unto m-cc			hin in the second se		<u> </u>		1		
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35.0-1		130/912 3	slakpogy Cr					8 <u>-</u>		И		
		415 37 4	1 m-gy_vf: F	m r						N		
40.0 +++++		<u>912.55</u>	$\frac{tn}{4}$	mr	<u>.</u>					N		· · · · · · · · · · · · · · · · · · ·
¥2.5		97255/5	$\frac{1}{1}$ $\frac{1}$	ma						N		misture first noted e 42.5
45.0-		<u>qtz.ss</u>	Th mer	mà					1	4		
47.5		91255	<u>m</u> m	wr					1	<u> </u>		
50.0		<u> 912 SJ</u>	m m-cr	mr					ſ	۷L		Well began producing H7DE SO.D
52.5		<u> 9tz 55/sh</u>	th-Hgy m	mr					<u></u> _	N		
SS.D-		<u> qtzss/sh</u>	gy f- peb	<u>ρ</u> Α					1	<u>۷</u>]3	刘工	abund chert peobles and frags.
57.5		<u>5h/qt255</u>	dkay m-cr	Pa					ŀ	১ বি	ZT.	Some chert peb, and frags
60.0		Sndy sh	94 m- cr	P A		·				0	I	Began H2D injection & ODD' Some Chest forms
623 - 23		cg1/qTzss	orgy m-pet	Pa)	٧		Abund multi colored chart ach and frags
65.0 0		cg1/972.55	orgy m-peb	PO					١	1		(and a constant per per state 1993.
675 - 89		gtz55/cal	thay make	po	<u> </u>	3%	4		٨	J		Abund chert frags should sulfide as some to line
70.0		9Tz 53/51+5	-Vltavan Vff	w a	2				N	ئ ا ا		Pour oran in- 1. Do what Swithies as certent a clisse
725		atz 35	VHAYAN VEF	wa)		
75 0		atzss/sh	Vitanan vf.f	2					٦ ۲	1		
775		atz 35/Sh	VItarian VF-F									
201		Situatess	Itayan sit vf	22	<u> </u>				n N			
075		atzsalah	Hayan CC					- 12	1			rd cherttrag.
05 h		atzs/sh	Itango yPB						<u>ା</u> ଆକୁ	1		
07-		atz 55	Hayan Em	<u></u>	8	120	2			1		
Onn -		at- 35		12		1/0 /			i D Va	1 1		3parse swiftides
0.0		22 5 5	Lah C		3 			-8			-	Very hard/stow drilling beginning @ 87.5
				<u>0</u>								
95.0		1255/31	White an +- mi			19/61			· /v	1		
9/5-1		11			-	12 7		· (8)	N			Some chevit firogs. sulfides present.
100.0		1253	Vitay Cr-9m	2) Y				-	N			some chartfrogs.
102.5		AT2 55	Vitgy Cr-grift	<u> NR</u>			14		j N			water flow mereased to approx. 5 gpm. chert peobless fr
105.0		<u>1972 55</u>	VItgy-wh m-Er	VR					N			
1075-		<u>972 55</u>	vitgy-wh min	<u>/ ۲</u>					N			
110.0-		atzss	ltgy ern	<u>r</u> R	<u>_</u>				N			some chertfrags.
112.5		19tz Ss/sh_	Hgy-gn-pprobner	n r	<u>-</u>				5			Brushy Basin Chie 111.0 mottled shale -
115.0日至		sh	Hgn-pprobn						S			mottled shale
117.5		sh	Iton-pproba						N			T.D. 117.5
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Date <u>9-11-13</u> Geologist	Casebolt	Drilling Go. 🚣	Boyles Exploration L	Hole No. <u>TW4-33</u>
County San Juan State	Atah	Unit	No Sec	Twp Rge
<u> </u>	/		11/131	Elev
5 15 15 15 15 15 15 15 15 15 15 15 15 15	1 14 /4	PYRI		PAGE 1 OF 1
4 /4 × /4 /4 /5	of shir sh	2 / 2 / 2 / 2 / 2 / 5 / 5 / 5 / 5 / 5 /	1 3 / 3 / 5 / 5 /	T.D. DRILL 90.0
			2/5/5/5/4/ 5/8/8/9	FLUID LEVEL
		<u> </u>	×/&/ ×/ ×/	REMARKS
25 - rdbn		┝┥╌┼┥┥┥╴┥	m Surface soin	I.C. (loan clay)
75 115 Sudy show 100	<u>cm</u> ch	┶┼╌┼┼╋┥╴┼	VS Surface Soi	CE/Mancos shall @ 4.0'
100 - Sindy Sh. Lywho	$\frac{1}{\Gamma} = \frac{1}{\Gamma} = \frac{1}{\Gamma}$		<u>V5</u>	
125 19tzss/sh uwbn-to				
150 atzss Horth	m-ormA		N Opper Dokota	
175 gtzss/sh Horay	merfa		w	· · · · · · · · · · · · · · · · · · ·
20.0 gt ss/sh Horth-9	y m-crfA		N	
22.5 Horth	CrMA		N	
25.0 dia ates Horto	mmð		N	
275 qt2ss	mwa		N	
30.0 $atzss t_n$	mwr		N	
32.5	mwr		N	
35.0	MWF		N	· · · · · · · · · · · · · · · · · · ·
$\frac{1}{2}$	f mwr			
475	m-crmm		N Some chert	rains and frags
45.0 atzs akayba	mwr		NTT	rains and trags.
425 Hayto	FMME		N	
500 - at ss gyin	f-grtp a		N some chert.	wains and frags.
52.5 5 cgl/qtzss gytn	m-pet p 2		N abund, cher	t frags.
55.0 - <u>gizss</u> gutn	m-grt P D		N	1
575	M-grt P a		N =>	
600	fmma	<u> </u>	N	
625 - Hayta	mwr		<u>, </u>	
175 Hor M	M-grip I.		N Moisture first	noted & 65.0° a bund chart frags.
$\frac{1}{700}$			N	
725 4tz ss 4 to	Marmin		/*	
75 1 This ate ss/cal Horto	m-pebpr		N	,i
775 t.» at s/ Call+tn	m-peppr		N	
80.0 r. atzss/cg/	m-peap r		N	
825-1 qt255/sh ll+tn-blar			W Brushy Bisin, At	6 82 0' Sharp contact
85.0 Sh gygn			J	
87.5 = Sh gygn			Ν	
90.0-1==- sh			N TR @ 90.0'	
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County <u>Gan Juan</u> State <u>Mah</u> $\frac{1}{100}$ $\frac{1}{100}$	L Cation	Sec. Twp. Rge. Elev. Elev. Elev. Elev. PAGE / OF 1 T.D. PROBE 97:9 T.D. PROBE 97:9 T.D. DRILL 97:5 FLUID LEVEL REMARKS Surface soil CL (leon clay) Surface soil CL (leon clay) Mancos Shale @ 5.0' Bome selenite abundselenite (gypsum crystals) Friable ss Upper Dakota (L @ 27.5' Upper Dakota (L @ 10.25' Dabund. multi colored chect grains and peb. U " " " " " " " " " " " " D " " " " " " " " " " " " " " " " " " "
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$\begin{array}{cccccccccccccccccccccccccccccccccccc$		ABE _ OF _ 1 T.D. PROBE _ 97.9 T.D. PROBE _ 97.9 T.D. DRILL _ 97.5 FLUID LEVEL REMARKS Surface soil CL (lean clay) Mancos Shale @ 5.0' Some selente abundselente (gypsum crystals) Fridle ss Upper Dokota (L @ 27.5' Upper Dokota (L @ 27.5' Mointure first noticed @ 47.5' Mointure first noticed @ 47.5' Mointure first noticed @ 47.5'
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2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5		FLUID LEVEL REMARKS Surface soil CL (lean clay) Surface soil CL (lean clay) Mahcos Shale @ 5.0' Some selenite abundselenite (gypsum crystals) Friable ss Upper Dakota (L. @. 27.5' Upper Dakota (L. @. 27.5' Abund. Chert groins Moisture first noticed @ 47.5' Moisture fir
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SAMPLE DESCRIPTION KEY

DEPTH SCALE Scale is 1"-50' for drill samples and 1"-5' for core. SAMPLE TAKEN Mark through interval which X special chip sample is saved, with an "X" mark through core interval with shading. GRAPHIC LOG Standard rock symbol for interval. ALTERATION | Reduction + Dissolution 8 Oxidation GAMMA ANOMALY (Probe) T 3xBG - .009 1 .010 - .049 2 .050 - .199 3 .200 > Trace Low Mineral High Mineral Ore BRECCIA PIPE | Definate Unsure LITHOLOGY Standard abbreviation for rock type. COLOR GSA Rock-Color Chart of wet samples. GRAIN SIZE Sandstone Carbonates Pebble Peb vc Very Coarse vc С Coarse С m Medium m f Fine f vf Very Fine vf SORTING W Well-sorted Μ Moderately-sorted P Poorly-sorted IJ **Un-sorted** ANGULARITY VA Very Angular Α Angular а subangular r Subrounded R Rounded Well Rounded WR CEMENT-MATRIX A Argillaceous С Carbonate D Dolomite S Silica F Ferruginous

IRON OXIDE Hematite H Α Abundant Limonite Moderate L Μ G Geothite Т Trace PYRITE-MARCASITE Amount - In percent. -Habit A Aggregate C. Interangular cement Globules G Individual Ι Μ Massive Marcasitic texture MT 0 Organic replacement Alteration F Fresh Т Tarnished Ρ Pseudomorphs after pyrite METALLIC MINERALS Mark with an "X" and clarify in remarks and metallic minerals observed. $(Mos_2, Nis, Pbs, UO_2, CU_2O, etc.)$ NON-METALLIC MINERALS Mark with an "X" and clarify in remarks any non-metallic minerals observed. (Barite, Anhydrite, Gypsum, Calcite, etc.) REACTION -10% HCL Very Strong VS S Strong Μ Moderate W Weak VW Very Weak Ν None CARBON MATERIAL Amount - In percent Туре Coal С F Distinct woody fragments Η Humic ΗY Hydrocarbon Interbedded trash Τ L Lignitic BRECCIA NOMENCLATURE See sample manual - use grain size, sorting and angularity columns for classification and description. REMARKS Use to clarify and expand on the columnar data. Explain anything not evident or any special characteristics such as: heavy minerals, tuffaceouness, cvclic sedimentation, fossils, sedimentary structures, formation picks, etc.

APPENDIX A.5

TWN - SERIES

	■N Standard (1999)			а, "
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Date <u>B-20-09</u> Geologies <u>CASE Bolf</u> Drilling Co. <u>Bayles Exploration Inc</u> Hole No. <u>Tww-7</u> Property <u>White Mesa Mill</u> Project <u>NITRATE STUDY</u> Unit No. <u>Sec.</u> Twp. <u>Rge.</u>

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PERCENTAGE COMPOSITION IMAGE



Date <u>8-74</u> Branasty (44	<u>9-09</u> Geo	ologist <u>L.C.A</u>	SEBOLT	Drilling Co.	Bayles Explore	tion, TAC_ Hole No. TWN-8
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PERCENTAGE COMPOSITION IMAGE





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Date <u>8-19:09</u> Geologist <u>L. Cosebelt</u> Drilling Co. <u>Bayles Exploration, Inc.</u> Hole No. <u>Th</u> Property <u>White Mesamill</u> Project <u>Nitrate Study</u> Unit No._____ Sec.____ Twp.____

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Property <i>Wi</i> County <u>San</u>	TUA	<u>/////////////////////////////////////</u>	Projection State <u>Uta</u>	41 KATE	<u>974</u>	<u>бу</u> _ Lo	catio	Unit n	No.			Sec Twp: Rge Elev
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PERCENTAGE COMPOSITION IMAGE





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10.0	Sh/atz Ss	ltiwto	f-mea	L	15	
125 4 3	atzss sh	ltbo	f-mpa	2	5	
15.0	sh	dkauba			S fr 1	trace carbonacemus frags.
17.5 日三	sh	dikay bn			NAI	abund. " »
20.0	<u>sh</u>	alkgybn_			μ Tr μ	trace n is
22.5	qtzss sh	gybn	f-mpr		N	Top. Dukotu Fin @ approx 21.0'
25.0	atzes	gyth	f-mka		N	
27.5	<u>atz 55</u>	tn	f-m a		N	
30.0	atz ss	tn	f-mr		Ń	
325-7-3	atz ss sh	<u>tn</u>	F-MEO		· N	<u> </u>
35.0-	<u>qtz 53, 517</u>	tn/gu	- t-w 60		N N	·
37,5	<u>1972 53</u>	<u>th</u>	<u> </u>		N	``````````````````````````````````````
40.0-	912 33	litth	<u> </u>		N	
42.5	qT2SS_	orta	+		N N	
45.0	1912 55	litbn			N CL	
47.6	ATZ 35	11+bn 11+autha	T A			Moisture first noted e 47
50.0	Caller S	Liter bo				Begin H20 neul at 47.5 tr. carbonaceous trage
S25	10725 Cal	14 to	M-poor o		N N	abund chert trags + pepples.
	ata sa estat	111-to			N	Some chert trags à publies,
	atz 55, 5h	H to	VF-M Pà		N	······································
	at ss cal	taba	M- meb Pr		N	some mult adored chest for a vine
	atzss	tn	m-ver Rr		N	" " " " aring
67	atzsa	tn	m-vorle r		N	
	atz 55		m-vcr g r		N	
	atzas cal	tn	m- peb P r		N	n n n h h
7.7.4	Cal atz se	stortn	M-RUD P A		N	dhund, " " " Brids publics
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80.0	atzss	th	m-crpr		4	in in in grangs
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85.0	97253	Itan	vf-f Ma		Ń	snarse chevt grains
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97.5	91253	wh'	vf f m a		j)	· · · · · · · · · · · · · · · · · · ·
100.0	<u>772.55</u>	wh	VF-P MA		LL I	
102.5	<u>qtzss</u>	wh	VE FRA		N	Trace of pyrite grains
105.0	atz 55	INP	vffpa		N	
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Date _	9-29-09	Geologist Z. Casebolt	Drilling Co. Baules Exploration Inc.	Hole No. TWN-12
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2.5			cgl, atz ss	. <u>.</u>	<u>f-pe</u>						1	<u>,  </u>		abund. Chert frags = peubles
5.0			cgl, qt235	34	<u>f-pt</u>	<u>4</u> ])				<u> </u> -	٩	V 📓		- 11 11 11 11 11 11
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PERCENTAGE COMPOSITION IMAGE 

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Date <u>9-30-09</u>	_ Geologist <u>, L. Ca</u>	<u>sebolt</u> Drill	ng Co. <u>Bayles Fx</u>	nlonstion, Inc. Hole No. TUN-13	
County San Tuan	<u>A MA</u> /Project <u>///16</u>	cate Study	Unit No	Sec Twp Rge	
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20.0 - 20.0	<u>33</u> th	f mà L	· N		
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25.0-日三日	os Ith-th	f-vor P a	N	some chert-grains	
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40.0	<u>nt e</u> 8	mmr	N N	centra ar gray chem trags a grains _	
42.5	<u>-ss tn</u>	Fmmr	H H	······································	
45.0	SS. TA	f-mmar	И		
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60.0	Se cal dkto	m-public a	N	shund she to age a publics	
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70.0	ss vitta r	n-vcr P a	Ň		
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97.5 - St.	atzss rabn-gy	n-ver P a	4		
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102,5 qtz	ss, cgl wh	<u>f- peb P 2 17</u>		ery abund, chert frags + pubbles	
105.0-0.00	$L = \frac{ wh-lfm_{l} }{ wh-lfm_{l} }$	n-lege a fr	C N	н н н л 	
107.5-1000				$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	
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/20,0日毛 <u>sh</u>	au-rdbn		N		<u> </u>

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Date <u>Sept. 28, 2009</u> Geologist <u>L. Casebolt</u> Drilling Co. <u>Bayles Exploration, Inc.</u> Hole No. <u>TWN-14</u> Property <u>White Mess Mill</u> **Reput**<u>Mitrate</u> Study Unit No. _____ Sec. ____ Twp: ____ Rge: __

County <u>San Juan</u>	_ State <u>Utoh</u>	Location		Elev
	/		1/2/3/	2225 / 25 2
x / × / & / + / * / ×	à v	Ly X X W PY	RITE SXX	T.D. PROBE
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5.0 Snolystra	t rdbn		S Jurface soi	
7.5 + =   _ qtz.58_	then cr	2011	S Color Channe	at 5 0'9tz ss then Top of Dakota Fm
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22.5 qt2.53.51	<u>n tn-Itgy F-M</u>	<u>"                                     </u>	N	
25.0	In-gy f.m		N carbonaceou	s fragments
27.5	<u>r hargy r-min</u>		N sparce carb	onaceous fragments
30.0 - 2 = 1   qt2.55-5t	111-94 VF-m		N	
325 - 325	Vltgutn m-crit	4r L	N Spance gy ch	ert frongs
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42.5	$f_{n}$	nr	N n n	р
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475	$-Vltm_{1}$		N some mult	i colored chiert frags + grains
50.0 4 30 972 55	VIPTN MM	V K	N abunt "	<u>n n n n n</u>
525	V(tTN = f-m)		N Some 1	n 11 grains
550 412 55	$-\frac{1}{1}$		N D D	20 20 12
57.5-+	Vitto f-mo		N Some angul	ar chevit frags.
	1194-94		N	
62.5-1-1-1 Sh-3171	<u>- 194-akgy</u>			
	<u>ss 94 </u>			
	<u>- WN-VITGY VEIM</u>		N 3bund mw	tticolored chert grains
10.0	$\frac{11}{10}$ $\gamma + m$	· ·		
72.5 H	to Cyrre		N abund olkg	4 Chemt grains
	$- \frac{11}{1}$ $+ - \frac{1}{2}$			a colored chever grains
	V 14 to an Cycle 4	λ	$\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$ $\frac{1}{1}$	and trags
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5.0 the states of	$\frac{1}{1}$ $\frac{1}$	T	N A A	<u> </u>
	100-1730 VE-6		NI SOME CHURT	grains
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int interest	wh-yltan yc. e		N	
1025 11-2 at 55-51+5	+ man-valon VC	a	N .	
1100 HET SHOT-SH	gyan-rabo		N Suma 2002-	nt clickonside surfaces
1125 Hard Siltst-sh	In-rabn neb	Р	N chevet a bli	
In Sh	rdbn		N	· · · · · · · · · · · · · · · · · · ·
1175 HAN Sheals	s Itan reb	ρ	N chewt perbla	£5.
1200 HOP Cal 35	olktn f. ppb.	62	N abund chewit	albbusy from some dissen nurity
1775 H St ST ST	Han-robn VF- F M	Ρ	N Npper Brush	14 Basin Ct @ 120.0
125:0 H=== sltst	Ifan-rabn		N	1

