Environmental Report In Support of Construction
Tailings Cell 4b
White Mesa Uranium Mill
Blanding, Utah

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April 30, 2008

Introduction

Denison Mines (USA) Corp. is seeking an amendment to its' Radioactive Materials License, No. UT1900479 in order to obtain UDEQ's approval to construct, operate and (when operations are complete) reclaim a proposed new tailings impoundment at its White Mesa Uranium Mill, Cell 4b. The construction of the Cell 4b is an essential element of future operations at the White Mesa Mill as its construction is necessary in order to continue providing sufficient impoundment surface area for the evaporation of Mill processes water. This Cell also provides additional tailings capacity which is necessary to accommodate the tailing volume associated with routine ore processing operations. While the new cell has not yet been constructed, it was contemplated, described and assessed previously, being a critical component of the initial 1978 NRC-FEIS and attendant licensing of the facility. More specifically, the initial environmental analysis and license application for the facility contemplated six tailing cells; operating cells 1, 2 and 3, as well as 3 additional 80 acre cells, Cells 4, 5 and 6. With the construction of Cell 4a (40 acres), Cell 4b will consume the second 40 acres of the previously authorized 80 acre Cell 4.

The information required for an amendment to the Mill's Radioactive Materials License is found at R313-24-3. More specifically, the regulations state the following:

> (1) Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following:
>
> (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;
>
> (b) An assessment of any impact on waterways and groundwater resulting from the activities conducted pursuant to the license or amendment;
>
> (c) Consideration of alternatives, including alternative sites and engineering methods, to the activities to be conducted pursuant to the license or amendment;
> and
>
> (d) Consideration of the long-term impacts including decommissioning, decontamination, and reclamation impacts, associated with activities to be conducted pursuant to the license or amendment.

In order to fulfill the requirements above, Denison considered and used the information topics and format cited by NRC in its guidance document NUREG 1359 for its recent

License Renewal Application. Because the Renewal Application provided current environmental information and assessments, the scope of this Environmental Report can be limited in some respects, focusing on pathways and assessments directly related to the construction of the new tailings cell. Accordingly, topical headings suggested by NUREG 1359 have been included in this document; however, where previously provided information is sufficient and unaffected by this amendment request, the prior information is incorporated by reference. Denison's assessment of the pathways to be considered for construction of cell 4b is principally focused on the examination of potential airborne releases from the pond and the groundwater considerations typically attendant to the design of a tailing cell. It is important to note that UDEQ has approved the design and construction of directly adjacent and nearly completed Cell 4a. The liner design and underlying ground conditions for Cell 4b are identical to those of Cell 4a.

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1.0 Site Location and Layout

The Mill is regionally located in central San Juan County, Utah, approximately 6 miles (9.5 km) south of the city of Blanding. The Mill can be reached by taking a private road for approximately 0.5 miles west of Utah State Highway 191. See Figure 1.

Within San Juan County, the Mill is located on fee land and mill site claims, covering approximately 5,415 acres , encompassing all or part of Sections 21, 22, 27, 28, 29, 32, and 33 of T37S, R22E, and Sections 4, 5, 6, 8, 9, and 16 of T38S, R22E, Salt Lake Base and Meridian. See Figure 2.

All operations authorized by the License are conducted within the confines of the existing site boundary. The milling facility currently occupies approximately 50 acres and the current tailings disposal cells encompass another 250 acres. See Figure 2.

The resident currently nearest to the milling facility is located approximately 1.2 miles (1.9 km) north of the Mill site, just north of air sampling station BHV-1. See Figure 2.

2.0 Climate and Meteorology

2.1 Regional Climate

The climate of southeastern Utah is classified as dry to arid continental. Although varying somewhat with elevation and terrain, the climate in the vicinity of the Mill can be considered as semi-arid with normal annual precipitation of about 13.4 inches. Most precipitation is in the form of rain with snowfall accounting for about 29% of the annual total precipitation. There are two separate rainfall seasons in the region, the first in late summer and early autumn (August to October) and the second during the winter months (December to March). The mean annual relative humidity is about 44 percent and is normally highest in January and lowest in July. The average annual Class A pan evaporation rate is 68 inches (National Oceanic and Atmospheric Administration and U.S. Department of Commerce, 1977), with the largest evaporation rate typically occurring in July. This evaporation rate is not appropriate for determining water balance requirements for the tailings management system and must be reduced by the Class A pan coefficient to determine the later evaporation rate. Values of pan coefficients range from 60% to 81%. Denison assumes for a water balance calculations an average value of 70% to obtain an annual lake evaporation rate for the Mill area of 47.6 inches. Given the annual average precipitation rate of 13.4 inches, the net evaporation rate is 34.2 inches per year.

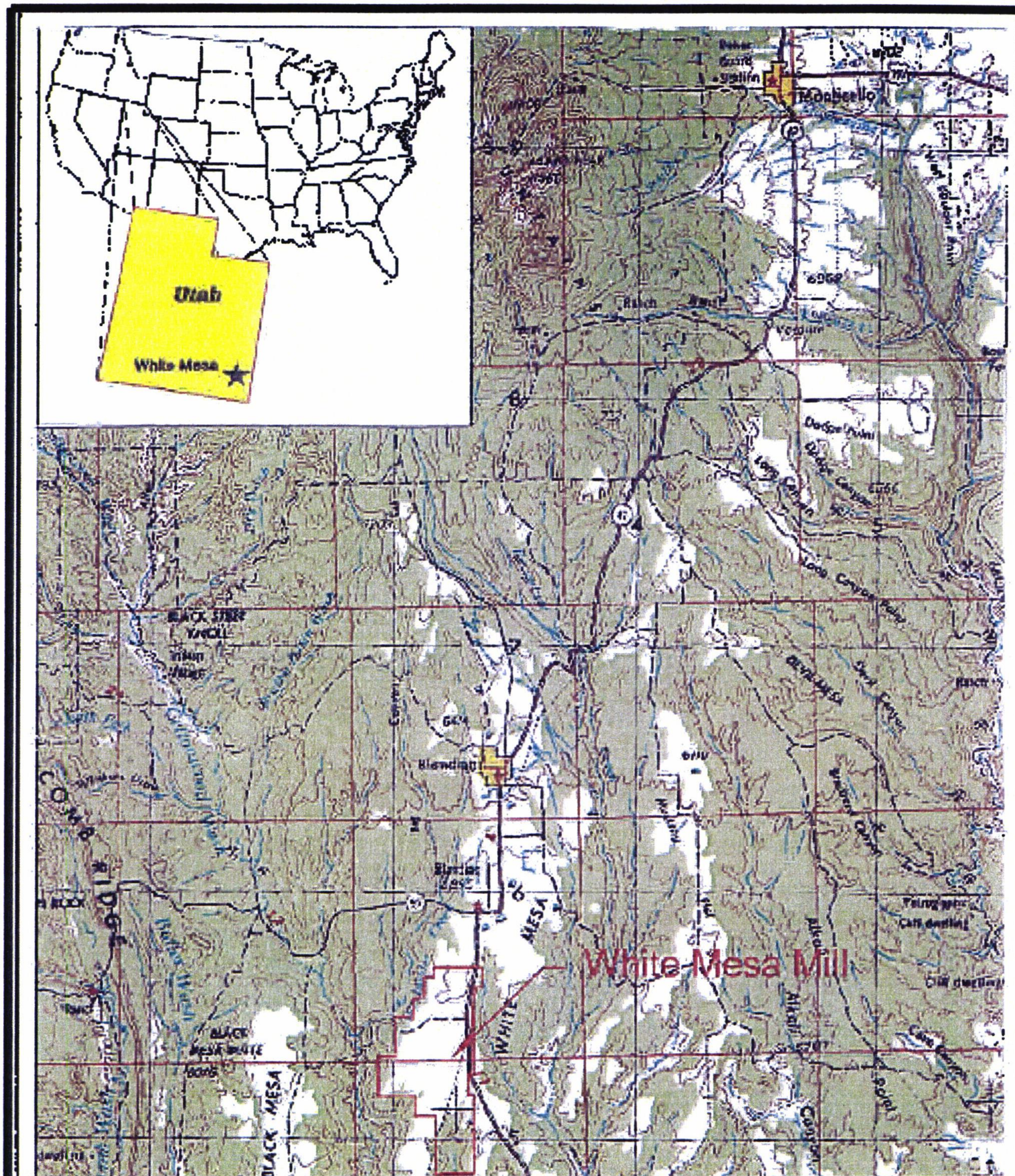

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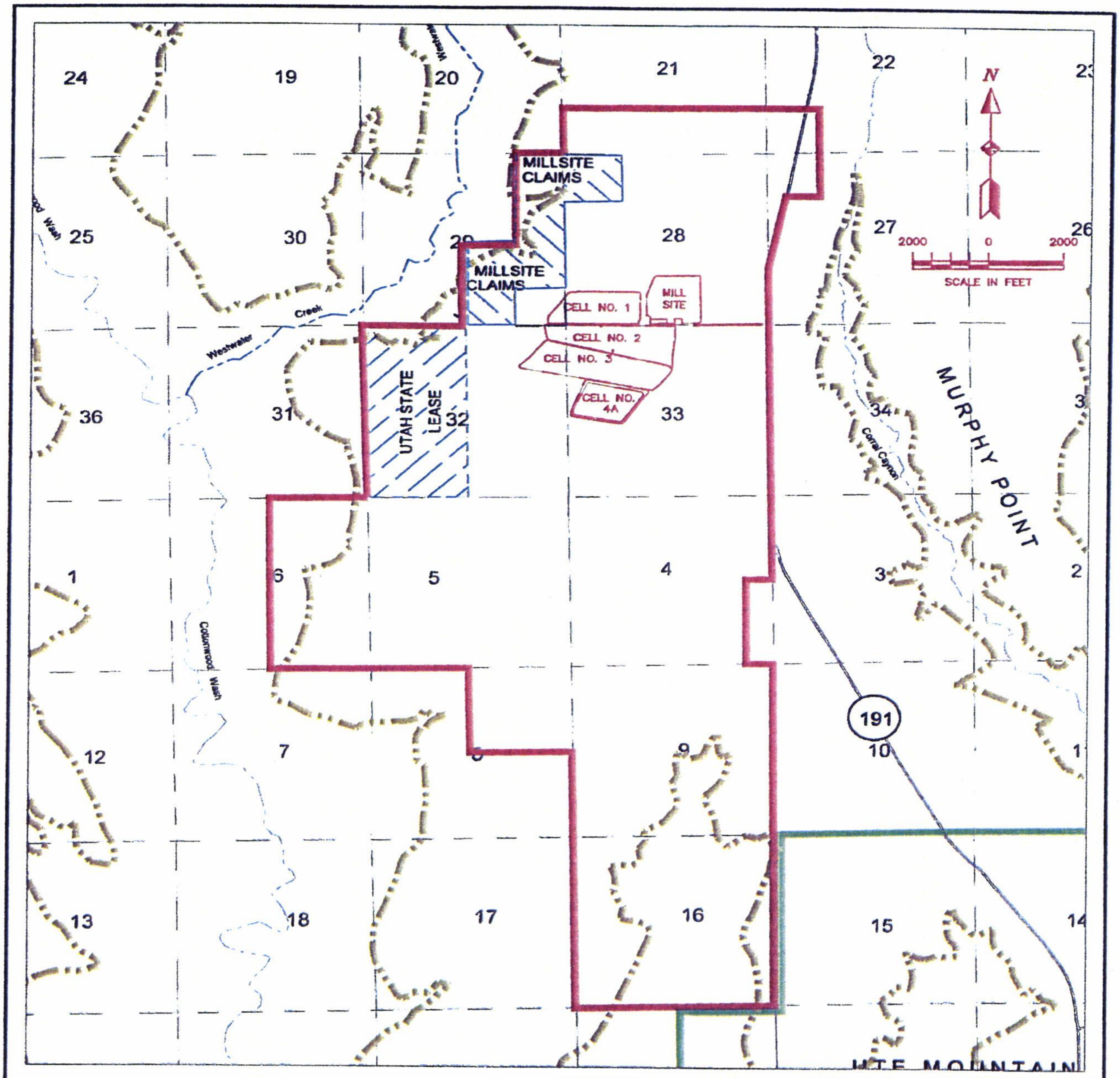
Figure 1
White Mesa Mill
Location Map



Property Boundary

Reservation Boundary

Canyon Rim

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Figure 2
White Mesa Mill
Land Map

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The weather in the Blanding area is typified by warm summers and cold winters. The mean annual temperature in Blanding is about 50° (F). January is usually the coldest month and July is usually the warmest month.

Winds are usually light to moderate in the area during all seasons, although occasional stronger winds may occur in the late winter and spring. The predominant winds are from the north through north-east (approximately 30 percent of the time) and from the south through south-west (about 25 percent of the time). Winds are generally less than 15 mph, with wind speeds faster than 25 mph occurring less than one percent of the time. The National Weather Service Station in Blanding, Utah is located about 6.25 miles north of the Mill. Data from the station is considered representative of the local weather conditions (1978 ER, Section 2.7.2). However, as an element of the pre-construction baseline study and ongoing monitoring programs, the Mill operates an onsite meteorological station, described in greater detail below. Further details about weather and climate conditions are provided in the 1978 ER (Section 2.7) and in the FES (Section 2.1). The 1978 ER and FEIS are resource documents, incorporated here by reference.

2.2 On Site Monitoring Program

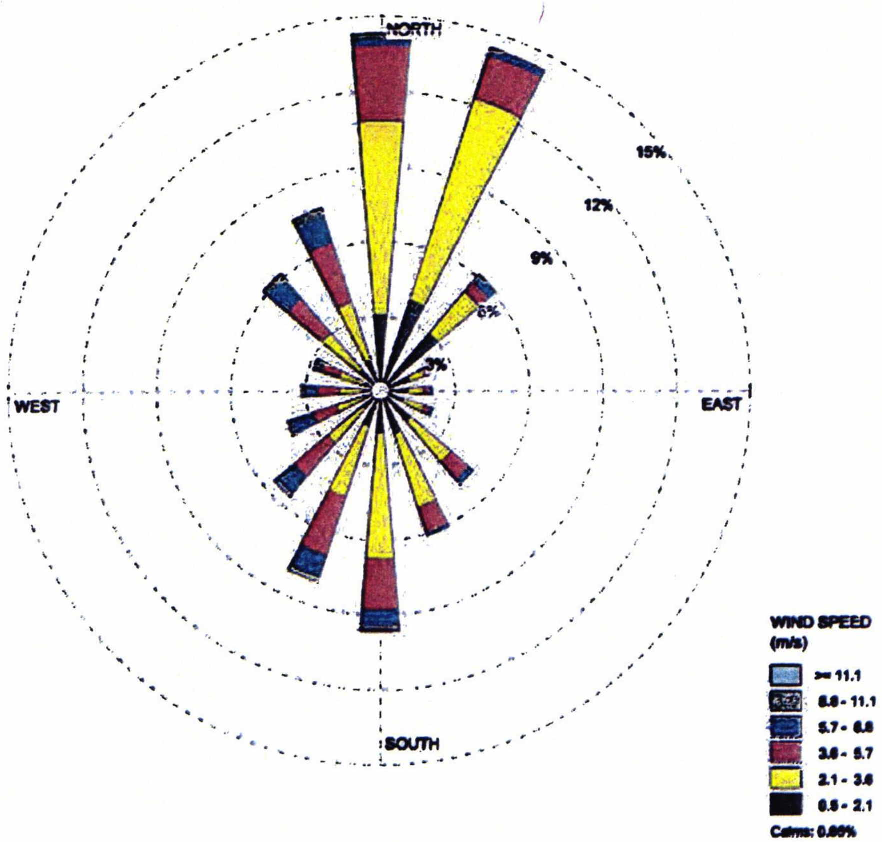
On-site meteorological monitoring at the Mill was initiated in early 1977 and continues today. The original purpose of the meteorological monitoring program was to document the regional atmospheric baseline and to provide data to assist in assessing potential air quality and radiological impacts arising from operation of the Mill.

After the Mill construction was completed, the monitoring programs were modified to facilitate the assessment of Mill operations. The current meteorological monitoring program includes data collection for wind speed, wind direction, atmospheric stability according to the standard Pasquill scheme (via measurements of deviations in wind direction, referred to as sigma-theta), and precipitation as either rain or snow. The recorded on-site meteorological conditions are reported to Denison on a semi-annual basis and are described in semi-annual reports prepared for Denison and maintained at the Mill. Figure 3 shows the windrose for the Mill site during the period of January – December 2007, the most recent full year of compiled meteorological data.

3.0 Use of Adjacent Lands and Water

Approximately 65.8% of San Juan County is federally owned land administered by the U.S. Bureau of Land Management, the National Park Service, and the U.S. Forest Service. Primary land uses include livestock grazing, wildlife range, recreation, and exploration for minerals, oil, and gas. Approximately 22% of the county is Native American land owned either by the Navajo Nation or the Ute Mountain Ute Tribe. The area within 5 miles of the Mill site is predominantly range land owned by Blanding residents. The Mill site, including tailings cells, encompasses approximately 300 acres.

WIND ROSE PLOT:	DISPLAY:
White Mesa Mill **Blanding, Utah**	**Wind Speed** **Direction (blowing from)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	2007 **Jan 1 - Dec 31** **00:00 - 23:00**	**Denison Mines (USA) Corporation**	
		MODELER: **McVehil-Monnett Associates**	Figure 3
	CALM WINDS: **0.65%**	TOTAL COUNT: **8753 hrs.**	
	AVG. WIND SPEED: **3.36 m/s**	DATE: **2/4/2008**	PROJECT NO.: **2018-06**

WRPLOT View - Lakes Environmental Software

A more detailed discussion of land use at the Mill site, in surrounding areas, and in southeastern Utah, is presented in the FES (Section 2.5). Results of archeological studies conducted at the site and in the surrounding areas as part of the 1978 ER are also documented in the FES (Section 2.5.2.3).

4.0 Population Distribution and Socioeconomic Profile

Demographic information is generally derived from information obtained by the U.S. Census Bureau. These records are updated on a five year frequency for population centers which exceed 65,000 people and on a ten year frequency for lesser populations. As such, the local population update for the area of interest was last recorded in the year 2000, and it is that data base which was utilized to formulate the demographic information provided in the recent license renewal effort and this report. According to the 2000 census, the population density of San Juan County, in which the Mill is located, is 1.8 individuals per square mile. By comparison, the statewide density is greater than 27.2 persons per square mile. The town of Blanding, Utah, approximately 6 miles north of the Mill, is the largest population center near the Mill site, with 3,162 persons. Approximately 5 miles southeast of the Mill site is the White Mesa community, where approximately 277 Ute Mountain Ute tribal members reside. See Figure 4. The Navajo Reservation is located approximately 19 miles southeast of the Mill. The nearest community on the Navajo Reservation is Montezuma Creek, a community of approximately 507 individuals in Utah. The nearest resident to the Mill is located approximately 1.5 miles to the north of the Mill, near air monitoring station BHV-1.
Table 1 provides population centers located within 50 miles of the Mill site.

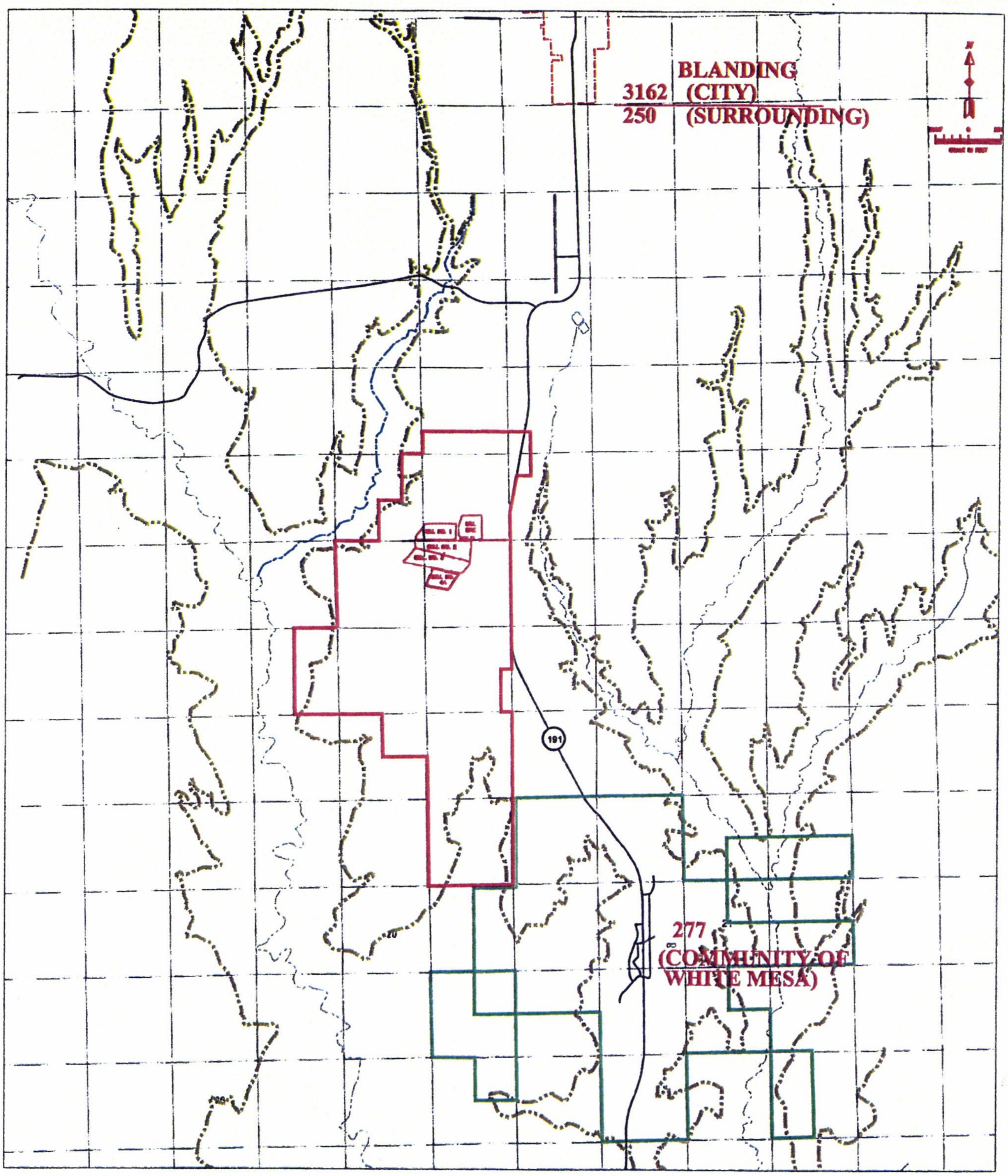
Table 1-Population Centers Within 50 Miles of the Mill Site

Population Center	2000 Population	Distance From Site[2] (miles)
Blanding, UT	3,162	6
White Mesa, UT	277	4
Bluff, UT	320	15
Montezuma Creek, UT	507	20
Aneth, UT	598	27
Mexican Hat, UT	88	30
Monticello, UT	1,958	27
Eastland/Ucolo, UT	249[3]	32
Dove Creek, CO	698	37
Towaoc, CO	1,097	50

Source: http://factfinder.census.gov

[1] 2000 Census
[2] Approproximate distance from Mill site by air
[3] Based on 1978 population estimate

San Juan County, Utah, is the largest and poorest county in Utah. As of December 2006, the unemployment rate in San Juan County was 4.9%, compared to 2.6% for Utah as a whole, and 4.5% for the nation as a whole. When operating, the Mill is one of the largest private employers in San Juan County, employing up to 60-140 full time employees. As



SCALE
0 1 2
MILES

PROPERTY BOUNDARY
RESERVATION BOUNDARY
CANYON RIM

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Figure 4
Population in The Project Vicinity
2000 Census

Z:\White Mesa Mill\2007 License Renewal Application\Environmental Report - Figures\Figure 3.9-1.dwg, Figure 3.9 - 1, 02/24/2007 11:08:44 AM, Adobe PDF.pc3, Letter such, the Mills employees represent a significant economic base for the city of Blanding and rural residents of San Juan County. In addition, the Company pays local taxes to San Juan County, further supporting the development of the local economic base. The Mill also provides income to local minorities, typically employing a high percentage of minority workers ranging from 45-75% Native Americans.

Since its inception in 1980, the Mill has run on a campaign basis, in each case remaining on standby pending accumulation of sufficient ore stockpiles to justify a milling campaign. Currently, Mill employees are predominantly residents of San Juan County, or residents of neighboring counties who commute to the Mill on a daily basis. Historically, the Mill has drawn upon such residents of San Juan County and neighboring counties for each milling campaign, rather than relying upon an influx of workers to the area. As a result, Mill campaigns have not given rise to any unusual demands on public services or resulted in any cultural or socioeconomic issues for the surrounding areas.

5.0 Topography

The Mill site is located on a gently sloping mesa that, from the air, appears similar to a peninsula, as it is surrounded by steep canyons and washes and is connected to the Abajo Mountains to the north by a narrow neck of land. On the mesa, the topography is relatively flat, sloping at less than one (1) percent to the south and nearly horizontal from east to west. See Figure 5.

6.0 Geologic Setting

6.1 Regional Geology

The Mill site lies within a region designated as the Canyon Lands section of the Colorado Plateau physiographic province. Elevations in the region range from approximately 3,000 feet in the bottom of canyons to over 11,000 feet among the peaks of the Henry, Abajo and La Sal Mountains. The average elevation for the area, excluding deeper canyons and isolated mountain peaks, is about 5,000 feet.

The sedimentary rocks exposed in southeastern Utah have a total thickness of approximately 6,000 to 7,000 feet. These sedimentary units range in age from Pennsylvanian to Late Cretaceous; older rock units which underlie those of Pennsylvanian age are not exposed in the Mill site area.

Structural features in the Mill site area have been divided into three main categories on the basis of origin or mechanism of the stress that created the structure. These categories are: (1) structures related to large-scale regional uplifting or downwarping directly related to movements in the basement complex (the Monument Uplift and the Blanding Basin); (2) structures due to diapiric deformation of thick sequences of evaporate deposits, salt plugs and salt anticlines (the Paradox Fold and Fault Belt); and (3) structures formed due to magmatic intrusions (the Abajo Mountains). A generalized stratigraphic column for the region is provided as Figure 6.

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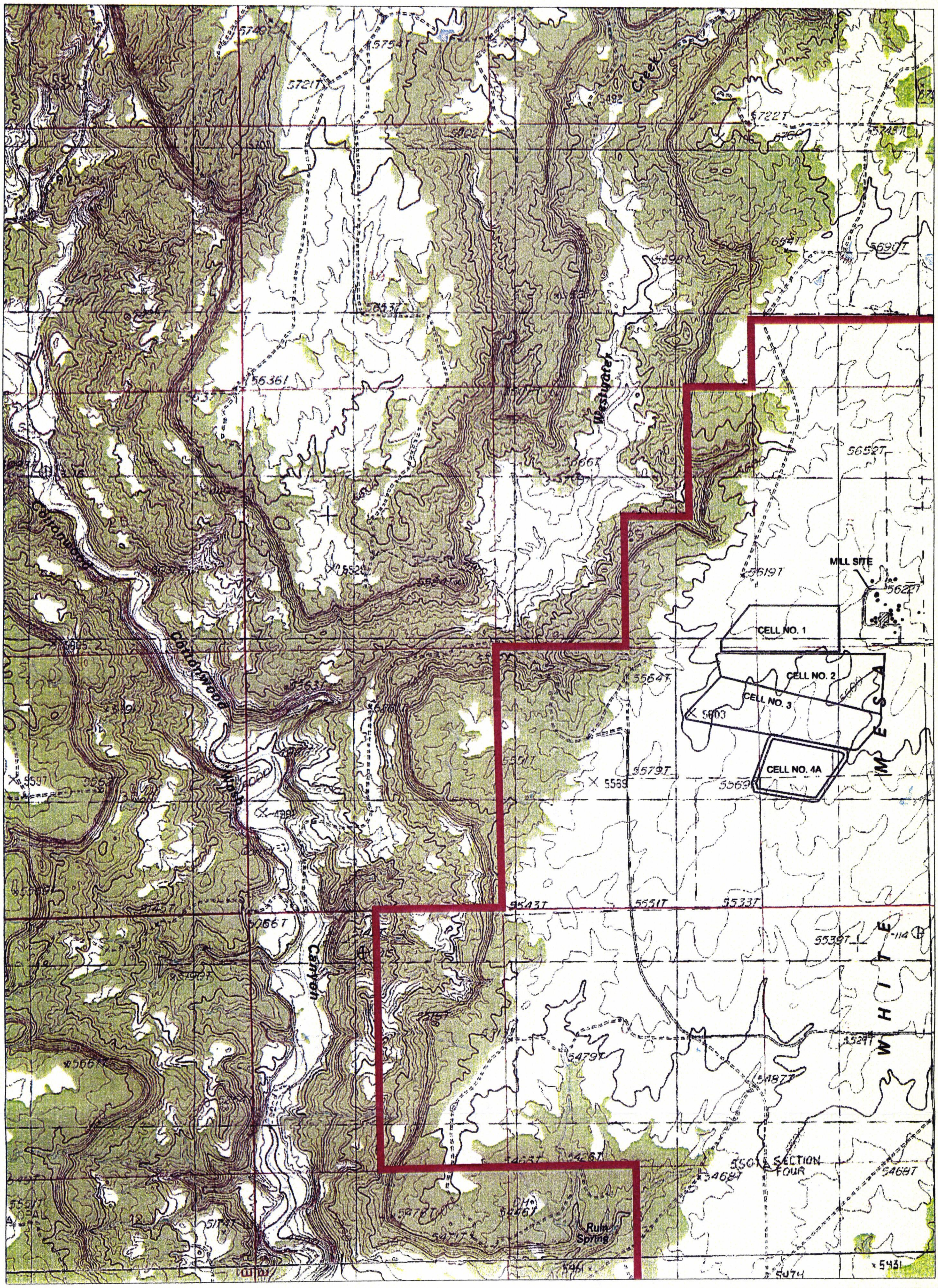

From USGS 7.5 minute quad sheet for Black Mesa

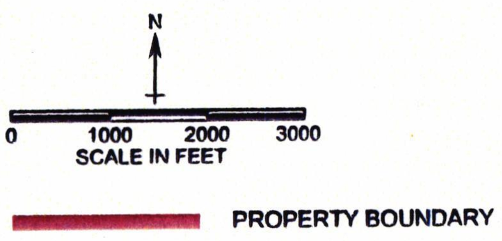

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Figure 5
Local Topography
And Location of Ruin Spring

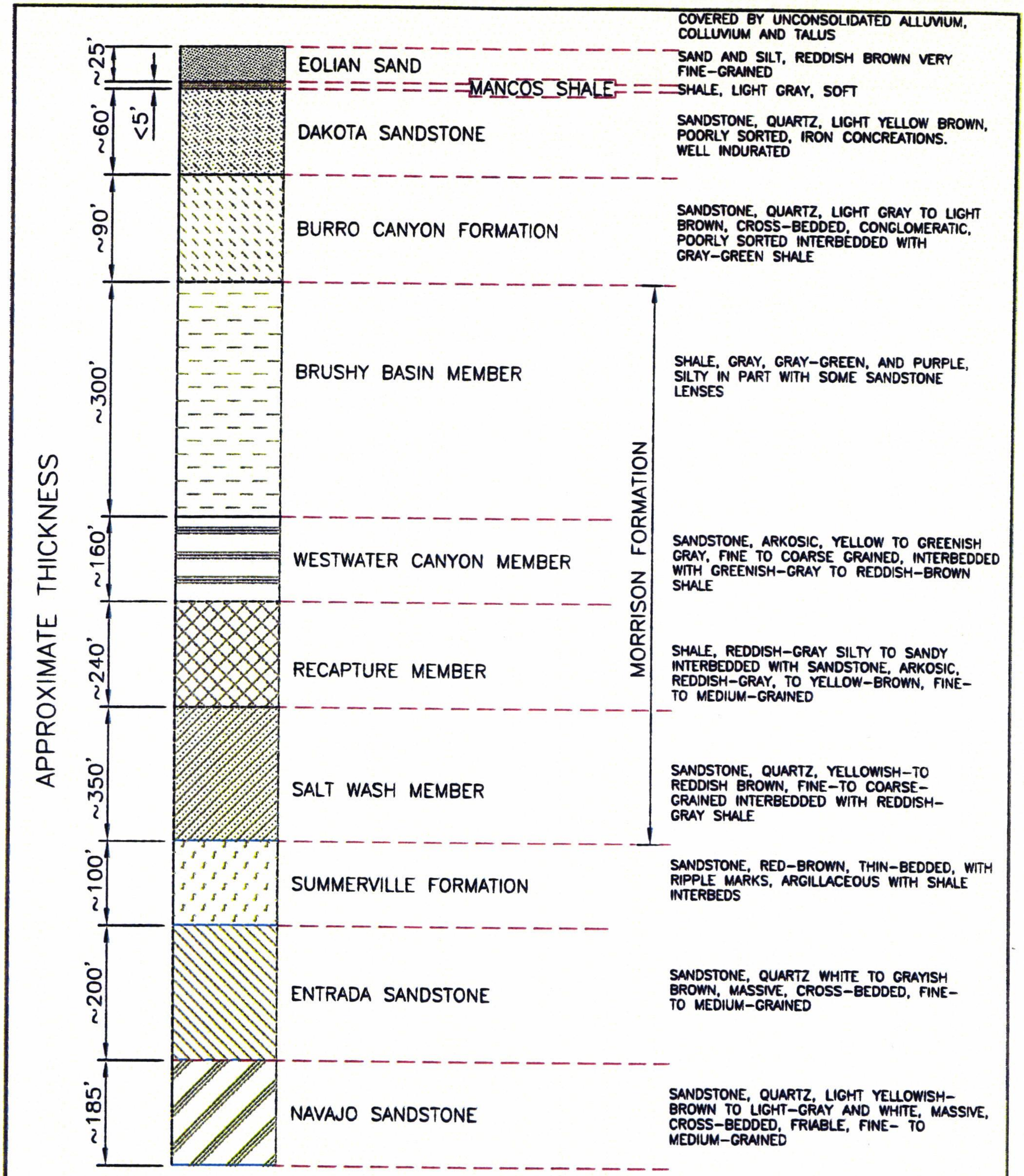

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Figure 6
Generalized Stratigraphy of
White Mesa Mill

Taken from Stratigraphic Section near Water Well #3

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The Summerville Formation, Entrada Sandstone, and Navajo Sandstone are the deepest units of concern encountered at the site.

6.2 Local Geology

The Mill site is located on the western edge of the Blanding Basin, sometimes referred to as the Great Sage Plain, lying east of the north/south-trending Monument Uplift, south of the Abajo Mountains and adjacent to the northwest-trending Paradox Fold and Fault Belt. The Abajo Mountains are the most prominent topographic feature in the region, rising over 4,000 ft above the surface of the plain. The lithology of the immediate area is composed of thousands of feet of multi-colored pre-Tertiary age marine and non-marine sedimentary rocks. Erosion on the regionally-uplifted sedimentary strata has produced an array of eroded canyons and mesas.

