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November 29, 2011

**VIA PDF and FEDERAL EXPRESS**

Mr. Rusty Lundberg  
Executive Secretary  
Utah Division of Radiation Control  
Utah Department of Environmental Quality  
195 North 1950 West  
Salt Lake City, UT 84116-3097

**Re: Nitrate Corrective Action Plan for the White Mesa Mill Site -- Docket No. UGW09-03-A and Amended Stipulated Consent Agreement Executed September 30, 2011**

Dear Mr. Lundberg:

This letter transmits Denison Mines (USA) Corp.'s ("Denison's") *Corrective Action Plan for Nitrate, White Mesa Uranium Mill, Near Blanding, Utah* (the "CAP") as required under the Amended Stipulated Consent Agreement Executed September 30, 2011 between Denison and the Utah Division of Radiation Control.

We have enclosed two hard copies of the CAP document for your review.

If you have any further questions please contact me at 303-389-4132.

Yours very truly,

**DENISON MINES (USA) CORP.**

A handwritten signature in blue ink that reads "Jo Ann S. Tischler".

Jo Ann S. Tischler  
Director, Compliance and Permitting

Enclosure

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# **CORRECTIVE ACTION PLAN FOR NITRATE WHITE MESA URANIUM MILL NEAR BLANDING, UTAH**

November 30, 2011

*Prepared for:*

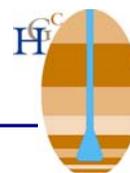
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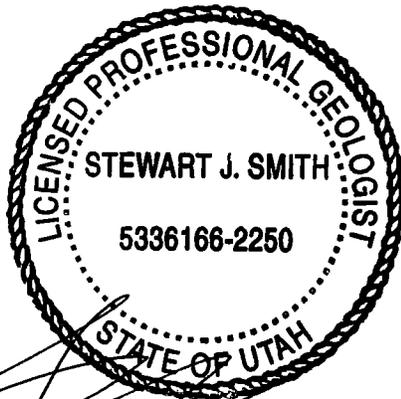


**CORRECTIVE ACTION PLAN FOR NITRATE  
WHITE MESA URANIUM MILL  
NEAR BLANDING, UTAH**

Prepared for:

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November 30, 2011



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## 1. INTRODUCTION, OVERVIEW, AND SCOPE

This document presents a Corrective Action Plan (CAP) to address nitrate + nitrite (as nitrate) (heretofore referred to as “nitrate”) contamination in a shallow perched groundwater zone beneath the White Mesa Uranium Mill (the “site” or the “Mill”), located near Blanding, Utah, operated by Denison Mines (USA) Corp. (“Denison”). Figure 1 is a map of the site showing the locations of perched zone monitoring wells and the area of the perched groundwater zone affected by nitrate concentrations exceeding 10 milligrams per liter (mg/L) that is the focus of this CAP. Elevated concentrations of chloride were also detected in the monitoring wells having elevated concentrations of nitrate. In a letter dated December 1, 2009, the Co-Executive Secretary of the Utah Water Quality Board (the “Executive Secretary”) recommended that Denison also address and explain the elevated chloride concentrations.

Nitrate within the area shown in Figure 1 was first detected in wells TW4-19, TW4-22, TW4-24, and TW4-25 that were installed as part of the investigation of a chloroform plume discovered at perched well MW-4 in 1999. Pumping of chloroform-laden perched water began in 2003 (HGC, 2007a) and continues to the present time via pumping of wells MW-4, MW-26, TW4-4, TW4-19, and TW4-20.

Investigation of nitrate exceeding 10 mg/L in the perched water included installation of 19 temporary TWN-series wells shown in Figure 1 and numerous shallow borings as part of a source investigation. Denison identified and prioritized potential sources of the nitrate in the December 2009 *Source Review Report for Nitrate and Chloride in Groundwater at the White Mesa Mill*, (INTERA, 2009a) and in the subsequent August 2011 *Nitrate Investigation Revised Phases 2 through 5 Work Plan*. (INTERA, 2011).