PERCENTAGE COMPOSITION IMAGE



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Date <u>9-30-09</u> Ge	ologist <u>Lasebolt</u>	_ Drilling Co. <u>Bay Ks Ex</u>	ploration, Inc. Hole No. TWN-16
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Date 10-7-09 Geologist L. Casebolt	Drilling Co Baules E	Exploration TAG Hole NO TWN-17
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County San Juan State Utah	_ Location	
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PERCENTAGE COMPOSITION IMAGE



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## SAMPLE DESCRIPTION KEY

DEPTH SCALE	IRON OXIDE
Scale is 1"-50' for drill	H Hematite A Abundant
Samples and I -5 for core.	L Limonite M Moderate G Geothite T Trace
SAMPLE TAKEN	
Mark through interval which	PYRITE-MARCASITE
saved, with an "X" mark	Amount - In percent.
through core interval with	Habit
shading.	A Aggregate
	G Globules
Standard rock symbol for	I Individual
interval.	M Massive
	MT Marcasitic texture
ALTERATION	
[ Reduction	Alteration
+ Dissolution	T Tarnished
8 Oxidation	P Pseudomorphs after pyrite
GAMMA ANOMALY (Probe)	Mark with an "X" and clarify i
T $3 \times BG = .009$ Trace	remarks and metallic minerals
2.050199 High Mineral	observed.
3.200 > Ore	(MoS ₂ ,NiS,PbS,UO ₂ ,CU ₂ O,etc.)
DDDCCTA DTDD	NON-METALLIC MINERALS
Definate	Mark with an "X" and clarify i
Unsure	remarks any non-metallic minerals observed (Barite
• • • • • • • • • • • • • • • • • • • •	Anhydrite, Gypsum, Calcite,
LITHOLOGY	etc.)
Standard abbreviation for rock	PRACTION -108 HOL
type.	VS Very Strong
COLOR	S Strong
GSA Rock-Color Chart of wet	M Moderate
samples.	w weak VW Verv Weak
GRAIN STZE	N None
Sandstone Carbonates	
Peb Pebble	Amount - In percent
vc Very Coarse vc	
c Coarse c	<u>Type</u> C Coal
m Medium m f Fine f	F Distinct woody fragments
vf Very Fine vf	H Humic
	HY Hydrocarbon I Interbedded trash
SORTING Weill-conted	L Lignitic
M Moderately-sorted	
P Poorly-sorted	BRECCIA NOMENCLATURE
U Un-sorted	size, sorting and angularity
ANGULARTTY	columns for classification and
VA Very Angular	description.
A Angular	REMARKS
a subangular r Subrounded	lise to clarify and expand on
R Rounded	the columnar data. Explain
WR Well Rounded	anything not evident or any
CENEND NAMELY	special characteristics such
CEMENT-MATRIX A Argillaceous	ness. cyclic sedimentation.
C Carbonate	fossils, sedimentary struc-
D Dolomite	tures, formation picks, etc.
S Silica	
F Ferruginous	

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## **APPENDIX B**

## WELL CONSTRUCTION SCHEMATICS

**APPENDIX B.1** 

**DR - SERIES** 












































**APPENDIX B.2** 

**MW - SERIES** 











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PEEL Environmental	24 ryices 122-4116		WMMW-16
Protect: White Mesa	Surface Elev. 5588.18 T.	D. = 91.5	JMETCO Minerals Corporatio
Dale: 12/07/92	Depth to Water: Dry Ge	ologist; F. A. Peel	
Gamma (Nat) Depth	Neutron - APT	Sample Description	Comments Well Costruct
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		80	ore Hole No. :		
	PEEL Environmental S	Services	WMMW-17		
	Project: White Mass	Surface Elev. 5575 06 T. D. = 110'	METCO Minerals Corporation		
	Date: 12/07/92	Depih la Water: 86.5' Geologist; F. A. Peel			
	Gamma (Nal) Depth	Neutron - API Sample Description	Commenta Well Costruction		
		Sand: ware, reddin brean, for so rundam grand read to su			
	Soll Dakola Fm	A A A A A A A A A A A A A A A A A A A			
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		Services		Bore Hole No. :	]
	Profect: White Messe	Surface Elev. 5657.58	T.O 148.5		-
	Date: 12/07/92	Depth to Water: 92	Geologist: F. A. Peel		-
	Gamma (Nat)	Neutron - API	Sample Description	Comments Well Costructio	n
	<u> </u>	1 0 7004	nd; quartz, red brown, silly.	IN' Steel	ส
	Soil Mancos Shale		ale: black, platy, hard.		
	Dakota Fm	Sur Participation of the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second secon	ndstense: quariz, light buill is light gray, subround, et statisting >>> least toward base, Cicc lithic people also particle.	Landredic, lance	
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			-			Bore Hole	No. :		
	PEEL Environmental Services						WMMW-19		
	Protect: Mitrie Lie		Surf	aca Elev 5655.05					
	Data: 12/07/92			In the Waters (EA		UMETCO Minerals Corporation			
	Dett. (Bernse			BI IO WATET: 150	Geologist:		Comments Well		
	Gamme (Nat) D	epth		Neutron - API	Sample Description		Costruction		
		• t	$\overline{}$	Sard	: quartz, réddah kravnuline grained, sity.				
	7	t	1	San	dziene: quertz, fight gray, line-grained, subrou	nd, kaodintic,			
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		1			ana: quartz, light gray, line- le machan-grainne	, conglamaratic			
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	_ <b>{</b>   [™]	C to the	M		aran, quarte, qu'i granan gray, very ani-grat Bons la vary argitectore, s'in gran state per I brown state pering at base.	irga, wary,			
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6	irushy Basin Member				dark raddak brown, and.				
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	Services	·	Bore Hole No. : WMMW-20
Arveda, CO (303)422	-5114	1	
Project; White Mesa	Surface Elev. 5538 Es	T, D, = 114.5	PBTD ≈ 90'
Date: 8/4/94	Depth to Water: 86.4	Geologist: C. Bilgood	
Gamma (Nal)	Neutron - API	Sample Description	
		Sand; quarte, teiddah brown, eily, argliaceorn, ee	odan. 5 
e e e e e e e e e e e e e e e e e e e	Тор ракота (12.5).	Sandalone: quaris, light gray to butt, very the lo argitacoous, suborgular, solu	Eno grained, Congrained, Congrained, Congrained, Congrained, Congrained, Congrained,
		Sandstone: quarta, liphi gray, line- to medium gr sidh, trace iron stasiung, irace pixpoint porce ty.	ahad, argifaceous,
2		Sandatone: 44 above, conglomeratic in part with	) data gray chan dasin.
		Contractor (NY STAL MOLADOUT (AL	• to motion grained.
		Gun.	2 - Centration
		Sandstone: as above, conglorieratic in part, i clasis.	fack gray and while chort
g		Sandstone: 44 above, becoming less stoplat medium-gratned, well sorted, las huergranuta	eaus, BgM brown gray, I porosity.
		Sandslone: quartr, light gray, medium-grain grained, subargular lo subrounded bocomin chasis loom 72.0 to 72 °C.	ed, occus brazy coarse- g very argitaceors, shale
		Conglomerate: Inhc, potble, shale and then sorted tubrounded. Shale: obve green, warr, soft, inp 0 2 block Missing Core	1. diale, very landy, booty 1. diale, very landy, booty 1. diale, very landy, booty 5. real 5 to 3
		Sandstone: guart, dat reddish green to g auftaceous, skoroundel, scanayed hon ta becoming dat reddah gray, itin bedded a Missing Core	and the photos hard, topie. No phare as base
	6 0AIIng break (90) TOP BRUSHY BASIN (90	Sitistione: dark teddish brown, eandy in par- ol dark ted brown sitty shake at top. Sitistone: green, wary, britie, occasional y in part, bon staining along 27 near vertical	n, angliaceous, this ettingen entral lension johits, e fly fractures.
		Claratorial plains, wary, ilived vertical join at base. Claratorial plains, wary, ilived vertical join at base. Claratoria: Rohi green gray, shr to sandy Claratoria: not affect to sandy. hard, mode	h cast, poorly developed is, becorring lighter in color , hard to very hard.
		poorly developed hotrontal plaring. Claptone: date reddith purple with occa- ventical inclure at base finds with nink a Claptone: early red, poorly developed vertical 270 4" halime inscrue rilled and	abnal green Kriga, block r. 2" Say. bortional plating, some Unin a all ea lo light green in cober fine to republic graend, way
		Sarosinose guars, gas grant pooty so egilicenus, schargilla, all pooty so byte green gran stillates and byte green giver and scharger and so and so and Claytone: Gak red biome, marken, hu Claytone: Gak red biome, marken, du Claytone: Gak gree green, poort deve that contained and so withing and shake.	ring in part grading downward into gray shale, vary hard and d. koped horizontal glating, hard.

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PEEL Environmental Arvada, CO (103)(1)	Bore Hole No. : WMMW-21		
Prolect; White Mesa	Surface Elev. 5558 Est	T. D. = 117.0'	PBTD = 90.0'
Dale: 0/12/94	Depth to Water: Dry	Geologist: C. Bilgood	
Gamma (Nal)	Neutron - API	Sample Description	
		Sard; anolian sand, quadz, teddish brown,	- Commufication to Grant
		Sandstone: quantz, bohi gray, Rise- giahned, angutar b rounded, well sonted, argitaceoux, some light ian to g line - to modium grained sandstone. Sandstone: quantz, bohi ten, line- to mecham-grained bronkic staining, abundani chieri tragments (probabili	e subangular ta pray pooly soned
40 50		Sandstona: quart, Ighi tan, fina- to modium-grained, so ied, olive green soli deystone clasis. Sandstone: quart, Ighi grap to greenich grap, line- to	filable, wet
		Sandulona: guant, gray to light gray, line- to medium sub-outed chan ingroves, conglorowalic in part, py Sandulona: guant, gray to light gray, line- to medium sub-ounded, anglitacoous, wall sorted, abundari pyth puthably developed along tractures.	rs, nhundañi rific. •grained, ie and pyrile crystale
70 80		Mining Core Sandtome quant, light grey, medlum-grained, subro angilarnowi, conformatic, chind lagorapit, angular occasional subrounded peoples, black chent lagorapit Maring Core Conglommistic black proble, chert, very sandy, quant subroundd, very sublaccous. Sandstone: quant, congtomeratic grading downward conglomerate. Missing core Conglomerate: chert peoble, argRaccous, sandy, han Surdstone: quant, Jght gray, fine to medium prates subrounded, congtomeratic, argBacecus, hand, light.	undad, vary lo subangular, . modium-grained to sandy d. fight. 8, subangular to
90		Sanstione: quart, light gray, fine to motion galance is ubround at Sight gong market, way hard and tigh a taxous partneri, no visible porosky. Sanstione: as above with large vertical functives files and store: quart, light gray, fine- to medium-gra tounded, very hard and tight, sitceous commit, no vis Sanstione: quart, light gray, fine- to medium-gra and egits, no visible porosky. Sinsione: very fait gray green, pyrible, near vertical functional bedrag painty, which, because wertical in part. Sinsione: very fait gray green, pyrible, near vertical functional bedrag painty, hard, becaming more Sanst Claystone: tight gray green, sandy, near vertical fractu- in part. Missing Core Sanstione: quart, light gray green, way fine-grabed functives, accordance find pathing and provide and bedrage	1. rounded to 4. weil anded, with pyrke. 1. whoreved to bide porcety. Inded, poorty bideding takes. pyrke. very fland actures. some area. pyrke. biochy rea. pyrke.biochy vertical inter poort
110		Shaja: grey-green, slightly sandy, bedding plane and v lactores Claysboa: gray green, wary, soft, Missing Core Straine: Upht grey green with very Ben-grahed sand Christ hagmonts, avgilaceous, very aandy. Shaja: brownish prev, bocorring grey green, soft very emision fractureg. Shaja: bit green bit grey to green grey, very sandy, v including.	rentcal lons lon