The Mill is more specifically located on White Mesa and rests on alluvial windblown silt and sand which covers sandstones and shales of Jurassic and Cretaceous age. The surface of the mesa is nearly flat, with a surface relief of 98 ft. The maximum relief between White Mesa and the adjacent Cottonwood Canyon is about 750 ft.

6.3 Site-Specific Geologic Setting

The Mill is located within the Blanding Basin of the Colorado Plateau physiographic province. Typical of large portions of the Colorado Plateau province, the rocks underlying the site are relatively underformed. The average elevation of the site is approximately 5,600 ft (1,707 m) above mean sea level (amsl).

The site is underlain by unconsolidated alluvium and indurated sedimentary rocks consisting primarily of sandstone and shale. The indurated rocks are relatively flat lying with dips generally less than 3°. The alluvial materials consist mostly of aeolian silts and fine-grained aeolian sands with a thickness varying from a few feet to as much as 25 to 30 ft (7.6 to 9.1 m) across the site. The alluvium is underlain by the Dakota Sandstone and Burro Canyon Formation, which are sandstones having a total thickness ranging from approximately 100 to 140 ft (31 to 43 m). 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 Westwater Canyon and Salt Wash Members also have a low average vertical permeability due to the presence of interbedded shales. See Figure 6 for a generalized stratigraphic column for the region.

Beneath the Morrison Formation lies 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 ft (305 to 335 m) of materials having a low average vertical permeability. Groundwater within this system is under artesian pressure in the vicinity of the site, and is used only as a secondary source of water at the site.

7.0 Hydrogeologic Setting

The site is located within a region that has a dry to arid continental climate, with average annual precipitation of approximately 13.4 in. Recharge to aquifers 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.

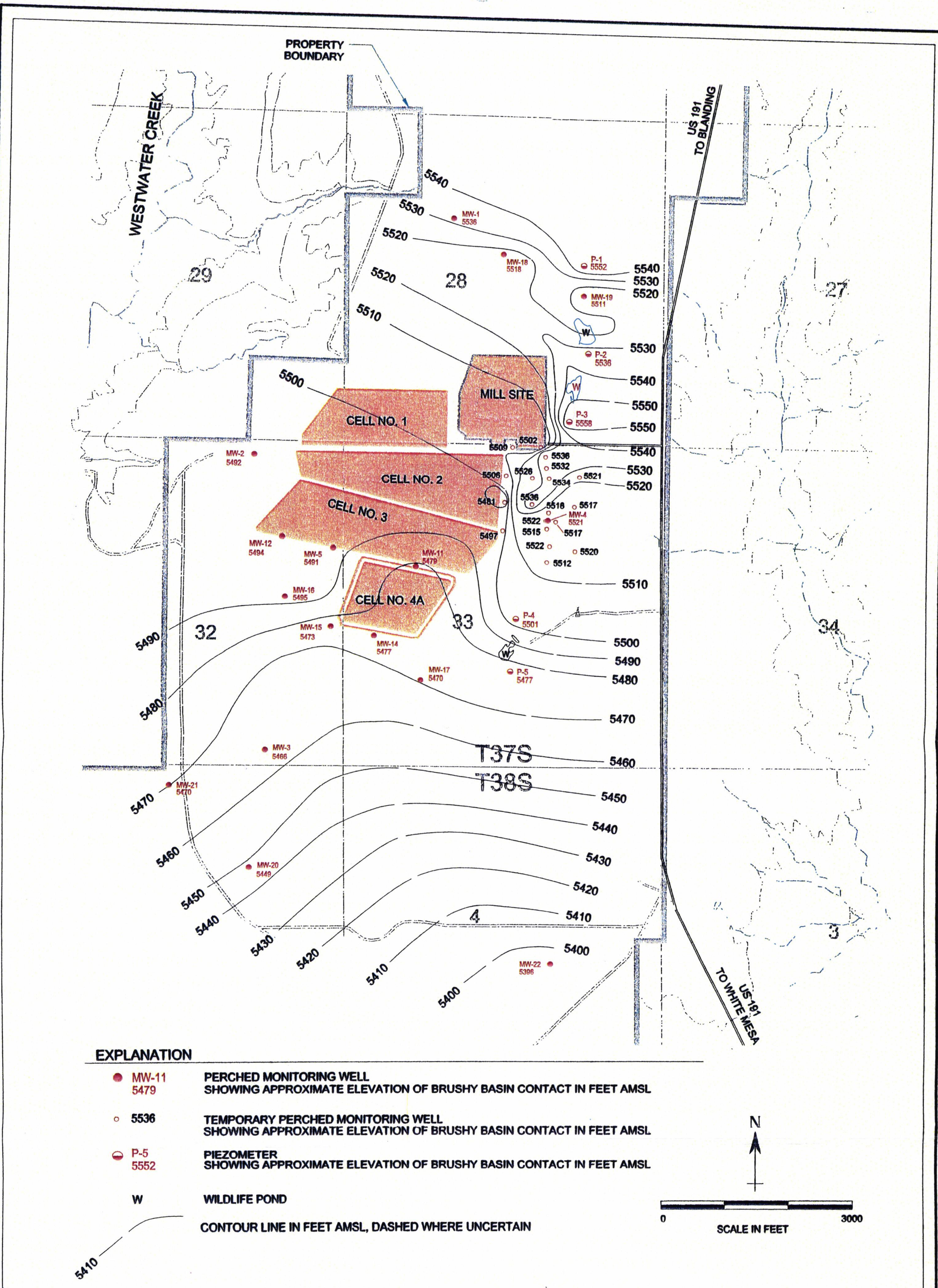
Although the water quality and productivity of the Navajo/Entrada aquifer are generally good, the depth of the aquifer (approximately 1,200 ft below land surface (bls)) makes access difficult. The Navajo/Entrada aquifer is capable of yielding significant quantities of water to wells (hundreds of gallons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

7.1 Perched Zone Hydrogeology

Perched groundwater beneath the site occurs primarily within the Burro Canyon Formation. Perched groundwater at the site has a generally low quality due to high total dissolved solids (TDS) in the range of 1,200 to 5,000 milligrams per liter (mg/L), and is used primarily for stock watering and irrigation in the areas upgradient (north) of the site, 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. Perched water is supported within the Burro Canyon Formation by the underlying, fine-grained Brushy Basin Member. Figure 7 is a contour map showing the approximate elevation of the contact of the Burro Canyon Formation with the Brushy Basin Member, which essentially forms the base of the perched water zone at the site. Contact elevations are based on monitoring well drilling and geophysical logs and surveyed land surface elevations. As indicated, the contact generally dips to the south/southwest beneath the site.

The permeability of the Dakota Sandstone and Burro Canyon Formation at the site is generally low. 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.

Based on samples collected during installation of wells MW-16 and MW-17 (the locations of the various monitoring wells are indicated on Figure 7), located immediately downgradient of the tailings cells at the site, porosities of the Dakota Sandstone range from 13.4% to 26%, averaging 20%, and water saturations range from 3.7% to 27.2%, averaging 13.5%. The average volumetric water content is approximately 3%. The permeability of the Dakota Sandstone based on packer tests in borings installed at the site ranges from 2.71E-06 centimeters per second (cm/s) to 9.12E-04 cm/s, with a geometric average of 3.89E-05 cm/s.



Denison Mines (USA) Corp

Figure 7
White Mesa Mill
Approximate Elevation
Top of Brushy Basin

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, located immediately downgradient of the tailings cells at the site, porosity ranges from 2% to 29.1%, averaging 18.3%, and water saturations of unsaturated materials range from 0.6% to 77.2%, averaging 23.4%. Titan, 1994, reported that the hydraulic conductivity of the Burro Canyon Formation ranges from 1.9E-07 to 1.6E-03 cm/s, with a geometric mean of 1.1E-05 cm/s, based on the results of 12 pump/recovery tests performed in monitoring wells and 30 packer tests performed in borings prior to that time.

Hydraulic testing of wells MW-1, MW-3, MW-5, MW-17, MW-18, MW-19, MW-20, and MW-22 during the week of July 8, 2002, yielded average perched zone permeabilities ranging from approximately 4.0E-07 cm/s to 5.0E-04 cm/s, similar to the range reported by previous investigators at the site (HGC, 2002). Downgradient (south to southwest) of the tailings cells, average perched zone permeabilities based on tests at MW-3, MW-5, MW-17, MW-20, and MW-22 ranged from approximately 4.0E-07 to 4.0E-05 cm/s. Permeability estimates were based on pump/recovery and slug tests analyzed using several different methodologies.

A number of temporary monitoring wells have been installed at the site to investigate elevated concentrations of chloroform initially discovered at well MW-4 in 1999. Some of the conglomeratic zones encountered within the perched zone during installation of these wells are believed to be partly continuous or at least associated with a relatively continuous zone of higher permeability (IUSA and HGC, 2001). The higher permeability zone defined by these wells is generally located east to northeast of the tailings cells at the site, and is hydraulically cross-gradient to upgradient of the tailings cells with respect to perched groundwater flow. Relatively high permeabilities 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 4, of 1.4E-03 cm/s and 7.5E-04 cm/s, respectively (UMETCO, 1993), may indicate that this zone extends beneath the southeastern margin of the cells. This zone of higher permeability within the perched water zone does not appear to exist downgradient (south-southwest) of the tailings cells, however. At depths beneath the perched water table, the zone is not evident in lithologic logs of the southernmost temporary wells TW4-4 and TW4-6 (located east (cross-gradient) of Cell 3), nor is it evident in wells MW-3, MW-5, MW-12, MW-15, MW-16, MW-17, MW-20, MW-21, or MW-22, located south to southwest (downgradient) of the tailings cells, based on the lithologic logs or hydraulic testing of the wells.

Because of the generally low permeability of the perched zone beneath the site, well yields are typically low (less than 0.5 gpm), although yields of about 2 gpm may be possible in wells intercepting the higher permeability zones on the east side of the site. Sufficient productivity can, in general, only be obtained in areas where the saturated thickness is greater, which is the primary reason that the perched zone has been used on a limited basis as a water supply to the north (upgradient) of the site.

7.2 Perched Groundwater Flow

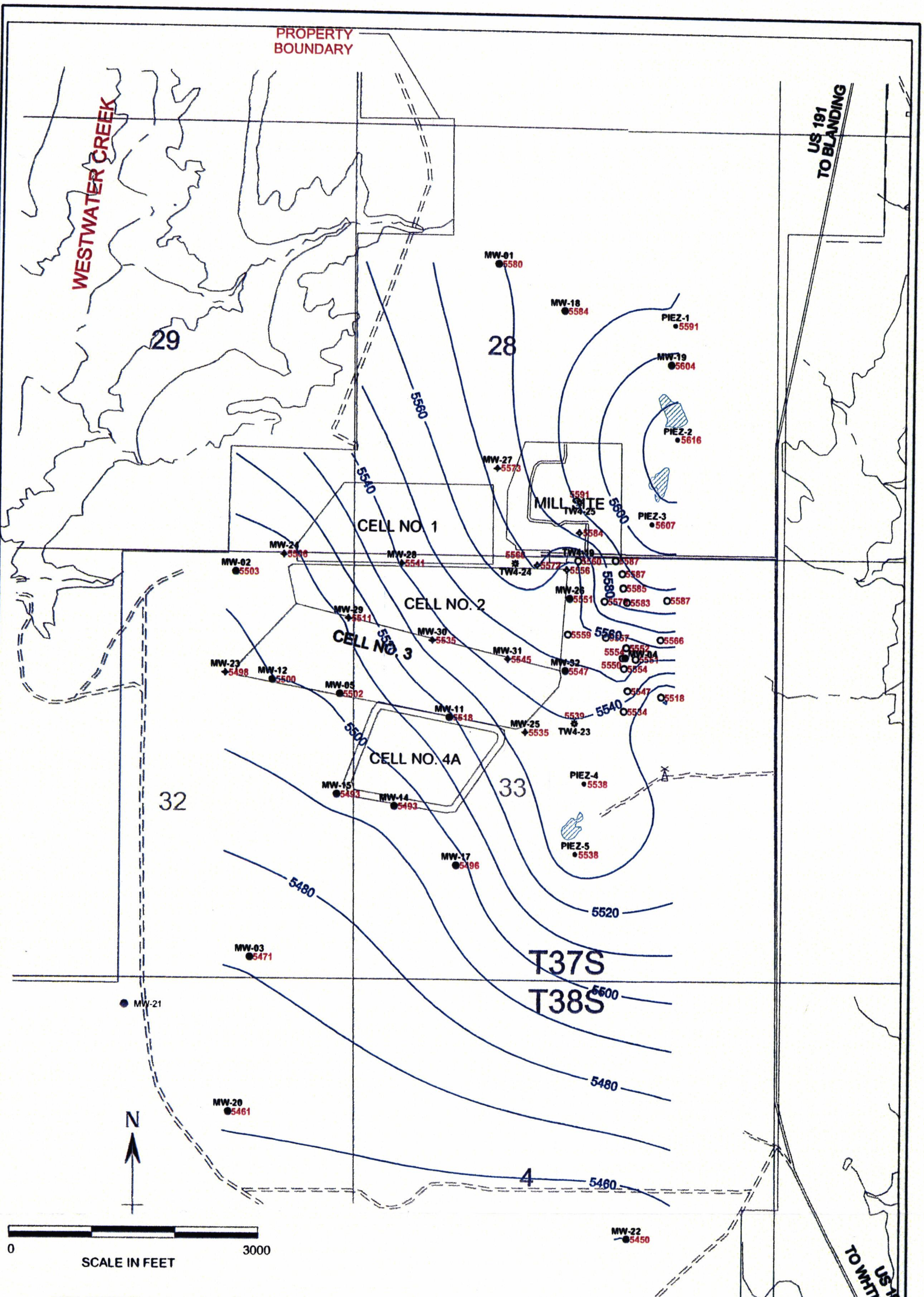
Perched groundwater flow at the site is generally to the south/southwest. Figure 8 displays the local perched groundwater elevation contours at the Mill. As indicated, the perched groundwater gradient changes from generally southwesterly in the western portion of the site to generally southerly in the eastern portion of the site.

Perched water discharges in springs and seeps 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 outcrops. Perched water flowing beneath the tailings cells eventually discharges in springs and seeps located in Westwater Canyon, to the south-southwest of the cells. The primary discharge point for perched water flowing beneath the tailings cells is believed to be Ruin Spring, located approximately 10,000 ft south-southwest of the Mill site, as shown in Figure 9.

7.3 Perched Zone Hydrogeology
(Beneath and Down-gradient Of the Tailings Cells)

As of the 4th Quarter, 2006, perched water has been encountered at depths of approximately 50 to 115 ft bls in the vicinity of the tailings cells at the site (Figure 10). Beneath tailings Cell 3, depths to water ranged from approximately 72 ft below top of casing (btoc) east of the cell (at MW-31), to approximately 115 ft btoc at the southwest margin of the cell (at MW-23). Assuming an average depth of the base of tailings Cell 3 of 25 ft below grade, this corresponds to perched water depths of approximately 47 to 90 ft below the base of the cell, or an average depth of approximately 70 feet beneath the base of the cell.

The saturated thickness of the perched zone as of the 4th Quarter, 2006 ranged from approximately 94 ft in the northeast portion of the site to less than 5 ft in the southwest portion of the site. Beneath tailings Cell 3, the saturated thickness varies from approximately 49 ft in the easternmost corner of the cell to approximately 6 ft in the westernmost corner of the cell. South-southwest of the tailings cells, the saturated thickness ranges from less than 1 ft at MW-21 to approximately 25 ft at MW-17. The average saturated thickness south-southwest of the tailings cells, based on measurements at MW-3, MW-5, MW-12, MW-14, MW-15, MW-17, and MW-20, is approximately 14 ft. The average saturated thickness based on measurements at MW-5, MW-15, MW-3, and MW-20, which lay close to a line between the center of tailings Cell 3 and Ruin Spring, is approximately 12 ft. By projecting conditions at these wells, the average saturated thickness is estimated to be approximately 10 to 15 ft between MW-20 and Ruin Spring.



EXPLANATION

MW-20 ● 5461 perched monitoring well showing elevation in feet amsl

○ 5550 temporary perched monitoring well showing elevation in feet amsl

PIEZ-1 • 5591 perched piezometer showing elevation in feet amsl

MW-31 ✦ 5545 perched monitoring well installed April, 2005 showing elevation in feet amsl

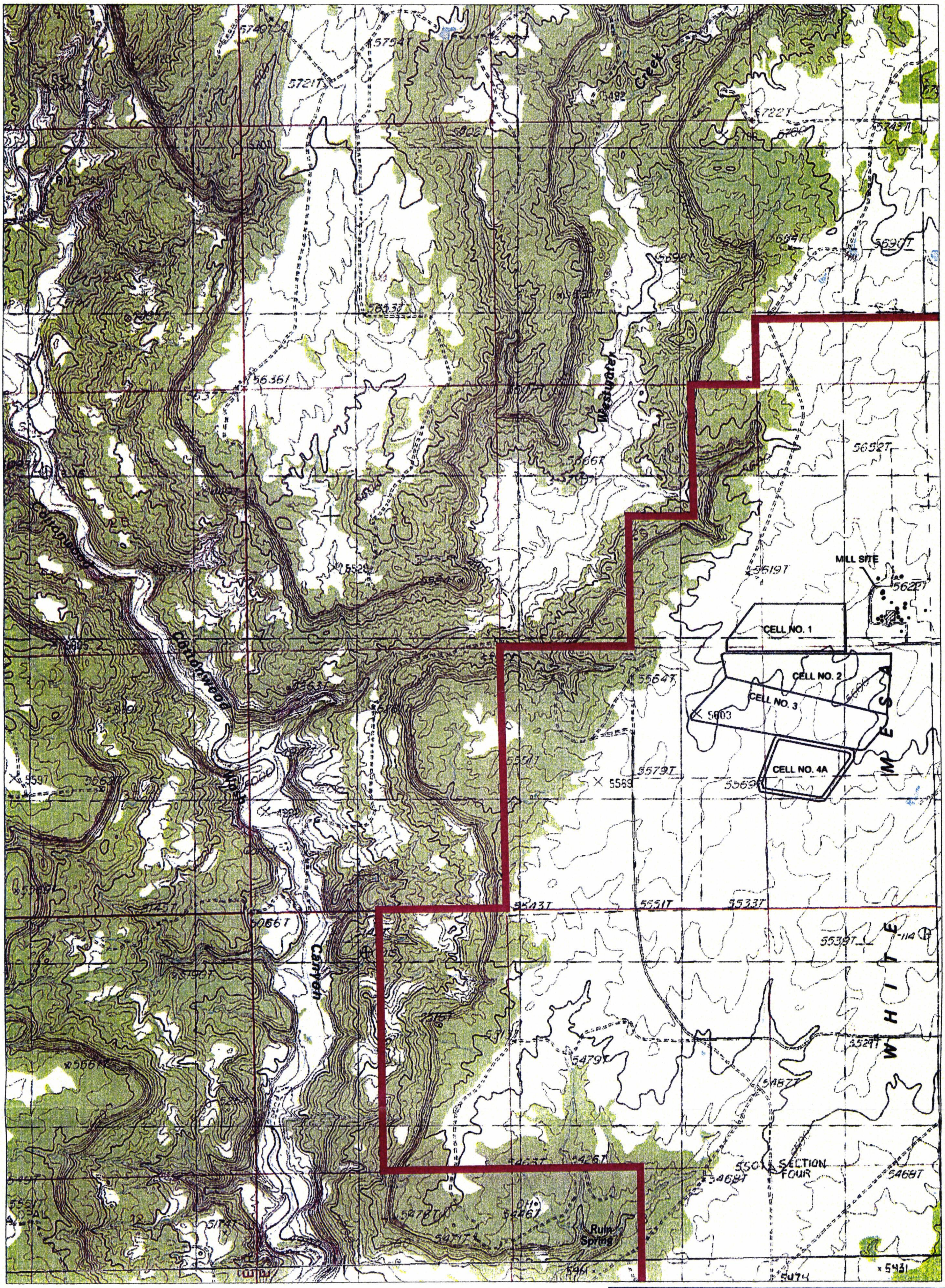
✧ 5572 temporary perched monitoring well installed April, 2005 showing elevation in feet amsl

✲ 5539 temporary perched monitoring well installed May, 2007 showing approximate elevation in feet amsl

NOTES: Locations and elevations for TW4-23, TW4-24, and TW4-25 are approximate; Water level for TW4-6 is from the third quarter, 2007

HYDRO GEO CHEM, INC.

Figure 8
Kriged 4th Quarter, 2007 Water Levels



From USGS 7.5 minute quad sheet for Black Mesa

N

0 1000 2000 3000
SCALE IN FEET

PROPERTY BOUNDARY

Denison Mines (USA) Corp

Figure 9
White Mesa Mill
Approximate Location
Ruin Spring

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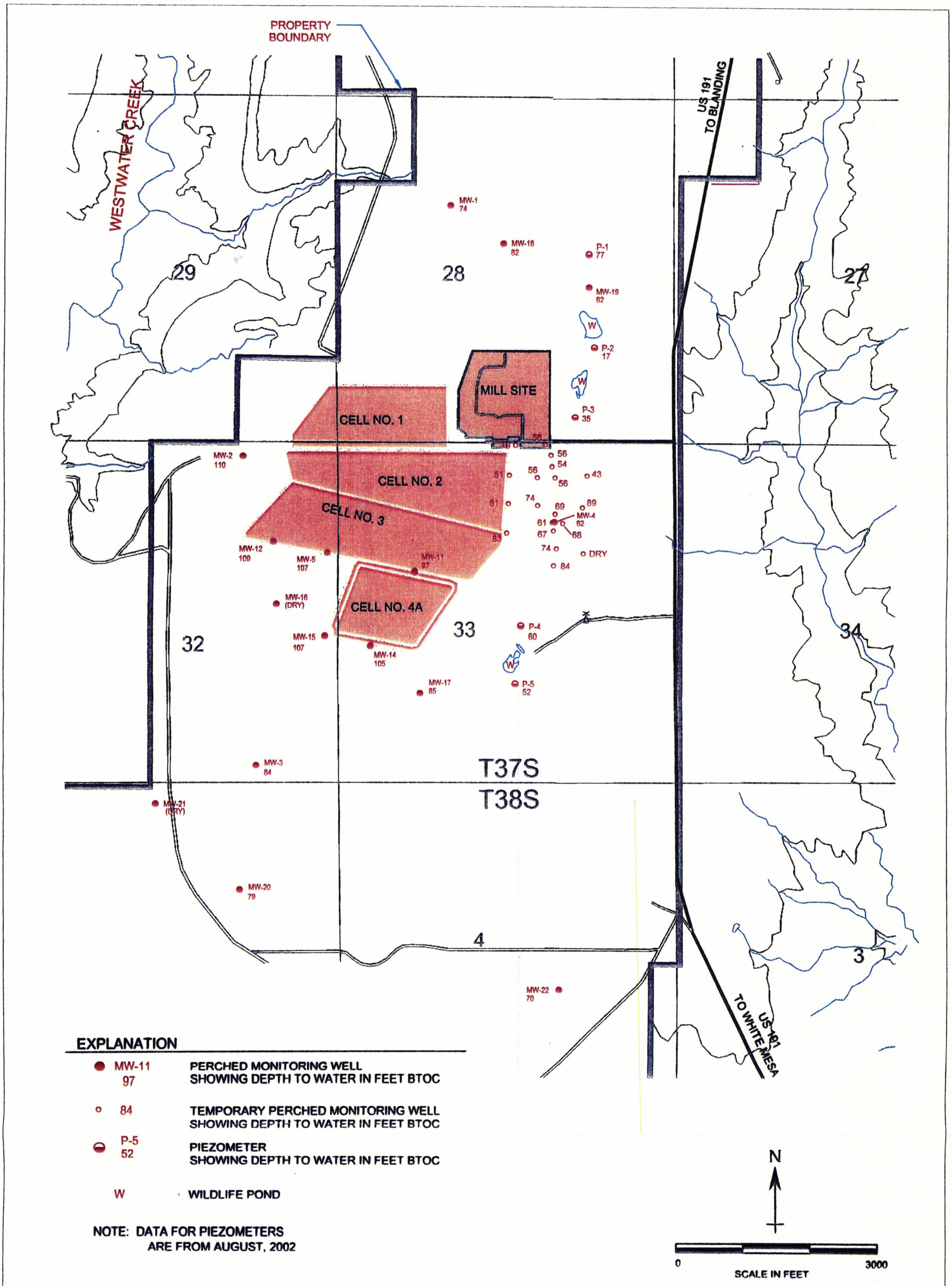

Denison Mines (USA) Corp.

Figure 10
White Mesa Mill
Depth to Perched Water
September, 2002

Perched zone hydraulic gradients currently range from a maximum of approximately 0.04 feet per foot (ft/ft) immediately northeast of tailings Cell 3 to less than 0.01 ft/ft downgradient of Cell 3, between Cell 3 and MW-20. The average hydraulic gradient between the downgradient edge of tailings Cell 3 and Ruin Spring was approximated by HGC to be approximately 0.012 ft/ft. HGC also estimated a hypothetical worst case average perched zone hydraulic gradient, assuming the perched water elevation to be coincident with the base of tailings Cell 3, to be approximately 0.019 ft/ft. See Section 3.2 of Appendix A.

HGC also estimated the average permeability of the perched zone downgradient of tailings Cell 3, based on pump/recovery test and slug test data obtained from perched zone wells located along the downgradient edge of and south of Cell 3, to be between 2.39E-05 cm/s and 4.3E-05 cm/s. See Section 3.3 of Appendix A to the February 28, 2007 Environmental Report incorporated here by reference.

7.4 Groundwater Quality

7.4.1 Entrada/Navajo Aquifer

The Entrada and Navajo Sandstones are prolific aquifers beneath and in the vicinity of the site. Water wells at the site are screened in both of these units, and therefore, for the purposes of this discussion, they will be treated as a single aquifer. Water in the Entrada/Navajo Aquifer is under artesian pressure, rising 800 to 900 ft above the top of the Entrada's contact with the overlying Summervillle Formation; static water levels are 390 to 500 ft below ground surface.

Within the region, this aquifer is capable of yielding domestic quality water at rates of 150 to 225 gpm, and for that reason, it serves as a secondary source of water for the Mill. Additionally, two domestic water supply wells drawing from the Entrada/Navajo Aquifer are located 4.5 miles southeast of the Mill site on the Ute Mountain Ute Reservation. Although the water quality and productivity of the Navajo/Entrada aquifer are generally good, the depth of the aquifer (>1,000 ft bls) makes access difficult.

Table 2 is a tabulation of groundwater quality of the Navajo Sandstone aquifer as reported in the FES and subsequent sampling. The total dissolved solids (TDS) range from 244 to 1,110 mg/liter in three samples taken over a period from January 27, 1977, to May 4, 1977. High iron (0.057 mg/liter) concentrations are found in the Navajo Sandstone. Because the Navajo Sandstone aquifer is isolated from the perched groundwater zone by approximately 1,000 to 1,100 ft of materials having a low average vertical permeability, sampling of the Navajo Sandstone is not required under the Mill's previous NRC Point of Compliance monitoring program or under the state's GWDP. However, samples were taken at two other deep aquifer wells (#2 and #5) on site (See Figure 11 for the locations of these wells), on June 1, 1999 and June 8, 1999, respectively, and the results are included in Table 2.

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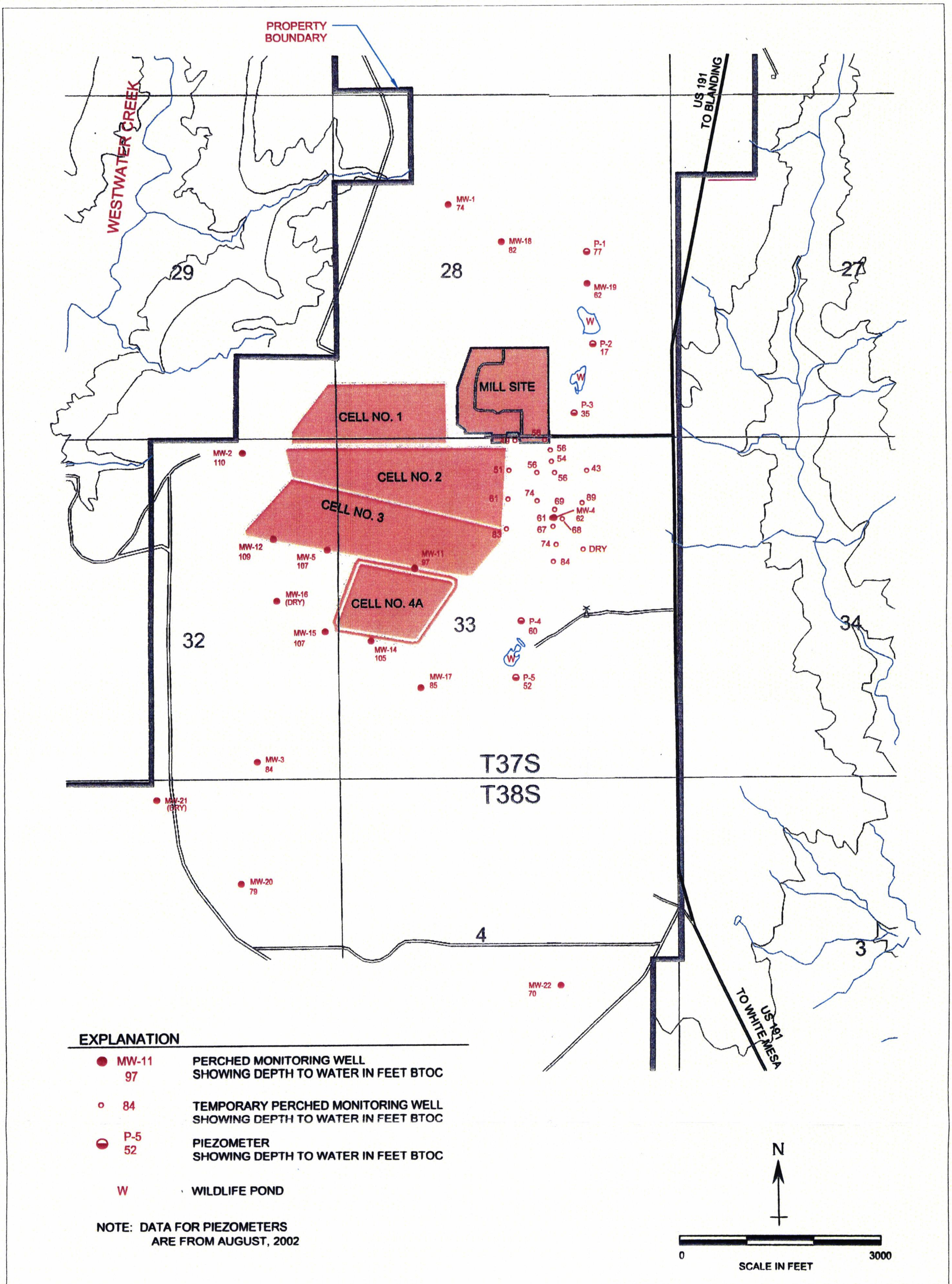

Denison Mines (USA) Corp.

Figure 11
White Mesa Mill
Stock Watering Pond Locations

Table 2
Water Quality of Groundwater in the Mill Vicinity

Parameter	FES, Test Well (G2R) (1/27/77 - 3/23/78[1])	Well #2 6/01/99[1]	Well #5 6/08/99[1]
Field Specific Conductivity (umhos/cm)	310 to 400		
Field pH	6.9 to 7.6		
Temperature (°C)	11 to 22		
Estimated Flow m/hr (gpm)	109(20)		
pH	7.9 to 8.16		
Determination, mg/liter			
TDS (@180°C)	216 to 1110		
Redox Potential	211 to 220		
Alkalinity (as $CaCOS_3$)	180 to 224		
Hardness, total (as $CaCO_3$)	177 to 208		
Bicarbonate		226	214
Carbonate (as CO_3)	0.0	<1.0	<1.0
Aluminum		0.003	0.058
Aluminum, dissolved	<0.1		
Ammonia (as N)	0.0 to 0.16	<0.05	<0.05
Antimony		<0.001	<0.001
Arsenic, total	.007 to 0.014	0.018	<0.001
Barium, total	0.0 to 0.15	0.119	0.005
Beryllium		<0.001	<0.001
Boron, total	<0.1 to 0.11		
Cadmium, total	<0.005 to 0.0	<0.001	0.018
Calcium		50.6	39.8
Calcium, dissolved	51 to 112		
Chloride	0.0 to 50	<1.0	2.3
Sodium		7.3	9.8
Sodium, dissolved	5.3 to 23		
Silver		<0.001	<0.001
Silver, dissolved	<0.002 to 0.0		
Sulfate		28.8	23.6
Sulfate, dissolved (as SO_4)	17 to 83		
Vanadium		0.003	0.003
Vanadium, dissolved	<.002 to 0.16		
Manganese		0.011	0.032
Manganese, dissolved	0.03 to 0.020		
Chromium, total	0.02 to 0.0	0.005	0.005
Copper, total	0.005 to 0.0	0.002	0.086
Fluoride		0.18	0.18
Fluoride, dissolved	0.1 to 0.22		
Iron, total	0.35 to 2.1	0.43	0.20
Iron, dissolved	0.30 to 2.3		

[1] Zero values (0.0) are below detection limits.

Parameter	FES, Test Well (G2R) (1/27/77 - 3/23/78[1])	Well #2 6/01/99[1]	Well #5 6/08/99[1]
Lead, total	0.02 - 0.0	<0.001	0.018
Magnesium		20.4	21.3
Magnesium, dissolved	15 to 21		
Mercury, total	<.00002 to 0.0	<0.001	<0.001
Molybdenum		0.001	<0.001
Molybdenum, dissolved	0.004 to 0.010		
Nickel		<0.001	0.004
Nitrate + Nitrate as N		<0.10	<0.10
Nitrate (as N)	<.05 to 0.12		
Phosphorus, total (as P)	<0.01 to 0.03		
Potassium		3.1	3.3
Potassium, dissolved	2.4 to 3.2		
Selenium		<0.001	<0.001
Selenium, dissolved	<.005 to 0.0		
Silica, dissolved (as SiO_2)	5.8 to 12		
Strontium, total (as U)	0.5 to 0.67		
Thallium		<0.001	<0.001
Uranium, total (as U)	<.002 to 0.16	0.0007	0.0042
Uranium, dissolved (as U)	<.002 to 0.031		
Zinc		0.010	0.126
Zinc, dissolved	0.007 to 0.39		
Total Organic Carbon	1.1 to 16		
Chemical Oxygen Demand	<1 to 66		
Oil and Grease	1		
Total Suspended Solids	6 to 1940	<1.0	10.4
Turbidity		5.56	19.1
Determination (pCi/liter)			
Gross Alpha			<1.0
Gross Alpha ± precision	1.6±1.3 to 10.2±2.6		
Gross Beta			<2.0
Gross Beta ± precision	8±8 to 73±19		
Radium 226 ± precision			0.3±0.2
Radium 228			<1.0
Ra–226 ± precision	0.1±.3 to 0.6±0.4		
Th–230 ± precision	0.1±0.4 to 0.7±2.7		
Pb–210 ± precision	0.0±4.0 to 1.0±2.0		
Po–210 ± precision	0.0±0.3 to 0.0±0.8		

Source: Adapted from FES Table 2.25 with additional Mill sampling data

7.4.2 Perched Groundwater Zone

Perched groundwater in the Dakota/Burro Canyon Formation is used on a limited basis to the north (upgradient) of the site because it is more easily accessible. The quality of the Burro Canyon perched water beneath and downgradient from the site is poor and extremely variable. The concentrations of total dissolved solids (TDS) measured in water sampled from upgradient and downgradient wells range between approximately 1,200 and 5,000 mg/1. Sulfate concentrations measured in three upgradient wells varied between 670 and 1,740 mg/l (Titan, 1994). The perched groundwater therefore is used primarily for stock watering and irrigation.