Based on the investigations, Denison and the Executive Secretary have agreed that the corrective actions will involve three Phases. Phase I will involve source control in the vicinity of the Mill’s Ammonia Sulfate tanks, the one remaining potential source of contamination. Phase II will involve near term active remediation of the nitrate contamination by pumping contaminated water into the Mill’s tailings cells for disposal, combined with monitored natural attenuation. Phase III, if necessary, will be at the discretion of Denison and would involve a long term solution for the nitrate contamination, in the event that the continuation of Phase II is not considered adequate or appropriate. Phases I and II are addressed in this CAP and will commence shortly upon Executive Secretary approval of this CAP. Phase III is not covered in detail in this CAP and, if determined to be necessary, will be addressed in a separate CAP revision.

The elements of this CAP document include the following items:

- A History of the Nitrate Contamination Investigation
- A discussion of the decision to proceed with Corrective Action
- A summary of the applicable requirements
- CAP objectives
- A description of the site hydrogeology
- The nature and extent of nitrate in the perched zone
- Proposed corrective remedial actions and concentration limits
- Proposed corrective action contingencies

## **2. HISTORY OF NITRATE CONTAMINATION INVESTIGATION**

A brief discussion of the Nitrate Contamination Investigation and the decision to proceed with corrective action is provided in Sections 2.1 and 2.2.

### **2.1 Summary of Contamination Investigation Report Activities**

On January 27, 2009 the Executive Secretary of the Utah Division of Radiation Control (“DRC”) and Denison entered into the 2009 Stipulated Consent Agreement (“SCA”), which set forth the requirement that Denison would submit a written Contaminant Investigation Report (CIR) for Executive Secretary review and approval, to among other things, characterize the source(s), physical extent, transfer mechanisms and characteristics of the Nitrate contamination of the shallow aquifer at the site.

Denison submitted to the Executive Secretary a CIR which had been prepared by their consultant INTERA, Inc. The CIR was dated December 30, 2009 (INTERA, 2009b) and entitled "Nitrate Contamination Investigation Report White Mesa Uranium Mill Site Blanding, Utah" (2009 CIR). On October 5, 2010 the Executive Secretary issued a Notice of Additional Required Action (NARA) letter that notified Denison of the Executive Secretary’s determination that the 2009 CIR was incomplete.

On December 20, 2010 Denison and the Executive Secretary entered into a Tolling Agreement (Tolling Agreement (Rev. 0) to defer any monetary penalties that might accrue under the 2009 SCA, in order to provide a time period (Tolling Period) for:

Denison to prepare and submit a plan and schedule (Plan and Schedule) by which to conduct additional investigations to resolve open issues identified in the October 5, 2010 NARA on or before February 15, 2011,

The Executive Secretary to provide his initial comments on the Plan and Schedule on or before March 15, 2011, and for Denison and the Executive Secretary to finalize the Plan and Schedule, and

Denison and the Executive Secretary to negotiate, finalize and execute a revised or replacement SCA that incorporates the Plan and Schedule.

In addition, the Tolling Agreement (Rev. 0) required that the Tolling Period be extended from January 4, 2010 (submittal of the 2009 CIR to the Executive Secretary) until April 30, 2011.

Pursuant to the Tolling Agreement (Rev. 0), Denison submitted a Plan and Schedule on February 14, 2011 and a revised Plan and Schedule on February 18, 2011, and the Executive Secretary

provided his comments on the revised Plan and Schedule on March 21, 2011. In an April 20, 2011 meeting, Denison and the Executive Secretary agreed that the Plan and Schedule to conduct additional nitrate investigations would be composed of at least four (4) and possibly five (5) phases of study, including:

- 1) Phase 1A through C - including geoprobe drilling, and soil sampling/analysis of soils to investigate:
  - a) Possible natural nitrate salt reservoir in the vadose zone beyond the mill site area (Phase 1A);
  - b) Potential nitrate sources in the mill site area (Phase 1 B); and
  - c) Other potential nitrate sources (Phase 1 C).
- 2) Phase 2 - including groundwater quality sampling and analysis of existing monitoring wells for non-isotopic analytes.
- 3) Phase 3 - including deep bedrock core sampling/analysis of possible natural nitrate reservoir and potential nitrate source locations, with similar objectives as Phases 1 A through C.
- 4) Phase 4 - including stable isotopic sampling/analysis of groundwater in existing monitoring wells. Details of this investigation were to be determined at a later date, and approved by both parties.
- 5) Phase 5 - including stable isotopic sampling/analysis of soil/core samples, if needed.