(PEEL) F	anini C							Bore Hole N	10. :	
Arveds, CO	enial Serv (203)(22-311)	1088	-			-		WMM	W-22	
Prolect: White Me	338 S	urlace	Elev.		<u>5516 (</u>	st	T. D. = 140'	PBTD = 120'		
Dale: 8/4/94		epih i	o Wat	er:	76	┦	Geologist: C. Bilgood	L		
Gamma (Nat)		N	eutro	n - A	Pl 2000		Sample Description			
3							Sandslone: aeoEan sand, quarta, saddish brown.		Received and the second	· · · · · ·
	02 02 02 i ****************						Congloments: chen, Spit gray to data gray, occasi insolved with light gray quark sandwore, round Congloments: sandstone and congloments as abo	onst transluce nt, ed, thin badded. DV9.		1/4* Sisei Surtace Cag
	00 						Sanchitore; quarz, while to very light gray, line-to aigžaceoun	nedium-grained,	A STATE A STATE A STATE A STATE A STATE A STATE A STATE A STATE A STATE A STATE A STATE A STATE A STATE A STATE	-Cement:Bertoni Grout
	40						5		na canana ana ana ang ang ang ang ang ang an	- 4" schedual 41 PL
``````````````````````````````````````	50			5		-	Santsions; quarz, white to very light tan, line-gra haid, light	ned, wall camented,	N/S/Manala	and and the product
$\left  \right $		_		$\left  \right\rangle$			Sanchtone as allove, very hard, ediceous camere		=	Centralizer
	60					-	Sandstone as above entrince light gray chart fr estiming	agments, trace fron	2	0) - Berstanile Sest
( )	70						Sandatama quarre, fojd gar ta lojd tan, var filo ober (clauti la 107, pilosou canare, wiel emen skalning, occasionaly fojk green in color. Sandatora: ababos with homase in chert clauti Massing Core	e grained, aubangutar, ied, hand, kon k.		
	80 -	<u> </u>					Sentatione: quera, fait la ha la tiple gray, frem-to subangular to subneurisde, skoou carenart, fait conglomeratic at base, hard, well carented. Santatione: a datore to occurring congenerate la pubbles sub a ngular le subnound, varicobred Kasing Care Conglomerate: varicobred as sbore, chen and co Sandatone: ouero, way fait gray, way fine-grai subnorded, occasional rock clasts, suce integr holtonal bodding paring, some cross bedding	medium-grained, a, becoming very base. Conglomerate base. Conglomerate base. Signature claystone tragments. Intel, srgiterceus, soular porcesy, some		10-20 Color)
·	- 8 -			∄	-  -	-	Hissing Core Sandstore; quantz, light gray to light green gray, grahed, subargular to nuncled, poorly sorted, la	fine- to very coarse- rgs 1° green gray		Shca Sard
				$\left \right $			Sandelona: quartz, very light gray, fine-to medi, to subrounded, very inisole, good intergranular p web sorted.	nj, ver sapa. Im-grained, subangular Grosky, massive,		
	100	<u></u>		]_    .			Sandukum iqtindi, fiyla giran giri, Die grahmd Jair Inhigramikar pomitiy, hebib	ا, میکریور محمد محمد به میرو		
/	110						Masing Core			
	120		IOP BRI	I317 E	ASIN (17	2	Sindstone quarts, forb green grey, fine-to coa al base, conglomersic, variabled, with green hild bagments Chysical green, wasy Masing Core Charitane red brown, mottled green, some hor	ina-grained, argilaceous claysione, cheri and othe claysione, cheri and othe grant and and and and and and and and and and		
	100					_	Claystone gray green to bright green, some no Storane. Igdit gray green, hand, very argitaceo t gradmy into kyte graan starstone.	d mottling and banding us, slightly sandy, lower	-	
							Citystore issue gray monied, with red brown of players, some 3" to 10" vertial hadrones, so release	layslone, haid, some me sealed, some leitson		



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**APPENDIX B.3** 

**TW4 - SERIES** 

	TW 4-1	TW 4-2	TW 4-3	TW 4-4	TW 4-5	TW 4-6	<u>TW 4-7</u>	TW 4-8	<u>TW 4-9</u>
Approximate screened	70-110	80-120	67 <b>-</b> 97	72-112	80-120	57.5-97.5	80-120	85-125	80-120
interval (feet bls)									
Depth to water ¹ (feet below	81.1	76.4	65.3	90.5 ²	61.4	86.5 ²	67.5	75.2	60.5
measuring point)					<u> </u>				
pH	6.80	7.06	6.72	NS	6.24	NS	6.87	6.97	6.26
Electrical conductivity	4,063	3,581	3,655	2,100	1,787	3,487	4,056	3,402	3,049
(mS/cm)									
Temperature (°C)	13.1	14.4	13.4	14.8	14.5	15.0	14.4	14.2	13.3
Chloroform (µg/L)	5.8	2,510	702	NS	29.5	NS	256	<1	4.2
(1 st sampling)									
Chloroform (µg/L)	1,100	5,520	834	NS	49	NS	616	21.8	1.88
(2 nd sampling)									· · · _ · - ·
Chloroform (µg/L)	1,490	NS	NS	NS	NS	NS	NS	NS	NS
(3 rd sampling)				-					
Chloroform (µg/L)	NS	NS	NS	< 0.5	NS	<0.5	NS	NS	NS
(initial sampling of TW 4-4									
and TW 4-6)									
Chloroform (µg/L)	2,320	5,220	836	<1	124	<1	698	102	14.2
(4 th sampling)									
(2 nd sampling of TW 4-4									
and TW 4-6)				Į.					

 TABLE 3

 Temporary Perched Well Completion and Analytical Parameters

Note: l = Depth to water measured on January 3, 2000 2 = Depth to water measured on July 27, 2000 NS = not sampled

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**APPENDIX B.4** 

**TWN - SERIES** 






































### **APPENDIX C**

### **INTERA SOIL BORING LOGS**

#### APPENDIX C INTERA SOIL BORING LOGS SUMMARY

In May and June 2011, INTERA, Inc. installed 75 soil borings in the vicinity of the mill site. Borings GP-01A1 through GP-02A1 and GP-01C through GP-07C were installed to the north and south of the mill site and tailings cells; GP-01B through GP-48B were completed within and immediately outside the area of the mill site. Borings were drilled by Earth Worx using the Geoprobe push probe method. Soil samples for lithologic logging were collected using the continuous dual tube method. Locations of soil borings are provided on Figures C.1 and C.2; copies of the boring logs are provided in Appendix C.1.

Soil samples from the GP-A1 and GP-B series borings showed a consistent lithology. Depths of refusal ranged from 2.7 ft bgs to 9.7 ft bgs. Yellowish-red, silty, fine sand predominated from the ground surface to about four to six ft bgs, generally transitioning to pink, silty, fine sand or pink sandstone to the depth of refusal. Roots were occasionally present in the top several feet of the borings.

Soil samples from the GP-C series borings within or near the mill site showed more variable lithology. Depths to refusal were deeper overall than in the GP-A1 and GP-B series borings, and ranged from 1.7 to 24.5 ft bgs. Yellowish-red silty sand predominated in the upper portion of the GP-C borings, from approximately four to 10 ft bgs, and was typically underlain by interbedded reddish clay or clayey silt, and pinkish silt or silty sand to the depth of refusal. Gypsum precipitate was commonly seen in the lower portions of the GP-C series borings, and fine gravel was present in low proportions in multiple borings.

FIGURES





## Cell 3

# Cell 2





### **APPENDIX C.1**

### **INTERA BORING LOGS**

				34		Log of Soil E	Boring GP-01A	<b>\</b> 1		
			$\sim$					(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/17/11 : 05/17/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
-		Project	#: DENN	IC.C002.000	Drilling Co./Driller	: Earth Worx			1	
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Desi	mitted for laboratory anal	iysis atory analysis DESCRIPTION			nscs	GRAPHIC
	0 - -		4.0/ 2.95 0.5/	0-3.7' Silty SAND, red little white mottling, H 3.7-4.5' Silty SAND, p strong	ddish brown (5YR 4/4 Cl strong pink (5YR 6/4), very fi	), very fine-grained sand, ne-grained sand, silt, poc	silt, poorly graded, ver	ry loose, dry, Inse, dry, HCI	SM	
			0.65							
gs\Denison\GP-01A1.bor	5			Total depth of boring	4.5' bgs (refusal)					
cts/BoreLo	10									
S:\Proj∈	Note(s)	I :								
07-28-2011										

			T	RA	Log of Soil Boring GP-02A1		
			$\sim$		(Page 1 of	1)	
-		Denisor White Me	Project N n Nitrate esa Mill, I	Name: Investigation Blanding, Utah	Date/Time Started       : 05/17/11       Driller       : L. Trujillo         Date/Time Completed       : 05/17/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : J. Reed         Sampling Method       : Continuous Dual Tube       Driller       : Earth Work		
-	Depth	mple Interval	n./Rec. (feet)	Sample Interval Des	pription nitted for laboratory analysis mple submitted for laboratory analysis		APHIC
	Feet	Sai	Реі		DESCRIPTION	N	U U U U U
Fee	0		4.0/ 3.2 3.1/ 3.0	0-4.7' Silty SAND, ye dense, dry, HCI weak 4.7-7.1' Silty SAND, j trace fine sand	lowish red (5YR 4/6), very fine-grained sand, silt, poorly graded, loose to medium to moderate, little white mottling w/ HCl strong	SM	1
cts\BoreLogs\Denison\GP-02A1.bor	-	-		Total depth of boring	'.1' bgs (refusal)		
S:\Proje	Note(s)	):					
07-28-2011 5							

			RΔ	Log of Soil Boring GP-03A1		
				(Page 1 of 1)		
	Deniso White M	Project N on Nitrate esa Mill, I	lame: Investigation Blanding, Utah IC C002 000	Date/Time Started     : 05/17/11     Driller     : L. Trujillo       Date/Time Completed     : 05/17/11     Depth to Water     : NA       Drilling Method     : Geoprobe     Logged by     : J. Reed       Sampling Method     : Continuous Dual Tube     Earth Worx		
Depth	ple Interval	/Rec. (feet)	Sample Interval Des	cription mitted for laboratory analysis ample submitted for laboratory analysis (1)	- vi	PHIC
Feet	Sam	Pen.		DESCRIPTION	nsc	GRA
0-		4.0/ 3.0 2.8/ 3.1	0-4.0' Silty SAND, ye top, HCI strong - 4.0-6.8' Silty SAND, dense, dry, HCI stron	reddish yellow (6/6), very fine-grained sand, silt, poorly graded, loose, dry, root at g	SM	
10 – Note(s) 1. Dupl addi	): icate samp	ble collecter	d. Sample interval was inc required by the analytical	reased to 2 feet to accommodate laboratory.		

						Log of Soil E	Boring GP-04A	1		
						·	•	(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/17/11 : 05/17/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
-		Project	#: DENN	IC.C002.000	Drilling Co./Driller	: Earth Worx				
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Soil sample sub	mitted for laboratory anal	ysis atory analysis DESCRIPTION			nscs	GRAPHIC
	0-		4.0/ 3.6 3.7-4.0' Silty SAND, pink (5YR 6/4), very fine-grained sand, silt, poorly graded, very loose, dry, 3.7-4.0' Silty SAND, pink (5YR 6/4), very fine-grained sand, silt, poorly graded, medium dense, dry, HCl strong						SM	
Projects\BoreLogs\Denison\GP-04A1.bor	5			Total depth of boring	4.0' bgs (refusal)					
07-28-2011 S:\P	Note(s)	:								

			ITE	RΔ	Log of Soil Boring GP-05A1		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started       : 05/17/11       Driller       : L. Trujillo         Date/Time Completed       : 05/17/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : J. Reed         Sampling Method       : Continuous Duel Tube       : Continuous Duel Tube		
	Depth in	Project uble Interval	n./Rec. (feet) :#	AC.C002.000 Sample Interval Des Z Soil sample sub Duplicate soil sa	Drilling Co./Driller : Earth Worx cription mitted for laboratory analysis ample submitted for laboratory analysis	CS	APHIC
	0- - - - - - - -	Sa Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor Carlor	4.0/ 2.7 3.6/ 3.6	0-6.4' Silty SAND, ye HCI moderate 6.4-7.6' Silty SAND, I HCI strong, trace fine	Ight brown gray (10YR 6/2), very fine-grained sand, silt, poorly graded, dense, dry, sand	SM	<u>9</u>
ts\BoreLogs\Denison\GP-05A1.bor	-	-		Total depth of boring	7.6' bgs (refusal)		
07-28-2011 S:\Projec	10 – Note(s)	<u>1</u> ::					

		RΛ	Log of Soil	Boring GP-06A1		
				(Page 1 of	1)	
Deniso White M Proiect	Project N on Nitrate esa Mill, I t #: DENN	lame: Investigation Blanding, Utah //C.C002.000	Date/Time Started: 05/17/11Date/Time Completed: 05/17/11Drilling Method: GeoprobeSampling Method: Continuous Dual TubeDrilling Co./Driller: Earth Worx	Driller : L. Trujillo Depth to Water : NA Logged by : J. Reed		
imple Interval	:n./Rec. (feet)	Sample Interval Des	iption itted for laboratory analysis ple submitted for laboratory analysis (1)		scs	ZAPHIC
Sa	Ъе		DESCRIPTION		<u> </u>	5
	4.0/ 3.1	0-5.9' Silty SAND, ye dense, dry, HCI mode	owish red (5YR 4/6), very fine-grained sand ate, trace roots at top, little white mottling w	d, silt, poorly graded, loose to medium // HCI strong	SM	
	4.0/ 3.8	5.9-8.0' Silty SAND, HCI strong, trace fine	ry pale brown (10YR 8/4), very fine-grained	d sand, silt, poorly graded, dense, dry,		
		Total depth of boring	0' bgs (refusal)			
-						
): licate samp idditional sa	e collecte ample volu	d. Sample interval was inc me required by the analyti	ased to 2 feet to accommodate laboratory.			
	Deniso White M Project	Project M Project #: DENN Project #: DENN (199) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) 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(190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190) (190)	Project Name: Denison Nitrate Investigation White Mesa Mill, Blanding, Utah         Project #: DENMC.C002.000         Image: Construct the interval Description of the solid sample interval Description of the solid sample solid sample solid sample solid sample solid sample solid sample solid sample of the solid sample interval Duplicate solid sample of the solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid sample solid 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sample solid sample solid sample solid	Project Name:       Date/Time Startled :: 05/17/11         Denison Nitrate Investigation       Date/Time Complete: :: 06/17/11         Nitrate Investigation       Date/Time Complete: :: 06/17/11         Project #: DENMC.CO02.000       Date/Time Complete: :: 06/17/11         Project #: DENMC.CO02.000       Date/Time Complete: :: 06/17/11         Project #: DENMC.CO02.000       Sample submitted for laboratory analysis         Image: Instruct Transmitted for laboratory analysis (1)       Diplicate soil sample submitted for laboratory analysis (1)         Image: Instruct Transmitted for laboratory analysis (1)       DESCRIPTION         Image: Instruct Transmitted for laboratory       Description         Image: Instruct Transmitted for laboratory       Description         Image: Instruct Transmitted for laboratory       Descriptio	Project Name: Project Name: Devices Nitrite Investigation Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO22.00  Project #: DENUCC CO2.00  Project #: DE	Experience       Log of Soil Boring CP-06A1         Project # Name: Demision Nitrate Investigation Note: Nitrate Investigation Note: Nitrate Investigation Note: Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision Nitrate Investigation Demision 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		Ite	RΔ		Log of So	oil Boring GP-07A	1		
		Project N		Data/Time Started	. 05/47/44	Driller	(Page 1 of 1)		
	Deniso White M	esa Mill, I	Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/17/11 : 05/17/11 : Geoprobe : Continuous Dual Tu	Depth to Water Logged by be	: L. Trujilo : NA : J. Reed		
	Project	t #: DENN	AC.C002.000	Drilling Co./Driller	: Earth Worx			1	
Depth in	nple Interval	./Rec. (feet)	Sample Interval Des	mitted for laboratory anal	ysis atory analysis			- S	APHIC
Feet	Sam	Pen			DESCRIPTIO	N		nsc	GR/
0-		4.0/ 3.0	0-4.9' Silty SAND, ye dense, dry, HCI stron	llowish red (5YR 5/6), g, little white mottling,	very fine-grained s HCI strong 4 to 4.9'	and, silt, poorly graded, loose bgs	to medium		
5		4.0/ 3.3	4.9-7.5' Silty SAND, dense, dry, HCI strong 7.5-9.7' Silty SAND, strong, trace fine same	bink (7.5YR 7/4), very g, trace loose fine san bink (7.5YR 7/3), very	fine-grained sand, s d 7 to 7.5' fine-grained sand, s	silt, poorly graded, medium d silt, poorly graded, loose to d	ense to ense, dry, HCI	SM	
		1.7/ 1.8							
10-			Total depth of boring	9.7' bgs (refusal)					
Note(s)	:								

07-28-2011 S:\Projects\BoreLogs\Denison\GP-07A1.bor

				37		Log of Soil E	Boring GP-08A	.1		
								(Page 1 of 1)		
-		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/17/11 : 05/17/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
-		Project	#: DENN	IC.C002.000	Drilling Co./Driller	: Earth Worx				<u> </u>
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Desi ZZZ Soil sample sub Duplicate soil sa	mitted for laboratory ana ample submitted for labor	lysis atory analysis DESCRIPTION			USCS	GRAPHIC
eLogs\Denison\GP-08A1.bor	0-	i i i i i i i i i i i i i i i i i i i	4.0/ 3.3	0-3.5' Silty SAND, ye gravel, roots at top, H 3.5-4.0' Silty SAND, p Total depth of boring of	pink (7.5YR 8/4), very	fine-grained sand, silt, p	silt, poorly graded, loos	e, dry, trace	SM	
jects\Bo	10-	-								
07-28-2011 S:\Pro	Note(s)	):								

		ITE	RΔ	Log of S	Soil Boring GP-09A	.1		
		No.				(Page 1 of 1)		
	Deniso White M	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started       : 05/17/11         Date/Time Completed       : 05/17/11         Drilling Method       : Geoprobe         Sampling Method       : Continuous Dual         Drilling Co. (Deillog       : Earth Warrie	Driller Depth to Water Logged by Tube	: L. Trujillo : NA : J. Reed		