The saturated thickness of the perched water zone generally increases to the north of the site. See the Background Groundwater Quality Report: Existing Wells For Denison Mines (USA) Corp.'s White Mesa Mill Site, San Juan County, Utah dated December 2006 prepared by Intera, Inc., Appendix B.

At the time of renewal of the Mill license by the NRC in March, 1997 and up until issuance of the Mill's Groundwater Discharge Permit ("GWDP") in March 2005, the Mill implemented a groundwater detection monitoring program to ensure compliance to 10 CFR Part 40, Appendix A, in accordance with the provisions of Mill License condition 11.3A. The detection monitoring program was in accordance with the report entitled, "Points of Compliance, White Mesa Uranium Mill," submitted by letter to the NRC dated October 5, 1994. Under that program, the Mill sampled monitoring wells MW-5, MW-11, MW-12, MW-14, MW-15 and MW-17, on a quarterly basis. Samples were analyzed for chloride, potassium, nickel and uranium, and the results of such sampling were included in the Mill's Semi-Annual Effluent Monitoring Reports that were filed with the NRC up until August 2004 and with the DRC subsequent thereto.

Prior to 1997, commencing in 1979, the Mill monitored up to 20 constituents in up to 13 wells. That program was changed to the Points of Compliance Program in 1997 because:

- The Mill and tailings system had produced no impacts to the perched zone or deep aquifer; and
- The most dependable indicators of water quality and potential cell failure were considered to be chloride, nickel, potassium and natural uranium.

8.0 Ecological Resources and Biota

8.1 Terrestrial

a) Flora

The natural vegetation presently occurring within a 25-mile (40-km) radius of the Mill site is very similar to that of the region, being characterized by pinyon-juniper woodland intergrading with big sagebrush (Artemisia tridentata) communities. The pinyon-juniper community is dominated by Utah juniper (Juniperus osteosperma) with occurrences of pinyon pine (Pinus edulis) as a codominant or subdominant tree species. The understory of this community, which is usually quite open, is composed of grasses, forbs, and shrubs that are also found in the big sagebrush communities. Common associates include galleta grass (Hilaria jamesii), green ephedra (Ephedra viridis), and broom snakewood (Gutierrezia sarothrae). The big sagebrush communities occur in deep, well-drained soils on flat terrain, whereas the pinyon-juniper woodland is usually found on shallow rocky soil of exposed canyon ridges and slopes. See Section 2.9 of the 1978 ER.

Based on the work completed by Dames & Moore in the 1978 ER, no designated or proposed endangered plant species occur on or near the project site (1978 ER, Section 2.8.2.1). Of the 65 proposed endangered species in Utah at that time, six have documented distributions in San Juan

County. A careful review of the habitat requirements and known distributions of these species by Dames & Moore in the 1978 ER indicated that, because of the disturbed environment, these species would probably not occur on the project site. The Navajo Sedge has been added to the list as a threatened species since the Dames & Moore study.

In completing the 2002 EA, NRC staff contacted wildlife biologists from the BLM and the Utah Wildlife Service to gather local information on the occurrences of additional species surrounding the Mill. In the 2002 EA, NRC staff concluded that the Navajo Sedge has not been observed in the area surrounding Blanding, and is typically found in areas of moisture (2002 EA at 4).

b) Fauna

Wildlife data were collected by Dames & Moore through four seasons at several locations on the Mill site, prior to construction of the Mill. The presence of a species was based on direct observations, trappings and signs such as the occurrence of scat, tracks, or burrows. A total of 174 vertebrate species potentially occur within the vicinity of the Mill (1978 ER, Appendix D), 78 of which were confirmed (1978 ER, Section 2.8.2.2).

Although seven species of amphibians are thought to occur in the area, the scarcity of surface water limits the use of the site by amphibians. Eleven species of lizards and five snakes potentially occur in the area (1978 ER, Section 2.8.2.2).

Fifty-six species of birds were observed in the vicinity of the Mill site (1978 ER, Section 2.8.2.2).

The food habits of eagles vary depending on the season and the region in which they live. Fish, carrion and waterfowl such as mallard, are consumed by eagles when available to them. The FES indicates that mallards are both common and permanent in the vicinity of the Mill (FES, Table 2.28).

Raptors are prominent in the western United States. Five species were observed in the vicinity of the site. Although no nests of these species were located at the time of the FES, all (except the golden eagle, Aquila chrysaetos) have suitable nesting habitat in the vicinity of the site. The nest of a prairie falcon (Falco mexicanus) was found about 3/4 mile (1.2 km) east of the site. Although no sightings were made of this species, members tend to return to the same nests for several years if undisturbed (1978 ER, Section 2.8.2.2).

Of several mammals that occupy the site, mule deer (Odocoileus hemionus) is the largest species. The deer inhabit the project vicinity and adjacent canyons during winter to feed on the sagebrush and have been observed migrating through the site to Murphy Point (1978 ER, Section 2.8.2.2). Winter deer use of the project vicinity, as measured by browse utilization, is among the heaviest in southeastern Utah at 25 days of use per acre in the pinyon-juniper-sagebrush habitats in the vicinity of the project site. In addition, this area is heavily used as a migration route by deer traveling to Murphy Point to winter. Daily movement during winter periods by deer inhabiting the area has also been observed between Westwater Creek and Murphy Point. The present size of the local deer herd is not known.

Other mammals present at the site include the coyote (Canis latrans), red fox (Vulpes vulpes), gray fox (Urocyon cineroargenteus), striped skunk (Mephitis mephitis), badger (taxidea taxus), longtail weasel (Mustela frenata), and bobcat (Lynx rufus). Nine species of rodents were trapped or observed on the site, the deer mouse (Peromyscus maniculatus) having the greatest distribution and abundance. Although desert cottontails (Sylvilagus auduboni) were uncommon in 1977, black-tailed jackrabbits (Lepus californicus) were seen during all seasons.

In the 2002 EA, NRC staff noted that, in the vicinity of the site, the U.S. Fish and Wildlife Service had provided the list set out in Table 3.12-1, of the endangered, threatened, and candidate species that may occur in the area around the site.

Table 3 Endangered, Threatened and Candidate Species in the Mill Area

Common Name	Scientific Name	Status
Navajo Sedge	Carex specuicola	Threatened
Bonytail Chub	Gila elegans	Endangered
Colorado Pikeminnow	Ptychocheilus lucius	Endangered
Humpback Chub	Gila cypha	Endangered
Razorback Sucker	Xyrauchen texanus	Endangered
Bald Eagle	Haliaeetus leucocephalus	Threatened
California Condor	Gymnogyps californianus	Endangered
Gunnison Sage Grouse	Centrocercus minimus	Candidate
Mexican Spotted Owl	Strix occidentalis lucida	Threatened
Southwestern Willow Flycatcher	Empidonax traillii extimus	Endangered
Western Yellow-billed Cuckoo	Coccyzus americanus occidentalis	Candidate
Black-footed Ferret	Mustela nigripes	Endangered

Source: 2002 EA

The 2002 EA also noted that, in addition, the species listed on Table 3.12-2 may occur within the Mill area that are managed under Conservation Agreements/Strategies

Table 4
Species Managed Under Conservation Agreements/Strategies at the Mill Area

Common Name	Scientific Name
Colorado River Cutthroat Trout	Oncorhynchus clarki pleuriticus
Gunnison Sage Grouse	Centrocercus minimus

Source: 2002 EA

For the 2002 EA, NRC staff contacted wildlife biologists from the BLM and the Utah Wildlife Service to gather local information on the occurrences of these additional species surrounding the Mill. NRC staff made the following conclusions (2002 EA p. 4):

While the ranges of the bald eagle, peregrine falcon, and willow flycatcher encompass the project area, their likelihood of utilizing the site is extremely low. The black-footed ferret has not been seen in Utah since 1952, and is not expected to occur any longer in the area. The

California Condor has only rarely been spotted in the area of Moab, Utah, (70 miles north) and around Lake Powell (approximately 50 miles south). The Mexican Spotted Owl is only found in the mountains in Utah, and is not expected to be on the Mesa. The Southwestern Willow Flycatcher, Western Yellow-billed Cuckoo, and Gunnison Sage Grouse are also not expected to be found in the immediate area around the Mill site.

8.2 Aquatic and Wetlands Biota

Aquatic habitat at the Mill site ranges temporally from extremely limited to nonexistent due to the aridity, topography and soil characteristics of the region and consequent dearth of perennial surface water. Two small stockwatering ponds are located on the Mill site a few hundred yards from the ore pad area (See Figure 11). One additional small "wildlife pond", east of Cell 4A, was completed in 1994 to serve as a diversionary feature for migrating waterfowl. Although more properly considered features of the terrestrial environment, these ponds essentially represent the total aquatic habitat on the Mill site. These ponds probably harbor algae, insects, other invertebrate forms, and amphibians. They also provide a water source for small mammals and birds. Similar ephemeral catch and seepage basins are typical and numerous to the northeast of the Mill site and south of Blanding.

Aquatic habitat in the Mill vicinity is similarly limited. The three adjacent streams (Corral Creek, Westwater Creek, and an unnamed arm of Cottonwood Wash) are only intermittently active, carrying water primarily in the spring during increased rainfall and snowmelt runoff, in the autumn, and briefly during localized but intense electrical storms. Intermittent water flow most typically occurs in April, August, and October in those streams. Again, due to the temporary nature of these steams, their contribution to the aquatic habitat of the region is probably limited to providing a water source for wildlife and a temporary habitat for insect and amphibian species.

In the 2002 EA, NRC staff concluded that (p. 4) no populations of fish are present on the project site, nor are any known to exist in the immediate area of the site. Four species of fish designated as endangered or threatened (the Bonytail Chub, Colorado Pikeminnow, Humpback Chub and Razorback Sucker) occur in the San Juan River 18 miles south of the site, which Dames & Moore noted in the 1978 ER (Section 2.8.2) is the closest habitat suitable for these species. NRC staff further concluded that there are no discharges of mill effluents to surface waters, and therefore, no impacts are expected for the San Juan River due to operations of the Mill.

9.0 Background Radiological and Non-Radiological Characteristics

Background Radiological and Non-Radiological Effects have been evaluated, updated and reported extensively in Denison's February 28, 2007 License Renewal Application and accompanying Environmental Report, incorporated here by reference.

10.0 Environmental Effects Related Directly to the Construction of Cell 4b

The environmental effects of Cell 4b construction consist of those related to the release of airborne particulate (dusting), radon release from the operating cell, and the impact, if any, on groundwater beneath the pond. In order to evaluate these environmental considerations two separate evaluations were completed, *Site Hydrogeology Estimation Of Groundwater Travel Times and Recommended Additional Monitoring Wells For Proposed Tailings Cell 4BWhite Mesa Uranium Mill Site Near Blanding, Utah, Hydro Geo Chem, Inc., 2008* and *Dose Assessment Pertaining to the Proposed Development of New Tailings Cells For the White Mesa Uranium Mill, SENES Consultants, Ltd, 2008.*

These evaluations are provided as Appendix A and Appendix B, respectively, and are discussed in summary in the pertinent subsections below.

10.1 Groundwater Pathway Impact

The evaluation provided by Hydro Geo Chem Inc. finds that travel time for any water exiting the pond to the perched water zone and then to the point(s) of perched zone discharge is very long, far exceeding the time period of milling operations and closure of the tailings cells when little free liquid is available for infiltration through the cell liner system. More specifically, HGC found that the time for fluids that could be released from the cells to reach the points of seepage and spring formation at ruin spring and Cottonwood seep are on the order of several thousand years. However, this analysis is very conservative in that travel time through the pond liner was not considered, and because the liner system is robust state-of-the art construction, travel time through the liner is a significant protective factor. In fact, this aspect has been evaluated extensively by MWH Americas, Inc. in their report *Infiltration and Contaminant Transport Modeling Report, White Mesa Mill Site, Blanding Utah, November, 2007,* incorporated here by reference. The infiltration modeling effort revealed that the construction design for Cells 4a and 4b will meet the "Closed Cell Performance Requirements" of the Groundwater Discharge Permit at Part 1.D.6. More specifically, MWH concluded that the approved reclamation plan for the cells will meet the following regulatory requirements for a period of not less than 200 years:

a) Minimize infiltration of precipitation or other surface water into the tailings, including but not limited to the radon barrier;
b) Prevent the accumulation of leachate head within the tailings waste layer that could rise above or over-top the maximum FML liner elevation internal to any disposal cell, i.e. create a "bathtub" effect; and,
c) Ensure that groundwater quality at the compliance monitoring wells does not exceed Ground Water Quality Standards or Ground Water Compliance Limits specified in Part 1.C.1 and Table 2 of the Permit.

10.2 Proposed Additional Groundwater Monitoring

In order to monitor the performance of Cell 4b, and consistent with EPA Guidance, it was concluded by Hydro Geo Chem Inc. that an additional well or wells will be needed to monitor the Cell's performance at the downgradient edge of the cell. This in addition to the many wells already incorporated into the Groundwater Discharge Permit for the facility. Accordingly, two additional wells are proposed, one at the southwest corner of proposed Cell 4b and one between the southwest corner well and existing well MW-15 (See Figure 10 of Appendix B. These installations will conservatively maintain the approximate existing spacing as defined by the proximity of MW-14 to MW-15 along the downgradient edge of existing Cell 4a.

10.3 Radiological Impact

In February 2007, a dose assessment was prepared for DUSA by SENES Consultants, Ltd. in support of the license renewal application for the mill. MILDOS-AREA was used to estimate the dose commitments that could potentially be received by individuals and the general population within a 50 mile (80 km) radius for processing of conventional ores. The assessment was prepared for scenarios in which Colorado Plateau (0.25% U_3O_8 and 1.5% V_2O_5) or Arizona Strip (0.637%) ores are processed at the mill.

In order to evaluate the radiological impact of Cell 4b's operation the prior dose assessment analyses was extended from the previous report of February 2007 to incorporate the dose from the proposed development of new tailings cells anticipated in the future. The results of this extended assessment are provided as Attachment B to this report (*Proposed Development of New Tailings cells For The White Mesa Uranium Mill, SENES, 2008),* and reveal that the addition of Cell 4b to the facility will not impact the ability of the facility to comply with regulatory requirements

The U.S. NRC approved MILDOS-AREA was used to estimate the dose commitments received by individuals and the general population within a 50 mile (80 km) radius of the site for the processing of either Colorado Plateau or Arizona Strip ore separately. In each scenario, the doses arising from emissions of dust and radon from the mill area and ore pads were assumed to be the same as the previous 2007 report since the scenarios both involve the processing of Colorado Plateau and Arizona Strip ores. Therefore, MILDOS-AREA runs from the previous report were revised to exclude the tailings cells. The doses from the tailings cells were estimated in separate MILDOS-AREA runs and added to the dose from the mill area and ore pads. Table 4 provides a summary of the source terms included in Phases 1 and 2 of the development of new tailings cells including Cells 4a and 4b.

TABLE 4
SOURCE TERMS INCLUDED IN PHASE 1 AND 2

Source Term	Phase 1	Phase 2
Mill area	included	included
Ore Pads	included	included
Tailings Cell 2 with Interim Soil Cover	included	included
Tailings Cell 3	active	interim soil cover
Tailings Cell 4A	active	active
Tailings Cell 4B	excluded	active

The wind erosion and radon release rates from the tailings cells (active and with interim soil cover) were modeled by using a maximal worst case approach.

Each active tailings cell was modeled to have an active area of 10 acres (i.e., the maximum expected to be uncovered at any time since it is not possible to predict the distribution of uncovered tailings between the active cells at any given time. The release rate of wind-eroded tailings dust was estimated for 10 acres. The total annual radon release rate was estimated by assuming a radon release rate of 20 pCi/m^{2}s (i.e., maximum radon-222 emissions to ambient air from an existing uranium mill pile) over the entire area of each cell consistent with NESHAPs.

Emissions from the tailings cells (2 and 3) with interim soil cover were assumed to occur over the entire area of each cell; however, only radon is released at a rate of 10 pCi/m^{2}s after the application of the soil cover.

The calculated total annual effective dose commitments (including radon) calculated using MILDOS-AREA were compared to the Utah Administrative Code R313-15-301(1)(a) requirement that the dose to individual members of the public shall not exceed 100 mrem/yr (radon included). For proposed development of new tailings cells for the processing of Colorado Plateau ore, the maximum total annual effective dose commitments was calculated to be a maximum of 1.4 mrem/yr for an infant at the nearest potential resident, BHV-1 (Tables 6.1-1 and 6.1-3) (i.e., effective dose) and is about 1.4% of the R313-15-301(1)(a) limit of 100 mrem/yr (radon included) to an individual member of the public for Phases 1 and 2. For proposed development of new tailings cell for the processing of Arizona Strip ore, the total annual effective dose commitments were calculated to be a maximum of 3.1 mrem/yr for an infant at the nearest potential resident, BHV-1 (i.e., effective dose) and is about 3.1% of the 100 mrem/yr limit (radon included) to an individual member of the public for Phases 1 and 2. Overall, the predicted annual effective dose commitments for proposed development of new tailings cells during anticipated ore processing operations comply with R313-15.

In addition, our MILDOS-AREA calculated 40 CFR 190 annual dose commitments (excluding radon) were compared to the 40 CFR 190 criterion, which is 25 mrem/yr to the whole body (excluding the dose due to radon) and 25 mrem/yr to any other organ to any member of the public (U.S. EPA 2002). The 40 CFR 190 doses were also used to demonstrate compliance with R313-15-101(4) (10 CFR 20.1101(d)) (i.e., the licensee must demonstrate that total effective dose equivalent to the individual member of the public likely to receive the highest total effective dose equivalent will not exceed 10 mrem/yr (absent of the radon dose). For proposed development of new tailings cells for the processing of Colorado Plateau ore, the 40 CFR 190 annual dose commitments were calculated to be a maximum of 4.8 mrem/yr for a teenage at the nearest potential resident, BHV-1 (i.e., dose to the bone) and is about 19% of the 40 CFR 190 dose criterion of 25 mrem/yr for Phases 1 and 2. Further, the 40 CFR 190 annual effective dose commitments demonstrate compliance with the R313-15-101(4) (10 CFR 20.1101(d)) limit of 10 mrem/yr to the individual member of the public likely to receive the highest total effective dose equivalent. For Arizona Strip ore, the 40 CFR 190 annual dose commitments were at most 12 mrem/yr for a teenage at the nearest potential resident, BHV-1 (i.e., dose to the bone) and is well within the 40 CFR 190 dose criterion of 25 mrem/yr for Phases 1 and 2. Further, the annual effective dose commitments demonstrate compliance with R313-15-101(4) (10 CFR 20.1101(d)) limit of 10 mrem/yr to the individual member of the public likely to receive the highest total effective dose equivalent.

10.4 Proposed Radiological Monitoring to Accommodate Cell 4b Operations

As an element of evaluating potential off-site doses related to the construction and operation of Cell 4b, Denison commissioned a review of its environmental monitoring programs in order to determine what, if any, additional monitoring would be needed to accommodate the operation of Cell 4b. The review was conducted by SENES Consultants, Ltd who concluded that the current environmental monitoring regime was sufficient and that added monitoring was not warranted due to the operation of Cell 4b. The results of the SENES review are attached here as Appendix C to this report.

11.0 Alternatives

The action under consideration is the construction of an already contemplated tailings Cell (Cell 4b) in order accomodate continued operation of the Mill. The alternatives available to the Executive Secretary are to:

a) Amend the License to include the construction of Cell 4b with its existing terms and conditions;

b) Amend the License to include the construction of Cell 4b with such additional conditions as are considered necessary or appropriate to protect public health, safety and the environment; or

c) Deny the addition of Cell 4b construction into the License.

As demonstrated in this ER, the environmental impacts associated with construction and operation of Cell 4b do not warrant either limiting the Mill's future operations or denying the Cell 4b construction approval request. As there are no significant public health, safety or environmental impacts associated with the construction of Cell 4b, Denison asserts that alternatives with equal or greater impacts need not be evaluated, and alternative a) is the appropriate alternative for selection.

11.1 Issuance of Amendment for Cell 4a

The Mill is one of only two operating uranium mills in the Unites States and the only uranium mill on the western slope of the Rocky Mountains. As a result, the Mill is the only currently available opportunity for production of uranium from conventionally mined ore in San Juan County and in the four corners area of the United States. The Mill therefore provides a benefit to the regional community and to the uranium industry as a whole in the United States. The construction of Cell 4b would allow the Mill to continue to provide these benefits for many more years and as contemplated in the original licensing effort.

As was demonstrated in Section 3 of the ER accompanying the 2007 License Renewal Application, the Mill's equipment, facilities and procedures are adequate to minimize impacts to public health, safety and the environment. More importantly, UDEQ has already approved the construction of Cell 4a which is identical to Cell 4b with regard to its robust and state-of-the-art protective design features. Also, the Mill has operated since its inception in compliance with all applicable regulatory standards and ALARA goals and is capable of continuing to operate in compliance with such standards and goals.

In addition to the License, the Mill has been issued a Groundwater Discharge Permit, which provides additional protection for public health and the environment, including a rigorous groundwater monitoring program to monitor and assess the performance of tailings cells associated with the facility. The Mill has demonstrated that it is capable of continuing to operate in a manner that satisfies all regulatory standards and ALARA goals under the existing terms and conditions of the License and GWDP, this amendment application has assessed and proposed additional monitoring necessary to accommodate newly constructed Cell 4b. Based upon these factors and considerations Denison asserts that there is no need to add any additional conditions to the License in order to protect public health, safety or the environment as a result of Cell 4b construction.

11.2 No Action Alternative

A "no action" alternative would result in the amendment request being denied and the immediately available processing opportunities for mined uranium ore being lost in the short term, severely impacting independent uranium miners in the area and lessening the United States' capability to respond to the need for uranium for nuclear power generation.

Denying the request for construction of Cell 4b severely constrain the utilization of the Mill in the near term and eliminate its ability to operate over the longer term during a time when commodity prices for uranium are favorable, and the demand for uranium milling capacity is unprecedented. Permitting the Mill to continue processing conventionally mined ore for the recovery of uranium and the construction of Cell 4b will provide the opportunity for regular employment in an economically depressed area of the United States. A large percentage of the workers at the Mill are Native American, and this employment opportunity has significant direct impact in the local Native American community. In addition to the direct hiring of employees at the Mill, local miners and other western United States mining companies require access to an operating uranium mill. The inability of these mining entities to gain access to local milling services will prevent the mining industry from responding to the current uranium supply shortage. Thus, secondary local economies will not enjoy the benefit of renewed mining income, and national demand for uranium will continue to be reliant primarily on foreign supplies of uranium for nuclear fuel. In order to respond to the current uranium market, conventional mining companies will be forced to license and construct new uranium milling facilities to engage in conventional ore processing, directly in opposition to the objective of non-proliferation of new uranium mill tailings disposal facilities embodied by 10 CFR Part 40 Appendix A, Criterion 2.

As has been demonstrated by the forgoing assessments, the impacts associated with the construction and operation of Cell 4b are well within the realm of impacts anticipated in the FES, the 1985 EA and the 1997 EA, and UDEQ's approval of Cell 4b construction will satisfy applicable criteria in R313-22-33 and R313-24. As a result, Denison asserts that the Executive Secretary should have no basis for denying the proposed action.

11.3 Alternatives Considered But Eliminated

a) Consideration of Alternative Sites

The Mill is already sited and in existence and has been operating for over 25 years. It is not feasible to consider moving the Mill to an alternative site or to construct additional tailing cells at a different location. Even if that were possible, it has been demonstrated in Section 3 of the February, 2007 ER accompanying the License Renewal Application that the Mill is sited in a good hydrogeologic setting and is otherwise well sited for its operations, including tailings cells contemplated at the time of the Mill's original licensure. This is evident from the fact that the Mill has operated since its inception in compliance with applicable regulatory standards and ALARA goals.

If the construction of Cell 4b is not approved as an element of continued milling operations, there can be no assurance that, as an alternative, an equally well-suited site for milling and tailings cell contruction, that complies with the applicable siting requirements of 10 CFR Part 40 Appendix A, can be identified and obtained. Even if a suitable alternative site were to be identified and obtained, licensing and construction of a new mill and tailings cells could not be accomplished in a time frame that would ensure production could commence in a period of suitable market conditions. Furthermore, as the existing Mill tailings would have to be decommissioned in place, creation of a new mill site would result in unnecessary proliferation of mill tailings disposal facilities in contravention of 10 CFR Part 40 Appendix A, Criterion 2.

b) Consideration of Alternative Engineering Methods

As will be demonstrated in Section 3, the existing Mill facilities, equipment, procedures and training of personnel have resulted in the Mill operating since inception in compliance with all applicable regulatory standards and ALARA goals. Current modeling demonstrates that the Mill is capable of continuing to operate under the existing terms and conditions of the License in a manner that will continue to comply with such standards and goals. Furthermore, the Mill's GWDP institutes additional protections and engineering controls, including the requirement that any new construction of tailings cells must meet current best available technology standards. Therefore, there is no need to consider alternative engineering methods. The existing equipment and facilities, together with the existing terms and conditions of the License and the GWDP are sufficient to ensure that all applicable requirements will continue to be satisfied.

11.4 Cumulative Effects

There are no past, present, or reasonably foreseeable future actions which could result in cumulative impacts that have not been contemplated and previously approved under the existing Mill License and the design of Cell 4b.

As stated throughout this License Amendment request, the Cell 4b construction will result in no activity with potential, significant, incremental impacts to public health, safety or the environment over and above the actions contemplated in the FES, the 1985 EA and the 1997 EA. The activities contemplated with regard to ore processing and disposal of tailings remain unchanged from those previously authorized under the License.

11.5 Comparison of the Predicted Environmental Impacts

There have been no observed significant impacts which were not previously quantified and addressed to public health, safety or the environment resulting from the proposed construction of Cell 4b. As there will be no significant changes in Mill operations if the License is amended to accommodate construction of Cell 4b, possible impacts to public health, safety or the environment will not exceed those predicted in the original License application and periodic renewals.

11.6 Updates & Changes to Factors That May Cause Reconsideration of Alternatives

As discussed in Section 12 below, Costs and Benefits, there have been no changes to factors that may cause reconsideration of alternatives. There have been no significant changes in the costs associated with operation of the Mill (including its impoundments), and the benefits associated with continued operation and construction of already contemplated tailing cells have become more evident over time as the number of uranium mills has dwindled and the demand for uranium milling service capacity from local miners and the industry as a whole has increased in recent years. Furthermore, no new alternatives to the services provided by the Mill and its impoundments have been identified since the last License renewal in 1997.

12.0 Cost and Benefits

Appendix A to NUREG 1569 requires that the applicant for a license renewal describe any updates and changes to the economic costs and benefits for the facility since the last application.

There have been no significant changes to the costs associated with the Mill since the last License renewal in 1997. While there will a change to the currently disturbed area as a result of the Cell 4b construction, this additional Cell was contemplated, described and assessed, as a critical component of the initial 1978 NRC-FEIS and attendant licensing of the facility. As indicated in Section 3 of February, 2007 ER accompanying the renewal application, the Mill has operated in accordance with applicable regulatory standards and ALARA goals since its inception, and updated MILDOS AREA modeling indicates that the Mill is capable of continuing to operate well within those standards and goals. There have been no significant demographic changes that have impacted the ability of the Mill to operate in a manner that will result in no significant impacts to public health, safety or the environment. It is expected that continued Mill operations will continue to draw primarily upon the existing work force in the area with little impact on social services.

The Mill is one of only two operating uranium mills in the United States and is one of the largest private employers in San Juan County. The benefits of the Mill will continue to be the provision of well-paying jobs to workers in San Juan County and the support of the tax base in that County. Moreover, as the only operating uranium mill on the western slope of the Rocky Mountains, the Mill is relied upon by the large number of independent uranium miners in San Juan County and the Colorado Plateau as the only feasible uranium mill for their uranium ores. With the recent gap between the supply and demand for uranium and the increases in the price of uranium, the need for continued licensing of the Mill is crucial for such miners and for the uranium industry in the United States as a whole.

In sum, the costs associated with the operation of the Mill have not changed significantly, but the benefits have become more evident over time as the number of uranium mills has dwindled and the demand for uranium milling services from local miners and the industry as a whole has increased.

13.0 Mitigation of Impacts

NUREG 1569 requires that the ER provide the "results of effectiveness of any mitigation proposed and implemented in the original license". In the case of the White Mesa Mill, there have not been any mitigations proposed or implemented under the License.

14.0 Long Term Impacts

The long term impacts, including decommissioning, decontamination, and reclamation impacts associated with activities conducted pursuant to the License have been considered in detail in the FES, the Mill's Reclamation Plan, and the 2000 EA prepared by the NRC in connection with the Reclamation Plan.

The Mill's Reclamation Plan and financial surety arrangements, as well as the provisions in the Mill's GWDP that relate to final reclamation of the site are described in detail in Section 8 of the February, 2007 License Renewal Application, and are incorporated here by reference. The construction of Cell 4b will not result in any changes to operations at the Mill that would impact decommissioning, decontamination or reclamation aspect associated with Mill activities, or the previous analyses of such aspects. The grading contours and other reclamation features related to closure of Cell 4b at site closure are shown in Figure 20. All design features for Cell 4b are included in the Cell 4b Design Report prepared by Geosyntec Consultants which was transmitted to UDEQ in January of 2008.

CELL 1 (EVAPORATION)
MILL YARD
CELL 2
CELL 3
CELL 4A
CELL 4B
PROJECTED APPROXIMATE CATCH POINT (SEE NOTE 1)
5H:1V DOWNSLOPE
SLOPE 0.2%
5H:1V
TOPSOIL
RANDOM FILL
CLAY
W. L. 5611.94
W. L. 5578.8
N 322000
N 321000
N 320000
N 319000
E 2577000
E 2578000
E 2579000
LEGEND
5582.6 EXISTING SPOT ELEVATION
5612 ELEVATION OF TOP OF COVER
5612 ELEVATION OF TOP OF COVER CELL 4B
5560 EXISTING GROUND CONTOUR
NOTES
1. THE COVER WILL MEET THE GROUND WITH A DOWNWARD SIDE SLOPE OF 5H:1V.
2. ELEVATION OF THE BERMS SHOULD BE ADJUSTED TO MATCH WITH THOSE OF THE COVER.
3. A PORTION OF CELL 1-I WILL BE USED FOR PERMENANT STORAGE OF CONTAMINATED MATERIALS UPON FINAL SITE DECOMMISSIONING.
4. TOPOGRAPHY BY KLH ENGINEERING FROM AERIAL PHOTOGRAPHY DATED AUGUST 23, 1993. CONTOUR INTERVAL IS 2 FT.
5. SEE FIGURES 3 AND 4 FOR CROSS SECTIONS AND DETAILS.
6. EXISTING GROUND SURFACES SHALL BE REGRADED TO CONSTRUCT THE COVER WITH A FINAL SURFACE THAT IS CONSISTENT WITH THE RECLAMATION COVER GRADING PLAN.
SCALE
200 0 200 400 FEET
N
After Titan Environmental, 1996
REV. No. | DATE | BY | REVISIONS
1 | 11/18/98 | RAH | Add rock apron at toe of slopes, increase width of breach in Cell 4A dike & change to IUC title block
2 | 4/5/99 | RAH | Add section lines through the breach in Cell 4A dike & change to IUC title block
3 | 6/30/00 | DLS | Add Cell 1-I Disposal Area
4 | 3/25/08 | dmf | Add Cell 4A Reclamation Cap
5 | 4/8/08 | dmf | Add Cell 4B Reclamation Cap
DENISON MINES
White Mesa Mill
FIGURE A-5.1-2
Reclamation Cover Grading Plan for Cell 4B
DESIGN:
DRAWN: R. Van Horn
CHKD BY:
DATE: Feb., 1997
APP:
SCALE: 1" = 200'
SHEET of

SITE HYDROGEOLOGY
ESTIMATION OF GROUNDWATER TRAVEL TIMES
AND RECOMMENDED ADDITIONAL MONITORING WELLS
FOR PROPOSED TAILINGS CELL 4B
WHITE MESA URANIUM MILL SITE
NEAR BLANDING, UTAH

Prepared for:

DENISON MINES (USA) CORP
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January 8, 2008

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FIGURES

1. INTRODUCTION

This report provides a brief description of the hydrogeology of the White Mesa Uranium Mill site (the "Mill" or the "site"), located south of Blanding, Utah, and focuses on the occurrence and flow of groundwater within the relatively shallow perched groundwater zone at the site. Based on available existing hydrogeologic information from the site, estimates of hydraulic gradients and intergranular rates of groundwater movement (interstitial or pore velocities) are provided. These estimates are used to calculate average travel times for a hypothetical conservative solute (assuming no dispersion) from existing tailings cell #3 and proposed cell 4B at the site to a downgradient discharge point. Recommendations for additional perched zone monitoring wells downgradient of proposed cell 4B are also provided. Figure 1 is a site plan showing the locations of perched monitoring wells and proposed cell 4B.

Tailings cell #3 has been in service for many years and a large quantity of groundwater monitoring and hydraulic test data exists for perched monitoring wells completed around the perimeter of the cell. Data from the vicinity of the cell are used in conjunction with data downgradient of the cell to calculate perched zone hydraulic properties and groundwater gradients between cell #3 and the discharge point. Cell 4B is proposed to be installed at the downgradient edge of cell #3. The data from the immediate vicinity and downgradient of cell #3 used to compute rates of movement and travel times for a hypothetical conservative solute will likewise be used to calculate travel times for the hypothetical solute from proposed cell 4B to the discharge point.

2. 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 primarily on Titan, 1994, but includes the results of more recent site investigations, is provided below.

2.1 Geologic Setting

The White Mesa Uranium Mill site is located within the Blanding Basin of the Colorado Plateau physiographic province. Typical of large portions of the Colorado Plateau province, the rocks underlying the site are relatively undeformed. The average elevation of the site is approximately 5,600 feet above mean sea level (amsl).

The site is underlain by unconsolidated alluvium and indurated sedimentary rocks consisting primarily of sandstone and shale. The indurated rocks are relatively flat lying with dips generally less than 3°. The alluvial materials consist mostly 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, which are sandstones having a total thickness ranging from approximately 100 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 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.