On April 28, 2011, Denison and the Executive Secretary entered into a Revised Tolling Agreement (Tolling Agreement (Rev. 1), to extend the Tolling Period through June 30, 2011 and adopt the agreements made in the April 20, 2011 meeting. Under the Tolling Agreement (Rev. 1), Denison agreed to submit a Revised Phase 1 (A through C) Work Plan on or before May 6, 2011 and a Revised Phase 2 through 5 Work Plan and Schedule on or before June 3, 2011.

Pursuant to the Tolling Agreement (Rev. 1), Denison submitted a May 6, 2011 Revised Phase 1 Work Plan and Schedule for the Phase 1 A - C investigation prepared by INTERA, for Executive Secretary review. On May 11, 2011, the DRC: 1) provided via email, comments on the May 6, 2011 INTERA document, and requested that Denison resolve all DRC comments before initiation of field activities. All comments were resolved, and Denison conducted field and laboratory work for the Phase 1 A-C study in May and June, 2011.

Pursuant to the Tolling Agreement (Rev. 1), Denison submitted a June 3, 2011 Revised Phase 2 through 5 Work Plan and Schedule (Phase 2 - 5 Work Plan), prepared by INTERA, for Executive Secretary review. In a letter dated June 23, 2011 DRC provided comments on this Denison document in the form of a URS memorandum, dated June 23, 2011 and advised Denison that in

order to revise the 2009 SCA to incorporate the deliverables and timelines set out in an approvable Phase 2 through 5 Work Plan, it would be necessary to provide a level of detail in revisions of that Work Plan for Phases 2, 3, 4, and 5 comparable to the level of detail for Phase 1 contained in Attachment 1 of the Tolling Agreement (Rev. 1).

On June 30, 2011, Denison and the Executive Secretary entered into a Revised Tolling Agreement [Tolling Agreement (Rev. 2)] to extend the Tolling Period to August 31, 2011, in order to facilitate the revision of the Phase 2 through 5 Work Plan to provide the level of detail required to construct a replacement SCA. Pursuant to the Tolling Agreement (Rev.2), Denison submitted a separate July 1, 2011 detailed Work Plan and Quality Assurance Plan ("QAP") for the Phase 2 investigation (Phase 2 Plan, Revision 0). Executive Secretary comments on this document were provided in a July 7, 2011 DRC letter. Denison provided a revised July 12, 2011 Phase 2 QAP and Work Plan (Phase 2, Revision 1.0). which DRC conditionally approved in a letter dated July 18, 2011.

On August 1 and 2, 2011 Denison submitted by email preliminary laboratory results for the Phase I A-C study to the Executive Secretary.

On August 4, 2011, Denison provided a revision to the Phase 2 - 5 Work Plan (Phase 2-5 Work Plan, Revision 1.0), prepared by INTERA, for Executive Secretary review. DRC comments on the Phase 2-5 Work Plan, Revision 1.0 and on the August 1, 2011 preliminary laboratory results for the Phase IA-C study, were provided to Denison on August 11, 2011 as part of a conference call, and a DRC email, which included an August 11, 2011 URS memorandum. Under a cover letter dated August 18, 2011, Denison submitted a revised Phase 2-5 Work Plan (Phase 2-5 Work Plan, Revision 2.0) for Executive Secretary review, in response to the comments provided to Denison on August 11, 2011.

As discussed in the following Sections, DRC and Denison have agreed to proceed with corrective action.

In an August 25, 2011 DRC letter, the Executive Secretary advised that per review of the Phase 2-5 Work Plan, Revision 2.0, the Executive Secretary has determined that a finalized Plan and Schedule, that meets the satisfaction of the Executive Secretary, and which would allow the preparation of a replacement SCA, is not possible at this time; and that the development of a replacement SCA for continued contaminant investigation activities is not supported.

At a meeting between Denison and DRC on August 29, 2011 to discuss the Executive Secretary's August 25, 2011 findings related to the Phase 2-5 Work Plan Rev. 2.0, the

preliminary laboratory results for the Phase I A-C study, and the approach forward, Denison and DRC agreed that:

1. After more than two years of investigation it has been determined that there are site conditions that make it difficult to determine the source(s) of the contamination at the White Mesa site;
2. As a result, resources will be better spent in developing a CAP in accordance with UAC R317-6-6.15(D), rather than continuing with further investigations as to the source(s) of the contamination.