Depth	ple Interval	/Rec. (feet)	Sample Interval Des	rription nitted for laboratory analysis mple submitted for laboratory analysis			- <u>v</u>	APHIC
Feet	Sam	Pen		DESCRIPTI	ON		nsc	GR/
0-		4.0/ 2.95 4.0-8.0' Silty SAND, y none, trace roots	lowish red (5YR 5/6), very fine-grained	d sand, silt, poorly graded, loos	e, dry, HCl	SM		
5-		4.0/ 3.75	graded, loose, HCI no	he, trace mica, trace white mottled w/ I	HCI strong	, on, poony		
			Total depth of boring	8.0' bgs (refusal)				
10 – Note(s) Duplica accomr	: te sample nodate add	collected. ditional sar	Sample interval was increa	sed to 2 feet to e analytical laboratory.				

				RA		Log of Soil B	Boring GP-10A	1		
								(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/18/11 : 05/18/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
_		Project	#: DENN	IC.C002.000	Drilling Co./Driller	: Earth Worx				
1	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Soil sample sub	mitted for laboratory ana ample submitted for labor	lysis atory analysis DESCRIPTION			nscs	GRAPHIC
	0		2.66/ 1.25							
	-		1.25	2.0-2.7' Sand/Silty Sa loose, dry, subangula	and, very pale brown ( r to subrounded, HCl	(10YR 8/3), very fine-grair none, little very fine sand	ned sand, trace silt, poc	orly graded,	SP/ SM	
Projects (BoreL.ogs (Denison) GP-10A1.bor	Total depth of boring			Total depth of boring	2.7' bgs (refusal)					
07-28-2011 S:\Pr	Note(s)	:								

			TE	RΔ	Log of Soil Boring GP-11A1			
			~~		(Page 1 of 1	)		
		Deniso White Me	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started: 05/18/11Driller: L. TrujilloDate/Time Completed: 05/18/11Depth to Water: NADrilling Method: GeoprobeLogged by: J. ReedSampling Method: Continuous Dual Tube			
		Project	#: DENN	/IC.C002.000	Drilling Co./Driller : Earth Worx			
	Depth in	nple Interval	./Rec. (feet)	Sample Interval Des	ription nitted for laboratory analysis nple submitted for laboratory analysis		APHIC	
	Feet	San	Pen		DESCRIPTION		GR/	
	0		4.0/ 3.6 1.0/ 1.2	0-3.0' Silty SAND, ye dense, dry, HCl none 3.0-5.0' Silty SAND, y graded, loose to medi brown, HCl weak to m	lowish red (5YR 5/6), very fine-grained sand, silt, poorly graded, loose to medium ellowish red (5YR 5/8 & very pale brown 10YR 8/2), fine-grained sand, silt, poorly um dense, dry, some white mottling w/ HCl strong, mottled but little red or very pale edium, trace fine sand	SM		
	-			Total depth of boring	i.0' bgs (refusal)			
rojects\BoreLogs\Denison\GP-11A1.bor	- - -							
07-28-2011 S:\P	Note(s): Duplicat accomn	ote(s): iplicate sample collected. Sample interval was increased to 2 feet to commodate additional sample volume required by the analytical laboratory.						

			BA		Log of Soil E	Boring GP-12A	.1		
							(Page 1 of 1)		
	Deniso White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/18/11 : 05/18/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
	Project	#: DENN	1C.C002.000	Drilling Co./Driller	: Earth Worx			1	<u> </u>
Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Desi	mitted for laboratory anal	ysis atory analysis DESCRIPTION			uscs	GRAPHIC
0 -		4.0/       2.0-4.0' Silty SAND, yellowish red (5YR 5/6), very fine-grained sand, silt, poorly graded, loose to medium dense, dry, HCl none         4.0/       3.2         2.0-4.0' Silty SAND, pink (5YR 7/4), very fine-grained sand, silt, poorly graded, medium dense loose to medium dense, trace fine sand, dry, some white mottling w/ HCl strong							
ojects\BoreLogs\Denison\GP-12A1.bor			Total depth of boring o	4.0' bgs (refusal)					
07-28-2011 S:\Prc	s):								

ΙΠΤΞΆ				37		Log of Soil E	Boring GP-13A	1		
	IIICE 74							(Page 1 of 1)		
Project Name: Denison Nitrate Investigation White Mesa Mill, Blanding, Utah					Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/19/11 : 05/19/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
_		Project #: DENMC.C002.000			Drilling Co./Driller	: Earth Worx			1	
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	mitted for laboratory ana ample submitted for labor	lysis ratory analysis DESCRIPTION			USCS	GRAPHIC
	0		4.0/ 3.1	0-4.0' Silty SAND, ye dense, dry, trace whit	ellowish red (5YR 4/6) e mottling w/ HCl stro	, very fine-grained sand, s ng	ilt, poorly graded, loose	to medium	SM	
	-		0.7/ 0.7	4.0-4.7' Silty SAND,   dry, HCl strong, trace	pink (5YR 7/4), very fi fine sand	ne-grained sand, silt, pool	rly graded, loose to mee	lium dense,		
ijects\BoreLogs\Denison\GP-13A1.bor	5			Total depth of boring	4.7' bgs (refusal)					
07-28-2011 S:\Proj	Note(s)	:								

ΙΠΤΕΊΑ					Log of Soil Boring GP-14A1		
			$\sim$		(Page 1 of 1)		
Project Name: Denison Nitrate Investigation White Mesa Mill, Blanding, Utah					Date/Time Started     : 05/19/11     Driller     : L. Trujillo       Date/Time Completed     : 05/19/11     Depth to Water     : NA       Drilling Method     : Geoprobe     Logged by     : J. Reed       Sampling Method     : Continuous Dual Tube     : Continuous Dual Tube		
-	Depth	ble Interval	/Rec. (feet)	Sample Interval Des	Drilling Co./Driller : Earth Worx cription mitted for laboratory analysis imple submitted for laboratory analysis	- vi	PHIC
	Feet	Sam	Pen.		DESCRIPTION	nsc	GRA
-	0 - - 5		4.0/ 2.9	0-5.8' Silty SAND, ye dense, dry, trace whit	llowish red (5YR 4/6), very fine-grained sand, silt, poorly graded, loose to medium e mottling w/ HCl strong, HCl none to weak	SM	
	-		2.9/ 1.9	5.8-6.9' Silty SAND, J loose to medium dens	pink (5YR 7/4 & yellowish red 5YR 5/6), very fine-grained sand, silt, poorly graded, se, dry, some what mottling w/ HCl strong, trace fine sand		
Is\Denison\GP-14A1.bor	-	-		Total depth of boring	6.9' bgs (refusal)		
rojects\BoreLog	10-	-					
07-28-2011 S:\P	Note(s)						
				RΔ	Log of Soil Boring GP-15A1		
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			$\sim$		(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started       : 05/19/11       Driller       : L. Trujillo         Date/Time Completed       : 05/19/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : J. Reed         Sampling Method       : Continuous Dual Tube       Entitive       Entitive		
		Project	#: DENN	Sample Interval Des	Cription : Earth Worx		
	Depth	ole Interval	'Rec. (feet)	Z       Soil sample sub         Duplicate soil sa	mitted for laboratory analysis Imple submitted for laboratory analysis	S	PHIC
	Feet	Samp	Pen./		DESCRIPTION	USC:	GRA
	0-		4.0/ 3.0	0-5.1' Silty SAND, ye dense, dry, trace whit	llowish red (5YR 5/6), very fine-grained sand, silt, poorly graded, loose to medium e mottling w/ HCl strong, HCl none to weak		
	- 5 -		3.6/ 4.0	5.1-7.6' Silty SAND, fine sand, HCl strong,	pink (5YR 7/4), very fine-grained sand, silt, poorly graded, medium dense, dry, trace some white mottling w/ HCl strong	SM	
rojects\BoreLogs\Denison\GP-15A1.bor		-		Total depth of boring	7.6' bgs (refusal)		
07-28-2011 S:\P	Note(s)						

			RΔ		Log of Soil Bo	oring GP-16A	1			
							(Page 1 of 1)			
	Deniso White Me	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started       : 05/         Date/Time Completed       : 05/         Drilling Method       : Gea         Sampling Method       : Con         Drilling Co //Driller       : Ear	19/11 19/11 oprobe ntinuous Dual Tube th Work	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed			
Depth	nple Interval	/Rec. (feet)	Sample Interval Des	cription mitted for laboratory analysis imple submitted for laboratory a	analysis			CS	APHIC	
Feet	Sar	Per		DE	SCRIPTION			SN	ВR	
-0			0-3.1' Silty SAND, ye dense, dry, HCl none	llowish red (5YR 4/6), very	fine-grained sand, silt	i, poorly graded, loose	to medium			
-		4.0/ 3.7								
-			3.1-7.1' Silty SAND, dry, HCl strong, trace	pink (5YR 7/4), very fine-gr fine sand	ained sand, silt, poorly	/ graded, loose to mec	lium dense,	SM		
5-										
-		3.1/ 3.3								
-										
-			Total depth of boring	7.1' bgs (refusal)						
-										
Note(s)	<u> </u>									
Duplica	Duplicate sample collected. Sample interval was increased to 2 feet to accommodate additional sample volume required by the analytical laboratory.									

		DA DA		Log of Soil E	Boring GP-17A	1		
						(Page 1 of 1)		
Deniso White Me	Project N n Nitrate esa Mill, I	Jame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/18/11 : 05/18/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
Project	en./Rec. (feet) III :#	IC.C002.000         Sample Interval Desi         Image: Constraint of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the stat	Drilling Co./Driller cription mitted for laboratory anal ample submitted for labor	: Earth Worx ysis atory analysis			scs	
Sa contraction of the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second s	3.2/ 2.9	0-2.5' Silty SAND, ye dense, dry, HCI weak 2.5-3.2' Silty SAND, y trace fine sand, little v	llowish red (5YR 4/6), pink (5YR 7/4), very fi white mottling w/ HCl s	DESCRIPTION very fine-grained sand, s ne-grainded sand, silt, loc strong	silt, poorly graded, loose	to medium	SM	
-		Total depth of boring	3.2' bgs (refusal)					
-								
	Denisor White Me Project	Project N Denison Nitrate White Mesa Mill, Project #: DENM	Project Name: Denison Nitrate Investigation White Mesa Mill, Blanding, Utah         Project #: DENMC.C002.000         Image: Construction of the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second secon	Project Name: Denison Nitrate Investigation White Mesa Mill, Blanding, Utah       Date/Time Started Date/Time Completed Drilling Method Sampling Method Drilling Co.D.D.lifer         Project #: DENMC.C002.000       Sample Interval Description Duplicate soil sample submitted for laboratory anal Duplicate soil sample submitted for laboratory and Duplicate soil sample submitted for laboratory dense, dry, HCl weak         1       0-2.5' Silty SAND, yellowish red (5YR 4/6), dense, dry, HCl weak         2       3.2/ 2.9       2.5-3.2' Silty SAND, pink (5YR 7/4), very fir trace fine sand, little white mottling w/ HCl s         1       Total depth of boring 3.2' bgs (refusal)       Total depth of boring 3.2' bgs (refusal)	Project Name: Demison Nitrate Investigation White Meas AMIL, Blanding, Utah       Date/Time Started ::::::::::::::::::::::::::::::::::::	Project Name: Tothis Mintel Investigation Mintel Mess Mill, Blanding, Utal       DataTime Started: ::05/18/11 DataTime Complete: ::05/18/11 DataTime Complete: ::05/18/11 Difference Continuous Dual Tube Difference C	Project Name:       Delar/Time Complexed:       Cif/1911       Diff. Diff. Complexed:       Cif/1911       Diff. Diff. Complexed:       Cif/1911       Diff. Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Diff. Complexed:       Cif/1911       Dif	Image: Developed in Nirds Hires Blank display to the Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Market Ma

			Ĩ	RΔ	Log of Soil Boring GP-18A1		
					(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started: 05/18/11Driller: L. TrujilloDate/Time Completed: 05/18/11Depth to Water: NADrilling Method: GeoprobeLogged by: J. ReedSampling Method: Continuous Dual Tube: Sampling Method: Sampling Method		
-		Project	#: DENN	IC.C002.000 Sample Interval Des	Drilling Co./Driller : Earth Worx		
	Depth in	mple Interval	n./Rec. (feet)	Soil sample sub	mitted for laboratory analysis ample submitted for laboratory analysis	cs	APHIC
	Feet	Sar	Per		DESCRIPTION	Ň	В
	0		4.0/ 3.0	0-6.9' Silty SAND, ye dense, dry, HCI strong	llowish red (5YR 5/6), very fine-grained sand, silt, poorly graded, loose to medium g, trace white mottling w/ HCl strong, trace roots at top	SM	
bor	-		3.3/ 3.1	6.9-7.3' Silty SAND, j dry, HCI strong, trace	pink (5YR 7/4), very fine-grainded sand, silt, poorly graded, loose to medium dense, fine sand		
ojects\BoreLogs\Denison\GP-18A1.t				Total depth of boring	7.3' bgs (refusal)		
07-28-2011 S:\Pr	Notes:						

			RΔ		Log of So	oil Boring GP-194	<b>\</b> 1		
							(Page 1 of 1)		
	Deniso White M	Project N n Nitrate esa Mill,	Jame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method Driller	: 05/18/11 : 05/18/11 : Geoprobe : Continuous Dual Tul	Driller Depth to Water Logged by be	: L. Trujillo : NA : J. Reed		
Depth	ple Interv	/Rec. (feet)	Sample Interval Des	cription mitted for laboratory ana ample submitted for labor	lysis ratory analysis			- vi	PHIC
Feet	Sam	Pen.			DESCRIPTION	N		nsc	GRA
- 0	Š	4.0/ 3.9	0-6.0' Silty SAND, ye dense, dry, HCI none	ellowish red (5YR 4/6) to weak, little white n	, very fine-grained sa tottling w/ HCI strong	and, silt, poorly graded, loos	se to medium	SM	
5-		4.0/ 4.0	6.0-8.0' Silty SAND, dry, HCl strong, trace	pink (5YR 7/4), very fi fine sand, sand & fin	ne-grainded sand, si e gravel 7.9-8.0' bgs	ilt, poorly graded, loose to r	nedium dense,		
-	-		Total depth of boring	8.0' bgs (refusal)					
10-									
Note(s) Duplica accomr	te sample collected. Sample interval was increased to 2 feet to nodate additional sample volume required by the analytical laboratory.								

			RΔ	Log of Soil Boring GP-20A1		
				(Page 1 of 1)		
	Deniso White Me	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started       : 05/18/11       Driller       : L. Trujillo         Date/Time Completed       : 05/18/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : J. Reed         Sampling Method       : Continuous Dual Tube		
Depth in Feet	ample Interval	en./Rec. (feet)	Sample Interval Des	Difining CO./Difiei Learth Work cription mitted for laboratory analysis imple submitted for laboratory analysis DESCRIPTION	ISCS	SRAPHIC
0			0-3.1' Silty SAND, ye dense, dry, HCl none	llowish red (5YR 4/6), very fine-grained sand, silt, poorly graded, loose to medium		
5		4.0/ 3.0 1.1/ 1.3	3.1-5.1' Silty SAND, to strong, little white r	bink (5YR 7/4), very fine-grainded sand, silt, loose to medium dense, dry, HCl weak nottling w/ HCl strong, trace fine sand	SM	
			Total depth of boring	5.1' bgs (refusal)	•	
jects\BoreLogs\Denison\GP-20A1.bor 01						
07-28-2011 S:\Proj						

				37		Log of Soil	Boring GP-01E	3		
								(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill,	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/12/11 : 06/12/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
_		Project	#: DENN	//C.C002.000	Drilling Co./Driller	: Earth Worx			, ,	
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	cription mitted for laboratory ana ample submitted for labor	lysis atory analysis DESCRIPTION			uscs	GRAPHIC
	0-		4.0/ 3.15	0-3.1' Silty SAND, ye dense, dry, HCI strong	ellowish red (5YR 5/6) g, mottling common	, very fine-grained sand ( [,]	~70%), poorly graded, k	pose to	SM	
	-		0.4/	3.1-4.4' Silty Gravelly 0.1" diameter (~30%)	/ SAND, pinkish gray , well graded, angular	(5YR 7/2), very fine- to cc to subrounded, very loos	barse-grained sand (~60 se, non-plastic, dry, no H	%), gravel to ICI	SW/ SM	
ts\BoreLogs\Denison\GP-01B.bor	5-	-		Total depth of boring	4.4' bgs (refusal)					
07-28-2011 S:\Project	10- Note(s)	<u> </u> ;:								

			Ĩ	RΔ		Log of Soil	Boring GP-02B			
			$\sim$					(Page 1 of 1)		
-		Denisor White Me	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/12/11 : 06/12/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
-		Project	#: DENN	AC.C002.000	Drilling Co./Driller	: Earth Worx				
	Depth in	nple Interval	n/Rec. (feet)	Soil sample sub       Duplicate soil sa	mitted for laboratory analy	/sis atory analysis			SS	APHIC
	Feet	San	Per			DESCRIPTION			NS(	GR
	0 — - -	-	4.0/ 1.5	0-3.0' Silty SAND, ye subrounded, loose, di	llowish red (5YR 5/6), y, HCl strong, roots at	very fine-grained sand oundant top 0.5'	(~65%), poorly graded, su	bangular to	SM	
	-			3.0-7.0' Lean CLAY, subrounded, soft, me	light reddish brown (5) dium plastic, moist, HC	(R 6/3), very fine-grain I moderate	ed sand (~25%), subangul	ar to		
	5-		4.0/ 3.8						CL	
	-			7.0-11.8' Clayey SAN subangular to subrou	ID, light reddish brown nded, loose to dense, i	(5YR 6/3), very fine-gr medium plastic, moist,	ained sand (~60%), poorl HCI strong	y graded,		
	10 <i>-</i> -		3.8/ 3.5						SC	
s\BoreLogs\Denison\GP-02B.bor	-	-		Total depth of boring	11.8' bgs (refusal)					<u>e</u> e
² rojects	15-	}								
07-28-2011 S:\F	Note(s) 1. Dupl for ac	): licate sampl dditional san	e collecte nple volur	d. Sample interval was income required by the analytic	reased to 2 feet to accomr al laboratory.	nodate				

				RΛ	Log of Soil Boring GP-03B		
					(Page 1 of 1)		
-		Denisor White Me	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started       : 06/12/11       Driller       : L. Trujillo         Date/Time Completed       : 06/12/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : E. Muller         Sampling Method       : Continuous Dual Tube       : Continuous Dual Tube       : E. Muller		