2.2 Hydrogeologic Setting

The site is located within a region that has a dry to arid continental climate, with average annual precipitation of less than 11.8 inches, and average annual evapotranspiration of approximately 61.5 inches. Recharge to aquifers 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 of the aquifer (approximately 1,200 feet below land surface [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 wells completed across these units at the site rises approximately 800 feet above the base of the overlying Summerville Formation.

Perched groundwater in the Dakota Sandstone and Burro Canyon Formation is used on a limited basis to the north (upgradient) of the site because it is more easily accessible. Water quality of the Dakota Sandstone and Burro Canyon Formation is generally poor due to high total dissolved solids (TDS) 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.

2.3 Perched Zone Hydrogeology

Perched groundwater beneath the site occurs primarily within the Burro Canyon Formation. Perched groundwater at the site has a generally low quality due to high total dissolved solids (TDS) in the range of approximately 1,200 to 5,000 milligrams per liter (mg/L), and is used primarily for stock watering and irrigation in the areas upgradient (north) of the site. Perched water is supported within the Burro Canyon Formation by the underlying, fine-grained Brushy Basin Member. Figure 2 is a contour map showing the approximate elevation of the contact of the Burro Canyon Formation with the Brushy Basin Member, which essentially forms the base of the perched water zone at the site. Contact elevations are based on perched monitoring well drilling and geophysical logs and surveyed land surface elevations. As indicated, the contact generally dips to the south/southwest beneath the site.

Groundwater within the perched zone generally flows south to southwest beneath the site. Beneath the tailings cells, perched water flow is generally southwest to south-southwest.

2.3.1 Lithologic and Hydraulic Properties

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 hosts most 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. The permeability of the Dakota Sandstone and Burro Canyon Formation at the site is generally low.

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.

2.3.1.1 Dakota

Based on samples collected during installation of wells MW-16 (no longer in service) and MW-17, located immediately downgradient of the tailings cells at the site, porosities of the Dakota Sandstone range from 13.4 to 26 percent, averaging 20 percent, and water saturations range from 3.7 to 27.2 percent, averaging 13.5 percent. The average volumetric water content is approximately 3 percent. The permeability of the Dakota Sandstone based on packer tests in borings installed at the site ranges from 2.71 x 10^{-6} centimeters per second (cm/s) to 9.12 x 10^{-4} cm/s, with a geometric average of 3.89 x 10^{-5} cm/s.

2.3.1.2 Burro Canyon

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, located immediately downgradient of the tailings cells at the site (and no longer in service), porosity ranges from 2 to 29.1 percent, averaging 18.3 percent, and water saturations of unsaturated materials range from 0.6 to 77.2 percent, averaging 23.4 percent. Titan, 1994, reported that the hydraulic conductivity of the Burro Canyon Formation ranges from 1.9 x 10^{-7} to 1.6 x 10^{-3} cm/s, with a geometric mean of 1.1 x 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 that time.

Hydraulic testing of wells MW-01, MW-03, MW-05, MW-17, MW-18, MW-19, MW-20, and MW-22 during the week of July 8, 2002, and newly installed wells MW-23, MW-25, MW-27, MW-28, MW-29, MW-30, MW-31, MW-32, TW4-20, TW4-21, and TW4-22 during

June, 2005, yielded average perched zone permeabilities ranging from approximately 2 x 10^{-7} cm/s to 5 x 10^{-4} cm/s, similar to the range reported by previous investigators at the site (Hydro Geo Chem, Inc [HGC], 2002; HGC, 2005). Downgradient (south to southwest) of the tailings cells, average perched zone permeabilities based on tests at MW-3, MW-5, MW-17, MW-20, MW-22, and MW-25 ranged from approximately 4 x 10^{-7} to 1 x 10^{-4} cm/s Permeability estimates from these tests were based on pumping/recovery and slug tests analyzed using several different methodologies.

A number of temporary (TW4-series) perched zone monitoring wells have been installed at the site to investigate elevated concentrations of chloroform initially discovered at well MW-4 in 1999. Some of the conglomeratic zones encountered within the perched zone during installation of these wells are believed to be partly continuous or at least associated with a relatively continuous zone of higher permeability (International Uranium [USA] Corporation [IUSA] and HGC, 2001). The higher permeability zone defined by these wells is generally located east to northeast of the tailings cells at the site, and is hydraulically cross-gradient to upgradient of the tailings cells with respect to perched groundwater flow. Relatively high permeabilities 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 #4, of 1.4 x 10^{-3} cm/s and 7.5 x 10^{-4} cm/s, respectively (UMETCO, 1993), may indicate that this zone extends beneath the southeastern margin of the cells. This zone of higher permeability within the perched water zone does not appear to exist downgradient (south-southwest) of the tailings cells, however. At depths beneath the perched water table, the zone is not evident in lithologic logs of the southernmost temporary wells TW4-4 and TW4-6 (located east [cross-gradient] of cell #3), nor is it evident in wells MW-3, MW-5, MW-12, MW-15, MW-16, MW-17, MW-20, MW-21, or MW-22, located south to southwest (downgradient) of the tailings cells, based on the lithologic logs or hydraulic testing of the wells.

Because of the generally low permeability of the perched zone beneath the site, well yields are typically low (less than 0.5 gpm), although sustainable yields of as much as about 4 gpm may be possible in wells intercepting larger saturated thicknesses and higher permeability zones in the northeast portion of the site. Sufficient productivity can, in general, only be obtained in areas where the saturated thickness is greater, which is the primary reason that the perched zone has been used on a limited basis as a water supply to the north (upgradient) of the site.

2.3.2 Perched Groundwater Flow

Perched groundwater flow at the site has historically been to the south/southwest. Figures 3 through 6 are perched groundwater elevation contour maps for the years 1990, 1994, 2002, and 2007, respectively. The 1990, 1994, and 2002 maps were hand contoured because of sparse data. As groundwater elevations indicate, the perched groundwater gradient changes from generally southwesterly in the western portion of the site, to generally southerly in the eastern portion of the site. The most significant changes between the 2002 and 2007 water levels result from pumping of wells MW-4, TW4-19, TW4-20, and MW-26. These wells are pumped to reduce chloroform mass in the perched zone east and northeast of the tailings cells.

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 the 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 shown by comparing Figures 4 and 5. These water level increases in the northeastern and eastern portions of the site are likely the result of seepage from wildlife ponds located near the piezometers shown in Figure 5, which were installed in 2001 for the purpose of investigating these changes. The increase in water levels in the northeastern portion of the site has resulted in a local steepening of groundwater gradients over portions of the site. Conversely, pumping of wells MW-4, TW4-19, TW4-20, and MW-26 has depressed the perched water table locally and reduced average hydraulic gradients to the south and southwest of these wells.

Perched water discharges in springs and seeps 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 outcrops. The discharge point located most directly downgradient of the tailings cells is Ruin Spring. This feature is located approximately 10,000 feet south-southwest of tailings cell #3 and is depicted on the USGS 7.5-minute quad sheet for Black Mesa (Figure 7).

3. PERCHED ZONE HYDROGEOLOGY BENEATH AND DOWNGRADIENT OF THE TAILINGS CELLS

Perched water as of the 3rd Quarter, 2007 was encountered at depths of approximately 57 to 115 feet bls in the vicinity of the tailings cells at the site (Figure 8). Beneath tailings cell #3, depths to water ranged from approximately 77 feet below top of casing (btoc) in the eastern portion of the cell (at MW-25), to approximately 114 feet btoc at the southwest margin of the cell (at MW-23). Assuming an average depth of the base of tailings cell #3 of 25 feet below grade, this corresponds to perched water depths of approximately 52 to 89 feet below the base of the cell, or an average depth of approximately 70 feet beneath the base of the cell. A similar assumption can be made for proposed cell 4B.

3.1 Saturated Thickness

The saturated thickness of the perched zone as of the 3rd Quarter, 2007 ranges from approximately 93 feet in the northeast portion of the site to less than 5 feet in the southwest portion of the site (Figure 9). Beneath tailings cell #3, the saturated thickness varies from approximately 49 feet in the easternmost corner of the cell to approximately 7 feet in the western portion of the cell. South-southwest of the tailings cells, the saturated thickness ranges from less than 1 foot at MW-21 to approximately 26 feet at MW-17. The average saturated thickness south-southwest of the tailings cells, based on measurements at MW-3, MW-5, MW-12, MW-14, MW-15, MW17, and MW-20, is approximately 14 feet. The average saturated thickness based on measurements at MW-5, MW-15, MW-3, and MW-20, which lay close to a line between the center of tailings cell #3 and Ruin Spring, is approximately 12 feet. By projecting conditions at these wells, the average saturated thickness is estimated to be approximately 10 to 15 feet between MW-20 and Ruin Spring.

3.2 Perched Water Flow

Perched groundwater flow beneath the tailings cells has historically been southwest, with the gradient steepening in recent years (since about 1994) and becoming more westerly as perched water levels in the northeastern portion of the site have risen. Perched water flowing beneath the tailings cells eventually discharges in springs and seeps located in Westwater Canyon, to the south-southwest of the cells. The primary discharge point for perched water flowing beneath the tailings cells is believed to be Ruin Spring, located approximately 10,000 feet south-southwest of the cells.

Perched zone hydraulic gradients currently range from a maximum of approximately 0.05 feet per foot (ft/ft) east of tailings cell #2 to approximately 0.01 ft/ft downgradient of cell #3, between cell #3 and MW-20. The average hydraulic gradient between the downgradient edge of tailings cell #3 and Ruin Spring can be approximated assuming the following:

1) The elevation of Ruin Spring, based on the USGS topographic map for Black Mesa, is approximately 5,390 feet amsl.

2) The distance between the downgradient edge of tailings cell #3 and Ruin Spring is approximately 10,000 feet.

3) The average groundwater elevation at the downgradient edge of tailings cell #3 is approximately 5,510 feet amsl.

Using these assumptions, the average perched zone hydraulic gradient between tailings cell #3 and Ruin Spring is approximately:

$$\frac{5510 - 5390}{10,000} = 0.012 ft / ft$$

A hypothetical worst case average perched zone hydraulic gradient can also be estimated assuming the perched water elevation to be coincident with the base of tailings cell #3. The elevation of the base of tailings cell #3, which is also the approximate pre-existing land surface elevation near the center of the cell, is approximately 5,580 feet amsl. Under these conditions, for an unconfined perched zone, the maximum possible average perched zone hydraulic gradient between tailings cell #3 and Ruin Spring would be approximately:

$$\frac{5580 - 5390}{10,000} = 0.019 ft / ft$$

Although the downgradient edge of proposed cell 4B is closer to Ruin Spring (approximately 9,000 feet from Ruin Spring rather than about 10,000 feet), the above hydraulic gradient calculations can also be applied to cell 4B.

3.3 Permeability

The average permeability of the perched zone downgradient of tailings cell #3 can be approximated based on the pumping/recovery test and slug test data obtained from perched zone wells located along the downgradient edge of and south of cell #3. Peel conducted hydraulic tests at perched zone wells MW-11, MW-12, MW-14, and MW-15 in 1992 (UMETCO, 1993).

Results of these tests are provided in Table 1. HGC conducted slug tests at perched zone wells MW-3, MW-5, MW-17, MW-20, and MW-22 in July 2002 (HGC, 2002), and MW-25 in June, 2005 (HGC, 2005).

The HGC slug test results were analyzed using various solution methods including KGS (Hyder, 1994), and Bouwer-Rice (Bouwer and Rice, 1976). Each method yielded slightly different results as shown in Table 2, which is based on Table 1 of HGC, 2002, and Table 1 of HGC, 2005. A range of average permeabilities for the portion of the site south of the tailings cells can be obtained by taking the geometric mean of the Peel test results and the results obtained by the various solution methods used to analyze the HGC data. Averaging the Peel test results for wells MW-11, MW-12, MW-14, and MW-15 with the HGC KGS results for wells MW-3, MW-5, MW-17, MW-20, MW-22, and MW-25 yields a geometric average of 2.3×10^{-5} cm/s, and similarly averaging the Peel test results with the HGC Bouwer-Rice results yields a geometric average of 4.3×10^{-5} cm/s, as shown in Table 2. The "early time" results at MW-5 using the Bouwer-Rice solution (from Table 1 of HGC, 2002) were used in the computations to yield a conservatively high estimate of permeability.

4. EVALUATION OF POTENTIAL FLOW PATHS AND TRAVEL TIMES FOR HYPOTHETICAL SEEPAGE ORIGINATING FROM CELL #3

Although more than 25 years of groundwater monitoring at the site has shown no impact to perched water from the tailings cells, an evaluation of hypothetical transport of a conservative solute in seepage from existing cell #3 and proposed cell 4B is presented assuming a flow path from the base of the existing and proposed cells to the perched water, and thence to Ruin Spring. Average travel times for a conservative constituent moving from the base of tailings cell #3 and proposed cell 4B to the perched water, and then moving with the perched water to Ruin Spring, are computed assuming no dispersion.

The porosities and water saturations used in the calculations were based on measurements reported in Titan, 1994, for samples collected from the Dakota Sandstone during drilling of MW-16 and MW-17, and from the Burro Canyon Formation during drilling of MW-16.

4.1 Estimated Travel Time from the Base of Cell #3 and Proposed Cell 4B to the Perched Zone

Knight-Piésold 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 (Knight-Piésold, 1998). 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 ft^2, this rate is equivalent to 2.37×10^{-5} ft/day or 0.0086 feet per year (ft/yr).

The average rate of downward movement of a conservative solute dissolved in the seepage, assuming 1) no dispersion, 2) an average water saturation of 0.20, 3) an average porosity of 0.18, and assuming that this rate of seepage would not significantly raise the average saturation of the underlying materials, can be approximated as:

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

The average time to travel 70 feet to the perched water zone would then be approximately 290 years. This is a conservative estimate because the average water saturations would be likely to increase, thereby reducing the downward rate of travel, and increasing the travel time.

Assuming a similar travel time from the base of proposed cell 4B to the perched water would be even more conservative because the improved liner system to be used for that cell would result in less seepage than from cell #3. However, for purposes of calculation, potential seepage rates and downward rates of movement for a hypothetical conservative solute will be assumed to be the same for cell 4B as those calculated for cell #3.

4.2 Estimated Travel Times from Tailings Cell #3 and Proposed Cell 4B to Ruin Spring

Under current conditions, the average hydraulic gradient between the downgradient edge of tailings cell #3 to Ruin Spring is estimated to be 0.012, as discussed in Section 3.2. Assuming the following:

Average porosity	= 0.18
Average hydraulic gradient	= 0.012
Flow path length	= 10,000 feet
Average permeability range	= 2.3 x 10^{-5} to 4.3 x 10^{-5} cm/s (0.064 ft/day to 0.120 ft/day)

the average rate of intergranular movement of perched groundwater (interstitial or pore velocity) can be approximated to range from 0.0043 ft/day to 0.0080 ft/day (or 1.6 ft/yr to 2.9 ft/yr). The estimated average travel time for a conservative solute, assuming no dispersion, from tailings cell #3 to Ruin Spring would then be approximately 6,250 to 3,450 years over this range of permeabilities. Under conditions of the maximum possible average perched groundwater gradient of 0.019 ft/ft, as estimated in Section 3.2, and assuming the same permeabilities, porosity, and path length as above, the estimated average travel times would range from approximately 4,055 to 2,160 years.

For proposed cell 4B, which is about 9,000 feet from Ruin Spring, the estimated travel times would be approximately 5,625 to 3,100 years using the gradient of 0.012, and approximately 3,650 to 1,950 years using the gradient of 0.019.

4.3 Estimated Total Travel Time from the Base of Tailings Cell #3 and Proposed Cell 4B to Ruin Spring

The total average travel time for a conservative solute from the base of tailings cell #3 or proposed cell 4B to Ruin Spring under current conditions would be the sum of 1) the travel time from the base of either cell to the perched water table, and 2) the time to travel within the perched zone to Ruin Spring. Based on the estimates provided in Sections 4.1 and 4.2, the total average travel time of a conservative solute (assuming no dispersion) over the range of average permeability estimates would be between 6,540 and 3,740 years for cell #3, and between 5,915 and 3,390 years for proposed cell 4B, assuming an average hydraulic gradient of 0.012 ft/ft. As discussed in Section 4.1, because the rate of movement of a conservative solute from the base of cell 4B would likely be slower than for cell #3 because seepage rates would lower, the total travel time would likely be higher than estimated above.

Conditions may hypothetically develop under which travel times may be reduced, such as an increase in average perched zone groundwater gradients between tailings cell #3 or cell 4B and Ruin Spring (as discussed in Section 3.2) or as a result of reduced vadose zone travel times due to development of a relatively large leak in either cell. Under hypothetical conditions in which a relatively large leak were to develop, potentially reducing vadose zone travel times to only a few years, the vadose zone travel time could be ignored, and the total average travel time (assuming no dispersion) would range from approximately 6,250 to 3,450 years for cell #3, and between 5,625 and 3,100 years for proposed cell 4B, assuming an average hydraulic gradient of 0.012 ft/ft. Under hypothetical conditions in which the average perched zone hydraulic gradient between either cell and Ruin Spring reached 0.019 ft/ft, which also implies a negligible vadose zone travel time, the total average travel time (assuming no dispersion) over the estimated range in permeability would be between approximately 4,055 and 2,160 years for cell #3, and between 3,650 and 1,950 years for cell 4B.

Estimates based on hypothetical assumptions of a relatively large leak in tailings cell #3 or an average hydraulic gradient as high as 0.019 ft/ft between either cell and Ruin Spring are considered very conservative because they assume conditions that are unlikely ever to develop. Furthermore the improved construction and leak detection system proposed for cell 4B would make this hypothetical scenario even less likely for cell 4B than for cell #3.

5. RECOMMENDED ADDITIONAL PERCHED ZONE MONITORING WELLS DOWNGRADIENT OF PROPOSED CELL 4B

The current perched groundwater monitoring well network for the tailings cells includes wells that are upgradient, crossgradient, and downgradient of the cells as shown in Figure 10. Most of the wells are located along the margins of the cells and many that are between the cells function as both upgradient wells for the cell located immediately downgradient of the wells and as downgradient wells for the cell located immediately upgradient of the wells. For example, well MW-30 functions as a downgradient well for cell #2 and as an upgradient well for cell #3. Wells MW-5, MW-12, and MW-23 that currently function as downgradient wells for cell #3 would also serve as upgradient wells for proposed cell 4B. The current arrangement of tailings cell perched monitoring wells is conservative with respect to U.S. Environmental Protection Agency (US EPA) Draft Technical Guidance (US EPA, 1992) which generally recommends downgradient wells only along the downgradient margin of the facility which in this case would be the entire complex of tailings cells.

Once proposed cell 4B is installed, an additional well or wells would be needed at the downgradient edge of the cell to be consistent with EPA Draft Guidance (US EPA, 1992). As shown in Figure 10, two additional wells are proposed, one at the southwest corner of proposed cell 4B and one between the southwest corner well and existing well MW-15. These installations would conservatively maintain the approximate existing spacing as defined by the proximity of MW-14 to MW-15 along the downgradient edge of existing cell 4A. Existing wells MW-3, MW-20, and MW-21 would continue to function as distal downgradient wells for the entire cell complex. Once installed, sampling frequencies for the new wells will be based on testing of the wells for perched zone hydraulic properties in the same fashion as for the existing wells.

6. REFERENCES

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7. 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
Peel Hydraulic Test Results [1]

Well	Hydraulic Conductivity (cm/s)
MW-11	1.4×10^{-3}
MW-12	2.2×10^{-5}
MW-14	7.5×10^{-4}
MW-15	1.9×10^{-5}

Notes:

[1] *From UMETCO, 1993*

TABLE 2

Results of July 2002 and June 2005 Hydraulic Tests [2]

Well	Permeability in centimeters per second	
	KGS	Bouwer-Rice
MW-3	4.0×10^{-7}	1.5×10^{-5}
MW-5	3.5×10^{-6}	2.4×10^{-5}
MW-17	2.6×10^{-5}	2.7×10^{-5}
MW-20	--	9.3×10^{-6}
MW-22	1.0×10^{-6}	7.9×10^{-6}
MW-25	1.1×10^{-4}	7.4×10^{-5}

Geometric Average of above test results with Peel[3] test results for MW-11, MW-12, MW-14, and MW-15.

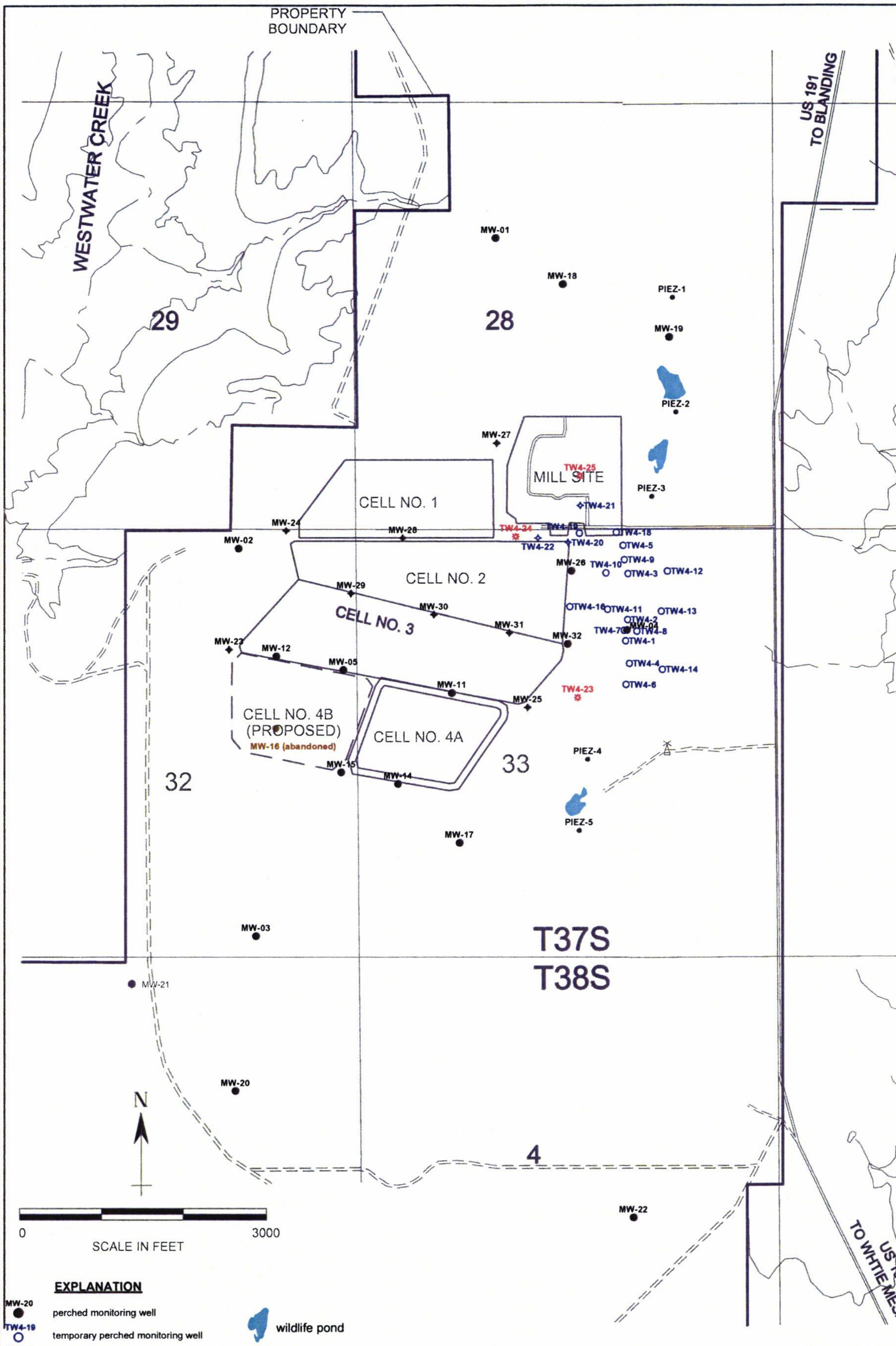
2.3×10^{-5}	4.3×10^{-5}

Notes:

[2] *From HGC, 2002; HGC, 2005*

[3] *From UMETCO, 1993*

FIGURES



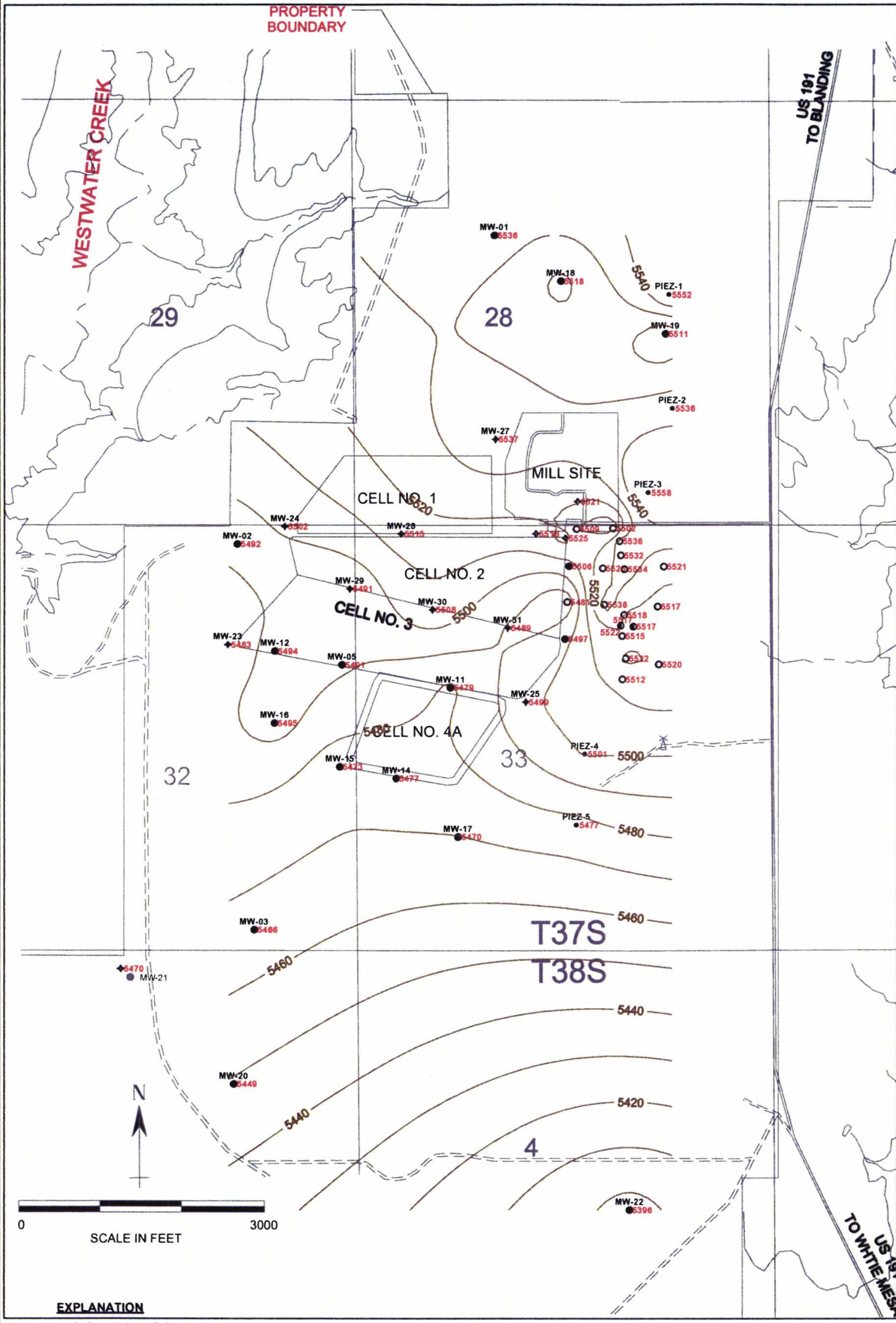
EXPLANATION

- MW-20 perched monitoring well
- TW4-19 temporary perched monitoring well
- PIEZ-1 perched piezometer
- MW-31 perched monitoring well installed April, 2005
- TW4-20 temporary perched monitoring well installed April, 2005
- TW4-23 new temporary perched monitoring well installed May, 2007 (locations approximate)
- wildlife pond

HYDRO GEO CHEM, INC.

SITE PLAN AND PERCHED WELL LOCATIONS WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	1/4/2008	H:/718000/cell4b/welloc.srf	1



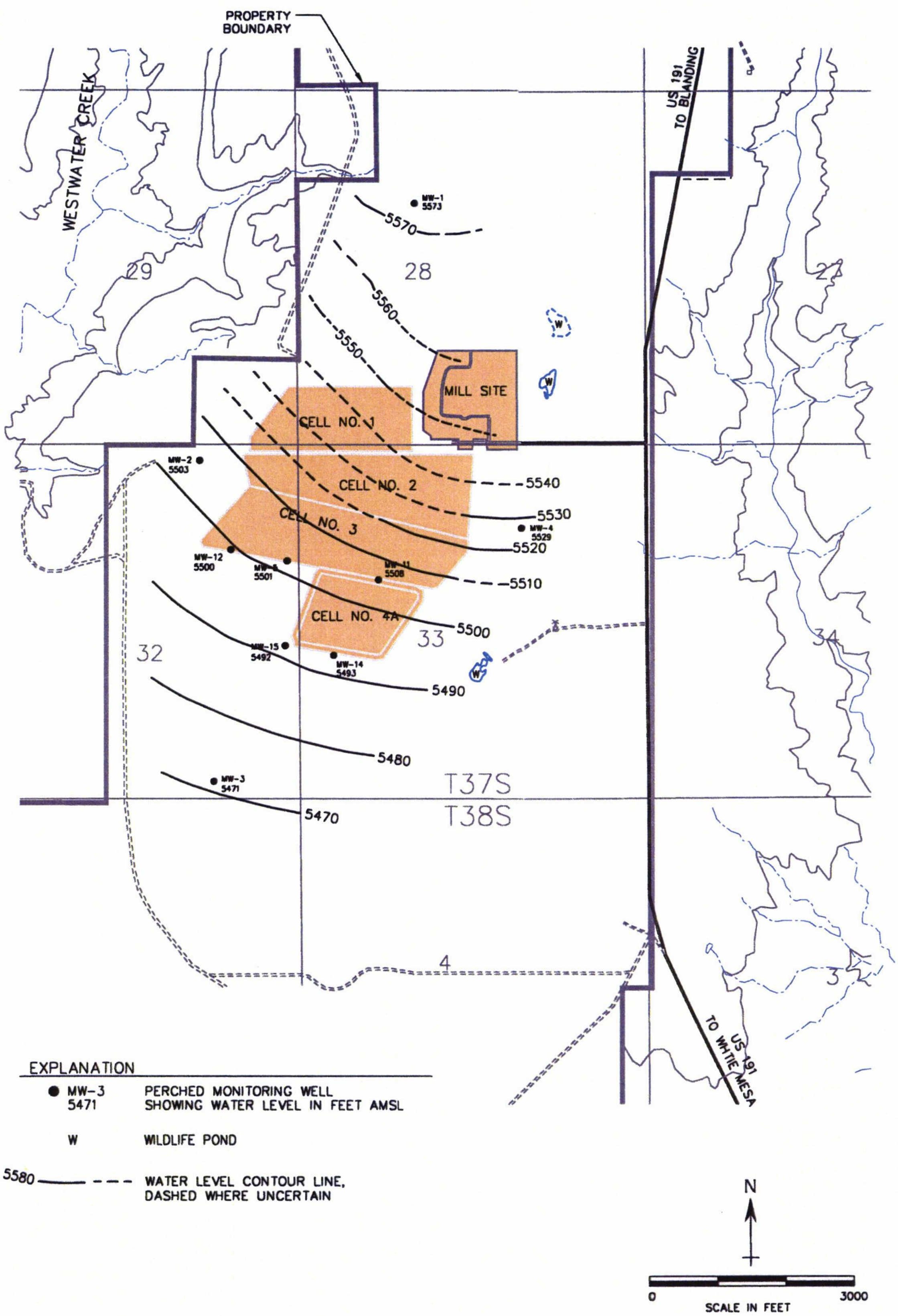
EXPLANATION

MW-20 ● 5449	perched monitoring well showing elevation in feet amsl
○ 5481	temporary perched monitoring well showing elevation in feet amsl
PIEZ-1 • 5552	perched piezometer showing elevation in feet amsl
MW-31 ✦ 5489	perched monitoring well installed April, 2005 showing elevation in feet amsl
✧ 5525	temporary perched monitoring well installed April, 2005 showing elevation in feet amsl

HYDRO GEO CHEM, INC.

KRIGED BRUSHY BASIN CONTACT ELEVATIONS
WHITE MESA SITE

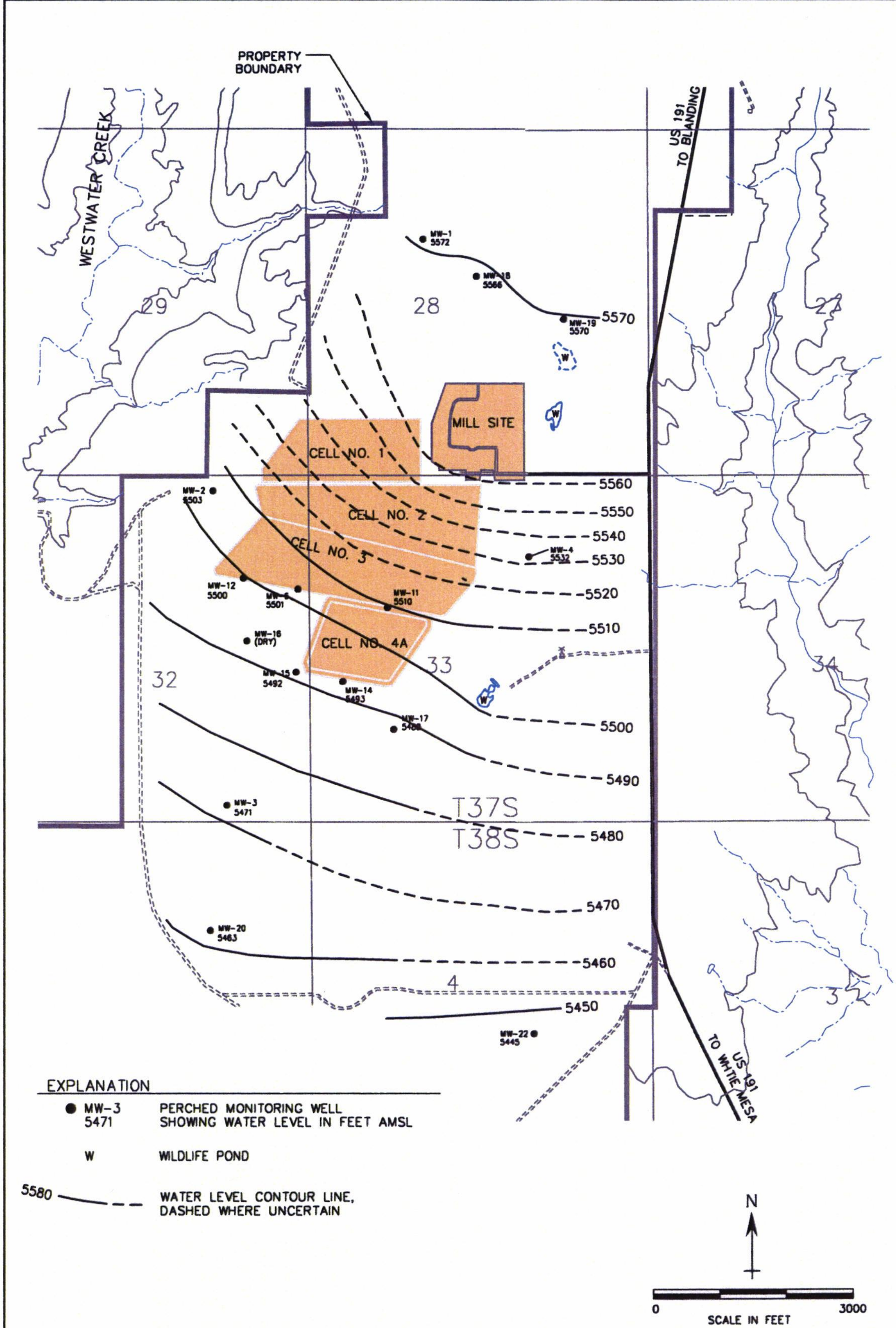
APPROVED	DATE	REFERENCE	FIGURE
SJS	9/19/2007	H:/718000/cell4b/bbel0705.srf	2



HYDRO GEO CHEM, INC.