During discussion throughout October 2011, Denison and the Executive Secretary acknowledged that it has not been possible to date to determine the source(s), cause(s), attribution, magnitudes of contribution, and proportion(s) of the local nitrate and chloride in groundwater, and thereby cannot eliminate Mill activities as a potential cause, either in full or in part, of the contamination. As a result, Denison and the Executive Secretary agreed that resources will be better spent in developing a CAP in accordance with UAC R317-6-6.15(D), rather than continuing with further investigations as to the source(s) and attribution of the groundwater contamination.

## **2.2 Conclusions from the Contamination Investigation**

The contamination investigation program from 2009 to 2011 has provided a basis for development of a CAP. Specifically the investigation has determined:

- the areal and spatial extent of the plume,
- that the plume is not increasing in size or concentration,
- that there are no unaddressed current or ongoing sources of contamination.

As discussed above, a number of potential mill and non-mill sources were identified in the December 2009 Source Review Report for Nitrate and Chloride in Groundwater at the Mill, and in the subsequent August 2011 Nitrate Investigation Revised Phases 2 through 5 Work Plan. Based on the investigation and source evaluations, there are no current unidentified or unaddressed sources. There appear to have been a number of known and potential historic sources; however, it has not been possible to confirm or quantify the contribution of each.

Although the source or sources have not been identified and quantified, based on analysis of the concentrations within and the areal extent of the plume over the past two years, it would appear that there is no significant unaddressed currently active source. That is, analytical results indicate that neither the average concentration of the plume nor the areal extent of the plume have increased during the monitored period. The only potential current source identified and

potentially requiring control is the ammonium sulfate tanks. This potential source is addressed in Phase I of the CAP, discussed in Sections 3.2.1 and 7.1 below.

The Executive Secretary determined that a CAP is required at the White Mesa facility, pursuant to UAC R317-6-6.15(C)(I) and Denison agreed to develop, secure Executive Secretary approval, and implement a CAP. The Executive Secretary has therefore determined, and Denison agreed to submit a CAP, pursuant to the requirements of the Utah Ground Water Quality Protection Rules [UAC R317 -6-6.15(C - E)].

The purpose of Phase I of this CAP is to remedy the effects of the ammonium sulfate tank potential source. The purpose of each of the proposed phases of this CAP is discussed further in section 3.2.



### 3. FRAMEWORK AND OBJECTIVES OF THE CAP

Applicable regulations and requirements governing the CAP, and preliminary milestones are discussed in Sections 3.1 through 3.3.

#### 3.1 Applicable Regulations and Requirements

Denison agreed to submit a CAP for Executive Secretary review and approval, on or before November 30, 2011 that meets the CAP related requirements of UAC R317-6-6.15 (D.2, 3 and E). This document constitutes the “Nitrate CAP”.

The remaining sections of this CAP are intended to demonstrate, per the requirements in UAC R317 -6-6.15(D)(2) and (3), that:

- the proposed action(s) are protective of public health and the environment, including consideration of future impacts of the nitrate plume on land and water resources not owned and controlled by Denison.
- the corrective action meets the State Ground Water Quality Standards, pursuant to UAC R317 -6-6.15(F). Alternatively, Denison may petition the Utah Water Quality Board for approval of an Alternate Corrective Action Concentration Limit as part of the CAP, Phase III, pursuant to UAC R317 -6-6.15(G).
- the action will produce a permanent effect.

Per UAC R317 -6-6.15(D)(2) and (3) the action proposed in the CAP is required to meet any other additional measure required by the Executive Secretary under UAC R317 -6-6.15(E)(5).

Denison has agreed with the Executive Secretary that these additional measures shall include, but are not limited to:

- Remediation guidance found in the April, 2004 EPA Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action (EPA530-R-04-030) or equivalent, to the extent applicable, as determined by the Executive Secretary;
- Determination of corrective action performance standards, objectives, and criteria for groundwater remediation system design, construction, operations and/or maintenance, as approved by the Executive Secretary in accordance with applicable regulations;
- Determination of long term operation, maintenance, system performance and groundwater quality monitoring requirements to evaluate effectiveness of the approved corrective action(s), at a frequency, and by methods approved by the Executive Secretary;
- Submittal of written quarterly Denison reports of pumping and monitoring well system performance and groundwater quality monitoring information for Executive Secretary review and approval. In the event that additional information is required of any report, Denison shall respond to and provide a Plan and Schedule for Executive Secretary

approval to resolve all issues /concerns within 30 calendar days of receipt of written Executive Secretary notice;

- Timely Denison verbal and written notification of process or equipment failures, and corrective actions taken, or a timely schedule by which corrective action will be taken to return the facility to full compliance with CAP performance standards, objectives, and criteria; and
- Periodic Denison review, summation, and report submittal, for Executive Secretary approval, to demonstrate if the approved corrective action is protective of public health and the environment. The interval of said report period shall not exceed five (5) years.