-	Depth	ble Interval	/Rec. (feet)	Sample Interval Des	Drilling Co./Driller : Earth Worx cription mitted for laboratory analysis ample submitted for laboratory analysis	S	PHIC
	Feet	Sam	Pen.		DESCRIPTION	nsc	GRA
	-0		4.0/	0-4.0' Silty SAND, ye subrounded, loose, di	llowish red (5YR 5/6), very fine-grained sand (~80%), poorly graded, subangular to y, HCl strong, mottling common		
	-			- 4.0-8.6' Silty SAND, y to subrounded, loose,	yellowish red (5YR 5/6), very fine-grained sand (~60%), poorly graded, subangular moist, HCI strong, mottling common	SM	
	-		4.0/ 4.0				
	-		1.6/ 2.2	8.6-9.6' Lean CLAY, moderately plastic, m	pink (5YR 7/4), very fine-grained sand (~25%), subangular to subrounded, soft, oist, HCl strong	CL	
Denison\GP-03B.bor	10- - -			Total depth of boring	9.6' bgs (refusal)		
^{&gt;} rojects\BoreLogs\C	- 15—	-					
07-28-2011 S:\F	Note(s)	r: 					

				34	Log of Soil Boring GP-04B		
			$\sim$		(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started: 06/12/11Driller: L. TrujilloDate/Time Completed: 06/12/11Depth to Water: NADrilling Method: GeoprobeLogged by: E. MullerSampling Method: Continuous Dual Tube		
-		Project	#: DENN	IC.C002.000	Drilling Co./Driller : Earth Worx		<u> </u>
	Depth in	nple Interval	ı./Rec. (feet)	Soil sample sub       Duplicate soil sa	mitted for laboratory analysis mple submitted for laboratory analysis	S	APHIC
	Feet	San	Pen		DESCRIPTION	NS(	В. В
	0-			0-4.0' Silty SAND, ye subrounded, loose, di	llowish red (5YR 5/6), very fine-grained sand (~70%), poorly graded, subangular to y, HCl weak, mottling common, roots in top 0.3'		
	-		4.0/ 3.3			SM	
	-			4.0-4.6' SILT, red (2.)	5YR 5/6), very fine-grained sand (~25%), loose, non-plastic, non-cohesive, dry, HCl		
			0.8/ 1.1	strong		ML	
rojects\BoreLogs\Denison\GP-04B.bor	5			Total depth of boring	4.8' bgs (refusal)		
07-28-2011 S:\Pro	Note(s)	:					

			T	34		Log of Soil	Boring GP-05B	3		
			$\sim$					(Page 1 of 1)		
-		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/08/11 : 06/08/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
-		Project	#: DENN	1C.C002.000	Drilling Co./Driller	: Earth Worx				
	Depth in Feet	sample Interval	en./Rec. (feet)	Soil sample sub       Duplicate soil sa	mitted for laboratory ana ample submitted for labor	lysis atory analysis DESCRIPTION			JSCS	BRAPHIC
	0-		<u>с</u>			fine and a set of	700() was an to smalled as			
	-		4.0/ 3.0	subrounded, loose, di	y, HCl strong, white n	nottling common, roots in	i top 1.3'	ubangular to	SM	
	5-		4.0/ 3.4	6.5-13.3' Clavey SIL	Γ. vellowish brown (10	YR 5/4), loose to dense.	non- to slightly plastic, c	Irv to moist.		
	-			HCI slight, gypsum str	ringers and precipitate	e common				
	-									
	10-	-	4.0/ 3.9						ML	
enison\GP-05B.bor	-		1.3/ 1.3							
ojects\BoreLogs\D€	- 15-			Total depth of boring	13.3' bgs (refusal)					
07-28-2011 S:\Pr	Note(s)	):								

			RΛ	I	Log of Soil Bc	oring GP-06B			
							(Page 1 of 1)		
	Deniso White Me	Project N n Nitrate esa Mill,	lame: Investigation Blanding, Utah	Date/Time Started       : 06/07         Date/Time Completed       : 06/07         Drilling Method       : Geop         Sampling Method       : Contin         Drillor       : Sath	/11 /11 robe nuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
Depth	ple Interval	/Rec. (feet)	Sample Interval Des	cription mitted for laboratory analysis mple submitted for laboratory an	alysis			S	PHIC
Feet	Sam	Pen.		DES	CRIPTION			nsc	GRA
0-		4.0/ 3.0 4.0/ 4.0	0-1.0' Silty SAND, ye subrounded, very loo 1-4' HCl strong and \$ 4.0-8.0' Silty SAND, subrounded, very loo	llowish red (5YR 5/6), very fi se, dry, no HCl YR 4/4 yellowish red (5YR 5/6), very se, dry, HCl	ne-grained sand (~80	%), poorly graded, ar	ngular to	SM	
		4.0/ 4.0 1.8/ 1.8	8.0-12' Clayey SILT, slight - 12-13.8' Clayey SILT laminated	yellowish brown (10YR 5/4), , yellowish brown (10YR 5/4)	poorly graded, loose, ), poorly graded, loose	non-plastic, dry to m e, non-plastic, dry, H0	oist, HCI CI slight,	ML	
15-			Total depth of boring	13.8' bgs (refusal)				•	
Note(s)	:								

			RΔ		Log of Sc	il Boring GP-07B	5		
							(Page 1 of 1)		
	Deniso White M	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/09/11 : 06/09/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
	Project	#: DENN	AC.C002.000	Drilling Co./Driller	: Earth Worx				1
Depti in	n nple Interval	./Rec. (feet)	Soil sample fillerval bes       Image: Soil sample sub       Image: Duplicate soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample soil sample	mitted for laboratory analy	ysis atory analysis			- S	APHIC
Feet	San	Pen			DESCRIPTION			nsc	GRV
C	-	4.0/ 3.5	0-4.0' Silty SAND, ye subrounded, loose, di	llowish red (5YR 4/6), y, HCl strong, white m	very fine-grained san ottling common	nd (~70%), poorly graded, si	ubangular to		
5			- 4.0-8.0' Silty SAND, subangular to subrou	reddish brown (5YR 5/ nded, loose, dry, HCl s	4), very fine-grainded trong, white mottling	l sand (~80%), poorly grade common	d,	SM	
	-	4.0/ 3.5	8.0-10.2' Silty SAND subangular to subrou	, reddish brown (5YR 5 nded, slightly dense, d	5/4), very fine-grainde ry, HCl strong, white	ed sand (~60%), poorly grad mottling common	led,		
10		2.8/ 4.0	10.2-10.8' SILT pink	(5YR 7/4) very dense	to hard, non-plastic	dry HCl strong		MI	
								ML	
js\Denison\GP-07B.bor	-		Total depth of boring	10.8' bgs (refusal)					
hojects/BoreLog	-								
Note: 1. Du accol	Note(s): 1. Duplicate sample collected. Sample interval was increased to 2 feet to accommodate for additional sample volume required by the analytical laboratory.								

			IRλ	Log of Soil Boring GP-08B			
				(Page 1 of 1	)		
	Deniso White M Project	Project N on Nitrate esa Mill, I	lame: Investigation Blanding, Utah //C.C002.000	Date/Time Started       : 06/09/11       Driller       : L. Trujillo         Date/Time Completed       : 06/09/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : E. Muller         Sampling Method       : Continuous Dual Tube       : Earth Worx			
Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	cription mitted for laboratory analysis ample submitted for laboratory analysis DESCRIPTION	USCS		GRAPHIC
0-			Road base				
-		4.0/ 3.6	0.8-4.0' Silty SAND, to subrounded, dense	yellowish red (5YR 4/6), very fine-grained sand (~80%), poorly graded, subangular e, dry, HCl strong, white mottling throughout	SM	1	
5		4.0/ 3.9	4.0-8.0' SILT, pink (5	YR 7/4), trace very fine-grained sand, loose, non-plastic, dry, HCl strong	ML	-	
- 10		4.0/ 4.0	8.0-11.3' Silty SAND subrounded, loose to 11.3-12' SILT, pink (	, pink (5YR 7/4), very fine-grained sand (~60%), poorly graded, subangular to dense, dry, HCl strong	SM	I	
-		<u> </u>	Total depth of boring	12' bgs (refusal)	I		
15-							
Note(s)	:						

			37	Log of Soil Boring GP-09B		
				(Page 1 of 1	)	
	Deniso White M	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started       : 06/09/11       Driller       : L. Trujillo         Date/Time Completed       : 06/09/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : E. Muller         Sampling Method       : Continuous Dual Tube       Earth Water       : Mage the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second s		
Depth	ple Interval	/Rec. (feet)	Sample Interval Des	cription mitted for laboratory analysis ample submitted for laboratory analysis	vi	APHIC
Feet	Sam	Pen.		DESCRIPTION	nsc	GRA
-0		4.0/	0-4.0' Silty SAND, re to subrounded, loose	ddish brown (5YR 5/4), very fine-grained sand (~60%), poorly graded, subangular , dry, HCl strong, white mottling common		
		4.0/	- 4.0-8.0' Silty SAND, subangular to subrou	reddish brown (5YR 5/4), very fine-grained sand (~80%), poorly graded, nded, loose, dry, HCl strong, white mottling common	SM	1
		3.4/	- 8.0-10.8' Silty SAND subangular to subrou	, yellowish red (5YR 4/6), very fine-grained sand (~70%), poorly graded, nded, slightly dense, dry to moist, HCl strong, white mottling common		
_			10.8-11.4' SILT, pink	(5YR 7/4), very dense, hard, non-plastic, dry, HCl strong	м	
		I	Total depth of boring	11.4' bgs (refusal)		

			RΔ	Log of Soil Boring GP-10B							
							(Page 1 of 1)				
	Deniso White M	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/09/11 : 06/09/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller				
Depth	nple Interval	.** PPEC. (feet)	Sample Interval Des	cription mitted for laboratory analy ample submitted for labora	ysis atory analysis			CS -	APHIC		
Feet	Sar	Per			DESCRIPTION			NN N	R.		
0		4.0/ 3.6 4.0/ 4.0	0-4.0' Silty SAND, ye subrounded, loose, d 4.0-8.0' Silty SAND, subangular to subrou 8.0-11.5' Silty SAND dense, dry, HCl stron	ellowish red (5YR 4/6), ry, HCl strong, white m reddish brown (5YR 5/ nded, loose, dry, HCl s , reddish brown (5YR 5	very fine-grained san lottling common 4), very fine-grained s strong, white mottling 5/4), very fine-grained	id (~60%), poorly graded, s sand (~60%), poorly grade common	d, ed, loose to	SM			
10		4.0/ 4.0	11.5- 12' SILT, pink (	(5YR 7/4), very dense,	hard, dry, HCl strong			ML			
-	<u> </u>	1	] _ , , , , , , , , , , , , , , , , , ,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,				1	1		
			Total depth of boring	12' bgs (refusal)							
Note(s):	:										

		INCERA			Log of Soil Boring GP-11B		
			$\sim$		(Page 1 of 1)		
		Denisor White Me Project	Project N n Nitrate esa Mill, I #: DENN	lame: Investigation Blanding, Utah IC.C002.000	Date/Time Started       : 06/07/11       Driller       : L. Trujillo         Date/Time Completed       : 06/07/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : E. Muller         Sampling Method       : Continuous Dual Tube       : Earth Worx		
	Depth in Feet	sample Interval	en./Rec. (feet)	Sample Interval Des	cription mitted for laboratory analysis mple submitted for laboratory analysis DESCRIPTION	JSCS	BRAPHIC
	0-			0-2.0' Silty SAND, reation to subrounded, very lo	ddish brown (5YR 4/4), very fine-grained sand (~60%), poorly graded, subangular bose, dry, HCl slight, roots		
	-		4.0/ 3.2	2.0-4.0' Silty SAND, I subangular to subrour	ight reddish brown (5YR 6/3), very fine-grained sand (~60%), poorly graded, nded, very loose, dry, HCl strong	0.14	
	- 5-			- 4.0-7.0' Silty SAND, I subangular to subrou	ight reddish brown (5YR 6/3), very fine-grained sand (~60%), poorly graded, nded, very loose, dry, HCl strong	SM	
	-		4.0/ 3.2	7.0-12.1' Clayey SILT	, pinkish gray (7.5YR 6/2), loose to dense, non-plastic, dry, HCl strong, white		
	-			mottling common, lan	inated		
	10—		4.0/ 3.2			ML	
gs\Denison\GP-11B.bor	-		<del></del>	Total depth of boring	12.1' bgs (refusal)	<u> </u>	
\Projects\BoreLo	- 15-						
07-28-2011 S:	1 NOLE(S)						

				34		Log of Soil	Boring GP-12E	3		
			$\sim$					(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, E	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/07/11 : 06/07/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
		Project	#: DENN	IC.C002.000	Drilling Co./Driller	: Earth Worx				
De	epth in eet	Sample Interval	Pen./Rec. (feet)	Soil sample sub       Duplicate soil sa	mitted for laboratory anal	ysis atory analysis DESCRIPTION			USCS	GRAPHIC
	0-			0-1.5' Silty SAND, ye	llowish red (5YR 5/6),	very fine-grained sand,	poorly graded, subangu	lar to		
	-		4.0/ 3.5	subrounded, very loos 1.5-8.0' Silty SAND, i subrounded, very loos	se, dry, no HCl 0-1.5 [°] l reddish brown (5YR 5. se, dry, HCl slight, lam	bgs, HCI slight /4), very fine-grained sar hinated	nd, poorly graded, subar	igular to	SM	
	5		4.0/ 3.1							
	-		4.0/	8.0-12.4' Clayey SIL laminated, gypsum pr	Γ, light olive brown (2. ecipitate throughout	5YR 4/3), poorly graded,	loose, non-plastic, dry,	HCI,		
or			3.4	10.5-12' 5-10mm gyp	osum stringers				ML	
9-12B.b	-		0.4/0.4							
ojects\BoreLogs\Denison\GF	- 15-	-		Total depth of boring	12.4' bgs (refusal)					
07-28-2011 S:\Pi	ote(s) Dupli for ad	): icate sampl Iditional sar	e collecteo nple volun	d. Sample interval was inco ne required by the analytic	reased to 2 feet to accom al laboratory.	modate				

			IRΛ	Log of Soil Boring GP-13B						
							(Page 1 of 1)			
	Deniso White Me	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/07/11 : 06/07/11 : Geoprobe : Continuous Dual Tub : Earth Worx	Driller Depth to Water Logged by De	: L. Trujillo : NA : E. Muller			
Depth	ole Interval	Rec. (feet)	Sample Interval Des	cription mitted for laboratory anal	ysis atory analysis			0	DHIC	
Feet	Samp	Pen./			DESCRIPTION	٨		nsc:	GRAI	
0-		4.0/ 3.6	0-1.5' Silty SAND, ye subrounded, very loo 1.5-6.2' Silty SAND, subrounded, very loo	ellowish red brown (5Y se, dry, HCl slight light reddish brown (5` se, dry, HCl slight	R 4/6), very fine-grai	ined sand, poorly graded, su ained sand, poorly graded, s	ubangular to	SM		
5		4.0/ 4.0	6.2-8.0' Clayey SILT non-plastic, dry to mo 8.0-12' Clayey SILT,	, reddish brown (5YR t ist, HCl strong, white r dark grayish brown (1	5/4), trace very fine-g nottling throughout 0YR 4/2), dense, slig	grained sand, loose to dense ghtly plastic, dry, HCl weak,	e, thin bedding			
- 10-		4.0/ 4.0						ML		
-		1.8/ 1.8	- 12-13.8' Clayey SILT	, light yellowish brown	(10YR 6/4), loose, i	non-plastic, dry, HCl slight, t	hin bedding			
15-			Total depth of boring	13.8' bgs (refusal)						
Note(s):										

				RΔ	Log of Soil Boring GP-14B							
			$\sim$					(Page 1 of 1)				
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/07/11 : 06/07/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller				
		Project	#: DENN	AC.C002.000	Drilling Co./Driller	: Earth Worx				<u> </u>		
Dej ir Fe	pth n	ample Interval	en./Rec. (feet)	Sample Interval Des	mitted for laboratory analy	usis atory analysis			scs	RAPHIC		
	0	ů	Å						Š	σ		
	0		4.0/ 3.0 4.0/ 3.0	0-4.0' Silty SAND, ye subrounded, very loos quartz fragments 4.0- 4.7-8.0' Silty SAND, r dry, HCI moderate, wi	Ilowish red (5YR 5/6), se, dry, no HCl 4.7' bgs reddish yellow (2.5YR hite mottling throughou	orky graded loose to	d, poorly graded, subangu d sand, poorly graded, loos	lar to se to dense,	SM			
ogs/Denison/GP-14B.bor	- - 10 - -		4.0/ 3.5 2.0/ 2.0	- 12-14' Clayey SILT, slight	yellowish brown (10YR	8 5/6), poorly graded,	loose to dense, non-plastic	c, dry, HCI	ML			
BoreLo				Total depth of boring	14' bgs (refusal)							
ojects\E	15—											
07-28-2011 S:\PI	te(s):	:										

			Bλ		Log of S	Log of Soil Boring GP-15B							
							(Page 1 of 1)						
	Deniso White M	Project Non Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/08/11 : 06/08/11 : Geoprobe : Continuous Dual Tub	Driller Depth to Water Logged by De	: L. Trujillo : NA : E. Muller						
Depth	le Interval	Rec. (feet)	Sample Interval Des	Drilling Co./Driller scription omitted for laboratory ana ample submitted for labor	: Earth Worx lysis atory analysis				HIC				
Feet	Samp	Pen./			DESCRIPTION	١		nsca	GRAF				
-0		4.0/ 3.4	0-3.5' Silty SAND, ye angular to subrounde	ellowish red (5YR 4/6) ed, loose, dry to moist,	very fine- to mediun HCI moderate, mino	n-grained sand (~80%), well r white mottling	graded,	SM					
-			3.5-4.0' Clayey SILT	, light reddish brown (	5YR 6/4), poorly grad	ded, dense, slightly plastic, r	noist, HCl						
5		4.0/ 3.4	4.0-10' Silty SAND, y to subrounded, loose	yellowish red (5YR 4/6 , dry to moist, HCl stro	), very fine-grainded ong, white mottling th	sand (~75%), poorly graded	l, subangular	SM					
10-		4.0/ 2.8	10-12' CLAY, yellowi	ish red (5YR 4/6), den	se, low to medium pl	lastic, cohesive, moist, HCl s	slight						
		4.0/ 4.0	- 12-16' CLAY, pale br minor FeO staining	rown (10YR 6/3), very	dense, low plastic, s	slightly cohesive, dry, HCL m	ioderate,	CL					
-			Total depth of boring	16' bgs (refusal)									
20													
Note(s):	:												

			T	34		Log of So	il Boring GP-16B	3		
			$\sim$					(Page 1 of 1)		
_		Denisor White Me	Project N n Nitrate esa Mill,	Jame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/08/11 : 06/08/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
-		Project	#: DENN	Sample Interval Des	cription	: Earth Worx				
	Depth in	nple Interval	n/Rec. (feet)	Soil sample sub	mitted for laboratory analy ample submitted for labora	ysis atory analysis			- SC	APHIC
	Feet	San	Per			DESCRIPTION			NS(	GR
-	0	-	4.0/ 3.0	0-5.5' Silty SAND, ye subrounded, loose, di	llowish red (5YR 4/6), ry to moist, no HCl	very fine-grained san	d (~75%), poorly graded, si	ubangular to	SM	
	5		4.0/ 3.2	5.5-8.0' Silty SAND, i subangular to subrour	reddish yellow (5YR 6/ nded, loose, dry, HCl s	6), very fine-grained strong, white mottling	sand (~60%), poorly gradec throughout	i,		
	-			8.0-11.3' CLAY, redd	ish yellow (5YR 6/6), h	nard, medium plastic,	cohesive, dry to moist w/ in	creasing		