PERCHED WATER LEVELS
AUGUST 1990

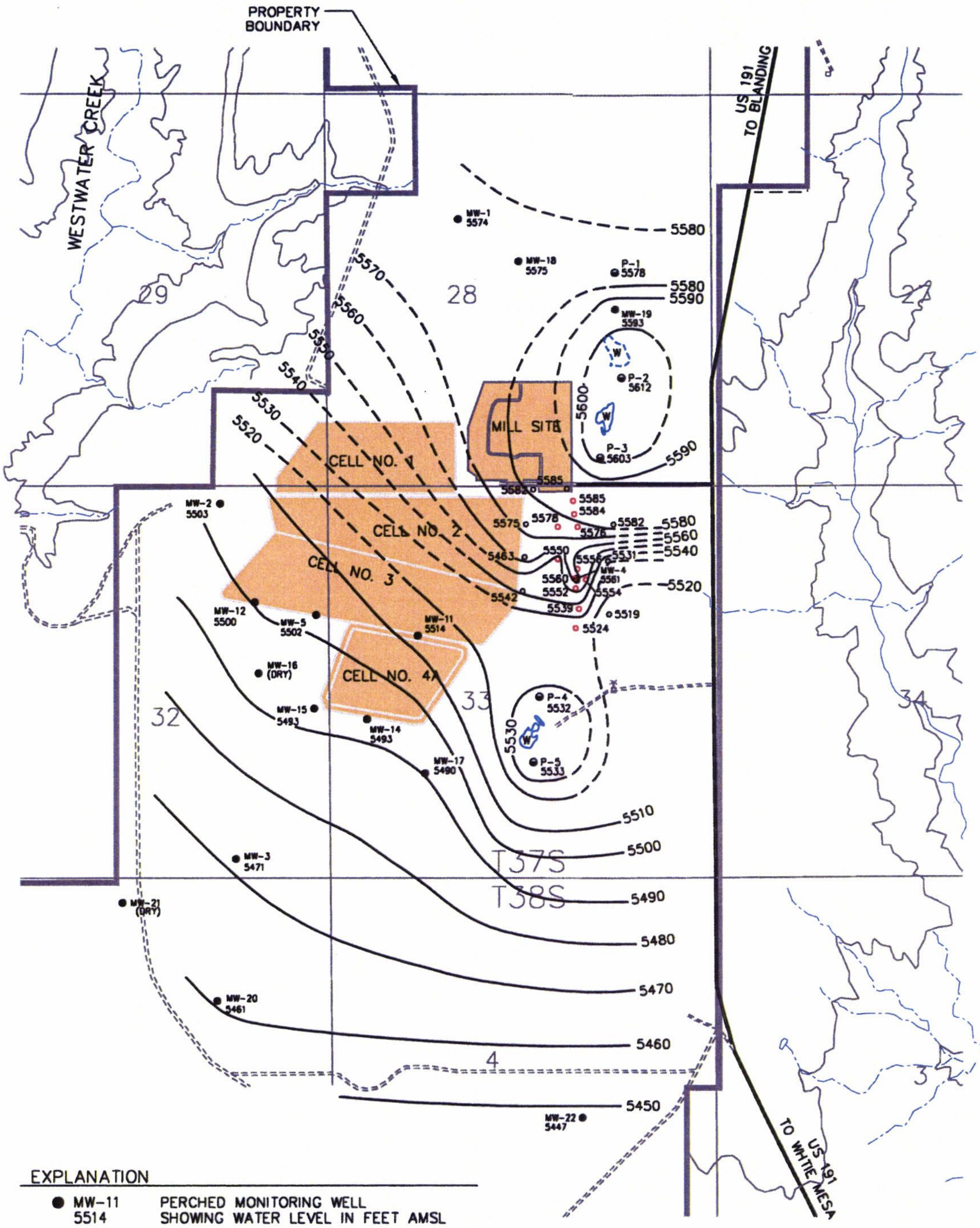
Approved	Date	Revised	Date	Reference:	FIG:
SS	01/30/03			71800101	3



HYDRO GEO CHEM, INC.

PERCHED WATER LEVELS
AUGUST 1994

Approved	Date	Revised	Date	Reference:	FIG:
SS	01/30/03			71800102	4



EXPLANATION

●	MW-11 5514	PERCHED MONITORING WELL SHOWING WATER LEVEL IN FEET AMSL
o	5524	TEMPORARY PERCHED MONITORING WELL SHOWING WATER LEVEL IN FEET AMSL
◓	P-5 5533	PIEZOMETER SHOWING WATER LEVEL IN FEET AMSL
5580 ——— - - -		WATER LEVEL CONTOUR LINE, DASHED WHERE UNCERTAIN
W		WILDLIFE POND

NOTE: WATER LEVELS FOR PIEZOMETERS ARE FROM AUGUST, 2002

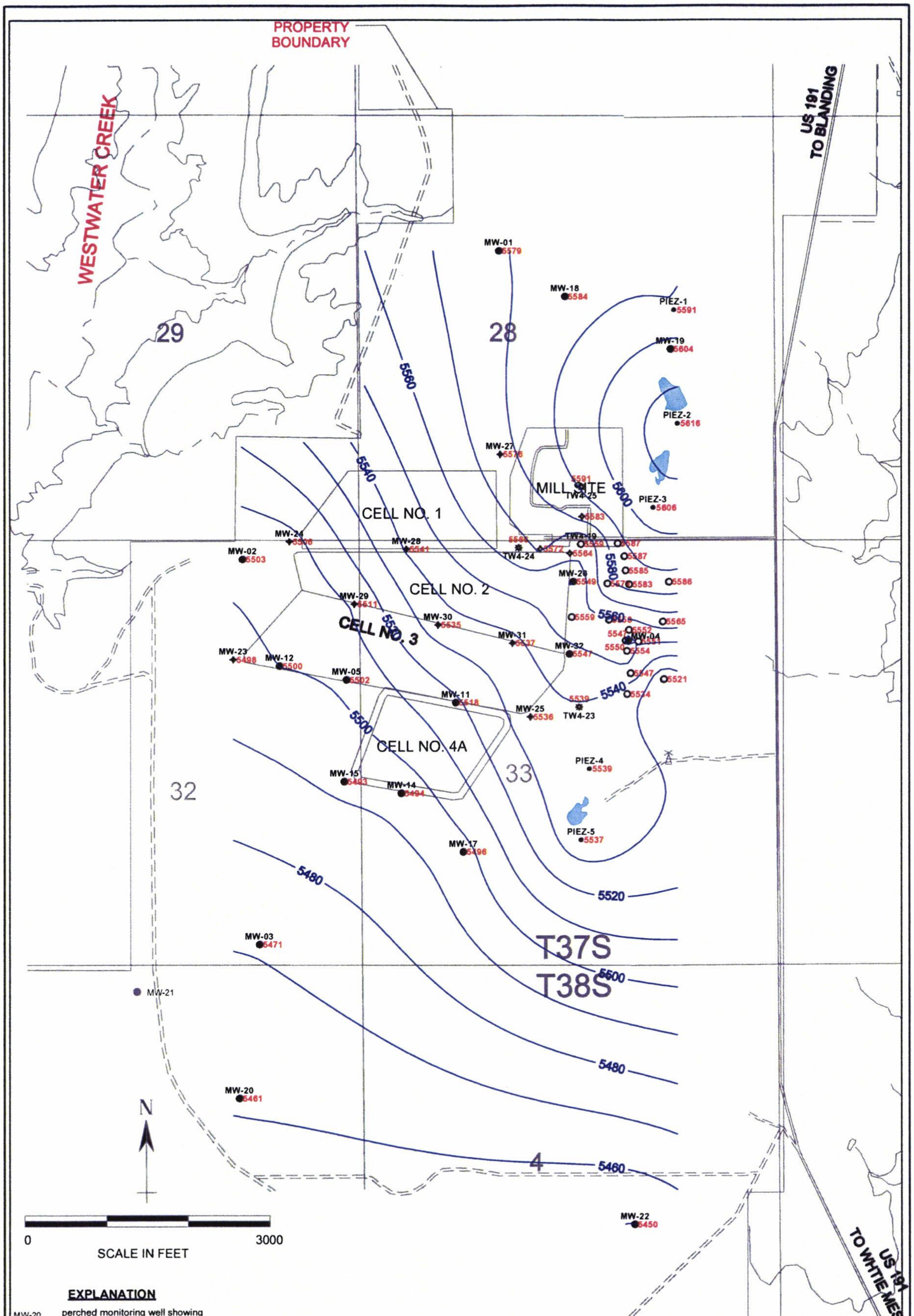
N

0 SCALE IN FEET 3000

HYDRO GEO CHEM, INC.

PERCHED WATER LEVELS SEPTEMBER 2002

Approved	Date	Revised	Date	Reference:	FIG:
SS	01/30/03			71800103	5



EXPLANATION

MW-20 ● 5461	perched monitoring well showing elevation in feet amsl
○ 5550	temporary perched monitoring well showing elevation in feet amsl
PIEZ-1 • 5591	perched piezometer showing elevation in feet amsl
MW-31 ✦ 5537	perched monitoring well installed April, 2005 showing elevation in feet amsl
✧ 5571	temporary perched monitoring well installed April, 2005 showing elevation in feet amsl
✲ 5539	temporary perched monitoring well installed May, 2007 showing approximate elevation in feet amsl

NOTES: Locations and elevations for TW4-23, TW4-24, and TW4-25 are approximate; Water level for MW-26 (TW4-15) is from the second quarter, 2007

HYDRO GEO CHEM, INC.

KRIGED 3rd QUARTER, 2007 WATER LEVELS WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
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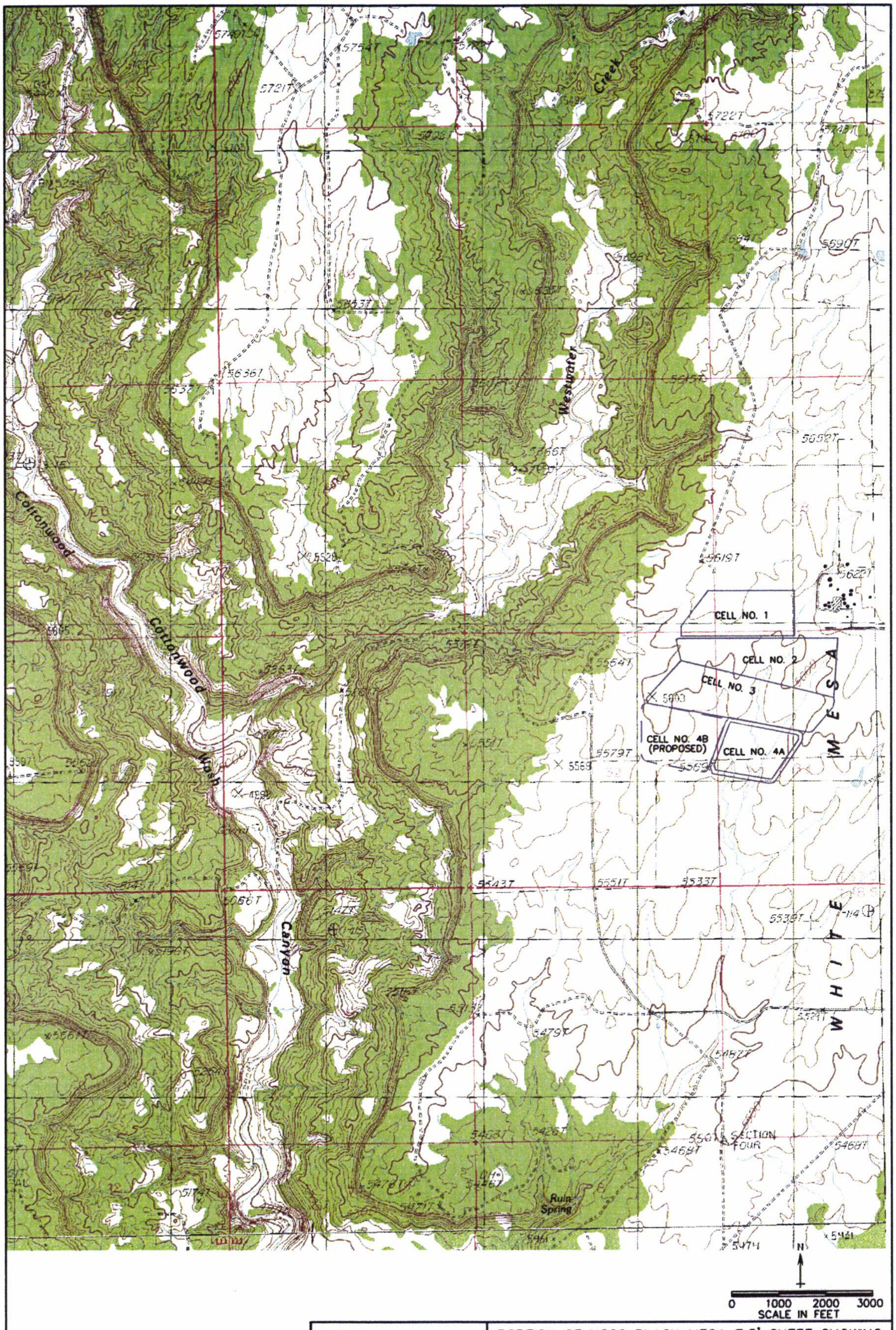
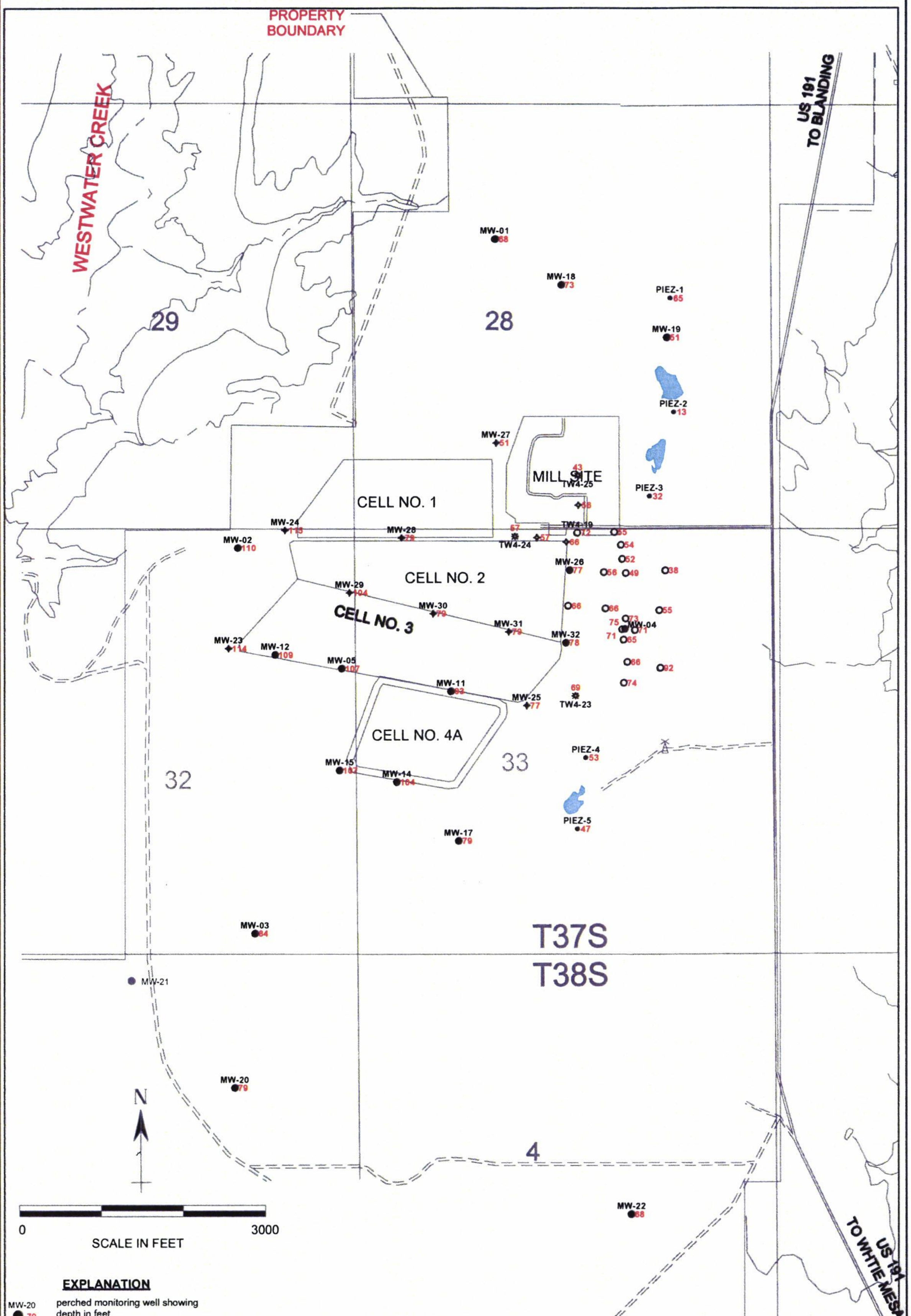


HYDRO GEO CHEM, INC.

PORTION OF USGS BLACK MESA 7.5' SHEET SHOWING APPROXIMATE LOCATION OF TAILING CELLS IN RELATION TO NEARBY CANYONS AND RUIN SPRING

Approved	Date	Revised	Date	Reference:	FIG:
SS	1/30/03			71800100	7



EXPLANATION

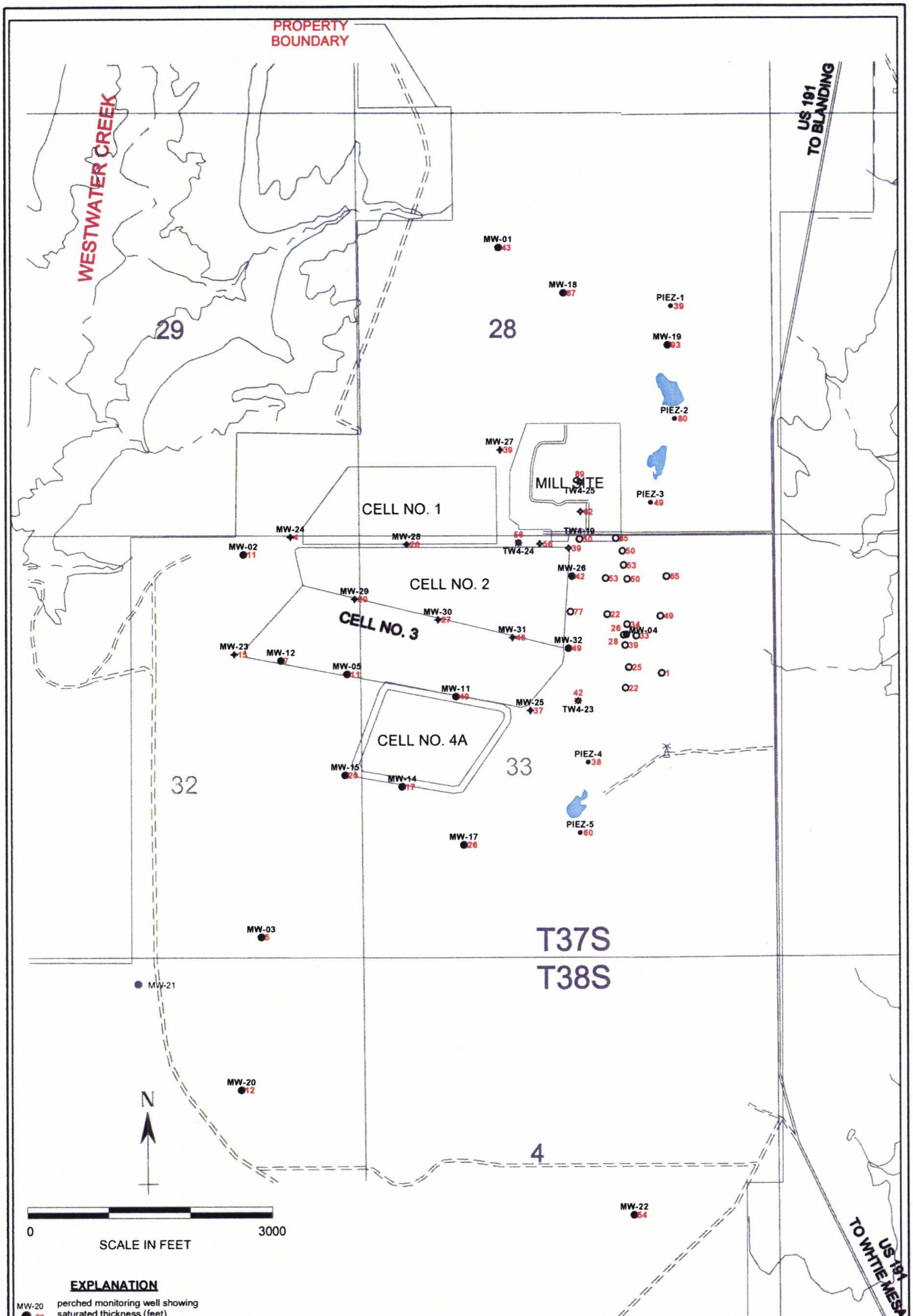
MW-20 ● 79	perched monitoring well showing depth in feet
O 71	temporary perched monitoring well showing depth in feet
PIEZ-1 • 65	perched piezometer showing depth in feet
MW-31 ✦ 79	perched monitoring well installed April, 2005 showing depth in feet
✧ 57	temporary perched monitoring well installed April, 2005 showing depth in feet
✲ 69	temporary perched monitoring well installed May, 2007 showing depth in feet

NOTES: Locations of TW4-23, TW4-24, and TW4-25 are approximate; Measurement for MW-26 (TW4-15) is from the second quarter, 2007

HYDRO GEO CHEM, INC.

DEPTHS TO WATER
3rd QUARTER, 2007
WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	1/4/2008	H:/718000/cell4b/dtw0807.srf	8



EXPLANATION

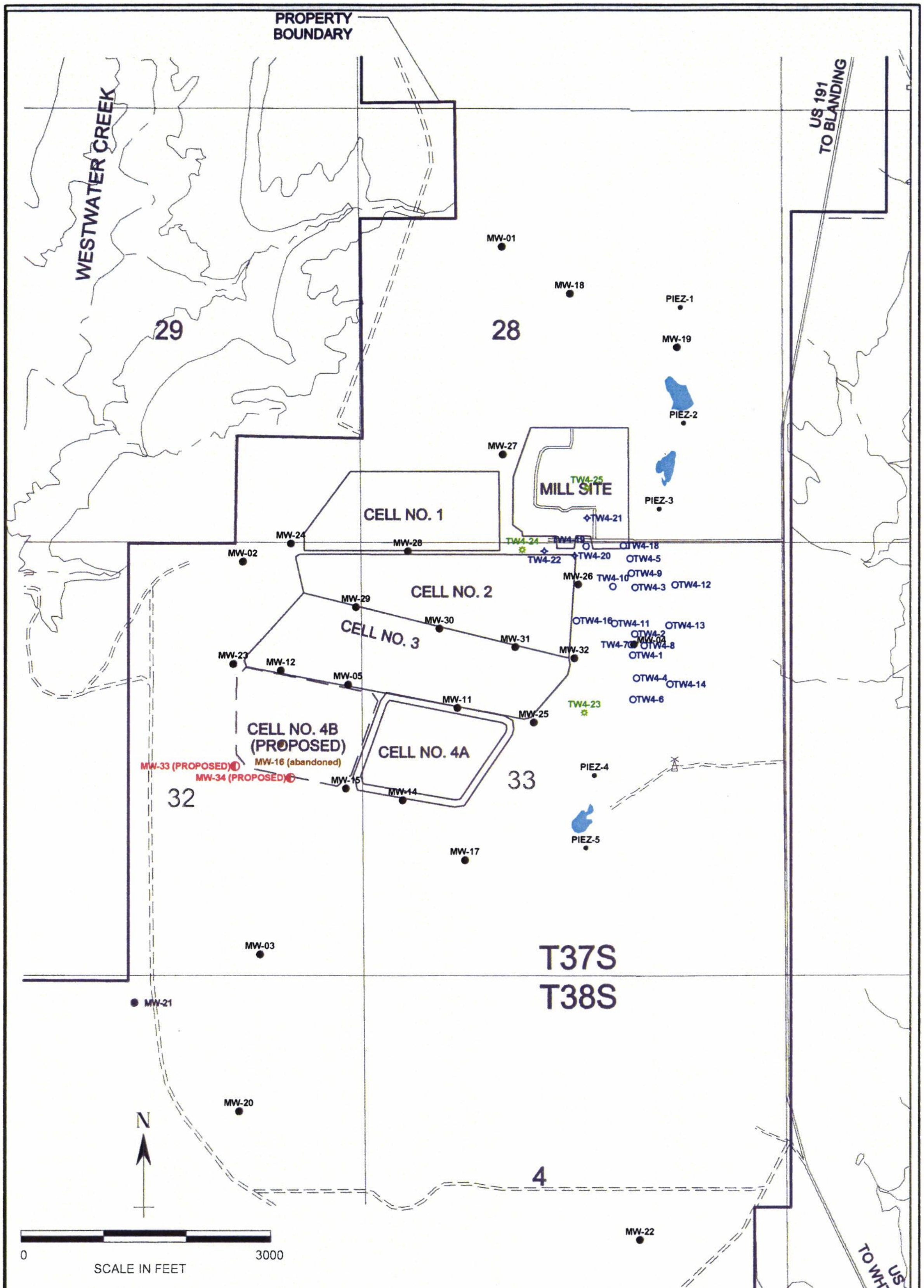
- MW-20 79 — perched monitoring well showing saturated thickness (feet)
- 71 — temporary perched monitoring well showing saturated thickness (feet)
- PIEZ-1 65 — perched piezometer showing saturated thickness (feet)
- MW-31 79 — perched monitoring well installed April, 2005 showing saturated thickness (feet)
- 57 — temporary perched monitoring well installed April, 2005 showing saturated thickness (feet)
- 69 — temporary perched monitoring well installed May, 2007 showing saturated thickness (feet)

NOTES: Locations and values for TW4-23, TW4-24, and TW4-25 are approximate;
Value for MW-26 (TW4-15) is based on the second quarter, 2007 water level

HYDRO GEO CHEM, INC.

APPROXIMATE SATURATED THICKNESS
3rd QUARTER, 2007
WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	1/4/2008	H:/718000/cell4b/satdthck.srf	9



EXPLANATION

MW-20 ●	perched monitoring well
TW4-19 ○	temporary perched monitoring well
PIEZ-1 •	perched piezometer
TW4-23 ☼	new temporary perched monitoring well installed May,2007 (locations approximate)
MW-33 ◐	proposed temporary perched monitoring well
(blue shape)	wildlife pond

HYDRO GEO CHEM, INC.

SITE PLAN SHOWING EXISTING AND PROPOSED PERCHED WELL LOCATIONS WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	1/4/2008	H:/718000/cell4b/propwell.srf	10

DOSE ASSESSMENT IN SUPPORT OF THE LICENSE RENEWAL APPLICATION & ENVIRONMENTAL REPORT FOR THE WHITE MESA URANIUM MILL

Prepared for:

Denison Mines (USA) Corp. (DUSA)

Prepared by:

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February 2007

Printed on Recycled Paper Containing Post-Consumer Fibre

EXECUTIVE SUMMARY

Denison Mines (USA) Corp. (DUSA) operates the White Mesa Uranium Mill (hereafter referred to as the "mill") in San Juan County, Utah, approximately 6 miles (9.5 km) south of the city of Blanding. The mill is located on a parcel of land and mill site claims covering approximately 5,415 acres (2,191 ha). The mill is licensed by the State of Utah Division of Radiation Control (DRC) to process uranium ore and selected alternate feed materials.

DUSA has commenced mining activities in the Colorado Plateau district, and conventional ores are being hauled and stockpiled at the mill. In addition, DUSA has mining assets in the Arizona Strip and processing of ores from those properties can be anticipated in the future. Milling of conventional ore is scheduled for early 2008 when the milling of currently available alternate feed material is completed (DUSA 2007).

This dose assessment was prepared in support of the license renewal application for the mill. An element of the license renewal application is to complete a dose estimate to members of the public based on the operations at the mill.

During the recovery of uranium from conventionally mined ore at the mill, small amounts of uranium and other radioactive contaminants can be released to the atmosphere from various processes and activities. The radioactivity can be dispersed by wind into the surrounding environment and subsequently, via deposition to soil, plants and animals.

In this assessment, MILDOS-AREA was used to estimate the dose commitments that could potentially be received by individuals and the general population within a 50 mile (80 km) radius for the processing of Colorado Plateau ore or Arizona Strip ore. The expected ore grade from the Colorado Plateau ore is an average of 0.25% U_3O_8 and 1.5% V_2O_5 (NRC 1980) while the Arizona Strip ore is assumed to contain 0.637% U_3O_8 (DUSA (2007a)). The proposed ore process rate for the Colorado Plateau ore and Arizona Strip ore is approximately 730,000 tons per year (tpy) (an average of 2000 tons per day). Assuming that the average uranium recovery is at the historical recovery yield of 94%, approximately 1,715 tons (3,431,000 lbs) of U_3O_8 per year would be recovered from Colorado Plateau ore at the proposed ore process rate. Similarly, approximately 4,371 tons (8,742,188 lbs) of U_3O_8 per year would be recovered from Arizona Strip ore at the proposed ore process rate. The proposed operating schedule at the mill is assumed to be 24 hr/day for 365 days per year.

The MILDOS-AREA calculated total annual effective dose commitments (including radon) were compared to the Utah Administrative Code R313-15-301(1)(a) requirements that the dose to individual members of the public shall not exceed 100 mrem/yr (radon included). Overall, the total annual effective dose commitments are at most 1.20 mrem/yr (effective dose for infant at BHV-1) of the R313-15-301(1)(a) limit of 100 mrem/yr (radon included) to an individual member of the public for the processing of Colorado Plateau ore. The total annual effective dose commitments are at most 2.94 mrem/yr (effective dose for infant at BHV-1) of the R313-15-301(1)(a) limit of 100 mrem/yr (radon included) to an individual member of the public for the processing of Arizona Strip ore. Therefore, the predicted annual effective dose commitments for anticipated ore processing operations comply with R313-15.

In addition, the MILDOS-AREA-calculated 40 CFR190 annual dose commitment (excluding radon) was compared to the 40 CFR190 Criterion of 25 mrem/yr to the whole body (excluding the dose due to radon) and 25 mrem/yr to any other organ to any member of the public (EPA 2002). The 40CFR 190 doses were also used to demonstrate compliance with R313-15-101(4) (i.e., the licensee must demonstrate that total effective dose equivalent to the individual member of the public likely to receive the highest total effective dose equivalent will not exceed 10 mrem (absent of the radon dose)). Overall, from Table 6.3, the 40 CFR190 annual dose commitments are at most 4.62 mrem/yr (dose to the bone for the teen at BHV-1) of the 40 CFR190 dose criterion of 25 mrem/yr for Colorado Plateau ore. In addition, the 40 CFR190 annual effective dose commitments demonstrate compliance with the R313-15-101(4) limit of 10 mrem/yr to the individual member of the public likely to receive the highest total effective dose equivalent. From Table 6.8, the 40 CFR190 annual dose commitments are at most 11.7 mrem/yr (dose to the bone for the teen at BHV-1) of the 40 CFR190 dose criterion of 25 mrem/yr for Arizona strip ore. In addition, the 40 CFR190 annual effective dose commitments demonstrate compliance with the R313-15-101(4) limit of 10 mrem/yr to the individual member of the public likely to receive the highest total effective dose equivalent. For Colorado Plateau ores, the maximum effective dose is 0.535 mrem/yr and for Arizona Strip Ore it is 1.37 mrem/yr, in both cases for an infant at BHV-1. Therefore, the predicted 40 CFR annual effective dose commitments for anticipated ore processing operations comply with R313-15-101(4).

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ACRONYMS & ABBREVIATIONS

ALC	Allowable Concentration
ANL	Argonne National Laboratory
ALARA	As Low As Reasonably Achievable
Avg.	Average
ASCII	American Standard Code for Information Interchange
Bi-210	Bismuth 210
Bi-214	Bismuth 214
CCD	Counter Current Decantation
CFR	Code of Federal Regulations
Ci	Curie
DCF	Dose Conversion Factor
DRC	State of Utah Division of Radiation Control
DUSA	Denison Mines (USA) Corp.
EPA	Environmental Protection Agency
E_W	Process Emission Factor
F	Radon Release
FES	Final Environmental Statement
F_S	Annual frequency of occurrence of wind group S
ft	Feet
ft^3	Cubic feet
g	grams
g ore	Grams of ore
GPS	Global Positioning System
GUI	Graphical User Interface
ha	hectares
hr	hours
ICRP	International Commission on Radiological Protection
ID	Induced Draft
lbs	Pounds
km	Kilometres
kts	Knots
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NRC	Nuclear Regulatory Commission
NUREG	Regulatory Guide
m	Meters
m^2	Square metres
mrem	Millirem

MPC	Maximum Permissible Concentration
Pb-210	Lead 210
Pb-214	Lead 214
pCi	picoCurie
Po-210	Polonium 210
Po-218	Polonium 218
Ra-226	Radium 226
Rn-222	Radon 222
R_S	Resuspension rate for wind group S
s	Seconds
S	Emission Rate
SENES	Specialists in Energy, Nuclear and Environmental Science
TGLM	Task group on Lung Dynamics Lung Model
Th-230	Thorium 230
tpy	tons per year
U_3O_8	Triuranium octaoxide ("Yellowcake")
Unat	Natural Uranium
U-234	Uranium 234
U-235	Uranium 235
U-238	Uranium 238
V_2O_5	Vanadium Oxide
yd^3	Cubic yards
yr	Years

1.0 INTRODUCTION

1.1 BACKGROUND

Denison Mines (USA) Corp. (DUSA) operates the White Mesa Uranium Mill (hereafter referred to as the "mill") in San Juan County, Utah, approximately 6 miles (9.5 km) south of the city of Blanding. The mill is located on a parcel of land and mill site claims covering approximately 5,415 acres (2,191 ha). The mill was built in 1979 and licensed by the U.S. Nuclear Regulatory Commission (NRC) to process uranium ore and selected alternate feed materials. The mill began operations in July 1980. In August 2004, the State of Utah became an Agreement State for the regulation of uranium mills, and primary regulatory authority over the mill was assumed by the State of Utah Division of Radiation Control (DRC) at that time.