	- 10-		4.0/ 3.1	moisture towards bas	e of interval, HCl stron	g			CL	
	-			11.3-16' CLAY, pale	brown (10YR 6/3), ver	y hard, slightly plastic	, slightly cohesive, moist, H	ICI strong		
bor	- - 15-		4.0/ 4.0						ML	
16B.t	_			<b>_</b>						
ects\BoreLogs\Denison\GP	- - 20-	-		Total depth of boring	16' bgs (refusal)					
S:\Proj	Note(s)	):								
07-28-2011										

			ITE	34		Log of Soil	I Boring GP-17E	3		
			$\sim$					(Page 1 of 1)		
-		Denisor White Me Project	Project N n Nitrate esa Mill, I #: DENN	lame: Investigation Blanding, Utah IC.C002.000	Date/Time Started Date/Time Completed Drilling Method Sampling Method Drilling Co./Driller	: 06/09/11 : 06/09/11 : Geoprobe : Continuous Dual Tube : Earth Worx	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
ŀ				Sample Interval Des	cription					
	Depth in Feet	ample Interval	en./Rec. (feet)	Soil sample sub     Duplicate soil sa	mitted for laboratory analy	rsis tory analysis DESCRIPTION			ISCS	RAPHIC
ŀ	0-	ν ν	<u>م</u>							
				0-1.4' FILL						
	-		4.0/ 3.6	1.4-12' Silty SAND, y to subrounded, loose,	ellowish red (5YR 5/6) dry, HCl moderate, wl	, very fine-grained sand nite mottling common	d (~75%), poorly graded,	subangular		
	5		4.0/ 3.85							
	- 10— -		4.0/ 3.65						SM	
	- - 15—		4.0/ 3.4	12-15.6' Silty SAND, to subrounded, loose,	yellowish red (5YR 5/6 moist, HCl strong, wh	<ul> <li>very fine-grained sainted to the same saintee mottling common</li> </ul>	nd (~60%), poorly graded	l, subangular		
7B.bor	-			15.6-16' SILT, very p	ale brown (10YR 7/4), ellowish red (5YR 5/6)	hard, non-plastic, non-	-cohesive, dry, HCI mode	rate	ML	
enison\GP-17	-		2.6/ 2.6	plastic, slightly cohesi	ive, moist, HCl slight	very line-grained sand	a ( 3070), subrounded, se	n, signity	ML/ CL	
¦Logs\⊡		<u> </u>		18-18.6' SILT, very p	ale brown (10YR 7/4),	hard, non-plastic, non-	-cohesive, dry, HCI mode	rate	ML	
ects\Bore	20-			Total Depth of Boring	18.6' bgs (refusal)					
07-28-2011 S:\Proj	Note(s)	·								

			RΛ	Log of So	il Boring GP-18B		
					(Page	e 1 of 1)	
	Deniso White M	Project N n Nitrate esa Mill, I	Name: Investigation Blanding, Utah	Date/Time Started       : 06/09/11         Date/Time Completed       : 06/09/11         Drilling Method       : Geoprobe         Sampling Method       : Continuous Dual Tube         Drilling Co /Driller       : Farth Worx	Driller : L. Depth to Water : NA Logged by : E.	Trujillo A Muller	
Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	ription nitted for laboratory analysis nple submitted for laboratory analysis DESCRIPTION			GRAPHIC
0-			0-1.5' FILL				
		4.0/ 4.0 3.8 4.0/ 3.8 4.0/ 3.8 4.0/ 3.25	1.5-12' Silty SAND, y to subrounded, loose, 12-16' Silty SAND, y to subrounded, loose, mottling	Ilowish red (5YR 5/6), very fine-grained sa dry, HCI strong, white mottling common, ca lowish red (5YR 5/6), very fine-grained sar slightly moist with moisture increasing w/ do	nd (~75%), poorly graded, subang aliche rich 10-10.5' bgs nd (~75%), poorly graded, subang epth, HCl strong, occasional white	ular SM	1
-		2.5/ 2.85	16-17.9' Sandy Silty plastic, slightly cohes	LAY, yellowish red (5YR 5/6), very fine-gra e, moist, HCI slight	ained sand (~30%), soft, slightly	ML	1
			17.9-18.5' SILT, very	pale brown (10YR 7/4), hard, non-plastic, n	on-cohesive, dry, HCl strong, sha	le ML	
20-			Total depth of boring	8.5' bgs (refusal)			
Note(s)	<u> </u> ::						

			RΛ	Log of Soil Boring GP-19B		
				(Page 1 of 1)		
	Deniso White M Proiect	Project N on Nitrate esa Mill, I	lame: Investigation Blanding, Utah IC.C002.000	Date/Time Started       : 06/09/11       Driller       : L. Trujillo         Date/Time Completed       : 06/09/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : E. Muller         Sampling Method       : Continuous Dual Tube       : Earth Worx		
Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	cription mitted for laboratory analysis ample submitted for laboratory analysis DESCRIPTION	uscs	GRAPHIC
-0		4.0/ 3.85	0-2.5' FILL			
		4.0/ 3.85 4.0/ 3.95 4.0/ 3.95	2.5-12' Silty SAND, y to subrounded, loose 12-17.1' Silty SAND, to subrounded, loose mottling	rellowish red (5YR 5/6), very fine-grained sand (~75%), poorly graded, subangular , dry, HCl moderate, occasional white mottling yellowish red (5YR 5/6), very fine-grained sand (~60%), poorly graded, subangular to dense, slightly moist to moist increasing w/ depth, HCl strong, occasional white	SM	
			Total depth of boring	17.9' bgs (refusal)	ML	
Note(s)	<u> </u>					

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		122	RΔ		Log of Soil	Boring GP-20	3		
							(Page 1 of 1)		
	Denisc White M Proiec	Project N on Nitrate lesa Mill, I	Name: Investigation Blanding, Utah //C.C002.000	Date/Time Started Date/Time Completed Drilling Method Sampling Method Drilling Co./Driller	: 06/09/11 : 06/09/11 : Geoprobe : Continuous Dual Tube : Earth Worx	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	ample submitted for labor	lysis atory analysis DESCRIPTION			USCS	GRAPHIC
0-	-	4.0/	0-1.0' FILL 1.0-12' Silty SAND, y to subrounded, loose	vellowish red (5YR 5/6 , dry, HCl moderate, o	), very fine-grained sand	(~70%), poorly graded,	subangular		
5-		4.0/ 3.9	-					SM	
- 10		4.0/ 3.5	- 12-16' Silty SAND, ye to subrounded, loose	ellowish red (5YR 5/6) , moist, HCl moderate	), very fine-grained sand , occasional white mottlir	(~60%), poorly graded, ig	subangular		
15-	-	4.0/ 3.2							
-		1.4/	16-16.7' Sandy Lean plastic, medium cohe	CLAY, very fine-grain sive, very moist, HCl s	ned sand (~15%), yellowi slight	sh red (5YR 5/6), soft, r	nedium	CL	
20 – Note(s) 1. Dupl for ad	): ditional same	ble collecte	16.7-17.4' SILT, very Total depth of boring d. Sample interval was include required by the analytica	v pale brown (10YR 7/- 17.4' bgs (refusal) reased to 2 feet to accom al laboratory.	4), hard, non-plastic, dry,	HCl strong, shale		<u> </u>	

				RΔ	Log of Soil Boring GP-21B		
					(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started: 06/12/11Driller: L. TrujilloDate/Time Completed: 06/12/11Depth to Water: NADrilling Method: GeoprobeLogged by: E. MullerSampling Method: Continuous Dual Tube		
	Depth	Die Interval	Rec. (feet) :#	VC.C002.000 Sample Interval Des	Drilling Co./Driller : Earth Worx cription mitted for laboratory analysis mple submitted for laboratory analysis	S S S S S S S S S S S S S S S S S S S	PHIC
	Feet	Sam	Pen./		DESCRIPTION	nsc	GRA
	0 0 0-4.5' Silty SAND, yellowish red (5YR 5/6), very fine-grained sand (~70%), poorly graded, subangular to subrounded, loose, moist, HCl weak, gravel from 3.8-4.0' 4.0/ 2.3 4.5-5.5' Silty SAND, pink (5YR 7/3), very fine-grained sand (~60%), poorly graded, subrounded, loose,						
			2.7/ 2.9	4.5-5.5' Silty SAND, slightly cohesive, wet 5.5-6.7' Sandy SILT, subrounded, loose, di	bink (5YR 7/3), very fine-grained sand (~60%), poorly graded, subrounded, loose, HCI moderate light yellowish brown (10YR 6/4), very fine-grained sand (~15%), poorly graded, y, thin bedding, HCI strong	MI	
Logs\Denison\GP-21B.bor	- - 10 - -			Total depth of boring	5.7' bgs (refusal)		
ojects∖Bor	15-						
07-28-2011 S:\Prc	Note(s)						

				RΔ		Log of Soil	Boring GP-22E	3		
								(Page 1 of 1)		
-		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/12/11 : 06/12/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
_		Project	#: DENN	1C.C002.000	Drilling Co./Driller	: Earth Worx				
	Depth in Feet	ample Interval	en./Rec. (feet)	Sample Interval Des	cription mitted for laboratory anal ample submitted for labor	uysis atory analysis			scs	RAPHIC
-	0-	ŝ	Pe			DESCRIPTION			۳ ۲	Ū
			4.0/ 3.2	0-4.0' Silty SAND, ye loose, dry to slightly n 4.0-7.6' Silty SAND, y	ellowish red (5YR 5/6), noist, HCl no to weak yellowish red (5YR 5/6	very fine-grained sand ( 6), very fine-grained sand	(~75%), poorly graded, s d (~60%), poorly graded,	ubrounded,	SM	
	5		4.0/ 2.9	subrounded, loose, m	ioist to very moist, HC	Iweak				
	-		0.9/ 1.9	7.6-8.0' SILT, pink (5 cohesive, moist, HCI 8.0-8.9' SILT, browni loose, slightly moist, H	YR 8/3), very fine-gra strong sh yellow (10YR 6/6), HCI weak, thin bedding	ined sand (~25%), poorly very fine-grained sand ( g	y graded, subrounded, d ~25%), poorly graded, si	ense, slightly ubrounded,	ML	
	10-			Total depth of boring	8.9' bgs (refusal)					
S:\Projects\BoreLogs\Denison\GP-22B.bor	- - - 15 – Note(s)									
07-28-2011										

			RΔ	Log of Soil Boring GP-23B		
				(Page 1 of 1)		
	Deniso White Me	Project N n Nitrate esa Mill, I	Name: Investigation Blanding, Utah AC C002 000	Date/Time Started     : 06/11/11     Driller     : L. Trujillo       Date/Time Completed     : 06/11/11     Depth to Water     : NA       Drilling Method     : Geoprobe     Logged by     : E. Muller       Sampling Method     : Continuous Dual Tube     Drilling Co./Driller     : Earth Worx		
Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	DESCRIPTION	USCS	GRAPHIC
0-			0-2.0' Silty SAND, re subrounded, loose, n	eddish gray (5YR 5/2), very fine- to coarse-grained sand, well graded, angular to on-plastic, dry, HCI moderate	SW/ SM	
		4.0/ 3.2	2.0-4.0' Lean CLAY of graded, angular to su bgs 4.0-15.3' Sandy Lear diameter gravel (<100 weak	w/ Sand, brownish yellow (10YR 6/6), fine- to coarse-grained sand (~20%), well brounded, hard, slightly plastic, moist, HCl slight, burned (ash?) layer from 2.0-2.2' n CLAY, reddish brown (5YR 5/4), fine- to coarse-grained sand (~30%), up to 0.05' %), well graded, angular to subrounded, soft, low to moderate plastic, moist, HCl		
-		4.0/ 2.5	-			
- 10- -		4.0/ 2.0	-			
- - 15—		3.3/ 2.3				
-			Total depth of boring	15.3' bgs (refusal)		
Note(s) 1. Dupli for add	] : icate samp ditional sar	le collecte nple volum	d. Sample interval was inc e required by the analytica	reased to 2 feet to accommodate al laboratory.		

				RΛ	Log of Soil Boring GP-24B		
					(Page 1 of 1)		
		Denisor White Me	Project N Nitrate esa Mill, I	Jame: Investigation Blanding, Utah	Date/Time Started       : 06/11/11       Driller       : L. Trujillo         Date/Time Completed       : 06/11/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : E. Muller         Sampling Method       : Continuous Dual Tube       : Farth Work       : Farth Work		
	Depth in	mple Interval	.t./Rec. (feet)	Sample Interval Desc ZZ Soil sample sub	cription mitted for laboratory analysis imple submitted for laboratory analysis	CS	APHIC
-	Feet	Sar	Per		DESCRIPTION	Ň	GR
	0		4.0/ 3.7	0-8.0' Clayey Gravell (~75%), up to 0.04' di	y SAND, dark yellowish brown, (10YR 4/4), very fine- to coarse-grained sand ameter gravel (~15%), soft, slightly plastic, moist, HCl weak	SW /SC	
	5		4.0/ 2.7				
	- 10-		4.0/ 2.5	8.0-11.3' Sandy Grav diameter gravel (~10%	elly SIL I, brown (10YR 5/3), fine- to coarse-grained sand (~30%), up to 0.02' 6), soft, slightly plastic, moist, HCl weak	ML	
	-		0.8/	11.3-12.5' Silty SANE subangular to subrou 12.5-12.8' Silty SANE subangular to subrou	D, brownish yellow (10YR 6/6), very fine- to fine-grained sand (~70%), well graded, nded, dense, dry, no HCl, gypsum precipitate throughout D, yellowish red (5YR 4/6), very fine- to fine-grained sand (~80%), poorly graded, nded, loose, wet, HCl weak	SM	
s\Denison\GP-24B.bor	- 15 — - -			Total depth of boring	12.8' bgs (refusal)		
S:\Projects\BoreLogs	20-						
07-28-2011 5	X-7						

		TE	RA		Log of Soi	il Boring GP-25E	3			
		Project N	Jame:	Date/Time Started	06/08/11	Driller	(Page 1 of 1)			
	Deniso White M	esa Mill,	Investigation Blanding, Utah	Date/Time Completed : Drilling Method : Sampling Method : Drilling Co /Driller	06/08/11 Geoprobe Continuous Dual Tube Farth Worx	Depth to Water Logged by	: NA : E. Muller			
Depth	ple Interval	./Rec. (feet)	Sample Interval Des	cription mitted for laboratory analys ample submitted for laborato	is ory analysis				APHIC	
Feet	Sam	Pen			DESCRIPTION			nso	GR/	; ;
-00	o     a     b       0     -       -     -       4.0/       3.1         4.0/         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         -         - <td></td> <td></td>									
5		4.0/ 3.6						SM		
- 10— -		4.0/ 3.8								
-			11.7-13.3' CLAY, rec strong	ldish yellow (5YR 6/6), c	lense, plastic to very	plastic, cohesive, slightly	moist, HCl	CL/		7///
- 15-		4.0/ 4.0	13.3-19.4' CLAY, pal weathered shale, plat	e brown (10YR 6/3), der y shale fragments incre	nse, slightly plastic, s asing w/ depth, weat	slightly cohesive, dry, HCl hered shale w/ shale fragr	slight, nents			2
-		3.4/ 3.4								
20-			Total depth of boring	19.4' bgs (refusal)				•		
Note(s): 1. Dupli for add	: cate samp ditional sar	ble collecte mple volun	d. Sample interval was inc ne required by the analytica	reased to 2 feet to accomm al laboratory.	odate					

				34	Log of Soil Boring GP-26B		
			$\sim$		(Page 1 of 1)		
_		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started: 06/09/11Driller: L. TrujilloDate/Time Completed: 06/09/11Depth to Water: NADrilling Method: GeoprobeLogged by: E. MullerSampling Method: Continuous Dual Tube		
+		Project	#: DENN	IC.C002.000 Sample Interval Des	Drilling Co./Driller : Earth Worx		1
	Depth in	mple Interval	n./Rec. (feet)	Soil sample sub     Duplicate soil sa	mitted for laboratory analysis	CS	APHIC
	Feet	Sai	Реі		DESCRIPTION	SU	L L L
	0		4.0/ 3.3	0-0.3' Road base gra 0.3-4.0' Silty SAND, y to subrounded, dense	vel yellowish red (5YR 4/6), very fine-grained sand (~60%), poorly graded, subangular e, moist, HCl strong, white mottling common		
	5- - - - - - - - - - - - - - - - - - -			4.0-10.1' Silty SAND, subangular to subrou	yellowish red (5YR 5/6), very fine-grained sand (~80%), poorly graded, nded, dense, dry to moist, HCl moderate, white mottling common	SM	
	- - 10 — - -		4.0/ 3.6	10.1-13' Silty SAND, to subrounded, dense	yellowish red (5YR 5/6), very fine-grained sand (~70%), poorly graded, subangular e, moist, HCl moderate		
	_			13-16' SILT vellowis	h brown (10YR 5/4) very dense, hard, dry, HCl strong		
or	- 15—		4.0/ 4.0			ML	
Denison\GP-26B.b	-			Total depth of boring	16' bgs (refusal)		
ojects\BoreLogs\I	20-	20-					
07-28-2011 S:\Pr	Note(s)	:					

		Ĩ	T	34	Log of Soil Boring GP-27B		
			$\sim$		(Page 1 o	of 1)	
-		Denisor White Me	Project N n Nitrate esa Mill, I #: DENN	Jame: Investigation Blanding, Utah	Date/Time Started       : 06/10/11       Driller       : L. Trujil         Date/Time Completed       : 06/10/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : E. Mulle         Sampling Method       : Continuous Dual Tube       : Farth Worx       : Farth Worx	lo er	
-	Depth in Feet	ample Interval	en./Rec. (feet)	Sample Interval Des	ription nitted for laboratory analysis mple submitted for laboratory analysis	SCS	
-	0-	м М	đ			<u>ש כן כ</u>	5 
	-		4.0/ 3.2	0-4.0' Silty SAND, ye subrounded, loose, di	lowish red (5YR 4/6), very fine-grained sand (~80%), poorly graded, subangular to y, HCl moderate, mottling common	0	
	- 5- -		4.0/ 3.3	4.0-11.8' Silty SAND, subangular to subrou	yellowish red (5YR 4/6), very fine-grained sand (~70%), poorly graded, ided, loose, moist, HCl weak, mottling rare	SM	
	- 10-		4.0/ 3.6				
	-			11.8-13' Clayey SAN plastic, moist, HCl stro	D, yellowish red (5YR 4/6), very fine-grained sand, subrounded, loose, slightly ong, mottling throughout	sc	Ŋ
	-		2.6/ 2.6	13-14.6' Sandy SILT, non-plastic, non-cohe	yellowish brown (10YR 5/6), very fine-grained sand (~25%), subrounded, loose, sive, dry, HCl strong	ML	
s\Denison\GP-27B.bor	15 — - -	-		Total depth of boring	I4.6' bgs (refusal)		
Projects\BoreLog	20-						
07-28-2011 S:\	Note(s) 1. Dupli for add	: icate sampl ditional sam	e collecte nple volum	d. Sample interval was inco e required by the analytica	eased to 2 feet to accommodate laboratory.		

			37		Log of S	oil Boring GP-28	B		
							(Page 1 of 1)		
	Deniso White M	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/10/11 : 06/10/11 : Geoprobe : Continuous Dual Tu	Driller Depth to Water Logged by be	: L. Trujillo : NA : E. Muller		
	Project		Sample Interval Des	cription	: Earth Worx				
Depth in	mple Interval	n./Rec. (feet)	Soil sample sub	mitted for laboratory anal ample submitted for labor	ysis atory analysis			scs	SAPHIC
reel	Sa	Ре			DESCRIPTION	N		S	В
0		4.0/ 3.3 4.0/ 3.0	0-7.4' Silty SAND, ye subrounded, loose, m	llowish red (5YR 4/6), oist, HCl weak to stro	very fine-grained sang	and (~60%), poorly graded.	, subangular to	SM	
			7.4-7.7' Lean CLAY	w/ Sand, very dark gra	y (5YR 3/1), very fir	ne-grained sand (~15%), so	oft, plastic,	CL	
10-		4.3/ 3.4	7.7-12' Silty SAND, y to subrounded, loose	rellowish red (5YR 4/6 , moist, HCl weak, occ	), very fine-grained a asional mottling	sand (~80%), poorly graded	d, subangular /	SM	
-			12-12.3' Clayey SAN	D, very pale brown (10 subrounded, loose, s	0YR 7/3), very fine- lightly plastic, moist	grained sand w/ plastic fine t. HCl strong	s, poorly	SC	77
- - - - - - - - - - - - - - - - - - -			Total depth of boring	12.3' bgs (refusal)					

			lte	RA		Log of Soil I	Boring GP-29	B (Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/10/11 : 06/10/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
		Project	#: DENN	1C.C002.000	Drilling Co./Driller	: Earth Worx				
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	cription mitted for laboratory anal ample submitted for labor	ysis atory analysis DESCRIPTION			USCS	GRAPHIC
	0-			0-1.3' Road base						
	-		4.0/ 2.95	1.3-3.0' Silty SAND, y to subrounded, loose, 3.0-4.0' Silty SAND, y to subrounded, loose,	yellowish red (5YR 5/6 , dry, HCl moderate, w yellowish red (5YR 5/6 , moist, gravel and wo	<ul> <li>b), very fine-grained sand</li> <li>c), very fine-grained sand</li> <li>c), very fine-grained sand</li> <li>common, H</li> </ul>	(~80%), poorly graded (~80%), poorly graded Cl moderate,	l, subangular I, subangular		
	- 5 -		4.0/ 3.0	4.0-12' Silty SAND, y to subrounded, loose,	rellowish red (5YR 5/6 , dry to moist, HCI wea	), very fine-grained sand ( ak, occasional mottling	(~70%), poorly graded,	subangular		
	- - 10		4.0/ 3.25						SM	
	-			12-13.2' Silty SAND, to subrounded, loose,	yellowish red (5YR 5/ , moist, HCl moderate	6), very fine-grained sand	l (~60%), poorly grade	d, subangular		
	-		2.4/ 2.6	13.2-14.4' Silty SANE subangular to subrout	D, yellowish brown (10 nded, dense, moist, H	YR 5/4), very fine-grained Cl moderate	d sand (~60%), poorly	graded,		
Jenison\GP-29B.bor	15— - -			Total depth of boring	14.4' bgs (refusal)				1	
2011 S:\Projects\BoreLogs\[	20 – Note(s) 1. Dupli	: cate sampl	e collecte	d. Sample interval was inco	reased to 2 feet to accom	modate				
07-28-					-					

			RΛ		Log of S	oil Boring GP-30	В		
							(Page 1 of 1)		
	Deniso White M	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/10/11 : 06/10/11 : Geoprobe : Continuous Dual Tub : Earth Worx	Driller Depth to Water Logged by De	: L. Trujillo : NA : E. Muller		
Depth	mple Interval	n./Rec. (feet)	Sample Interval Des	cription mitted for laboratory anal	ysis atory analysis			SCS	APHIC
Feet	Sa	Ре			DESCRIPTION	1		S	Ъ
0		4.0/ 3.3 4.0/ 3.15	0-7.1' Silty SAND, ye subrounded, loose, di	ellowish red (5YR 4/6), ry to moist, HCI weak,	very fine-grained sa occasional mottling	and (~70%), poorly graded,	subangular to	SM	
-			7 1 7 2' Clavey SANI	Dw/ low plastic fines	dark reddich brown (	(5VP 3/4) yery fine grained	leand	sc	
			poorly graded, subrou	unded, soft, slightly pla	istic, moist, HCI mod	derate		/	
- 10-		4.0/ 3.3	subrounded, loose, m	oist, HCl none to wea	k	sana ( 6678), poony grade	4,	SM	
-			- 12-13.1' Silty SAND, subrounded, loose, w	yellowish red (5YR 4/ et, HCl moderate	6), very fine-grained	sand (~60%), poorly grade	ed,		
- 15			Total depth of boring	13.1' bgs (refusal)					
Note(s)	<u> </u>								

07-28-2011 S:\Projects\BoreLogs\Denison\GP-30B.bor
		n	Rλ		Log of Soil	Boring GP-31	3		
							(Page 1 of 1)		
	Deni White Proje	Project N son Nitrate Mesa Mill,	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method Drilling Co /Driller	: 06/08/11 : 06/08/11 : Geoprobe : Continuous Dual Tube : Farth Worx	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
Dep	th ble Interval	/Rec. (feet)	Sample Interval Des	scription omitted for laboratory ana ample submitted for labor	lysis ratory analysis			- vi	APHIC
Fee	et Sam	Pen.			DESCRIPTION			nsc	GRA
		4.0/ 3.1	0-4.7' Silty SAND, ye subrounded, very loo	ellowish red (5YR 5/6) se, dry, HCl moderate	, very fine-grained sand ( e, white mottling througho	~65%), poorly graded, s	subangular to	SM	
:	5-	1.6/ 1.6	4.7-5.6' SAND w/ min graded, subangular to	nor Silt, pinkish gray ( o subrounded, very lo	7.5YR 6/2), very fine- to f ose, moist, HCl strong	fine-grained sand, poorl	y to well	SP/ SM	
	-		Total depth of boring	5.6' bgs (refusal)				1	
	-								
	-								
1	0-								
Note	e(s):	andaP. (							
for	upiicate sai additional s	npie collecte sample volun	<ul> <li>a. Sample interval was inc ne required by the analytica</li> </ul>	reased to 2 feet to accon al laboratory.	nmodate				

				34		Log of Soil I	Boring GP-32	В		
								(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/08/11 : 06/08/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
		Project	#: DENN	1C.C002.000	Drilling Co./Driller	: Earth Worx				
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	cription mitted for laboratory ana ample submitted for labor	lysis atory analysis DESCRIPTION			USCS	GRAPHIC
	0-		4.0/ 2.9	0-4.0' Silty SAND, ye subrounded, very loos	Ilowish red (5YR 4/6) se, dry to moist increa	, very fine-grained sand (~ sing w/ depth, HCI moder	60%), poorly graded, ate	subangular to	SM	
-ogs\Denison\GP-32B.bor	5			Total depth of boring	4.0' bgs (refusal)					
jects/Borel	10-									
07-28-2011 S:\Prc	Note(s)	:								

				37		Log of Soil	Boring GP-33	3		
								(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/08/11 : 06/08/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
-		Project	#: DENN	IC.C002.000	Drilling Co./Driller	: Earth Worx			1	
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Soil sample sub       Duplicate soil sa	mitted for laboratory analy	vsis htory analysis DESCRIPTION			nscs	GRAPHIC
	0		1.7/ 1.7	0-1.2' Silty SAND, ye subrounded, very loos	llowish red (5YR 4/6), se, dry, HCl moderate,	very fine-grained sand ( minor white mottling	(~75%), poorly graded, s	subangular to	SM	
				1.2-1.7' SAND w/ mir graded, subangular to	or Silt, pinkish gray (5 subrounded, very loo	YR 6/2), very fine- to fin se, dry, HCl strong	e-grained sand, poorly	to well	SP/ SM	
o:\Projects\BoreLogs\Denison\GP-33B.bor	2			Total depth of boring	1.7' bgs (refusal)					
07-28-2011 S:	1000(0)									

				34		Log of Soi	il Boring GP-34E	3		
			$\sim$					(Page 1 of 1)		
		Denisor White Me	Project N Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/08/11 : 06/08/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
	Depth	nple Interval	:/Rec. (feet)	Sample Interval Des	cription mitted for laboratory analy ample submitted for labora	: Earth Worx /sis ttory analysis			SS	APHIC
	Feet	San	Pen			DESCRIPTION			NS(	GR
	0-		3.8/ 2.7	0-3.0' Silty SAND, ye subrounded, loose, di	llowish red (5YR 4/6), ry to moist, HCl slight, ∣	very fine-grained sanc minor roots 0-0.8' bgs	ł (~65%), poorly graded, s	ubangular to	SM	
	-			3.0-3.8' SAND w/ mir graded, subangular to	nor silt, pinkish gray (5 o subrounded, very loo	YR 6/2), very fine- to fi se, moist, HCl strong	ine-grained sand, poorly to	o well	SP/ SM	
ects\BoreL ogs\Denison\GP-34B.bor	- 5- - - - -			Total depth of boring	3.8' bgs (refusal)					
07-28-2011 S:\Proje	Note(s)	I								

		ÌT	RA	Log of Soil Boring GP-35B					
	Deniso	Project Non Nitrate	Name: Investigation	Date/Time Started Date/Time Completed	: 06/11/11 : 06/11/11	Driller Depth to Water	(Page 1 of 1) : L. Trujillo : NA		
	Project	esa Mill, t #: DENN	MC.C002.000	Drilling Method Sampling Method Drilling Co./Driller	: Geoprobe : Continuous Dual Tube : Earth Worx	Logged by e	: E. Muller		
Depth in Feet	ample Interval	en./Rec. (feet)	Sample Interval Des	scription omitted for laboratory analy ample submitted for labora	nsis ntory analysis			scs	RAPHIC
0	Ŭ.	4.0/ 3.5	0-4.0' SAND w/ grav diameter, well graded	el FILL, dark reddish b d, angular to subrounde	rown (5YR 3/3), fine- ed, loose, dry, HCl mo	to coarse-grained sand, gra	avel to 0.06'	sw	U
5		4.0/	4.0-11' Silty SAND, y loose, moist, HCI mo	vellowish red (5YR 4/6) derate, mottling commo	, very fine-grained sa	and (~75%), poorly graded, s	subrounded,		
- 10- -		4.0/ 2.7	11-12' Silty SAND, y dense, moist, HCl we 12-17.4' Silty SAND,	ellowish red (5YR 4/6), eak yellowish red (5YR 4/6	very fine-grained sa	nd (~75%), poorly graded, s sand (~75%), poorly graded	subrounded,	SM	
- - 15-		4.0/ 3.7	subrounded, loose, m	foist to wet near botton	n of interval. HCI wea	3K			
-		2.9/ 2.8	17.4-18.9' Clayey SI	LT, yellowish brown (10	DYR 5/4), dense, slig	htly plastic, moist, HCl stron	g	ML/ CL	
			Total depth of boring	18.9' bgs (refusal)					
Note(s)									

			RΛ	Log of Soil Boring GP-36B					
				(Page 1 of	1)				
	Deniso White Me Proiect	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah //C.C002.000	Date/Time Started       : 06/11/11       Driller       : L. Trujillo         Date/Time Completed       : 06/11/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : E. Muller         Sampling Method       : Continuous Dual Tube       : Earth Worx					
Depth in Feet	ample Interval	en./Rec. (feet)	Sample Interval Des	cription mitted for laboratory analysis ample submitted for laboratory analysis DESCRIPTION	scs	RAPHIC			
-0		4.0/	0-2.5' Silty SAND, ye HCl moderate, mottlir	llowish red (5YR 4/6), very fine-grained sand (~60%), poorly graded, loose, dry, ig common	SM	<u></u>			
		4.0/ 2.6 4.0/ 2.8	2.5-11' Clayey Silty S subrounded, loose, so 11- 13' Clayey Silty S subrounded, dense, s	SAND, yellowish red (5YR 4/6), very fine-grained sand (~60%), poorly graded, oft, slightly plastic, moist, HCI moderate	SM/ SC				
- 15- - -		4.0/ 3.4 9.3/ 3.1	- 13-18.3° Silty SAND, subrounded, loose, d	reddisn yellow ( 5YR 6/8), very fine-grained sand (~70%), poorly graded, ry to moist increasing with depth, HCl strong, mottling common	SM				
-			18.3-19.3' SILT, light dry, HCI strong, FeO	gray (10YR 7/2), very fine-grained sand (~30%), subrounded, dense, non-plastic, staining	ML				
20			Total depth of boring	19.3' bgs (refusal)					
Note(s)	ote(s):								

			RΛ	Log of Soil Boring GP-37B						
								(Page 1 of 1)		
	Deniso White M	Project N n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method Drilling Co (Driller	: 06/11/11 : 06/11/11 : Geoprobe : Continuous Dual T : Earth Worx	Drille Depi Logo	אר th to Water ged by	: L. Trujillo : NA : E. Muller		
Depth	ple Interval	/Rec. (feet)	Sample Interval Des	cription mitted for laboratory and ample submitted for labo	alysis alysis				- <u>v</u>	PHIC
Feet	Sam	Pen.			DESCRIPTIC	ON			nsc	GRA
-0-	-	4.0/ 3.3	0-4.0' Silty SAND, ye loose, dry, HCl strong	ellowish red (5YR 5/6 g, mottling throughout	), very fine-grained	sand (~60%), poo	rly graded, s	ubrounded,		
5-		4.0/ 3.2	4.0-9.0' Silty SAND, subrounded, loose, m	yellowish red (5YR 5/ loist, HCl slight, occa	′6), very fine-graine sional mottling	ed sand (~70%), po	oorly graded,		SM	
- 10- -		4.0/ 4.0	9.0'-13.2' Clayey SAI subrounded, soft, slig	ND, yellowish red (5Y htly plastic, moist, H0	'R 5/6), very fine-gr Cl strong, ~30% mo	rained sand (~60%	َّه), poorly gra	ded,	sc	
- 15-		4.0/ 4.0	13.2-16' Clayey SILT mottling	, yellowish brown (10	)YR 5/6), soft to ha	rd, slightly plastic,	moist, HCI s	trong, ~5%	ML/ CL	
-	-		Total depth of boring	16' bgs (refusal)						
Note(s)	];									

		nti	RA		Log of Soi	l Boring GP-38B			
							(Page 1 of 1)		
	Denis White M	Project N son Nitrate Mesa Mill,	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Samping Method	: 06/11/11 : 06/11/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
	Proje	Ct #: DENN	Sample Interval Des	cription	: Earth Worx				
Dep	th nple Interval	./Rec. (feet)	Soil sample sub	mitted for laboratory analy	ysis atory analysis			S	APHIC
Fee	et San	Pen			DESCRIPTION			nsc	GR
		4.0/ 3.3	0-5.0' Silty SAND, ye loose, dry, HCL stron	llowish red (5YR 5/8), g, mottling common	very fine-grained sanc	l (~70%), poorly graded, su	ubrounded,		
	5	4.0/ 3.3	5.0-11.9' Silty SAND subrounded, dense, r	yellowish red (5YR 5/ noist, HCI weak	8), very fine-grained s	and (~60%), poorly graded	l,	SM	
1	0-	4.0/ 3.1							
por	5-	4.0/	11.9-16' Clayey SILT massive-transitions to	, yellowish brown (10 platy structure near b	/R 5/6), soft to hard, sl ottom of interval, HCl s	ightly plastic, moist, slight		ML/ CL	
ts/BoreLogs/Denison/GP-38B.	-		Total depth of boring	16' bgs (refusal)					
07-28-2011 S:\Projec 0 1. D 10 0	0 – e(s): uplicate sam r additional s	nple collecte sample volur	d. Sample interval was inc ne required by the analytic	reased to 2 feet to accomi al laboratory.	nodate				

				34		Log of Soi	il Boring GP-39E	3		
			$\sim$					(Page 1 of 1)		
-		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/12/11 : 06/12/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
F		Project	#: DENN	Sample Interval Des	cription	: Earth Worx				
	Depth in	nple Interval	n./Rec. (feet)	Soil sample sub	mitted for laboratory analy	ysis atory analysis			cs –	APHIC
	Feet	Sar	Per			DESCRIPTION			NSU	ЯG
	0 - - 5-		4.0/ 3.6	0-6.6' Silty SAND, ye loose, dry to moist, He	Ilowish red (5YR 4/6), CL none 0-4' bgs & str	very fine-grained sanc ong 4-6.6' bgs, mottlin	d (~70%), poorly graded, s g common 4-6.6' bgs	ubrounded,	SM	
	-		4.0/							
	- - - 10-		4.0/ 4.0/ 4.0	6.6-11' Lean CLAY, r subrounded soft, sligh	eddish brown (5YR 5/3 ntly plastic to plastic, m	3), very fine-grained sa loist, HCI strong	and (~15%), poorly graded	1,	CL	
	-			11-12.8' Silty SAND,	yellowish red (5YR 4/6	6), very fine-grained sa	and (~60%), poorly graded	I,		
	-			subrounded, loose, m	ioist w/ moisture increa	asing with depth, HCl v	veak		SM	
	-		2.2/ 3.4	12.8-14.2' Sandy SIL dense, dry, HCI weak	T, gray (10YR 5/1), ve , thin bedding to platy,	ry fine-grained sand (~ FeO common 12.8-13	~30%), poorly graded, sub 3.6' bgs	prounded,	ML	
Logs\Denison\GP-39B.bor	15 — - -			Total depth of boring	14.2' bgs (refusal)					
ojects\Borel	- 20—	-								
07-28-2011 S:\Pr	Note(s) 1. Dupli for ad	: icate sampl Iditional sar	e collecteo nple volun	d. Sample interval was incr ne required by the analytic	reased to 2 feet to accomi al laboratory.	nodate				

			ITE	34	Log of Soil Boring GP-40B		
			$\sim$		(Page 1 of 1	)	
-		Denisor White Me	Project N n Nitrate esa Mill, I # DENN	lame: Investigation Blanding, Utah IC C002 000	Date/Time Started       : 06/12/11       Driller       : L. Trujillo         Date/Time Completed       : 06/12/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : E. Muller         Sampling Method       : Continuous Dual Tube       Drilling Co /Driller       : Farth Worx		
-	Depth	nple Interval	./Rec. (feet)	Sample Interval Dese ZZZ Soil sample sub	cription mitted for laboratory analysis imple submitted for laboratory analysis		APHIC
	Feet	Sar	Per		DESCRIPTION	NS(	GR
	0 — - -		4.0/ 3.3	0-4.0' Silty SAND, ye loose, dry to moist, He	llowish red (5YR 5/6), very fine-grained sand (~70%), poorly graded, subrounded, CL moderate	SM	
	5		4.0/ 4.0	4.0-8.0' Sandy Silty L subrounded, soft, slig	ean CLAY, yellowish red (5YR 5/6), very fine-grained sand (~20%), poorly graded, htly plastic, moist, HCl moderate, occasional mottling	ML/ CL	
	- - 10 -		4.0/ 3.9	8.0-13' Silty SAND, y loose, moist, HCI moo	ellowish red (5YR 5/6), very fine-grained sand (~60%), poorly graded, subrounded, lerate, occasional mottling	SM	
	-		1.6/ 1.8	13-13.6' Sandy SILT,	yellowish brown (10YR 5/4), very fine-grained sand (~30%), poorly graded,	ML	
s\Denison\GP-40B.bor	- 15— - -			Total depth of boring	13.6' bgs (refusal)	/	
ojects\BoreLogs\	- 20—						
07-28-2011 S:\Prc	Note(s)	:					

				RΔ		Log of Soi	l Boring GP-41B	i i		
			$\sim$					(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/11/11 : 06/11/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
_		Project	#: DENN	Sample Interval Des	cription	: Earth Worx				
	Depth in	imple Interval	:n./Rec. (feet)	Soil sample sub	mitted for laboratory analy				scs	SAPHIC
		Sa	Ре			DESCRIPTION			<u> </u>	5
	0  		4.0/ 2.4	0-6.5' SAND, pale ye subrounded, dense, d	llow (5Y 8/2), very fine Iry, HCI none	- to fine-grained sand	(~85%), poorly graded, su	bangular to	SP	
	5		4.0/ 2.8	6.5-19' Silty SAND, li	ght brown (7.5YR 6/3)	to pinkish gray (7.5YR	7/2), very fine-grained sa	nd (~60%),		
	-			poorly graded, subang fragments, occasiona	gular to subrounded, lo I FeO stains	oose, dry, HCI none, th	in bedded, occasional san	dstone		
	- - 10 -		4.0/ 3.0							
	- - 15—		4.0/ 2.8						SM	
	- - - 20—		4.0/ 2.7	19-24.5' Silty SAND, subrounded, loose, dr	yellowish red (5YR 4/6 y, HCl strong, mottling	δ), very fine-grained sa ι common	nd (~60%), poorly graded,			
bor	-		4.0/ 3.8							
3P-41B.	25—	<u>                                    </u>	0.5/0.9	Total depth of boring	24.5' bos (refusal)					
enison\(	-									
Logs/De	-	-								
cts\Bore	- 30 —									
S:\Proje	Note(s)	:								
07-28-2011	1. Dupli for ad	icate sampl Iditional sar	e collected	d. Sample interval was incr ne required by the analytic	eased to 2 feet to accomi al laboratory.	nodate				

			37	Log of Soil Boring GP-42B					
							(Page 1 of 1)		