The mill is a standard design with both uranium and vanadium circuits and uses the acid leach-solvent extraction process for uranium recovery from uranium ores and uranium/vanadium ores. Vanadium in uranium/vanadium-bearing ores is partially solubilized during leaching, and the dissolved vanadium present in uranium raffinate is further processed for recovery of vanadium before recycling (NUREG 1979).

In the early 1990s, the mill began receiving "alternate feed material" (uranium-bearing materials other than conventionally mined ores) for processing. From 1999 to present, the mill has relied solely on alternate feed materials. The mill goes on standby for periods of time and then it processes the stockpiled alternate feeds for the recovery of uranium. The residual tailings from these processes are stored in the tailings ponds on-site. DUSA has commenced mining activities in the Colorado Plateau district and conventional ores are being hauled and stockpiled at the mill. In addition, DUSA has mining assets in the Arizona Strip and processing of those ores can be anticipated in the future. Milling of conventional ore is scheduled for early 2008, when the milling of currently available alternate feed material is completed (DUSA 2007).

This dose assessment was prepared in support of the license renewal application for the mill. An element of the license renewal application is to complete a dose estimate to members of the public based on the operations at the mill. The goal is to determine potential doses to both nearby individuals and to populations in the vicinity of the mill from ore processing operations at the mill.

1.2 OBJECTIVE

The objectives of this assessment are to estimate the potential annual doses to the people living close to the mill and to the population living within 50 miles (80 km), from any releases to the atmosphere of natural uranium (i.e., uranium-238 decay chain and associated radioactive constituents) during the routine ore processing operations.

The mill is licensed for the annual recovery of 4,380 tons of uranium (as U_3O_8) The amount of ore needed to provide that quantity of uranium depends on the grade(s) of the ores processed, with larger quantities of low grade ores and smaller quantities of higher grade ores required to achieve the same production. The mill uses an acid leach-solvent extraction process for uranium recovery with a nominal recovery of approximately 94%, with remainder of the uranium being discharged to tailings.

The ore supply expected for the mill is typically from mining activities on the Colorado Plateau and Arizona Strip districts. The expected ore grade from the Colorado Plateau district is an average of 0.25% U_3O_8 and 1.5% V_2O_5 (NRC 1980) while the Arizona Strip ore is assumed to contain 0.637% U_3O_8 and no vanadium (DUSA (2007a)).

In this assessment, the doses to individual members of the public are estimated separately for the processing of Colorado Plateau and Arizona Strip ores. The proposed ore process rate for the Colorado Plateau ore and Arizona Strip ore is approximately 730,000 tons per year (tpy) (an average of 2000 tons per day). Assuming that the average uranium recovery is at the historical recovery yield of 94%, approximately 1,715 tons (3,431,000 lbs) of U_3O_8 per year would be recovered from Colorado Plateau ore at the proposed ore process rate. Similarly, approximately 4,371 tons (8,742,188 lbs) of U_3O_8 per year would be recovered from Arizona Strip ore at the proposed ore process rate.

The activity concentration of the U-238 in the ore is calculated as follows:

$$\text{Activity Concentration} = (\text{Ore Grade } (\text{g } U_3O_8/\text{g ore}))(\%\ \text{U-238/g } U_3O_8)(\text{Specific Activity of U-238}) \qquad (1)$$

where,

- Ore Grade (g U_3O_8/ g ore) = 0.0025 for Colorado Plateau Ore and 0.00637 for Arizona Strip Ore
- % U-238/g of U_3O_8= 0.848
- Specific Activity of U-238=3.30 x 10^5 pCi/g U-238/g ore

Using equation 1, the activity concentration of U-238 for Colorado Plateau ore is 700 pCi U-238/g ore. Similarly, the activity concentration of U-238 for Arizona Strip ore is 1783 pCi U-238/g ore. In all cases, the ores are assumed to be in secular equilibrium.

It should be noted that the current licensed production capacity is 4,380 tons of U_3O_8 (8,760,000 lbs of U_3O_8) per year. Therefore, the processing of Colorado Plateau ore is approximately at 40% of the current licensed U_3O_8 production capacity while the processing of Arizona Strip ore is just below the current licensed yellowcake production capacity. The proposed operating schedule at the mill is assumed to be 24 hr/day for 365 days per year.

1.3 APPROACH

The MILDOS computer code calculates the dose commitments received by individuals and the general population within a 50 mile (80 km) radius of an operating uranium recovery facility. The MILDOS code is an NRC-approved code designed as a tool to provide input on regulatory and compliance evaluations for various uranium recovery operations.

As part of this assessment, the EnecoTech analysis (EnecoTech 1991a and 1991b) was reviewed to examine the input parameters and emissions calculations used to perform the previous MILDOS modeling for the mill in 1991. The intent of the review was to ensure that issues addressed in 1991 were addressed in the current assessment where relevant.

It should be noted that the MILDOS code developed in 1981 has gone through a number of changes over the years and served as the basis for the development of the MILDOS-AREA code.

The approach used for this assessment is to evaluate the exposure pathways considered in the EnecoTech analysis with the updated MILDOS-AREA code. All sources considered in the EnecoTech analysis (EnecoTech 1991a) are considered in this assessment and updated as appropriate to current conditions. As discussed later, emissions from the vanadium stacks are also considered in this analysis. A description of the sources used in this assessment is provided in Section 4.0.

The source emissions calculations for airborne radioactive releases at the mill include those related to dust generation during ore handling, area source dusting from ore pad stockpiles and the tailings ponds. The source emissions calculations generally follow the guidance of NRC's Regulatory Guide 3.59 (NRC 1987) and NUREG-0706 (NRC 1980). Details of emissions estimates are provided in Appendix A.

Many of the receptors used in the EnecoTech analysis were also used in this assessment. A description of the receptors used in this assessment is provided in Section 5.0. Locations for the sources and receptors used in this assessment were updated with Global Positioning System (GPS) coordinates provided by DUSA (DUSA 2007b).

The physical parameters pertaining to particle size (and distribution) are consistent with the EnecoTech analysis. These parameters are the default values within the MILDOS-AREA code (ANL 1998) as well as in NUREG-0556 (NRC 1979).

The dose to receptors near the mill was estimated using MILDOS-AREA for the processing of Colorado Plateau ore and, separately, for the processing of Arizona Strip ore. The proposed ore process rate for the Colorado Plateau ore is approximately 730,000 tpy which would recover approximately 2,573 tons (3,431,000 lbs) of U_3O_8 per year (assuming that the average uranium recovery is 94%). The proposed ore process rate for Arizona Strip ore is approximately 730,000 tpy, which would recover approximately 4,371 tons (8,742,188 lbs) of U_3O_8 per year (assuming that the average uranium recovery is 94%).

In addition to doses to individual receptors, the dose received by the general population within an 50 mile (80 km) radius of the mill is predicted.

1.4 CONTENTS OF THIS REPORT

The remainder of this report is arranged into seven sections.

Section 2.0, **Regulatory Compliance**, provides a description of the regulatory framework pertaining to the applicable dose limits to members of the public from licensed activities at the mill.

Section 3.0, **Radiation Dose Assessment**, describes the method used to estimate the radiation doses to members of the public and how MILDOS-AREA was used. Section 3.0 also describes how the MILDOS-AREA software has evolved, highlighting some of the key differences between the updated version, MILDOS AREA (NRC 1998), and the original version of MILDOS.

Section 4.0, **Source Terms**, describes the source terms and source emission rates related to the ore processing operations and other input parameters required (i.e., meteorological data and population data) for the MILDOS-AREA runs. The source emission rates were calculated for processing Colorado Plateau ore and Arizona Strip ore based on the ore grade, ore process rate and uranium recovery yield.

Section 5.0, **Receptors**, describes the receptors used in the MILDOS-AREA runs.

Section 6.0, **Radiation Dose Estimates**, provides the dose results from the MILDOS-AREA runs using the parameters described in Sections 4.0 and 5.0.

Section 7.0, **Overviews**, provides a summary of the dose estimates from the MILDOS-AREA runs.

Section 8.0, **References**, provides a list of reference material used to prepare this report.

Appendix A: **Emissions Calculations** describe the basis of the emission estimates for each source.

2.0 REGULATORY COMPLIANCE

The DRC has the regulatory authority over the license issued for the site. As required by Utah Administrative Code R313-15-101(2), the mill shall, to the extent practical, employ procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as reasonably achievable (ALARA). The licensee is required to demonstrate that the total dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem in a year, exclusive of the dose contribution from natural background (including radon) and medical sources. Under 10 CFR20.1301 (NRC 1991), the NRC has adopted the provisions of the U.S. Environmental Protection Agency (EPA) environmental radiation standards in 40 CFR190 (EPA 2002). This subpart requires that the licensee provide reasonable assurance that the radiation attributed the mill operations does not exceed the annual dose of 25 millirem (mrem) to the whole body, 75 millirem to the thyroid and 25 millirem to any other organ of any member of the public (radon and it daughters excepted). In addition, 10 CFR20.1301 (d) (R313-15-101(4)) sets a constraint limit on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters such that the individual member of the public likely to receive the highest total effective dose equivalent will not exceed 10 mrem/yr.

3.0 RADIATION DOSE ASSESSMENT

3.1 ENECOTECH ASSESSMENT

As mentioned in Section 1.3, all of the sources considered by EnecoTech are addressed in this analysis. In addition, the vanadium stack which is an additional point source, is considered in this assessment. The emission calculations from the mill point sources (grinder, loading ore to the grizzly, yellowcake stack and vanadium stack) and area sources such as the ore pads and the tailings ponds were revised based on the new operating parameters and meteorological data provided by DUSA. Some of the receptors used in the EnecoTech analysis are used in this assessment. In addition, there are new receptor locations added to this assessment. Locations for the sources and receptors used in this assessment were updated using the GPS coordinates provided by DUSA (DUSA 2007b).

A description of the sources and receptors used in this assessment is provided in Sections 4.0 and 5.0, respectively. It should be noted that the MILDOS code used in the EnecoTech analysis is outdated. The MILDOS code has been updated to MILDOS-AREA; the most up-to-date MILDOS-AREA code version 2.20β is used in this assessment. A discussion on the development of the MILDOS code is provided in Section 3.2.

3.2 GENERAL INFORMATION ABOUT MILDOS-AREA

The MILDOS computer code was developed from the version IV for Argonne National Laboratory's (ANL's) Uranium Dispersion and Dosimetry (UDAD) computer program 1981. The MILDOS program was based on the models and assumptions from the U.S. NRC's Draft Regulatory Guide RH802-4 (Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Material Resulting from Uranium Milling Operation) and portions of the UDAD document (Strenge and Bender 1981).

In 1989, ANL developed MILDOS-AREA code by modifying the MILDOS code developed in 1981. The MILDOS-AREA code was designed or used on IBM or IBM compatible computers; the changes made were intended to enhance capabilities for calculating dose from large area-sources and updated dosimetry calculations. The major revision from the original MILDOS code is the treatment of atmospheric dispersion from area sources; MILDOS-AREA substituted a finite-element approach for the virtual-point source method (the algorithm used in the original MILDOS code) when specified by the user. The new approach subsequently led to a reduction in the number of sources from 20 to 10 in MILDOS-AREA due to the fact that a large area can be considered as a single source rather than two or more point sources.

The internal dosimetry calculations were also updated in MILDOS-AREA. In the original version of MILDOS, the dose to exposed individual is calculated for comparison with requirements of both 40 CFR190 and 10 CFR Part 20 (R313-15). The calculations of ingestion DCFs were based on ICRP Publication 2 and 10A's ingestion models (ICRP 1966). The inhalation DCFs are calculated by the ANL computer program UDAD (Momeni 1979) in accordance with Task group on Lung Dynamics lung model (TGLM) of the International Commission on Radiological Protection (ICRP 1966; ICRP 1972). ICRP Publication 19 (ICRP 1972) gives dose commitments to adult members of the public at age 20 that are assumed to live another 50 years. DCFs are provided as a function of particle size and organ for the radionuclides U-238, U-234, Th-230, Ra-226, Pb-210, Po-210 and Bi-210. The inhalation dose factors incorporated into MILDOS-AREA are calculated using the dosimetric model from ICRP Publication 30 (ICRP 1979) (Yu 1991); the inhalation dose factors are provided for the age groups of infant, child, teenager and adult. However, these factors are fixed internally in the code, and are not part of the input options. The annual average air concentrations were computed to the maximum permissible concentrations (MPCs) in 10 CFR Part 20. The MPCs in 10 CFR20 (incorporated by reference in R313-15) were revised in 1994 to incorporate the updated dosimetry to the 1CRP 1978 recommendations.

In 1997, the MILDOS-AREA code was updated to meet the requirements of the revised 10 CFR Part 20. The dose limit to the general public also changed; which led to a revised calculation of the allowable concentrations (ALCs) for unrestricted areas, with MPC replaced with the term "effluent concentrations".

In 1998, ANL again updated the MILDOS-AREA code in an attempt to improve the "user friendliness" of the software. In the past, the user must develop an input file in an American Standard Code for Information Interchange (ASCII) file containing values that are required by the code. The code executes this file to produce the output. The latest version of MILDOS-AREA, has a graphical user interface (GUI) which provides an interface for the user to input each parameter needed for the calculations in the Windows operating system. The GUI allows the results of the MILDOS-AREA calculations to be viewed. The 1998 update was the last time ANL made changes to the MILDOS-AREA code. The most up-to-date version of MILDOS-AREA is used in this assessment.

MILDOS-AREA calculates the impacts based on annual average air concentrations of nuclides considered. The human pathways considered in MILDOS-AREA for individual and population impacts are: inhalation, external exposure from ground concentrations, external exposure from cloud immersion, ingestion of vegetables, ingestion of meat and ingestion of milk.

3.3 THE USE OF MILDOS-AREA IN THIS ASSESSMENT

The 1991 EnecoTech analysis conducted by EnecoTech Environmental Consultants (under contract from Umetco Minerals) evaluated the potential radiological doses arising from the production of 8,760,000 lbs of U_3O_8 per year at the mill from processing conventionally mined ores. As mentioned, the original MILDOS code is no longer applicable.

In this assessment, the most up-to-date MILDOS-AREA code version 2.20β (ANL 1998a) was used to estimate potential radiation doses to members of the public estimated from the processing of Colorado Plateau or Arizona Strip ores, in separate cases, at the proposed ore process rates for each ore. As mentioned, the proposed ore process rate for the Colorado Plateau ore is approximately 730,000 tpy would recover approximately 1,715 tons (3,431,000 lbs) of U_3O_8 per year (assuming that the average uranium recovery is 94%). The proposed ore process rate for Arizona Strip ore is approximately 730,000 tpy would recover approximately 4,371 tons (8,742,188 lbs) of yellowcake per year (assuming that the average uranium recovery is 94%).

MILDOS-AREA was used to design a conceptual model of the mill. MILDOS-AREA requires the location of sources and receptors to be defined by the user; the locations are calculated relative to the reference point at the mill on a Cartesian grid system. The reference point used for the MILDOS-AREA code used in this assessment was the vanadium stack. The GPS coordinates were plotted using Google Earth Pro (Google 2005). The easting, northing and elevation of each source and receptor relative to the vanadium stack were measured in Google Earth Pro. The measured coordinates are entered directly for point sources. For area (quadrilateral) sources (i.e., ore pads and tailings ponds), the user must enter the boundaries and elevation of the area source which are calculated based on the easting and northing of the source. The sources are defined to represent each significant radionuclide release point at the mill; radionuclide releases for particulates and radon are defined by the user for point sources. MILDOS-AREA calculates the release rates from area sources based on the radionuclide concentrations, source area and meteorological data.

MILDOS-AREA only considers airborne releases of radioactive materials; releases to surface water and groundwater are not addressed. The U-238 decay chain is assumed to be the only significant source of radiation from uranium milling operations (the contribution from the U-235 chain is less than 5% of that from the U-238 chain). The particulate releases include U-238, Th-230, Ra-226 and Pb-210. The gaseous releases are defined for Rn-222 with in-growth of short-lived daughter products also considered. These Rn-222 daughters include Po-218, Pb-214, Bi-214, Pb-210 and Po-210. The model accounts for the releases and in-growth of other radionuclides using the assumption of secular equilibrium within the U-238 decay chain.

The transport of model radiological emissions from the point and area sources is predicted using a sector averaged Gaussian plume dispersion model. The dispersion model uses the meteorological data provided by the user and also includes mechanisms of dry deposition of particulates, re-suspension, radioactive decay and progeny in-growth and plume reflection. Deposition build-up and in-growth of radioactive progeny are considered in estimating ground concentrations.

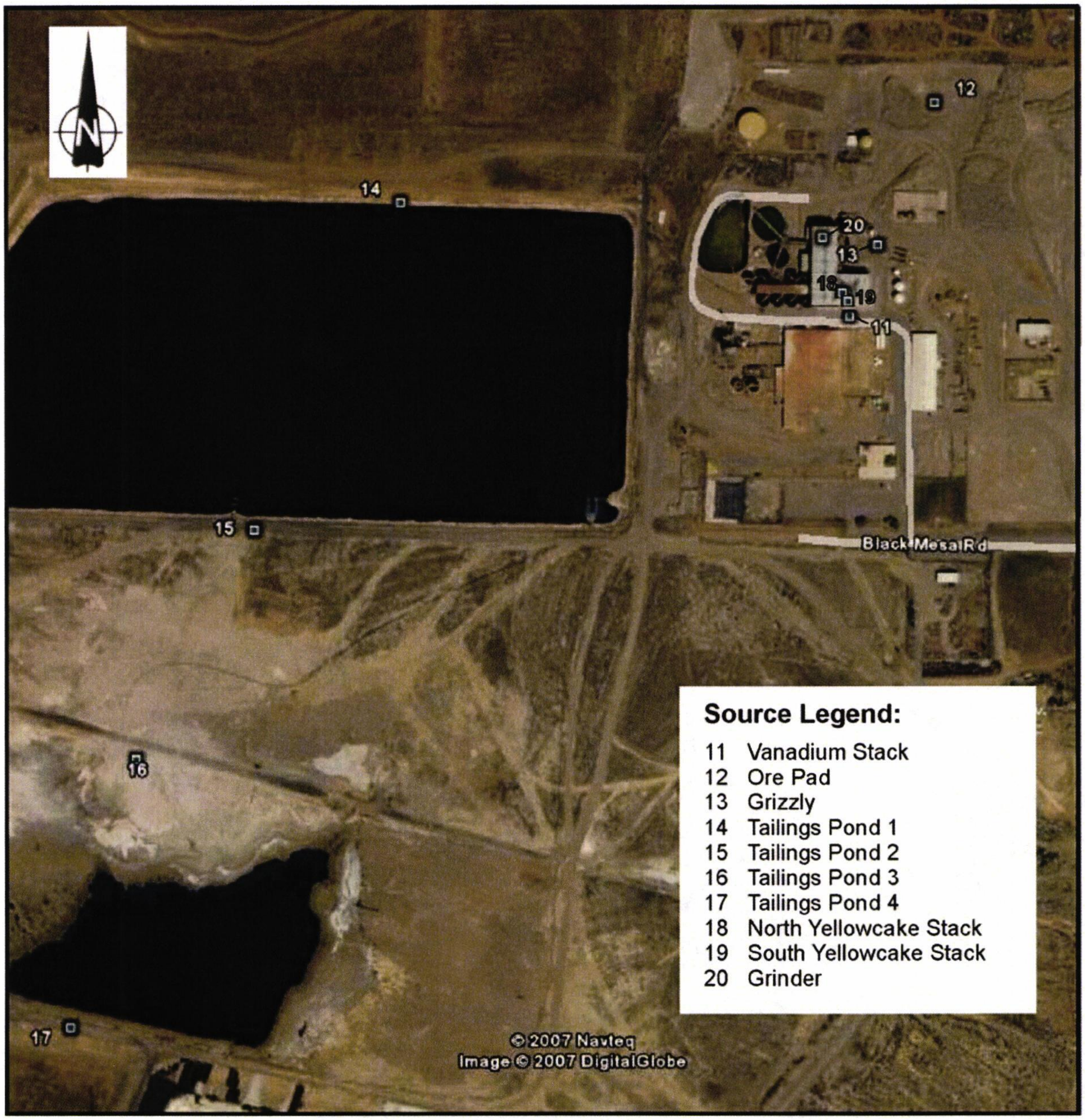
The impacts to humans through various pathways are estimated based on the calculated annual average air concentrations of radionuclides. The pathways considered in this analysis include: inhalation, external exposure from ground concentrations, external exposure from cloud immersion, and ingestion of meat and vegetables.

4.0 SOURCE TERMS

The radionuclides of concern for license renewal modeling consideration include; U-238 and its daughters Th-230, Ra-226, Pb-210 and Rn-222 which are assumed to be in secular equilibrium with the ore. The radioactive particulates and radon are emitted from airborne radioactive releases related to dust generation during ore handling (unloading ore from truck to ore pads and loading ore to the grizzly), point sources (grinder, yellowcake stacks and vanadium stack) and area source dusting from ore pad stockpiles and the tailings ponds. The large area sources such as the tailings area are divided into smaller sources (four tailings ponds) to allow for the size and irregular shape of these areas.

As mentioned in Section 3.3, the source locations used in the EnecoTech analysis were revised using the GPS coordinates provided by DUSA (DUSA 2007b). The coordinates for all the sources except for the grinder were calculated first by plotting the GPS coordinates provided by DUSA (DUSA 2007b) in Google Earth Pro and then using the measuring tool in Google Earth Pro to measure the easting, northing and elevation of each source relative to a reference point at the mill (i.e., the vanadium stack). The source locations (plotted in Google Earth) are shown in Figure 4.1.

FIGURE 4.1
SOURCE LOCATIONS



The dose to members of the public is estimated for the processing of Colorado Plateau ore or Arizona Strip ore in separate cases. Therefore, the emission calculations are provided for each ore type based on the activity concentration of U-238 in the ore, expected ore grade, average uranium recovery and the proposed ore process rate. It should be noted that the MILDOS-AREA model for Colorado Plateau ore has an additional point source (i.e., vanadium stack) since the ore may contain vanadium (assumed at 1.5% V_2O_5). A description of the approach used to calculate the emissions from the point and area sources are described in Section 4.1 and 4.2, respectively. Detailed source emissions calculations are provided in Appendix A.

4.1 Point Sources

Mill point sources used in the EnecoTech analysis were also used in this assessment. These sources include the grinder, loading ore to the grizzly and yellowcake stacks (north and south). The vanadium stack described in section 4.1.4 is exclusive to the processing of Colorado Plateau ore. A description of the approach used to calculate the emissions from point sources is provided in this section.

4.1.1 Grinder

There is no onsite crushing of the ore, only a wet grinding operation. The ore dust emissions are controlled because the material is wet during the grinding operations. The particulate emission control from the grinding operation is assumed to be 99.9%. U-238 and its decay daughters are all emitted at a rate of 9.27E-05 Ci/yr (assuming secular equilibrium) for Colorado Plateau ore. This calculation assumes the proposed ore process rate of 730,000 tpy and an ore specific activity of 700 pCi/g. Similarly, U-238 and its decay daughters are all emitted at a rate of 2.36E-04 Ci/yr (assuming secular equilibrium) for Arizona Strip ore. This calculation assumes the proposed ore process rate of 730,000 tpy and an ore specific activity of 1783 pCi/g. The emission rates for Rn-222 released during wet grinding is calculated assuming that only 20% of the radon is available for release or emanation from the mineral grains in which it is produced (NUREG 1980). The Rn-222 concentration in the ore was assumed to be equal to the U-238 concentration. The Rn-222 released during wet grinding is 92.7 Ci/yr and 236 Ci/yr for Colorado Plateau ore and Arizona Strip ore, respectively.

4.1.2 Grizzly

The emissions from trucks dumping ore onto the grizzly is highly controlled; the truck dump area is enclosed on three sides and has a negative pressure on it during dumping activities. The ore is delivered wet with an average moisture content of 10%. The exhaust from the induced draft (ID) fans used on the grizzly is ducted through a baghouse. The combined particulate dust control on this operation is assumed to be 99.9%. U-238 and its decay daughters are all emitted at a rate of 9.27E-05 Ci/yr (assuming secular equilibrium) for Colorado Plateau ore. This calculation assumes the proposed ore process rate of 730,000 tpy and an ore specific activity of 700 pCi/g. Similarly, U-238 and its decay daughters are all emitted at a rate of 2.36E-04 Ci/yr (assuming secular equilibrium) for Arizona Strip ore. This calculation assumes the proposed ore process rate of 730,000 tpy and an ore specific activity of 1783 pCi/g.

4.1.3 Yellowcake Stacks

The mill has two yellowcake dryers (north and south yellowcake dryers). From the EnecoTech analysis, stack tests on the yellowcake dryer yielded a yellowcake emission rate of 0.06 lbs/hr U_3O_8 when the process rate was 1300 lbs/hr. This yields an emission rate of 0.092 lbs/hr of yellowcake per ton of feed (EnecoTech 1991a and 1991b). The emission rate is with all the particulate emissions controls. Since there are north and south yellowcake dryers, the stack emissions from U-238 and its decay daughters are assumed to be divided equally between the two (i.e., north and south yellowcake stacks), and are based on the proposed ore process rate of Colorado Plateau ore and Arizona Strip Ore. Therefore, U-238 is all emitted at a rate of 1.01E-02 Ci/yr for Colorado Plateau ore. This calculation assumes the proposed ore process rate of 730,000 tpy and an ore specific activity of 700 pCi/g. Similarly, U-238 is emitted at a rate of 2.36E-04 Ci/yr for Arizona Strip ore. This calculation assumes the proposed ore process rate of 730,000 tpy and an ore specific activity of 1783 pCi/g.

Based on field measurements, the decay daughters of U-238 (Th-230, Ra-226 and Pb-210) are processed along with yellowcake at 0.22%, 0.13% and 0.78%, respectively (EnecoTech 1991a and 1991b). Therefore, the decay daughters Th-230, Ra-226 and Pb-210 are emitted at a rate of 2.22E-05 Ci/yr, 1.31E-05 Ci/yr and 7.88E-05 Ci/yr, respectively for Colorado Plateau ore. This calculation assumes the proposed ore process rate of 730,000 tpy (divided equally between the north and south yellowcake dryers) and an ore specific activity of 700 pCi/g. Similarly, the decay daughters Th-230, Ra-226 and Pb-210 are emitted at a rate of 5.67E-05 Ci/yr, 3.35E-05 Ci/yr and 2.01E-04 Ci/yr, respectively for Arizona Strip ore. This calculation assumes the proposed ore process rate of 730,000 tpy (divided equally between the north and south yellowcake dryers) and an ore specific activity of 1783 pCi/g.

Since the ore processing steps reject nearly all the radium to the tailings, very little radon is released during the production of yellow cake. No significant radon releases occur during yellowcake drying and packaging, since only about 0.1% of the original Ra-226 in the ore is found in yellowcake. Therefore, the amount of Rn-222 emitted from the yellowcake stack is assumed to be negligible.

4.1.4 Vanadium Stack

The vanadium stack source term was only used in the MILDOS-AREA model for Colorado Plateau ore. The vanadium present in the Colorado Plateau ore is partially solubilized during leaching. The dissolved vanadium is present in uranium raffinate. Depending on its vanadium content, the uranium raffinate will either be recycled to the counter-current decantation step or further processed for recovery of vanadium before recycling. The product from the vanadium recovery contains less than 0.005% U_3O_8 (NUREG 1980). Therefore, the emission rate for the vanadium stack was calculated to be 0.005% of the total emission rate from the yellowcake stacks (north and south yellowcake stack). U-238 is emitted at a rate of 1.01E-06 Ci/yr for Colorado Plateau ore. This calculation assumes the proposed ore process rate of 730,000 tpy and an ore specific activity of 700 pCi/g.

By adopting the EnecoTech analysis (EnecoTech 1991a and 1991b) measurements for the decay daughters of U-238 (Th-230, Ra-226 and Pb-210) processed along with yellowcake of 0.22%, 0.13% and 0.78%, respectively, the emissions from the remaining radionuclides are assumed to be negligible and in any event are likely discharged to the tailings ponds.

4.2 Area Sources

Mill area sources used in the EnecoTech analysis were also used in this assessment. These sources include the ore pads and the tailings ponds. The area of the ore pad was reduced in this assessment to match anticipated future requirements as discussed below. In addition, the number of tailings ponds was reduced from 5 (used in the EnecoTech analysis) to 4 in this assessment. A description of the approach used to calculate the emissions from area sources is provided in this section.

4.2.1 Ore Pads

The ore pad storage operation has two different sources of emissions namely unloading ore from trucks to the ore pad and wind emissions. Approximately 300,000 tons of ore is assumed to be temporarily stockpiled at the mill's ore pads at any given time. Using a bulk ore density of 1.47 tons/yd^3 (DUSA, Feb. 6/07), the quantity of ore would create a pile 30 ft. (9.1 m) tall covering approximately 4 acres (17,000 m^2) stockpile area.

With respect to the truck unloading emissions, a process emission factor of 0.04 lbs of ore is emitted per cubic yard handled (for a truck end and assuming no control (NRC 1987)) and a bulk ore density of 1.47 tons/yd^3 is used in the calculations. U-238 and its decay daughters are all emitted at a rate of 1.58E-02 Ci/yr for each isotope for Colorado Plateau ore. This calculation assumes the proposed ore process rate of 730,000 tpy and an ore specific activity of 700 pCi/g. Similarly, U-238 and its decay daughters are all emitted at a rate of 4.02E-02 Ci/yr (assuming secular equilibrium) for Arizona Strip ore. This calculation assumes the proposed ore process rate of 730,000 tpy and an ore specific activity of 1783 pCi/g.

Wind erosion from the ore pad is assumed to have a 50% control factor due to the active watering program in place. This is conservative, in that actual dust control on the ore pads may be better than this. The annual dust loss from the ore pad is 21.29 g/m^2yr; this was calculated using the method from NRC's Regulatory Guide 3.59 (NRC 1987) on the basis of the meteorological data (provided by DUSA (DUSA 2007c) presented in Appendix A; the annual dust loss from the ore pads is 10% that of the tailings piles since the particulates in the ore pads are coarse material (1 to 6 inch) because the ore has not yet been ground. U-238 and its decay daughters are all assumed to be emitted at a rate of 3.17E-04 Ci/yr for each isotope for Colorado Plateau ore. This calculation assumes the proposed ore process rate of 300,000 tpy and an ore specific activity of 700 pCi/g. Similarly, U-238 and its decay daughters are all emitted at a rate of 8.07E-04 Ci/yr (assuming secular equilibrium) for Arizona Strip ore. This calculation assumes the proposed ore process rate of 300,000 tpy and an ore specific activity of 1783 pCi/g. Therefore, the total emission rate of U-238 and its daughter from truck dumping and wind erosion is 1.61E-02 Ci/yr and 4.10E-02 Ci/yr for Colorado Plateau ore and Arizona Strip ore, respectively.

Rn-222 will be produced in the ore pads from the decay of Ra-226. The estimated annual radon release rate from the ore pads is 375 Ci/yr and 956 Ci/yr for Colorado Plateau ore and Arizona Strip ore, respectively.

4.2.2 Tailings ponds

The current, or anticipated, status of the various tailings ponds at the mill are summarized in Table 4.1. In brief, Tailings Cell 1 is used as an evaporation pond and will always have a water cover (tailings solution); hence, no dust or radon emissions are expected from Tailings Cell 1. Tailings Cell 2 is almost entirely covered with an interim soil cover. Data from the 2005 NESHAP's report indicates an average radon flux of 6.6 pCi/m^2s from covered areas and an average radon flux of 55.8 pCi/m^2s from remaining exposed beaches

TABLE 4.1
CHARACTERISTICS OF TAILINGS AT WHITE MESA

Tailings Cell	Water Cover (acres)	Interim Soil Cover (acres)	Beach (acres)
1	55	-	-
2	-	66.1	0.7
3	35	37	7
4A	36	-	4

Wind erosion of tailings from Cell 2 will be limited to the small area remaining to be covered. Tailings Cell 3 has a mixture of water cover (tailings solution), an interim soil cover and exposed tailings beach. As for cell 1, it is assumed that no tailings dust or radon will be released from the water covered parts of Cell 3. Wind eroded tailings dust would arise from uncovered tailings beach. Radon release rates are based on the 2005 NESHAP's report which indicates a radon flux about 7.1 pCi/m^2s from covered areas and 24.2 pCi/m^2s from exposed tailings beach.

In the case of Cell 4, for present purposes, it is assumed that the cell is fully developed with approximately 36 acres of water cover (tailings solution) and 4 acres of exposed tailings.

As mentioned in Section 4.0, large area sources such as the tailings area are divided into smaller sources (four tailings ponds) to allow for the size and irregular shape of these areas. Therefore, the tailings areas were divided into four area sources in the MILDOS-AREA run. Tailings ponds 1, 2, 3, and 4 represent cell 1, cell 2, cell 3 and cell 4A, respectively.

Using the onsite wind data generated over the last 3 years (provided by DUSA (DUSA 2007c)), the annual dust loss from the tailings ponds is estimated to be approximately 213 g/m^2yr; this was calculated using the method from NRC's Regulatory Guide 3.59 (NRC 1987). It is assumed that the average uranium recovery rate is 94%. In addition, a process emission control factor of 70% was assumed, based on 1) the active watering (tailings solutions spraying) program on exposed areas of tailings beaches in active areas; 2) solutions cover other tailings areas; and 3) crusting agents from the sprayed solutions act to minimize the erosion of the tailings beaches by wind. With these assumptions and the particulate emission factor, U-238 is emitted at a rate of 2.09E-04 Ci/yr and the decay daughters Th-230, Ra-226 and Pb-210 are emitted at a rate of 3.48E-03 Ci/yr from Cell 2 and 3 while U-238 is emitted at a rate of 1.09E-04 Ci/yr and the decay daughters Th-230, Ra-226 and Pb-210 are emitted at a rate of 1.81E-03 Ci/yr from Cell 4A for Colorado Plateau ore. These calculations assume the proposed ore process rate of 730,000 tpy and an ore specific activity of 700 pCi/g. Similarly, for Arizona Strip ore, U-238 is emitted at a rate of 5.32E-04 Ci/yr and the decay daughters Th-230, Ra-226 and Pb-210 are emitted at a rate of 8.87E-03 Ci/yr from Cell 2 and 3 while U-238 is emitted at a rate of 2.76E-04 Ci/yr and the decay daughters Th-230, Ra-226 and Pb-210 are emitted at a rate of 4.61E-03 Ci/yr from Cell 4A for Arizona Strip ore. These calculations assume the proposed ore process rate of 730,000 tpy and an ore specific activity of 1783 pCi/g.