	Deniso White M	Project N on Nitrate esa Mill, E	ame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method Drilling Co /Driller	: 06/11/11 : 06/11/11 : Geoprobe : Continuous Dual Tube : Farth Worx	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	cription mitted for laboratory anal	usis atory analysis DESCRIPTION			NSCS	GRAPHIC
0-		4.0/ 3.4	0-5.5' Silty SAND, ye subrounded, loose, d	ellowish red (5YR 4/6), ry to moist, HCI strong	very fine-grained sand , mottling common	I (~65%), poorly graded, s	subangular to	SM	
-		4.0/ 3.8	5.5-8.0' Clayey Silty subrounded, dense, s	SAND, reddish brown lightly plastic, moist, H	(5YR 5/4), very fine-gr.	ained sand, poorly graded	<b>1</b> ,	SM/ SC	
		0.5/1.1	8.0-8.5' Silty CLAY, or strong, weathered sha	dark reddish brown (5) ale, thin bedding	/R 3/2), soft, slightly pl	astic to plastic, non-cohes	sive, dry, HCl	ML/ CL	
	- -		Total depth of boring	8.5' bgs (refusal)					

				RA	Log of Soil Boring GP-43B			
					(Page 1 of 1)			
-		I Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started: 06/11/11Driller: L. TrujilloDate/Time Completed: 06/11/11Depth to Water: NADrilling Method: GeoprobeLogged by: E. MullerSampling Method: Continuous Dual Tube			
_		Project	#: DENN	1C.C002.000	Drilling Co./Driller : Earth Worx	_	<del></del>	
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	cription mitted for laboratory analysis imple submitted for laboratory analysis DESCRIPTION	L USCS	GRAPHIC	
ŀ	0-			0-1 8' Fill				
	-		4.0/	1.8-4.0' Silty SAND, y	/ellowish red (5YR 4/6), very fine-grained sand (~65%), poorly graded,			
	-		0.0	subrounded, loose, ar	CRAVEL was real bows (10)/R 2/2) find to medium project cond ( 10%)	SM		
	5—		4.07	gravel (~40%), well gr	aded, subangular to subrounded, very loose, non-plastic, dry, HCl moderate	GW/ GM		
	-		4.0	subrounded, dense, p	lastic, moist, HCI strong	SC		
	-		1.7/ 1.9	8.4-9.7' SILT, light ye	llowish brown (10YR 6/4), soft, non-plastic, non-cohesive, moist, HCl strong	ML		
	10-	-		Total depth of boring	9.7' bgs (refusal)			
oreLogs\Denison\GP-43B.bor	-	-						
jects∖B(	15—	-						
07-28-2011 S:\Prc	Note(s)	<u></u> 3):						

				RΔ		Log of Soi	l Boring GP-44B	i		
								(Page 1 of 1)		
_		Denisor White Me	Project N n Nitrate esa Mill, I	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/10/11 : 06/10/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
-		Project	#: DENN	AC.C002.000	Drilling Co./Driller	: Earth Worx				
	Depth in Feet	ample Interval	en./Rec. (feet)	Sample Interval Des	mitted for laboratory analy	vsis atory analysis			SCS	<b>APHIC</b>
		Sa	Ре			DESCRIPTION			Š	5
	0 - -		4.0/ 2.3	0-4.0' Silty SAND, pa subrounded, loose, dr	ile brown (10YR 6/3), v ry, HCl moderate, fine	very fine- to medium-gr crystals precipitate thr	ained sand (~80%), well g oughout	raded,	SW/ SM	
	- 5 -		4.0/ 2.8	4.0-6.0' Clayey Sitly subrounded, loose, sl 6.0-8.0' Clayey Silty subrounded, slightly p	SAND, very pale brow ightly plastic, dry, HCL SAND, yellowish red ( plastic, moist, HCl wea	n (10YR 7/4), very fine . none, small rocks, wo 5YR 4/6), very fine-grai k	-grained sand (~60%), poo od scattered throughout ned sand (~60%), poorly (	orly graded, graded,	SM/ SC	
	-			8.0-12' Lean CLAY, o	dark reddish brown (5)	(R 3/2), silt, soft, slightl	y plastic, moist, HCl weak			
	- 10— -		4.0/ 3.7						CL	
	-		4.0/	12-14.3' Sandy Lean graded, subrounded,	CLAY, dark reddish b very soft, plastic to ver	rown (5YR 3/2), very fii y plastic, very cohesive	ne-grained sand (~20%), p e, moist, HCl weak	poorly	CL/ CH	
L	15—		3.5	14.3-16' Lean CLAY, bedding, weathered s	gray to blueish gray (: hale	2 6/1), hard, plastic, no	n-cohesive, moist, HCl no	ne, laminate		
on\GP-44B.bo	-		2.4/	16-18' Lean CLAY, b staining throughout, v	lueish gray to gray (2 ) veathered shale	6/1), loose, plastic, moi	st, HCI none, thin bedding	, FeO	CL	
Denisc	-		3.1	19 19 4' SILT bluois	b = aray (2 E/1)	hard laminata hadding	chalo fragmonto		MI	
∖sboๅ∈	_			1, 10-10.4 SIL1, DIUEIS	n gray to gray (2 5/1),	naru, iaminate bedulng	, shale hayments		ا عسر	
rojects\Bor€	20-			Total depth of boring	18.4' bgs (refusal)					
:011 S:\F	Note(s)	:								
07-28-2										

			34	Log of Soil Boring GP-45B		
				(Page 1 of 1)		
	l Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started: 06/07/11Driller: L. TrujilloDate/Time Completed: 06/07/11Depth to Water: NADrilling Method: GeoprobeLogged by: E. MullerSampling Method: Continuous Dual Tube		
	Project	#: DENN	1C.C002.000	Drilling Co./Driller : Earth Worx		<u> </u>
Depth in Feet	sample Interval	² en./Rec. (feet)	Soil sample sub     Duplicate soil sa	mitted for laboratory analysis ample submitted for laboratory analysis DESCRIPTION	JSCS	GRAPHIC
0-	ö	4.0/ 3.0 0.6/ 0.6	0-4.0' Silty SAND, da subangular to subrour 4.0-4.6' SAND w/ mir subangular to subrour	billoontin mon rk reddish brown (5YR 3/4), fine- to very fine-grained sand, poorly graded, nded, very loose, moist to wet, HCl none, roots 0-2' bgs hor silt, pinkish gray (5YR 6/2), very fine- to fine-grained sand, poorly graded, nded, very loose, moist, HCl none	SM SP/ SM	0
rojects/BoreLogs/Denison/GP-45B.bor			Total depth of boring	4.6' bgs (refusal)		
Note(s 1. Dup for a	): licate sampl idditional sa	e collected mple volui	d. Sample interval was inc me required by the analytic	reased to 2 feet to accommodate cal laboratory.		

				34		Log of Soil	Boring GP-46	З		
			$\sim$					(Page 1 of 1)		
		Denisor White Me	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/07/11 : 06/07/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
		Project	#: DENN	1C.C002.000	Drilling Co./Driller	: Earth Worx				
Dep in Fe	oth 1 et	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	cription mitted for laboratory ana ample submitted for labor	lysis atory analysis DESCRIPTION			USCS	GRAPHIC
	- 0		4.0/ 2.8	0-3.7' Silty SAND, da subangular to subrou	nrk reddish brown (5Yl nded, very loose, moi:	R 3/4), very fine-grained s	sand (~70%), poorly gra	aded,	SM	
	_			3.7-4.3' SAND w/ mir subangular to subrou	nor silt, yellowish red ( nded, very loose, moi	5YR 5/6), very fine- to fir st, HCl none	ne-grained sand, poorly	graded,	SP/	
rojects\BoreLogs\Denison\GP 46B.bor	5		0.3/0.8	Total depth of boring	4.3' bgs (refusal)				SM	
07-28-2011 S:\Pro	e(s):									

				34		Log of Soil	Boring GP-47	В		
								(Page 1 of 1)		
		Deniso White Me	Project N n Nitrate esa Mill, B	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 06/08/11 : 06/08/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : E. Muller		
		Project	#: DENN	1C.C002.000	Drilling Co./Driller	: Earth Worx			1	1
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	cription mitted for laboratory ana ample submitted for labor	lysis atory analysis DESCRIPTION			USCS	GRAPHIC
s\BoreL ogs\Denison\GP 47B.bor	0-		4.0/ 2.6	0-4.7' Silty SAND, yes subrounded, very loos	4.7' bgs (refusal)	very fine-grained sand ( vet, HCI none, roots 0-2.5	-80%), poorly graded, bgs	subangular to	SM	
rojects	10-									
07-28-2011 S:\P	Note(s)	r.								

			ITE	RΔ	Log of Soil Boring GP-48B			
		Denisor White Me	Project N n Nitrate esa Mill, B	lame: Investigation Blanding, Utah	Date/Time Started     : 06/08/11     Driller     : L.       Date/Time Completed     : 06/08/11     Depth to Water     : N       Drilling Method     : Geoprobe     Logged by     : E	e 1 of 1) Trujillo A . Muller		
		Project	#: DENN	1C.C002.000	Sampling Method     : Continuous Dual Tube       Drilling Co./Driller     : Earth Worx			
	Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des	ription nitted for laboratory analysis nple submitted for laboratory analysis DESCRIPTION		USCS	GRAPHIC
	0		2.3/	0-2.0' Silty SAND, ye subrounded, very loos	lowish red (5YR 5/6), very fine-grained sand (~70%), poorly graded, subang e, dry, HCl none, roots 0-1.4' bgs	ular to	M	
ß.bor				2.0-2.3° SAND w/ mir subangular to subrour	aded, very loose, dry, HCI strong	S S	P/	
07-28-2011 S:\Projects\BoreLogs\Denison\GP-48t	- - - - - - - - - - - - - - - - - - -							

			N		Log of Soil	Boring GP-010	)		
							(Page 1 of 1)		
	Deniso White Me	Project n Nitrate esa Mill,	Name: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/19/11 : 05/19/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
	Project	#: DEN	MC.C002.000	Drilling Co./Driller	: Earth Worx				
Depth in	mple Interval	n./Rec. (feet)	Sample Field test sample Field test sample Duplicate soil sar	collected; not submitted is submitted for laboratory a not submitted for laboratory and the submitted for lab	to lab (1) analysis oratory analysis			cs	APHIC
Feet	Sar	Per			DESCRIPTION			NSU N	GR,
0-		3.5/ 2.8	0-3.1' Silty SAND, yell dense, dry, HCl none, 3.1-3.5' Sandstone, pi Total depth of boring 3	owish red (5YR 4/6), v trace white mottled HC nk (5YR 7/3), very fine .5' bgs (refusal)	rery fine-grained sand, s Cl strong	ilt, poorly graded, loose	to medium to strong	SM	
	]								
sP-01C.bor	-								
ogs\Denison\C	-								
ts\BoreL									
- 10 - 10 - 10 - 10 - 10 - 10 - 10 - 10	] )):								
1. Field	d test soil sa	ample not	submitted to laboratory due	e to no detectable results	during test kit analysis.				

			34		Log of Soil	Boring GP-020	C		
							(Page 1 of 1)		
	Deniso White Me	Project N n Nitrate esa Mill, E	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/19/11 : 05/19/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
	Project	#: DENN	IC.C002.000	Drilling Co./Driller	: Earth Worx				<u> </u>
Depth in	nple Interval	/Rec. (feet)	Field test soil sa	ample collected; not subm ample submitted for labora ample not submitted for la	itted to lab (1) atory analysis boratory analysis			S	APHIC
Feet	San	Pen			DESCRIPTION			nsc	GR4
0-		2.7/ 2.7	0-2.3' Silty SAND, ye dense, dry, HCl strong 2.3-2.7' Sandstone, b dense, dry, subangula	ellowish red (5YR 4/6), g prownish yellow (10YR ar to subrounded, HCI	very fine-grained sand, 8 6/6), very fine- to fine-g none	silt, poorly graded, loose	e to medium ded, loose to	SM	
rojects/BoreLogs/Denison/GP-02C.bor			Total depth of boring	2.7' bgs (refusal)					
¹ / ₂ Note(s) 1. Field 1. Field	: test soil sa	ample not s	submitted to laboratory due	e to no detectable results	during test kit analysis.				

INTERA	Log of Soil Boring GP-03C		
	(Page 1 of 1)		
Project Name: Denison Nitrate Investigation White Mesa Mill, Blanding, Utah Project #: DENMC.C002.000	Date/Time Started       : 05/19/11       Driller       : L. Trujillo         Date/Time Completed       : 05/19/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : J. Reed         Sampling Method       : Continuous Dual Tube       Drilling Co./Driller       : Earth Worx		
Image: Second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second	IS cription ample collected; not submitted to lab (1) ample submitted for laboratory analysis ample submitted for laboratory analysis DESCRIPTION	L SOSU	GRAPHIC
0 0 4.0/ 2.8 4.0-5.4' Silty SAND, ye dense, dry, HCl none 4.0-5.4' Silty SAND, dry, trace fine sand, H 5 5 5 5 5 5 4.0-5.4' Silty SAND, dry, trace fine sand, H HCl none to weak, su	pink (5YR 7/4), very fine-grained sand, silt, poorly graded, loose to medium pink (5YR 7/4), very fine-grained sand, silt, poorly graded, loose to medium dense, tCl medium to strong, white mottling w/ HCl strong light brown gray (10YR 6/2), very fine- to fine-grained sand, loose to dense, dry, ibangular to subrounded	SM	
Total depth of boring	6.6' bgs (refusal)		
Note(s): 1. Field test soil sample not submitted to laboratory du	e to no detectable results during test kit analysis.		

		ICE	RΔ		Log of Soil E	oring GP-04	С		
		~~					(Page 1 of 1)		
	Denisor White Me	Project N n Nitrate esa Mill, E	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/19/11 : 05/19/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
	Project	#: DENN	IC.C002.000	Drilling Co./Driller	: Earth Worx			_	-
Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des Field test soil sa Field test soil sa Duplicate soil sa	cription imple collected; not subn imple submitted for labor ample not submitted for la	nitted to lab (1) atory analysis aboratory analysis DESCRIPTION			USCS	GRAPHIC
-0 -0 - -0 - -0 - -0 - -0 - -0 		4.0/ 3.3 1.5/ 1.7	0-5.1' Silty SAND, ye dense, dry, HCl none,	llowish red (5YR 4/6) , trace white mottling ' 5.1' bgs (refusal)	, very fine-grained sand, sil w/ HCl strong, roots at top	It, poorly graded, loos	se to medium	SM	
07-28-2011 S:\Projects\BoreLogs\Deniso - 01 1. Field	): I test soil sa	imple not s	submitted to laboratory due	e to no detectable results	during test kit analysis.				

			RΔ		Log of Soil I	Boring GP-050	С		
							(Page 1 of 1)		
	Deniso White Me	Project N n Nitrate esa Mill, E	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method	: 05/19/11 I : 05/19/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
	Project	#: DENN	IC.C002.000	Drilling Co./Driller	: Earth Worx				
Depth in Feet	Sample Interval	Pen./Rec. (feet)	Field test soil sa	ample collected; not subr ample submitted for labo ample not submitted for l	nitted to lab (1) ratory analysis aboratory analysis DESCRIPTION			USCS	GRAPHIC
- 0		4.0/ 3.6	0-4.0' Silty SAND, ye	ellowish red (5YR 4/6) ttling w/ HCl strong	, very fine-grained sand, s	ilt, poorly graded, loos	e, dry, HCI	SM	
5- 			Total depth of boring	4.0' bgs (refusal)					
Note(s)	: I test soil sa	ample not s	submitted to laboratory due	e to no detectable results	e during test kit analysis.				

	ΙΠΤΕΡΔ				Log of Soil	Boring GP-06	С		
							(Page 1 of 1)		
	Deniso White M	Project N n Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started Date/Time Completed Drilling Method Sampling Method Drilling Co (Driller	: 05/19/11 : 05/19/11 : Geoprobe : Continuous Dual Tube	Driller Depth to Water Logged by	: L. Trujillo : NA : J. Reed		
Depth in Feet	Sample Interval	Pen./Rec. (feet)	Sample Interval Des Field test soil sa Field test soil sa Duplicate soil sa	Cription ample collected; not subm ample submitted for labor ample not submitted for la	hitted to lab (1) atory analysis aboratory analysis DESCRIPTION			L USCS	GRAPHIC
0		4.0/ 3.4 1.6/ 1.7	0-4.4' Silty SAND, ye dense, dry, HCI none 4.4-4.9' Silty SAND, HCI strong, trace fine 4.9-5.6' Rock fragme	pink (5YR 7/4), very fi sand ents, white, HCI none,	very fine-grained sand, mottling w/ HCI strong 3 ne-grained sand, silt, poo	silt, poorly graded, loos 3.2-4.4' bgs orly graded, loose to me	e to medium	SM	
-			Total depth of boring	5.6' bgs (refusal)					
	-								
10-	-								
Note(s) 1. Field	: test soil sa	ample not s	submitted to laboratory due	e to no detectable results	during test kit analysis.				

			37	Log of Soil Boring GP-07C					
				(Page 1 of 1)					
	Deniso White Me	Project N on Nitrate esa Mill, I	lame: Investigation Blanding, Utah	Date/Time Started       : 05/18/11       Driller       : L. Trujillo         Date/Time Completed       : 05/18/11       Depth to Water       : NA         Drilling Method       : Geoprobe       Logged by       : J. Reed         Sampling Method       : Continuous Dual Tube					
Depth in Feet	Sample Interval	Pen/Rec. (feet)	Sample Interval Des	cription ample collected; not submitted to lab (1) ample submitted for laboratory analysis ample not submitted for laboratory analysis DESCRIPTION	USCS	GRAPHIC			
0-			0-1.5' Sandy Clayey cohesive, HCl none	SILT, reddish brown (5YR 4/4), very fine-grained sand, medium stiff, dry to moist,	ML				
-		4.0/ 3.2	1.5-1.7' CLAY, dark r 1.7-4.9' Sandy SILT/ stiff/medium dense, s trace white mottling a	red brown (5YR 3/4), stiff, moist, medium plastic Silty SAND, reddish brown (5YR 4/4), very fine-grained sand, silt, medium lightly moist to moist, trace clay (cohesive), trace fine sand, HCl none to weak, t 2.5' bgs, little more sand or more silt	CL ML/ SM	,			
		2.1/ 2.1	amounts), medium de	SAND, brownish yellow (10YR 6/4), very fine- to fine-grained sand, silt (varying ense, slightly moist, trace medium sand, slightly cohesive, HCI none, little iron stained	SM/ SP	1			
-			Total depth of boring	6.1' bgs (refusal)					
-									
Note(s) 1. Field	] : i test soil sa	ample not s	submitted to laboratory due	e to no detectable results during test kit analysis.					

## **APPENDIX D**

## HISTORIC WATER LEVEL MAPS









W WILDLIFE POND







SCALE IN FEET

HYDRO GEO		PE	ERCHED AU	) WATE GUST 1	R LEVELS 994	
CHEM, INC.	Approved <b>SS</b>	Date <b>06/2/07</b>	Revised	Date	Reference: <b>71800070</b>	FIG: D.2



## **APPENDIX E**

## **TOPOGRAPHIC AND GEOLOGIC MAPS**





Geological Map of the Blanding Area, San Juan County, Utah (modified from Haynes et al., 1962; Dames & Moore, 1978 and Kirby, 2008) Base Map Prepared from Portions of the Blanding South, Black Mesa Butte, Big Bench and No Mans Land U.S.G.S. 7.5' Quadrangles.