The tailings consist of a mixture of sands and slimes, which are the sources of radon. The National Emission Standards for Hazardous Air Pollutants (NESHAPS) (Regulation 40 CFR60, Subpart W) standard limits the Rn-222 emission rate to 20 pCi/m^{2}s from uranium mills and their associated tailings impoundments. In order to demonstrate compliance with NESHAP's, the mill carries out a NESHAP's evaluation on an annual basis. As indicated previously, data from the 2005 NESHAP's report (IUC, 2005) was used in this assessment. In this analysis, a total annual radon releases rate of approximately 130 Ci/yr was estimated for the tailings source.

4.3 METEOROLOGICAL DATA

Meteorological conditions influence re-suspension and dispersion of radionuclides from point sources and area sources. The mill has an onsite weathering monitoring station that records the wind speed, wind direction and stability class. This data is used to formulate a joint frequency distribution which is a required input for MILDOS-AREA. The joint frequency distribution used in this assessment was provided by DUSA (DUSA 2007c) using the most recent three years (2004 to 2006) of recorded data.

4.4 POPULATION DATA

The population data was obtained from the year 2000 U.S. census and were used to complete demographic and population dose projections. Census data is only available in 10 year intervals and local demographics have experienced little change since the 2000 census.

4.5 URANIUM MILL SOURCE EMISSION RATES

4.5.1 Colorado Plateau Ore

The calculated mill radioactive particulate and radon emission rates from point sources and area sources described in Sections 4.1 and 4.2, respectively for Colorado Plateau ore are provided in Table 4.2.

TABLE 4.2
RADIOACTIVE PARTICULATE AND RADON EMISSION RATES (COLORADO PLATEAU ORE)

		Process							
		Grinding	**Ore Dump to Grizzly**	**Ore Pads**	**North YC Stack**	**South YC Stack**	**Tailings Cell 2 and 3**	**Tailings Cell 4A**	**Vanadium Stack[b]**
Emission Rate (Ci/yr)	U-238	9.27E-05	9.27E-05	1.61E-02	1. 01E-02	1. 01E-02	2.09E-04	1.09E-04	1. 01E-06
	Th-230	9.27E-05	9.27E-05	1.61E-02	2.22E-05	2.22E-05	3.48E-03	1.81E-03	2.22E-09
	Ra-226	9.27E-05	9.27E-05	1.61E-02	1.31E-05	1.31E-05	3.48E-03	1.81E-03	1.31E-059
	Pb-210	9.27E-05	9.27E-05	1.61E-02	7.88E-05	7.88E-05	3.48E-03	1.81E-03	7.88E-09
	Rn-222	9.27E+01	Note a	3.75E+02	Note a	Note a	117.71	12.36	Note a

Notes:

a) No significant release during this process.

b) Source is exclusive to the processing of Colorado Plateau ore.

4.5.2 Arizona Strip Ore

The calculated mill radioactive particulate and radon emission rates from point sources and area sources described in Sections 4.1 and 4.2, respectively for Arizona Strip ore are provided in Table 4.3.

TABLE 4.3
RADIOACTIVE PARTICULATE AND RADON EMISSION RATES (ARIZONA STRIP ORE)

		Process						
		Grinding	**Ore Dump to Grizzly**	**Ore Pads**	**North YC Stack**	**South YC Stack**	**Tailings Cell 2 and 3**	**Tailings Cell 4A**
Emission Rate (Ci/yr)	U-238	2.36E-04	2.36E-04	4.10E-02	2.58E-02	2.58E-02	5.32E-04	2.76E-04
	Th-230	2.36E-04	2.36E-04	4.10E-02	5.67E-05	5.67E-05	8.87E-03	4.61E-03
	Ra-226	2.36E-04	2.36E-04	4.10E-02	3.35E-05	3.35E-05	8.87E-03	4.61E-03
	Pb-210	2.36E-04	2.36E-04	4.10E-02	2.01E-04	2.01E-04	8.87E-03	4.61E-03
	Rn-222	2.36E+02		9.56E+02	Note a	Note a	117.71	12.36

Note:

a) No significant release during this process.

5.0 RECEPTORS

The receptors used in this assessment were provided by DUSA. The receptors used in this assessment are as follows:

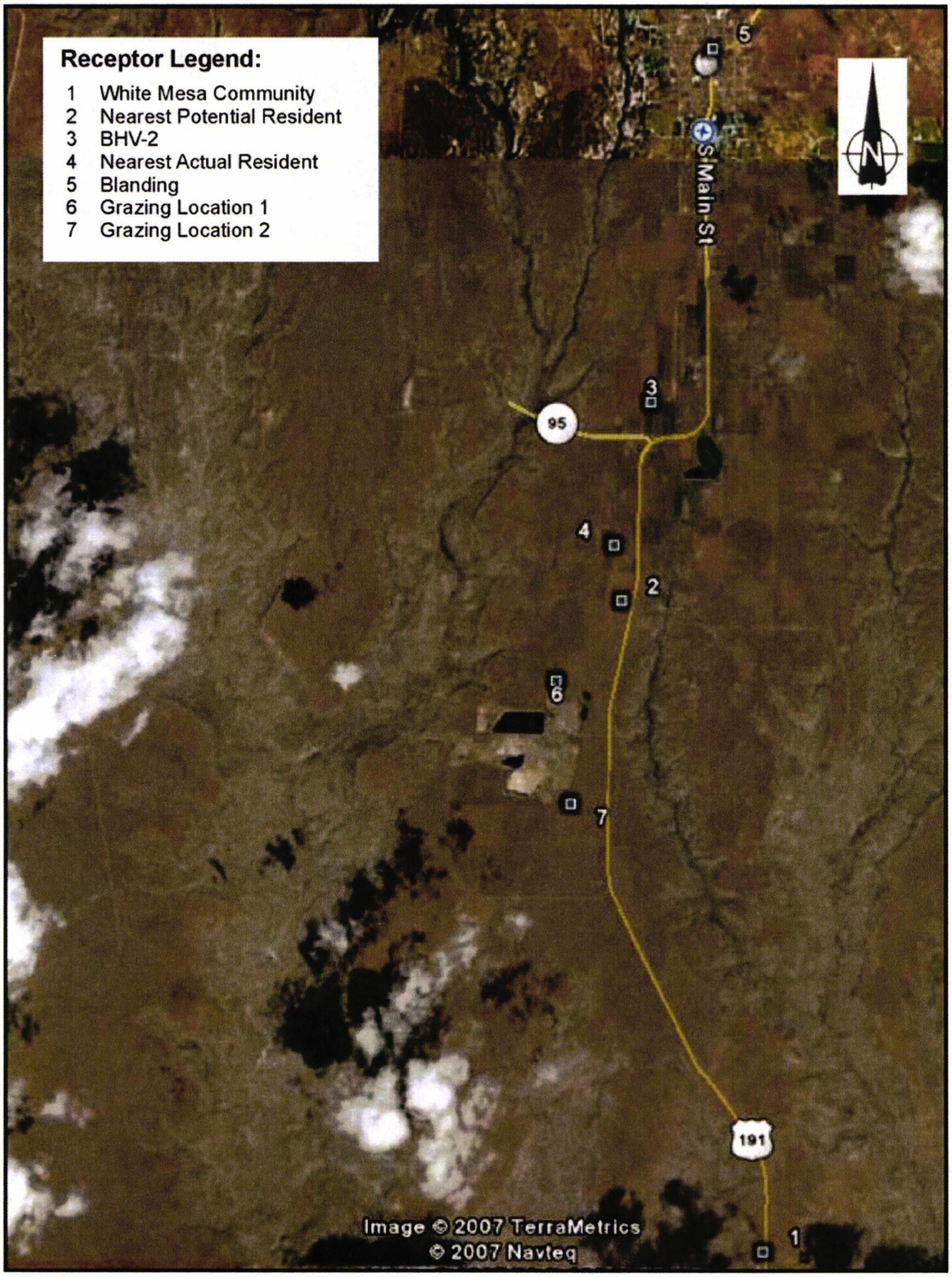
- Nearest Historical Resident (BHV-2);
- Nearest Actual Resident
- Nearest Potential Resident (BHV-1);
- White Mesa Ute Community;
- Blanding, Utah.

In addition, two grazing locations 1 and 2 are considered as a possible source of meat.

As mentioned in Section 1.3, the receptor locations were determined using a GPS receiver and were provided by DUSA (DUSA 2007b). The GPS coordinates were used for all the receptors except for Grazing location 1 and 2 where the easting and northing for Grazing locations 1 and 2 were taken as nominal "mid-points" in Google Earth for these two receptor locations.

The receptor locations (plotted in Google Earth) with respect to the vanadium stack are shown in Figure 5.1.

FIGURE 5.1
RECEPTOR LOCATIONS WITH RESPECT TO THE VANADIUM STACK



At the time of the 1979 Final Environmental Statement (FES) for the mill, the nearest resident lived approximately 4.8 miles (4.5) km north-north east of the mill building, near the location of air monitoring station BHV-2 (also referred to as the historical nearest resident). Currently, the nearest "potential" resident is approximately 1.2 miles (1.9 km) north of the Mill, near the location of air monitoring station BHV-1. The nearest actual resident is located approximately 1.6 miles (2.5 km) north of the mill. Nearby population groups include the community of White Mesa, about 8.5 km south east and the city of Blanding, approximately 6 miles (10 km) from the mill.

The area to the immediate north of the mill (Grazing location 1) is believed to be used only for grazing of meat animals (beef) (NRC 1979). A second location (Grazing location 2) to the east and south of the mill is also used for the grazing of meat animals (beef) as was assumed in the EnecoTech analysis (EnecoTech 1991a and 1991b). Although considered unlikely, in one worst case scenario, it is possible that the meat animal grazed at Grazing location 1 and 2 would be eaten by the residents near the mill. We have not included a scenario whereby it is assumed that grazing at Grazing locations 1 and 2 supports dairy cattle, because the prospect of supporting dairy cattle in those locations is not credible, given the arid climate and the much larger feed requirements of dairy cattle as opposed to beef cattle. We have also been advised by DUSA that no dairy cattle graze in Grazing locations 1 and 2. It should be noted, however, that in all of the MILDOS AREA model runs in this report, we did assume, conservatively, that individuals at each receptor location are assumed to drink all of their milk from cows and eat all of their beef from cattle that graze at the receptor location (but not at Grazing locations 1 or 2). This is also thought to be a very conservative assumption.

6.0 RADIATION DOSE ESTIMATES

This section describes the MILDOS-AREA results of the mill's potential radiological impacts to the population in the vicinity of the Mill. This analysis is primarily based on the estimated annual releases of radioactive materials and assumptions discussed in Sections 4.0 and 5.0. All potential exposure pathways which are likely to impact individuals near the mill have been included in the MILDOS-AREA model.

MILDOS-AREA calculates the total annual effective dose commitment (including radon). The calculated total annual effective dose commitments are compared to the 10 CFR20 (R313-15) requirements that the dose to individual members of the public shall not exceed 100 mrem/yr (radon included). In addition, MILDOS-AREA calculates 40 CFR190 doses (excludes radon). The 40 CFR190 Criterion is 25 mrem/yr to the whole body (excluding the dose due to radon) and 25 mrem/yr to any other organ to any member of the public (EPA 2002). The 40CFR 190 doses are also used to demonstrate compliance with 10 CFR20.1101(d) (R313-15-101(4)). Under 10 CFR 20.1101(d) (R313-15-101(4) the licensee must demonstrate that the total effective dose equivalent to the individual member of the public likely to receive the highest total effective dose equivalent will not exceed 10 mrem/yr (absent of the radon dose).

In this assessment, a worst case scenario in which there is a possibility that individuals near the mill ingest meat from cattle grown at Grazing Location 1 or 2 is considered. It is assumed that the cattle will graze at Grazing location 1 or 2 for 2 months of the year (due to the arid nature of the region and the lack of forage). Therefore, the meat ingestion dose to individuals near the mill who might consume beef grazed at Grazing Location 1 or 2 is assumed to be one-sixth of the MILDOS-AREA calculated meat ingestion dose from these grazing locations.

MILDOS-AREA was run separately for Colorado Plateau ore and Arizona Strip ore. Total annual dose commitments and 40 CFR190 annual dose commitments were estimated for locations in which individual members of the public might reside (BHV-1 (nearest potential resident), BHV-2, Nearest Actual Resident, White Mesa Ute Community and Blanding, Utah) are provided in Sections 6.1 and 6.2 for Colorado Plateau ore and Arizona Strip ore, respectively. In addition, total annual dose commitments and 40 CFR190 annual dose commitments from the meat ingestion pathway that is estimated for Grazing location 1 and 2 are provided in Sections 6.1 and 6.2.

6.1 MILDOS-AREA RESULTS FOR COLORADO PLATEAU ORE

The potential annual doses to the people living close to the mill and to the population living within 50 miles (80 km) as a result of processing Colorado Plateau ore is calculated using MILDOS-AREA. As mentioned in Section 1.2, the proposed ore process rate for the Colorado Plateau ore is approximately 730,000 tpy. Assuming that the average uranium recovery is at the historical recovery yield of 94%, the ore processing operations is expected to yield 1715 tons (3,431,000 lbs) of U_3O_8 per year.

The MILDOS-AREA-calculated total annual dose commitments (including radon) and 40 CFR190 total annual dose commitment for processing of Colorado Plateau ore are provided in Sections 6.1.1 and 6.1.2, respectively

6.1.1 R313-15-301(1)(a) Regulatory Compliance

The MILDOS-AREA calculated total annual dose commitments (including radon) are provided in this section. These doses are regulated by R313-15-301(1)(a) which requires the dose to an individual member of the public shall not exceed 100 mrem/yr (radon included).

Table 6.1 presents a summary of the individual dose commitments for the residential receptors for the age group of infant, child, teenage and adult.

TABLE 6.1
COMPARISON OF ANNUAL DOSE COMMITMENTS TO APPLICABLE RADIATION PROTECTION STANDARDS (COLORADO PLATEAU ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
Nearest Potential Resident (BHV-1)	Infant	Effective	1.20E+00	100	1.20E-02
		Bone	1.86E+00	-	-
		Avg. Lung	5.01E-01	-	-
		Bronchi	1.05E+01	-	-
	Child	Effective	8.93E-01	100	8.93E-03
		Bone	1.31E+00	-	-
		Avg. Lung	6.68E-01	-	-
		Bronchi	1.05E+01	-	-
	Teenage	Effective	9.34E-01	100	9.34E-03
		Bone	4.65E+00	-	-
		Avg. Lung	5.34E-01	-	-
		Bronchi	1.05E+01	-	-
	Adult	Effective	8.25E-01	100	8.25E-03
		Bone	2.04E+00	-	-
		Avg. Lung	3.72E-01	-	-
		Bronchi	1.05E+01	-	-

TABLE 6.1 (Cont'd)
COMPARISON OF ANNUAL DOSE COMMITMENTS TO APPLICABLE RADIATION PROTECTION STANDARDS (COLORADO PLATEAU ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
Nearest Historical Resident (BHV-2)	Infant	Effective	2.54E-01	100	2.54E-03
		Bone	2.89E-01	-	-
		Avg. Lung	9.56E-02	-	-
		Bronchi	2.69E+00	-	-
	Child	Effective	2.10E-01	100	2.10E-03
		Bone	2.16E-01	-	-
		Avg. Lung	1.17E-01	-	-
		Bronchi	2.69E+00	-	-
	Teenage	Effective	2.16E-01	100	2.16E-03
		Bone	7.18E-01	-	-
		Avg. Lung	9.42E-02	-	-
		Bronchi	2.69E+00	-	-
	Adult	Effective	2.00E-01	100	2.00E-03
		Bone	3.28E-01	-	-
		Avg. Lung	6.85E-02	-	-
		Bronchi	2.69E+00	-	-
Nearest Actual Resident	Infant	Effective	7.59E-01	100	7.59E-03
		Bone	1.09E+00	-	-
		Avg. Lung	2.95E-01	-	-
		Bronchi	7.01E+00	-	-
	Child	Effective	5.77E-01	100	5.77E-03
		Bone	7.71E-01	-	-
		Avg. Lung	3.93E-01	-	-
		Bronchi	7.01E+00	-	-
	Teenage	Effective	6.01E-01	100	6.01E-03
		Bone	2.70E+00	-	-
		Avg. Lung	3.16E-01	-	-
		Bronchi	7.01E+00	-	-
	Adult	Effective	5.38E-01	100	5.38E-03
		Bone	1.19E+00	-	-
		Avg. Lung	2.21E-01	-	-
		Bronchi	7.01E+00	-	-

TABLE 6.1 (Cont'd)
COMPARISON OF ANNUAL DOSE COMMITMENTS TO APPLICABLE RADIATION PROTECTION STANDARDS (COLORADO PLATEAU ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
White Mesa Community	Infant	Effective	1.77E-01	100	1.77E-03
		Bone	1.29E-01	-	-
		Avg. Lung	5.55E-02	-	-
		Bronchi	2.16E+00	-	-
	Child	Effective	1.56E-01	100	1.56E-03
		Bone	9.08E-02	-	-
		Avg. Lung	5.21E-02	-	-
		Bronchi	2.16E+00	-	-
	Teenage	Effective	1.57E-01	100	1.57E-03
		Bone	2.48E-01	-	-
		Avg. Lung	4.15E-02	-	-
		Bronchi	2.16E+00	-	-
	Adult	Effective	1.52E-01	100	1.52E-03
		Bone	1.25E-01	-	-
		Avg. Lung	3.31E-02	-	-
		Bronchi	2.16E+00	-	-
Blanding	Infant	Effective	8.37E-02	100	8.37E-04
		Bone	8.26E-02	-	-
		Avg. Lung	2.91E-02	-	-
		Bronchi	9.21E-01	-	-
	Child	Effective	7.09E-02	100	7.09E-04
		Bone	6.00E-02	-	-
		Avg. Lung	3.35E-02	-	-
		Bronchi	9.21E-01	-	-
	Teenage	Effective	7.23E-02	100	7.23E-04
		Bone	1.89E-01	-	-
		Avg. Lung	2.73E-02	-	-
		Bronchi	9.21E-01	-	-
	Adult	Effective	6.81E-02	100	6.81E-04
		Bone	8.89E-02	-	-
		Avg. Lung	2.06E-02	-	-
		Bronchi	9.21E-01	-	-

From Table 6.1, the total annual effective dose commitments are at most 0.0120 (effective dose for infant at BHV-1) of the R313-15-301(1)(a) limit of 100 mrem/yr (radon included) to an individual member of the public. Therefore, the predicted annual effective dose commitments comply with R313-15-301.

In the worst case scenario in which there is a possibility that individuals near the mill ingest meat from cattle grown at Grazing Location 1 or 2. It is assumed that the cattle will graze at Grazing location 1 or 2 for 2 months of the year. The meat ingestion dose to individuals near the mill who might consume beef grazed at Grazing Location 1 or 2 is assumed to be one-sixth of the MILDOS-AREA calculated meat ingestion dose from these grazing locations. Table 6.2 presents a summary of the annual dose commitments from the meat ingestion pathway for Grazing location 1 and 2. Even in the very unlikely event that a resident were to consume meat from one of the grazing locations, the total dose would remain well below regulatory limits.

TABLE 6.2
TOTAL ANNUAL DOSE COMMITMENTS (mrem) FOR MEAT INGESTION PATHWAY (COLORADO PLATEAU ORE)

Location	Age Group	Organ[b]		
		Effective[a]	Bone[a]	Avg. Lung[a]
Grazing Location 1	Infant	0.00E+00	0.00E+00	0.00E+00
	Child	1.08E-02	5.35E-02	4.87E-02
	Teenage	1.68E-02	2.78E-01	4.27E-02
	Adult	1.22E-02	1.51E-01	3.52E-02
Grazing Location 2	Infant	0.00E+00	0.00E+00	0.00E+00
	Child	5.82E-04	2.88E-03	2.38E-03
	Teenage	8.95E-04	1.52E-02	2.08E-03
	Adult	6.35E-04	7.93E-03	1.72E-03

Note:
a) Assumes cattle will graze at the particular Grazing location for 2 months of the year.
b) Exclusive of radon.

6.1.2 40 CFR190 Regulatory Compliance

MILDOS-AREA calculated 40 CFR190 doses (excludes radon). These doses are regulated by the 40 CFR190 criterion, which is 25 millirem (mrem) to the whole body (excluding the dose due to radon) (EPA 2002) or to any organ of the body. The 40CFR 190 doses are also used to demonstrate compliance with R313-15-101(4) (10 CFR20.1101(d)). The licensee must demonstrate that total effective dose equivalent to the individual member of the public likely to receive the highest total effective dose equivalent will not exceed 10 mrem/yr (absent of the radon dose).

Table 6.3 presents a summary of the 40 CFR190 individual dose commitments for the residential receptors for the age group of infant, child, teenage and adult.

TABLE 6.3
COMPARISON OF 40 CFR190 ANNUAL DOSE COMMITMENTS WITH APPLICABLE RADIATION PROTECTION STANDARDS (COLORADO PLATEAU ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
Nearest Potential Resident (BHV-1)	Infant	Effective	5.35E-01	25	2.14E-02
		Bone	1.82E+00	25	7.29E-02
		Avg. Lung	4.63E-01	25	1.85E-02
		Bronchi	9.55E-04	not limited	
	Child	Effective	2.23E-01	25	8.94E-03
		Bone	1.27E+00	25	5.10E-02
		Avg. Lung	6.30E-01	25	2.52E-02
		Bronchi	9.55E-04	not limited	
	Teenage	Effective	2.65E-01	25	1.06E-02
		Bone	4.62E+00	25	1.85E-01
		Avg. Lung	4.96E-01	25	1.98E-02
		Bronchi	9.55E-04	not limited	
	Adult	Effective	1.56E-01	25	6.24E-03
		Bone	2.00E+00	25	7.99E-02
		Avg. Lung	3.33E-01	25	1.33E-02
		Bronchi	9.55E-04	not limited	
Nearest Historical Resident (BHV-2)	Infant	Effective	7.84E-02	25	3.14E-03
		Bone	2.72E-01	25	1.09E-02
		Avg. Lung	8.01E-02	25	3.21E-03
		Bronchi	1.35E-04	not limited	
	Child	Effective	3.42E-02	25	1.37E-03
		Bone	1.98E-01	25	7.91E-03
		Avg. Lung	1.00E-01	25	4.01E-03
		Bronchi	1.35E-04	not limited	
	Teenage	Effective	4.03E-02	25	1.61E-03
		Bone	6.92E-01	25	2.77E-02
		Avg. Lung	7.76E-02	25	3.10E-03
		Bronchi	1.35E-04	not limited	
	Adult	Effective	2.40E-02	25	9.61E-04
		Bone	3.07E-01	25	1.23E-02
		Avg. Lung	5.25E-02	25	2.10E-03
		Bronchi	1.35E-04	not limited	

TABLE 6.3 (Cont'd)
COMPARISON OF 40 CFR190 ANNUAL DOSE COMMITMENTS WITH APPLICABLE RADIATION PROTECTION STANDARDS (COLORADO PLATEAU ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
Nearest Actual Resident	Infant	Effective	3.11E-01	25	1.25E-02
		Bone	1.06E+00	25	4.25E-02
		Avg. Lung	2.67E-01	25	1.07E-02
		Bronchi	5.50E-04	not limited	-
	Child	Effective	1.30E-01	25	5.18E-03
		Bone	7.40E-01	25	2.96E-02
		Avg. Lung	3.63E-01	25	1.45E-02
		Bronchi	5.50E-04	not limited	-
	Teenage	Effective	1.53E-01	25	6.14E-03
		Bone	2.66E+00	25	1.07E-01
		Avg. Lung	2.86E-01	25	1.14E-02
		Bronchi	5.50E-04	not limited	-
	Adult	Effective	9.01E-02	25	3.60E-03
		Bone	1.16E+00	25	4.64E-02
		Avg. Lung	1.93E-01	25	7.70E-03
		Bronchi	5.50E-04	not limited	-
White Mesa Community	Infant	Effective	3.18E-02	25	1.27E-03
		Bone	1.11E-01	25	4.43E-03
		Avg. Lung	4.04E-02	25	1.62E-03
		Bronchi	4.06E-05	not limited	-
	Child	Effective	1.18E-02	25	4.73E-04
		Bone	7.01E-02	25	2.80E-03
		Avg. Lung	3.39E-02	25	1.35E-03
		Bronchi	4.06E-05	not limited	-
	Teenage	Effective	1.24E-02	25	4.95E-04
		Bone	2.10E-01	25	8.38E-03
		Avg. Lung	2.39E-02	25	9.56E-04
		Bronchi	4.06E-05	not limited	-
	Adult	Effective	7.75E-03	25	3.10E-04
		Bone	9.88E-02	25	3.95E-03
		Avg. Lung	1.68E-02	25	6.71E-04
		Bronchi	4.06E-05	not limited	-

TABLE 6.3 (Cont'd)
COMPARISON OF 40 CFR190 ANNUAL DOSE COMMITMENTS WITH APPLICABLE RADIATION PROTECTION STANDARDS (COLORADO PLATEAU ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
Blanding	Infant	Effective	2.13E-02	25	8.51E-04
		Bone	7.34E-02	25	2.94E-03
		Avg. Lung	2.18E-02	25	8.73E-04
		Bronchi	3.36E-05	not limited	-
	Child	Effective	8.58E-03	25	3.43E-04
		Bone	4.97E-02	25	1.99E-03
		Avg. Lung	2.44E-02	25	9.78E-04
		Bronchi	3.36E-05	not limited	-
	Teenage	Effective	9.77E-03	25	3.91E-04
		Bone	1.69E-01	25	6.75E-03
		Avg. Lung	1.86E-02	25	7.43E-04
		Bronchi	3.36E-05	not limited	-
	Adult	Effective	5.87E-03	25	2.35E-04
		Bone	7.51E-02	25	3.00E-03
		Avg. Lung	1.26E-02	25	5.06E-04
		Bronchi	3.36E-05	not limited	-

From Table 6.3, the 40 CFR190 annual dose commitments are at most 0.185 (dose to the bone for the teen at BHV-1) of the 40 CFR190 dose criterion of 25 mrem/yr. In addition, the 40 CFR190 annual effective dose commitments demonstrate compliance with the R313-15-101(4) (10 CFR20.1101(d)) limit of 10 mrem/yr to the individual member of the public likely to receive the highest total effective dose equivalent. The maximum total effective dose equivalent was 0.535 mrem/yr (infant at BHV-1), or 0.0214 of the 10 mrem/yr limit.

In the worst case scenario in which there is a possibility that individuals near the mill ingest meat from cattle grown at Grazing Locations 1 or 2, it is assumed that the cattle will graze at Grazing location 1 or 2 for 2 months of the year. The meat ingestion dose to individuals near the mill who might consume beef grazed at Grazing Location 1 or 2 is assumed to be one-sixth of the MILDOS-AREA calculated meat ingestion dose from these grazing locations. Table 6.4 presents a summary of the 40 CFR190 annual dose commitments from the meat ingestion pathway for Grazing Locations 1 and 2. As before, in the unlikely event a receptor were to eat meat from cattle grazing in areas 1 or 2, the total dose would remain well below regulatory limits.

TABLE 6.4
40 CFR190 ANNUAL DOSE COMMITMENTS (mrem) FOR MEAT INGESTION PATHWAY (COLORADO PLATEAU ORE)

Location	Age Group	Organ[b]		
		Effective[a]	Bone[a]	Avg. Lung[a]
Grazing Location 1	Infant	0.00E+00	0.00E+00	0.00E+00
	Child	1.08E-02	5.35E-02	4.87E-02
	Teenage	1.68E-02	2.78E-01	4.27E-02
	Adult	1.22E-02	1.51E-01	3.52E-02
Grazing Location 2	Infant	0.00E+00	0.00E+00	0.00E+00
	Child	5.80E-04	2.87E-03	2.37E-03
	Teenage	8.92E-04	1.52E-02	2.07E-03
	Adult	6.33E-04	7.90E-03	1.72E-03

Note:
a) Assumes cattle will graze at the particular Grazing location for 2 months of the year.
b) Exclusive of radon.

The annual doses to the population estimated within 50 miles (80 km) of the site are provided in Table 6.5.

TABLE 6.5
ANNUAL POPULATION DOSE COMMITMENTS WITHIN 50 MILES (80 km) OF THE MILL FOR COLORADO PLATEAU ORE

Organ	ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR
	Mill Operations
Effective	1.15E-01
Bone	9.18E-01
Avg. Lung	1.22E-01
Bronchi	6.28E+00

The population dose arising from the processing of Colorado Plateau ore is estimated at 0.15 person-rem. This can be compared to the dose from natural background sources of radiation.

In the United States, nominal average levels of natural background radiation are as follows (National Council on Radiation Protection and Measurements (NCRP), 1987):

Cosmic and Cosmogenic	28 mrem/yr
Terrestrial	28 mrem/yr
Inhaled (Radon)	200 mrem/yr
Ingested	40 mrem /yr
Total (Average)	**296 mrem/yr (96 mrem/yr excluding radon)**

In the area of the White Mesa Mill, natural background radiation was measured at two sites in 1977: the project site (Blanding) and the Hanksville site. At the Blanding site, the average dose equivalent from external radiation was about 142 mrem/yr. Of this 142 mrem/yr, 68 mrem/yr came from cosmic radiation, while 74 mrem/yr came from terrestrial radiation. (Dames & Moore, 1978). At the Hanksville site, the corresponding average dose equivalent was about 122 mrem/yr (68 mrem/yr from cosmic radiation and 54 mrem/yr from terrestrial radiation). (Dames & Moore, 1978).

Ingested radionuclides would contribute (about) a further 18 mrem/yr (NRC, 1979). This brings the total background dose from external radiation and ingested radioactivity, but exclusive of the dose from radon-222, to about 161 mrem/yr; which is higher than both the US averages of 96 mrem/yr.

If the nominal U.S. dose from radon of about 200 mrem per year is added, then the total dose from natural background in the area of the mill is 360 mrem/y (or more assuming the dose from radon would increase along with that from terrestrial source).

The current population of San Juan county is about 14,400 people. Assuming everyone living in San Juan county receives an annual dose of (about) 360 mrem/y, then the total dose due to natural background is approximately 5184 person-rem. The theoretical incremental dose of 0.15 person-rem is clearly inconsequential by comparison.

6.2 MILDOS-AREA RESULTS FOR ARIZONA STRIP ORE

The potential annual doses to the people living close to the mill and to the population living within 50 miles (80 km) as a result of processing of Arizona Strip ore is calculated using MILDOS-AREA. As mentioned in Section 1.2, the proposed ore process rate for Arizona Strip ore is approximately 730,000 tpy. Assuming that the average uranium recovery is at the historical recovery yield of 94%, the ore processing operations is expected to yield 4,371 tons (8,742,188 lbs) of yellowcake per year.

The MILDOS-AREA calculated total annual dose commitments (including radon) and 40 CFR190 annual dose commitments for processing of Arizona Strip ore are provided in Sections 6.2.1 and 6.2.2, respectively.

6.2.1 R313-15-301 (1)(a) Regulatory Compliance

The MILDOS-AREA calculated total annual dose commitments (including radon) are provided in this section. These doses are regulated by R313-15-301(1)(a) which requires the dose to an individual member of the public shall not exceed 100 mrem/yr (radon included).

Table 6.6 presents a summary of the individual dose commitments for the residential receptors for the age group of infant, child, teenage and adult.

TABLE 6.6
COMPARISON OF ANNUAL DOSE COMMITMENTS WITH APPLICABLE RADIATION PROTECTION STANDARDS (ARIZONA STRIP ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
Nearest Potential Resident (BHV-1)	Infant	Effective	2.94E+00	100	2.94E-02
		Bone	4.74E+00	-	-
		Avg. Lung	1.27E+00	-	-
		Bronchi	2.49E+01	-	-
	Child	Effective	2.15E+00	100	2.15E-02
		Bone	3.35E+00	-	-
		Avg. Lung	1.69E+00	-	-
		Bronchi	2.49E+01	-	-
	Teenage	Effective	2.25E+00	100	2.25E-02
		Bone	1.18E+01	-	-
		Avg. Lung	1.35E+00	-	-
		Bronchi	2.49E+01	-	-
	Adult	Effective	1.97E+00	100	1.97E-02
		Bone	5.19E+00	-	-
		Avg. Lung	9.40E-01	-	-
		Bronchi	2.49E+01	-	-

TABLE 6.6 (Cont'd)
COMPARISON OF ANNUAL DOSE COMMITMENTS WITH APPLICABLE RADIATION PROTECTION STANDARDS (ARIZONA STRIP ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
Nearest Historical Resident (BHV-2)	Infant	Effective	6.00E-01	100	6.00E-03
		Bone	7.35E-01	-	-
		Avg. Lung	2.40E-01	-	-
		Bronchi	6.09E+00	-	-
	Child	Effective	4.87E-01	100	4.87E-03
		Bone	5.45E-01	-	-
		Avg. Lung	2.94E-01	-	-
		Bronchi	6.09E+00	-	-
	Teenage	Effective	5.03E-01	100	5.03E-03
		Bone	1.82E+00	-	-
		Avg. Lung	2.36E-01	-	-
		Bronchi	6.09E+00	-	-
	Adult	Effective	4.60E-01	100	4.60E-03
		Bone	8.29E-01	-	-
		Avg. Lung	1.70E-01	-	-
		Bronchi	6.09E+00	-	-
Nearest Actual Resident	Infant	Effective	1.83E+00	100	1.83E-02
		Bone	2.78E+00	-	-
		Avg. Lung	7.47E-01	-	-
		Bronchi	1.63E+01	-	-
	Child	Effective	1.37E+00	100	1.37E-02
		Bone	1.96E+00	-	-
		Avg. Lung	9.96E-01	-	-
		Bronchi	1.63E+01	-	-
	Teenage	Effective	1.43E+00	100	1.43E-02
		Bone	6.88E+00	-	-
		Avg. Lung	7.99E-01	-	-
		Bronchi	1.63E+01	-	-
	Adult	Effective	1.27E+00	100	1.27E-02
		Bone	3.03E+00	-	-
		Avg. Lung	5.59E-01	-	-
		Bronchi	1.63E+01	-	-

TABLE 6.6 (Cont'd)
COMPARISON OF ANNUAL DOSE COMMITMENTS WITH APPLICABLE RADIATION PROTECTION STANDARDS (ARIZONA STRIP ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
White Mesa Community	Infant	Effective	3.96E-01	100	3.96E-03
		Bone	3.23E-01	-	-
		Avg. Lung	1.36E-01	-	-
		Bronchi	4.72E+00	-	-
	Child	Effective	3.45E-01	100	3.45E-03
		Bone	2.24E-01	-	-
		Avg. Lung	1.26E-01	-	-
		Bronchi	4.72E+00	-	-
	Teenage	Effective	3.47E-01	100	3.47E-03
		Bone	6.18E-01	-	-
		Avg. Lung	9.94E-02	-	-
		Bronchi	4.72E+00	-	-
	Adult	Effective	3.34E-01	100	3.34E-03
		Bone	3.10E-01	-	-
		Avg. Lung	7.86E-02	-	-
		Bronchi	4.72E+00	-	-
Blanding	Infant	Effective	1.94E-01	100	1.94E-03
		Bone	2.08E-01	-	-
		Avg. Lung	7.20E-02	-	-
		Bronchi	2.06E+00	-	-
	Child	Effective	1.62E-01	100	1.62E-03
		Bone	1.50E-01	-	-
		Avg. Lung	8.27E-02	-	-
		Bronchi	2.06E+00	-	-
	Teenage	Effective	1.65E-01	100	1.65E-03
		Bone	4.74E-01	-	-
		Avg. Lung	6.68E-02	-	-
		Bronchi	2.06E+00	-	-
	Adult	Effective	1.54E-01	100	1.54E-03
		Bone	2.22E-01	-	-
		Avg. Lung	5.02E-02	-	-
		Bronchi	2.06E+00	-	-

From Table 6.6, the total annual effective dose commitments are at most 0.0294 (effective dose for infant at BHV-1) of the R313-15-301(1)(a) of 100 mrem/yr (radon included) to an individual member of the public. Therefore, the predicted annual effective dose commitments comply with R313-15-101(1)(a).

In the worst case scenario in which there is a possibility that individuals near the mill ingest meat from cattle grown at Grazing Location 1 or 2. It is assumed that the cattle will graze at Grazing location 1 or 2 for 2 months of the year. The meat ingestion dose to individuals near the mill who might consume beef grazed at Grazing Location 1 or 2 is assumed to be one-sixth of the MILDOS-AREA calculated meat ingestion dose from these grazing locations. Table 6.7 presents a summary of the annual dose commitments from the meat ingestion pathway for Grazing location 1 and 2. As before, even in the unlikely event that a receptor consumed beef from one of the grazing locations, the total dose would remain well below regulatory limits.

TABLE 6.7
TOTAL ANNUAL DOSE COMMITMENTS FOR MEAT INGESTION PATHWAY (ARIZONA STRIP ORE)

Location	Age Group	Organ[b]		
		Effective[a]	Bone[a]	Avg. Lung[a]
Grazing Location 1	Infant	0.00E+00	0.00E+00	0.00E+00
	Child	2.73E-02	1.37E-01	1.24E-01
	Teenage	4.28E-02	7.10E-01	1.09E-01
	Adult	3.10E-02	3.83E-01	8.97E-02
Grazing Location 2	Infant	0.00E+00	0.00E+00	0.00E+00
	Child	1.48E-03	7.35E-03	6.05E-03
	Teenage	2.28E-03	3.88E-02	5.30E-03
	Adult	1.62E-03	2.02E-02	4.38E-03

Note:
a) Assumes cattle will graze at the particular Grazing location for 2 months of the year.
b) Exclusive of radon

6.2.2 40 CFR190 Regulatory Compliance

MILDOS-AREA calculated 40 CFR190 doses (excludes radon). These doses are regulated by 40 CFR190 Criterion is 25 millirem (mrem) to the whole body (excluding the dose due to radon) (EPA 2002). The 40CFR 190 doses are also used to demonstrate compliance with R313-15-101(4) (10 CFR20.1101(d)). The licensee must demonstrate that total effective dose equivalent to the individual member of the public likely to receive the highest total effective dose equivalent will not exceed 10 mrem/yr (absent of the radon dose).

Table 6.8 presents a summary of the 40 CFR190 individual dose commitments for residential receptors for the age group of infant, child, teenage and adult.

TABLE 6.8
COMPARISON OF 40 CFR190 ANNUAL DOSE COMMITMENTS WITH APPLICABLE RADIATION PROTECTION STANDARDS (ARIZONA STRIP ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
Nearest Potential Resident (BHV-1)	Infant	Effective	1.37E+00	25	5.47E-02
		Bone	4.65E+00	25	1.86E-01
		Avg. Lung	1.18E+00	25	4.72E-02
		Bronchi	2.43E-03	not limited	
	Child	Effective	5.70E-01	25	2.28E-02
		Bone	3.24E+00	25	1.29E-01
		Avg. Lung	1.60E+00	25	6.41E-02
		Bronchi	2.43E-03	not limited	
	Teenage	Effective	6.75E-01	25	2.70E-02
		Bone	1.17E+01	25	4.70E-01
		Avg. Lung	1.26E+00	25	5.05E-02
		Bronchi	2.43E-03	not limited	
	Adult	Effective	3.96E-01	25	1.58E-02
		Bone	5.10E+00	25	2.04E-01
		Avg. Lung	8.48E-01	25	3.39E-02
		Bronchi	2.43E-03	not limited	
Nearest Historical Resident (BHV-2)	Infant	Effective	2.00E-01	25	8.00E-03
		Bone	6.96E-01	25	2.79E-02
		Avg. Lung	2.04E-01	25	8.18E-03
		Bronchi	3.45E-04	not limited	
	Child	Effective	8.72E-02	25	3.49E-03
		Bone	5.03E-01	25	2.01E-02
		Avg. Lung	2.55E-01	25	1.02E-02
		Bronchi	3.45E-04	not limited	
	Teenage	Effective	1.03E-01	25	4.10E-03
		Bone	1.76E+00	25	7.03E-02
		Avg. Lung	1.98E-01	25	7.91E-03
		Bronchi	3.45E-04	not limited	
	Adult	Effective	6.11E-02	25	2.45E-03
		Bone	7.83E-01	25	3.13E-02
		Avg. Lung	1.34E-01	25	5.35E-03
		Bronchi	3.45E-04	not limited	

TABLE 6.8 (Cont'd)
COMPARISON OF 40 CFR190 ANNUAL DOSE COMMITMENTS WITH APPLICABLE RADIATION PROTECTION STANDARDS (ARIZONA STRIP ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
Nearest Actual Resident	Infant	Effective	7.93E-01	25	3.17E-02
		Bone	2.71E+00	25	1.09E-01
		Avg. Lung	6.77E-01	25	2.71E-02
		Bronchi	1.40E-03	not limited	-
	Child	Effective	3.30E-01	25	1.32E-02
		Bone	1.89E+00	25	7.54E-02
		Avg. Lung	9.25E-01	25	3.70E-02
		Bronchi	1.40E-03	not limited	-
	Teenage	Effective	3.91E-01	25	1.56E-02
		Bone	6.80E+00	25	2.72E-01
		Avg. Lung	7.28E-01	25	2.91E-02
		Bronchi	1.40E-03	not limited	-
	Adult	Effective	2.29E-01	25	9.17E-03
		Bone	2.96E+00	25	1.18E-01
		Avg. Lung	4.90E-01	25	1.96E-02
		Bronchi	1.40E-03	not limited	-
White Mesa Community	Infant	Effective	8.12E-02	25	3.25E-03
		Bone	2.82E-01	25	1.13E-02
		Avg. Lung	1.03E-01	25	4.12E-03
		Bronchi	1.03E-04	not limited	-
	Child	Effective	3.01E-02	25	1.20E-03
		Bone	1.79E-01	25	7.15E-03
		Avg. Lung	8.62E-02	25	3.45E-03
		Bronchi	1.03E-04	not limited	-
	Teenage	Effective	3.16E-02	25	1.26E-03
		Bone	5.35E-01	25	2.14E-02
		Avg. Lung	6.08E-02	25	2.43E-03
		Bronchi	1.03E-04	not limited	-
	Adult	Effective	1.97E-02	25	7.90E-04
		Bone	2.53E-01	25	1.01E-02
		Avg. Lung	4.27E-02	25	1.71E-03
		Bronchi	1.03E-04	not limited	-

TABLE 6.8 (Cont'd)
COMPARISON OF 40 CFR190 ANNUAL DOSE COMMITMENTS WITH APPLICABLE RADIATION PROTECTION STANDARDS (ARIZONA STRIP ORE)

Location	Age Group	Organ	Estimated Dose (mrem/yr)	Applicable Limit (mrem/yr)	Fraction of Limit
Blanding	Infant	Effective	5.44E-02	25	2.18E-03
		Bone	1.87E-01	25	7.48E-03
		Avg. Lung	5.57E-02	25	2.23E-03
		Bronchi	8.57E-05	not limited	-
	Child	Effective	2.19E-02	25	8.76E-04
		Bone	1.27E-01	25	5.06E-03
		Avg. Lung	6.24E-02	25	2.49E-03
		Bronchi	8.57E-05	not limited	-
	Teenage	Effective	2.49E-02	25	9.95E-04
		Bone	4.30E-01	25	1.72E-02
		Avg. Lung	4.72E-02	25	1.89E-03
		Bronchi	8.57E-05	not limited	-
	Adult	Effective	1.49E-02	25	5.98E-04
		Bone	1.92E-01	25	7.66E-03
		Avg. Lung	3.22E-02	25	1.29E-03
		Bronchi	8.57E-05	not limited	-

From Table 6.8, the 40 CFR190 annual dose commitments are at most 0.47 (dose to the bone for the teen at BHV-1) of the 40 CFR190 dose criterion of 25 mrem/yr. In addition, the 40 CFR190 annual effective dose commitments demonstrate compliance with R313-15-101(4) (10 CFR20.1101(d)) limit of 10 mrem/yr to the individual member of the public likely to receive the highest total effective dose equivalent.

In the worst case scenario in which there is a possibility that individuals near the mill ingest meat from cattle grown at Grazing Location 1 or 2. It is assumed that the cattle will graze at Grazing location 1 or 2 for 2 months of the year. The meat ingestion dose to individuals near the mill who might consume beef grazed at Grazing Location 1 or 2 is assumed to be one-sixth of the MILDOS-AREA calculated meat ingestion dose from these grazing locations. Table 6.9 presents a summary of the 40 CFR190 annual dose commitments from the meat ingestion pathway for Grazing location 1 and 2. Again, even in the unlikely event that someone were to consume beef from grazing area 1 or 2, the total dose would be small and well below regulatory limits.

TABLE 6.9
40 CFR190 ANNUAL DOSE COMMITMENTS (mrem) FOR MEAT INGESTION PATHWAY (ARIZONA STRIP ORE)

Location	Age Group	Organ		
		Effective[a]	Bone[a]	Avg. Lung[a]
Grazing Location 1	Infant	0.00E+00	0.00E+00	0.00E+00
	Child	2.73E-02	1.37E-01	1.24E-01
	Teenage	4.28E-02	7.10E-01	1.09E-01
	Adult	3.10E-02	3.83E-01	8.97E-02
Grazing Location 2	Infant	0.00E+00	0.00E+00	0.00E+00
	Child	1.48E-03	7.32E-03	6.03E-03
	Teenage	2.27E-03	3.87E-02	5.28E-03
	Adult	1.61E-03	2.02E-02	4.35E-03

Note:

a) Assumes cattle will graze at the particular Grazing location for 2 months of the year.
b) Exclusive of radon.

The annual doses to the population estimated within 50 miles (80 km) of the site are provided in Table 6.10.

TABLE 6.10
ANNUAL POPULATION DOSE COMMITMENTS WITHIN 50 MILES (80 km) OF THE MILL FOR ARIZONA STRIP ORE

Organ	ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR
	Mill Operations
Effective	2.71E-01
Bone	2.21E+00
Avg. Lung	2.88E-01
Bronchi	1.41E+01

The population dose arising from the processing of Colorado Plateau ore is estimated at 0.345 person-rem. This can be compared to the dose from natural background sources of radiation in the Colorado Plateau of about 360 mrem/yr as previously discussed.

In the United States, nominal average levels of natural background radiation are as follows (National Council on Radiation Protection and Measurements (NCRP), 1987):

The current population of San Juan county is about 14,400 people. Assuming everyone living in San Juan county receives an annual dose of (about) 360 mrem/y, then the total dose due to natural background is approximately 5184 person-rem. The theoretical incremental dose of 0.345 person-rem is clearly inconsequential by comparison.

7.0 KEY OBSERVATIONS

As mentioned in Section 1.0, milling of conventional ore is scheduled for early 2008 when the milling of currently available alternate feed materials completed (DUSA 2007). This dose assessment was prepared in support of the license renewal application for the White Mesa Uranium mill.

The goal was to determine the potential doses to populations in the vanity of the mill.

In this assessment, MILDOS-AREA was used to estimate the dose commitments received by individuals and the general population within a 50 mile (80 km) radius for the processing of Colorado Plateau ore or Arizona Strip ore. The expected ore grade from the Colorado Plateau ore is an average of 0.25% U_3O_8 and 1.5% V_2O_5 (NRC 1980) while the Arizona Strip ore is assumed to contain 0.637% U_3O_8 (DUSA 2007a). The proposed ore process rate for the Colorado Plateau ore and Arizona Strip ore is approximately 730,000 tons per year (tpy) (2000 tons per day). Assuming that the average uranium recovery is at the historical recovery yield of 94%, approximately 1,715 tons (3,431,000 lbs) of U_3O_8 per year would be recovered from Colorado Plateau ore at the proposed ore process rate. Similarly, approximately 4,371 tons (8,742,188 lbs) of U_3O_8 per year would be recovered from Arizona Strip ore at the proposed ore process rate. The proposed operating schedule at the mill is assumed to be 24 hr/day for 365 days per year.

The MILDOS-AREA calculated total annual effective dose commitments (including radon) were compared to the R313-15-301(1)(a) (10 CFR20) requirements that the dose to individual members of the public shall not exceed 100 mrem/yr (radon included). Overall, the total annual effective dose commitments are at most 0.0120 (effective dose for infant at BHV-1) of the R313-15-301(1)(a) (10 CFR20) limit of 100 mrem/yr (radon included) to an individual member of the public for the processing of Colorado Plateau ore. The total annual effective dose commitments are at most 0.0294 (effective dose for infant at BHV-1) of the R313-15-301(1)(a) (10 CFR20) limit of 100 mrem/yr (radon included) to an individual member of the public for the processing of Arizona Strip ore. Therefore, the predicted annual effective dose commitments for anticipated ore processing operations comply with R313-15-301(1)(a) (10 CFR20).

In addition, the MILDOS-AREA-calculated 40 CFR190 annual dose commitment (excluding radon) were compared to the 40 CFR190 Criterion, which is 25 mrem/yr to the whole body (excluding the dose due to radon) and 25 mrem/yr to any other organ to any member of the public (EPA 2002). The 40CFR 190 doses were also used to demonstrate compliance with R313-15-101(4) (10 CFR20.1101(d)) (i.e., the licensee must demonstrate that total effective dose equivalent to the individual member of the public likely to receive the highest total effective dose equivalent will not exceed 10 mrem/yr (absent of the radon dose). Overall, from Table 6.3, the 40 CFR190 annual dose commitments are at most 0.185 (dose to the bone for the teen at BHV-1) of the 40 CFR190 dose criterion of 25 mrem/yr for Colorado Plateau ore. In addition, the 40 CFR190 annual effective dose commitments demonstrate compliance with the R313-15-101(4) (10 CFR20.1101(d)) limit of 10 mrem/yr to the individual member of the public likely to receive the highest total effective dose equivalent. From Table 6.8, the 40 CFR190 annual dose commitments are at most 0.47 (dose to the bone for the teen at BHV-1) of the 40 CFR190 dose criterion of 25 mrem/yr. In addition, the 40 CFR190 annual effective dose commitments demonstrate compliance with R313-15-101(4) (10 CFR20.1101(d)) limit of 10 mrem/yr to the individual member of the public likely to receive the highest total effective dose equivalent. Therefore, the predicted 40 CFR annual effective dose commitments for anticipated ore processing operations comply with R313 -15 (10 CFR20).

8.0 REFERENCES

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APPENDIX A

EMISSIONS CALCULATIONS

A.0 EMISSIONS CALCULATIONS

Supplemental Information which describes the model and assumptions used to calculate the source emissions for the sources described in Section 4.0 are provided below.

A.1 Calculation of Annual Dust Loss

The calculation of the annual dust loss from the ore pads and the tailings ponds was required to calculate an emission factor. This dusting rate for the tailings impoundments is calculated according to the emission factor (E_w) equation from NRC's Regulatory Guide 3.59 (NRC 1987). The equation of for the dusting rate is calculated as follows:

$$E_W = \frac{3.156 \times 10^7}{0.5} \times \sum_S R_S F_S \qquad \textbf{(A.1)}$$

where,

E_w= annual dust loss per unit area in g/m^2yr;
F_S= annual average frequency of occurrence of wind speed group S (dimensionless) obtained from the joint relative frequency distribution for the mill (provided by DUSA (DUSA 2007c);
R_S= resuspension rate for the tailings pond at the average wind speed for wind group S, for particles $\leq$ 20 μm in diameter in g/m^2s;
$3.156x10^7$= number of seconds per year; and,
0.5= fraction of the total dust lost constituted by particle $\leq$ 20 μm in diameter.

TABLE A.1
PARAMETER VALUES FOR CALCULATION OF ANNUAL DUSTING RATE FOR EXPOSED TAILINGS

Wind Speed (kts)	Average Wind Speed	Resuspension Rate (R_S) (g/m^2s)[a]	Frequency of Occurrence, (F_S)[b]	R_S x F_S
0 to 3	1.5	0	0.165	0.00E+00
4 to 6	5.5	0	0.427	0.00E+00
7 to 10	10.0	3.92E-07	0.276	1.08E-07
11 to 16	15.5	9.68E-06	0.106	1.03E-06
17 to 21	21.5	5.71E-05	0.021	1.20E-06
21+	28.0	2.08E-04	0.005	1.04E-06
			$\sum_S$	3.37E-06

Notes:
a) Resuspension rate of a function of wind speed is computed by the MILDOS code.
b) Wind speed frequency obtained from joint frequency distribution data provided by DUSA (DUSA 2007c).

Using equation A.1 and the parameters in Table A-1, the annual dust loss from the tailings ponds is approximately 213 g/m^2yr. As mentioned in Section 4.2.1, the annual dust lost for ore pads is 10% of that of the tailings ponds since the particulates on the ore pad are coarse material (1 to 6 inch) because the ore has not yet been ground; therefore the annual dust loss from the ore pad is 21.29 g/m^2yr.

A.2 Emission Calculations

The equations and assumptions used to calculate the radioactive particulate ((U-238) and its daughters thorium (Th-230), radium (Ra-226) and lead (Pb-210)) and radon emission rates from the grizzly, grinding, ore pads, vanadium stack (exclusively for processing Colorado Plateau ore), yellowcake stacks (north and south yellowcake stacks) and the tailings ponds were taken from NRC's Regulatory Guide 3.59 (NRC 1987), NUREG-0706 (NRC 1980) and the EnecoTech analysis (EnecoTech 1991a and 1991b).

A.2.1 Wet Grinding

Radioactive Particulate Emission Rates

	Colorado Plateau Ore	**Arizona Strip Ore**
Process Rate (tpy)	730,000	730,000
Contaminant Concentration (pCi/g U-238)	700	1783
Process Emission Factor (lbs/ton)[a]	0.16	0.16
Activity Enrichment Ratio	2.5	2.5
Control Factor (%)[b]	99.90	99.90

Notes:
a) For moisture <8% (NRC 1987).
b) Particulate emission control from the wet grinding operations is assumed to be 99.9% (EnecoTech 1991a and 1999b)

The U-238 Emission Rate (S) is calculated as follows:

S= (Process Rate (tons/yr))*(Process Emission Factor (lbs/ton))*(453.6 g/lb)*(Contaminant Concentration (pCi/g))*(Activity Enrichment Ratio)*(1-Control Factor)*(10^{-12} Ci/pCi) **(A.2-1)**

Using equation A.2-1, the U-238 Emission Rate from wet grinding operations of Colorado Plateau ore is approximately 9.27E-05 Ci/yr. U-238 decay daughters (Th-230, Ra-226 and Pb-210) are assumed to be in secular equilibrium; therefore the decay daughters are also emitted at a rate of 9.27E-05 Ci/yr. Similarly, the U-238 Emission Rate from the wet grinding operations of

Arizona Strip ore is approximately 2.36E-04 Ci/yr and the decay daughters (Th-230, Ra-226 and Pb-210) are also emitted at a rate of 2.36E-04 Ci/yr.

Radon Emission Rates

	Colorado Plateau ore	Arizona Strip ore
Process Rate (tpy)	730,000	730,000
Contaminant Concentration (pCi/g Ra-226)	700	1783
Activity Factor(%)[a]	20	20

Note:
a) It is assumed that only 20% of the radon is available for release or emanation from the mineral grains in which it is produced (i.e. the emanating fraction or power is 0.20) (NUREG 0706 1980).

Radon Release (F):

F= (Process Rate (tons/yr))*(2000 lbs/ton)*(453.6 g/ton)*(Contaminant Concentration pCi/g Ra-226)*(10^{-12} Ci/pCi)*(Activity Factor) **(A-2-2)**

Using equation A.2-2, the radon release from the wet grinding operations of Colorado Plateau ore is approximately 92.7 Ci/yr. Similarly, the radon release from the wet grinding operations of Arizona Strip ore is approximately 236 Ci/yr.

A.2.2 Ore Dump to Grizzly

Radioactive Particulate Emission Rates

	Colorado Plateau Ore	Arizona Strip Ore
Process Rate (tpy)	730,000	730,000
Contaminant Concentration (pCi/g U-238)	700	1783
Process Emission Factor (lbs/ton)[a]	0.16	0.16
Activity Enrichment Ratio	2.5	2.5
Control Factor (%)	99.90	99.90

Notes:
a) For moisture <8% (NRC 1987).
b) Grizzly Dump is enclosed on three sides. Trucks dump inside enclosure under negative pressure. The ID fans are ducted through a baghouse. Ore moisture content is 10 %.

The U-238 Emission Rate (S) is calculated as follows:

S= (Process Rate (tons/yr))*(Process Emission Factor (lbs/ton))*(453.6 g/lb)*(Contaminant Concentration (pCi/g))*(Activity Enrichment Ratio)*(1-Control Factor)*(10^{-12} Ci/pCi) **(A.2-3)**

Using equation A.2-3, the U-238 Emission Rate due to the trucks dumping Colorado Plateau ore on the grizzly is approximately 9.27E-05 Ci/yr. U-238 decay daughters (Th-230, Ra-226 and Pb-210) are assumed to be in secular equilibrium; therefore the decay daughters are also emitted at a rate of 9.27E-05 Ci/yr. Similarly, the U-238 Emission Rate due to the trucks dumping Arizona Strip ore on the grizzly is approximately 2.36E-04 Ci/yr and the decay daughters (Th-230, Ra-226 and Pb-210) are also emitted at a rate of 2.36E-04 Ci/yr.

Radon Emission Rates

No radon is released from the trucks dumping ore onto the grizzly.

A.2.3 Yellowcake Stacks

As mentioned in Section 4.1.3, the mill has two yellowcake dryers (north and south yellowcake stack dryers); therefore the total emissions were assumed to be divided equally between the two stacks (i.e., north and south yellowcake stacks).

Radioactive Particulate Emission Rates

	Colorado Plateau Ore	Arizona Strip Ore
Process Rate (tpy U_3O_8)	1716	4371
Contaminant Concentration (Ci/g of U-238)	3.33E-07	3.33E-07
Process Emission Factor (g U-238/g U_3O_8)	0.848	0.848
Emission Rate/ Control Factor (lbs/ton)[a]	0.092	0.092

Note:
a) Based stack tests that showed an emission rate of 0.06 lbs/hr U_3O_8 per 1300 lbs/hr process rate which translates to 0.092 lb/ton including controls.

The U-238 Emission Rate (S) for one yellowcake stack is calculated as follows:

S= [(Process Rate (tons/yr U_3O_8))*(Emission Rate (lbs/ton))*(Process Emission Factor)*(453.6 g/lb)*(Contaminant Concentration (Ci/g))]/2 **(A.2-4)**

Based on field measurements, the decay daughters Th-230, Ra-226 and Pb-210 are processed along with yellowcake at 0.22%, 0.13% and 0.78%, respectively.

Using equation A.2-4, the U-238 Emission Rate from each yellowcake stack (north and south yellowcake stacks) is approximately 1.01E-02 Ci/yr for the processing of Colorado Plateau ore. The emission rate for the decay daughters Th-230, Ra-226 and Pb-210 is 2.22E-05 Ci/yr, 1.31E-05 Ci/yr and 7.88E-05 Ci/yr, respectively from each yellowcake stack (north and south yellowcake stacks). Similarly, the U-238 Emission Rate from each yellowcake stack (north and south yellowcake stacks) is approximately 2.58E-02 Ci/yr for the processing of Arizona Strip ore. The emission rate for the decay daughters Th-230, Ra-226 and Pb-210 is 5.67E-05 Ci/yr, 3.35E-05 Ci/yr and 2.01E-04 Ci/yr, respectively from each yellowcake stack (north and south yellowcake stacks).

Radon Emission Rates

There is no significant radon releases during this process.

A.2.4 Vanadium Stack

Radioactive Particulate Emission Rates

As mentioned in Section 4.1.4, the vanadium source was only used in the MILDOS-AREA model for Colorado Plateau ore. The product from the vanadium recovery contains less than 0.005% U_3O_8 (NUREG 1980). Therefore, the emission rates of U-238 and its decay daughters from the vanadium stack were assumed to be 0.005% of the total emission rate from the yellowcake stacks (north and south yellowcake stacks).

Radioactive Particulate	Emission Rate (S) (Ci/yr)	
	Total from Yellowcake Stacks	Vanadium Stack[a]
U-238	2.02E-02	1.52E-06
Th-230	4.45E-05	3.34E-09
Ra-226	2.63E-05	1.97E-09
Pb-210	1.58E-04	1.18E-08

Note:
a) Total from yellowcake stacks (north and south yellowcake stacks)*0.005%

Radon Emission Rates

There are no significant radon releases during this process

A.2.5 Ore Pads

The ore pad storage operation has two different sources of emissions - namely unloading from the truck to the ore pad and wind emissions. For the wind emissions calculated, it was assumed that approximately 300,000 tons of ore are temporarily stockpiled with a height of 30 ft. and bulk density of ore of 120 lbs/ft^3 (1.47 tons/yd^3). Using these assumptions, the area of the ore pad is approximately 17,000 m^2.

Radioactive Particulate Emission Rates

Source Description: Truck Unloading

	Colorado Plateau Ore	**Arizona Strip Ore**
Process Rate (tpy)	730,000	730,000
Contaminant Concentration (pCi/g U-238)	700	1783
Process Emission Factor (lbs/yd^3)[a]	0.04	0.04
Activity Emission Ratio	2.5	2.5
Control Factor	None	None
Bulk Density of Ore (tons/yd^3)	1.47	1.47

Note:
a) Process emission factor for Truck end dump (NUREG 1987).

The U-238 Emission Rate (S) is calculated as follows:

S= (Process Rate (tons/yr))*(1 yd^3/1.47 tons)*(Process Emission Factor (lbs/yd^3))*(453.6 g/lb)*(Contaminant Concentration (pCi/g))*(Activity Enrichment Ratio)*(10^{-12} Ci/pCi) **(A.2-5)**

Using equation A.2-5, the U-238 Emission Rate from truck unloading Colorado Plateau ore is approximately 1.58E-02 Ci/yr. U-238 decay daughters (Th-230, Ra-226 and Pb-210) are assumed to be in secular equilibrium; therefore the decay daughters are also emitted at a rate of 1.58E-02 Ci/yr. Similarly, the U-238 Emission Rate from truck unloading of Arizona Strip ore is approximately 4.02E-02 Ci/yr and the decay daughters (Th-230, Ra-226 and Pb-210) are also emitted at a rate of 4.02E-04 Ci/yr.

Source Description: Wind Erosion

	Colorado Plateau Ore	Arizona Strip Ore
Area (m^2)[a]	17000	17000
Contaminant Concentration (pCi/g U-238)	700	1783
Process Emission Factor, E_W (g/m^2yr)[b]	21.29	21.29
Activity Enrichment Ratio	2.5	2.5
Control Factor (%)[c]	50	50

Notes:

a) Calculated assuming a stockpile of 300,000 tons of ore with a height of 30 ft. and bulk ore density of 1.47 tons/yd^3.

b) The process emission factor for the ore pad was derived in Section A.1.

c) The control factor of 50% is based on the assumption that an active watering program will be in place during operations.

The U-238 Emission Rate (S) is calculated as follows:

S= (Process Emission Factor (g/m^2yr))*(Area (m^2))*(Contaminant Concentration (pCi/g)) *(Activity Enrichment Ratio)*(1-Control Factor)*(10^{-12} Ci/pCi) **(A.2-6)**

Using equation A.2-6, the U-238 Emission Rate from trucks unloading Colorado Plateau ore is approximately 3.17E-04 Ci/yr. U-238 decay daughters (Th-230, Ra-226 and Pb-210) are assumed to be in secular equilibrium; therefore the decay daughters are also emitted at a rate of 3.17E-04 Ci/yr. Similarly, the U-238 Emission Rate from truck unloading of Arizona Strip ore is approximately 8.07E-04 Ci/yr Ci/yr and the decay daughters (Th-230, Ra-226 and Pb-210) are also emitted at a rate of 8.07E-04 Ci/yr.

The total radioactive particulate emission rates from the ore pad are obtained by adding the results of truck unloading and wind erosion and are as follows:

Radioactive Particulate	**Emission Rate (S) (Ci/yr)**	
	Colorado Plateau Ore	**Arizona Strip Ore**
U-238	1.61E-02	4.10E-02
Th-230	1.61E-02	4.10E-02
Ra-226	1.61E-02	4.10E-02
Pb-210	1.61E-02	4.10E-02

Radon Emission Rates

	Colorado Plateau ore	Arizona Strip ore
Area (m^2)	17000	17000
Contaminant Concentration (pCi/g Ra-226)	700	1783
Specific Radon Flux Factor (pCi Rn-222/m^2s)/(pCi/g Ra-226)	1	1

Radon Release (F):

F= (Specific Radon Flux Factor (pCi Rn-222/m^2s)/(pCi/g Ra-226))*(Contaminant Concentration (pCi/g Ra-226))*(Area (m^2)*(3.156×10^7 s/yr)*(10^{-12} Ci/pCi) **(A-2-7)**

Using equation A.2-7, the radon release from storage of Colorado Plateau ore is approximately 375 Ci/yr. Similarly, the radon release from storage of Arizona Strip ore is approximately 956 Ci/yr.

A.2-6 Tailings Ponds

Radioactive Particulate Emission Rates

	Colorado Plateau Ore		Arizona Strip Ore	
	Cell 2 and 3	Cell 4A	Cell 2 and 3	Cell 4A
Area (acres)	7.7	4	7.7	4
Contaminant Concentration (pCi/g U-238)[a]	42	42	107	107
Contaminant Concentration of all other isotopes (pCi/g)	700	700	1783	1783
Process Emission Factor, E_W (g/m^2yr)[b]	213	213	213	213
Activity Enrichment Ratio	2.5	2.5	2.5	2.5
Control Factor (%)[c]	70	70	70	70

Notes:

a) Assumes 94% recovery.

b) The process emission factor for the tailings ponds was derived in Section A.1.

c) The control factor of 70% is based on the assumption that an active watering program as well as crusting agents are used to minimize the erosion of the tailings by wind.

The Emission Rate (S) for U-238 and its decay daughters are calculated as follows:

S= (Process Emission Factor (g/m^2yr))*(Area (acres))*(4047 m^2/acre)*(Contaminant Concentration (pCi/g)) *(Activity Enrichment Ratio)*(1-Control Factor)*(10^{-12} Ci/pCi) **(A.2-8)**

Using equation A.2-8, the U-238 Emission Rate from Tailings Cell 2 and 3 from the processing of Colorado Plateau ore is approximately 2.09E-04 Ci/yr. The decay daughters (Th-230, Ra-226 and Pb-210) are emitted at a rate of 3.48E-03 Ci/yr. The U-238 Emission Rate from Tailings Cell 4A from the processing of Colorado Plateau ore is approximately 1.09E-04 Ci/yr. The decay daughters (Th-230, Ra-226 and Pb-210) are emitted at a rate of 1.81E-03 Ci/yr.

Similarly, the U-238 Emission Rate from the Tailings Cell 2 and 3 from the processing of Arizona Strip ore is approximately 5.32E-04 Ci/yr. The decay daughters (Th-230, Ra-226 and Pb-210) are emitted at a rate of 8.87E-03 Ci/yr. The U-238 Emission Rate from Tailings Cell 4A from the processing of Arizona Strip ore is approximately 2.76E-04 Ci/yr. The decay daughters (Th-230, Ra-226 and Pb-210) are emitted at a rate of 4.61E-03 Ci/yr.

Radon Emission Rates

	Colorado Plateau Ore		Arizona Strip Ore	
	Cell 2 and 3	Cell 4A	Cell 2 and 3	Cell 4A
Area (acres)	112.8	4	112.8	4
Contaminant Concentration (pCi/m^2s)	8.17	24.2	8.17	24.2

Radon Release (F):

F= (Contaminant Concentration (pCi/m^2s))*(Area (acres))*(4047 m^2/acre)*($3.156x10^7$ s/yr)*(10^{-12} Ci/pCi) **(A-2-9)**

Using equation A.2-9, the radon release from Tailings Cell 2 and 3 (combined) and Tailings Cell 4A is approximately 117.71 Ci/yr and 12.36 Ci/yr, respectively from the ore processing operations at the mill.

From: "Steve Landau" <slandau@denisonmines.com>
To: "'Loren Morton'" <LMORTON@utah.gov>
CC: "'David Frydenlund'" <dfrydenlund@denisonmines.com>, "'Dane Finerfrock'"...
Date: 5/14/08 2:26 PM
Subject: RE: Denison: Cell 4B Environmental Report - Problems with Figures
Attachments: FIGURE 4.1.pdf; Figure 12.pdf

Loren,

Please find attached the figures you have requested.

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-----Original Message-----
From: Loren Morton [mailto:LMORTON@utah.gov]
Sent: Tuesday, May 13, 2008 9:48 AM
To: Steve Landau
Cc: David Frydenlund; Dane Finerfrock; John Hultquist
Subject: Denison: Cell 4B Environmental Report - Problems with Figures

Steve,

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1. Missing Figure 12 - there was no electronic copy provided for Figure 12 of the Environmental Report.

2. Unreadable Figure in Appendix B - on page 4-2 of the 4/08 Senes Consultants Ltd report there is a Figure 4.1, Site Locations - that is unreadable in the PDF format.

Please provide the missing figure, and correct the unreadable one. If it will help, you can email the revised files to me.

Thanks,

Loren

From: Loren Morton
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CC: Dane Finerfrock; David Frydenlund; John Hultquist
Date: 5/13/08 9:48 AM
Subject: Denison: Cell 4B Environmental Report - Problems with Figures in Electronic Version

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