## **3.2 Objectives of the CAP**

The objectives of the CAP are the following:

- Minimize or prevent further downgradient migration of the perched nitrate plume (Figure 1) by a combination of pumping and reliance on natural attenuation,
- Prevent nitrate concentrations exceeding the action level from migrating to any potential point of exposure,
- Monitor to track changes in concentrations within the plume and to establish whether the plume boundaries are expanding, contracting, or stable,
- Provide contingency plans to address potential continued expansion of the plume and the need for additional monitoring and/or pumping points, and
- Ultimately reduce nitrate concentrations at all monitoring locations to the action level or below.

To achieve these objectives, the CAP proposes a phased approach.

### **3.2.1 Summary of Phase I Objectives and Scope**

Per Section 11A(1) of the SCA, Phase I is required to include a control for the soil contamination observed at the Ammonium Sulfate Crystal Tanks, a potential source of perched groundwater contamination. Pursuant to UAC 317-6-6.15 (E)(4)(b) this control will include at a minimum:

Determination, to the satisfaction of the Executive Secretary, of the physical extent of the soil contamination observed at the Ammonium Sulfate Crystal Tanks near borings GP-25B (Nitrate + Nitrite (as N) 1,530 mg/kg-dry at depth of 6 feet) and GP-26B (Ammonia (as N) 1,590 mg/kg-dry at a depth of 16 feet) that were part of the nitrate investigation. Such effort shall include an estimate of the volume (the "Contaminated Soil Volume") of the contaminated soils down to but not including bedrock, and an estimate of the surface area (the "Contaminated Surface Area") at or above the estimated location of the Contaminated Soil Volume; and either a Plan and

Schedule, to be submitted on or before January 1, 2012, for Executive Secretary approval, to cover the Contaminated Surface Area with at least six inches of concrete, to the extent not already covered by concrete or existing buildings, to prevent infiltration of surface water into the contaminated soils; and/or a Plan and Schedule, to be submitted on or before January 1, 2012, for Executive Secretary approval, to remove the Contaminated Soil Volume and dispose of the contaminated soils in the Mill's tailings impoundments. If Denison chooses to cover the Contaminated Surface Area with concrete, Denison must remove the Contaminated Soil Volume at a later date prior to site closeout and must submit a revised surety estimate on or before March 4, 2012 to include future costs to remove the Contaminated Soil Volume.

As discussed in Section 7.1 of this CAP, Denison proposes to construct a sloped and drained concrete pad of six inches in depth over an area covering at least twice the areal extent of contamination identified during the contamination investigation. Denison also proposes a future removal of contaminated soil at the time of Mill site reclamation and, for conservatism, proposes to revise the reclamation surety estimate to include a volume of soil to be removed and placed in the tailings area of twice the volume of contaminated soil identified in the contamination investigation. Further details are discussed in Section 7.1, below.

### 3.2.2 Summary of Phase II Objectives and Scope

Per Section 11A(2) of the SCA, Phase II is to include near term active remediation of the nitrate contamination by pumping contaminated water into the Mill's tailings cells for disposal. Said phase shall also include: 1) the development, implementation, operation, and monitoring requirements for a pumping well network designed to contain and hydraulically control the nitrate groundwater plume to maintain concentrations at or below the Utah Groundwater Quality Standard (10 mg/L), i.e., prevent physical expansion of said plume, and 2) monitoring of chloride concentrations.

Phase II constitutes an interim remedial action that consists of a combination of “active” and “passive” strategies. The active strategy consists of removing nitrate mass as rapidly as practical by pumping areas within the plume that have high nitrate concentrations and relatively high productivity. Continued monitoring within and outside the plume is considered part of the active strategy. The passive strategy consists of relying on natural attenuation processes to reduce nitrate concentrations. Reductions in concentrations would be achieved by physical processes such as hydrodynamic dispersion, and dilution via mixing with recharge and waters outside the plume.

Natural attenuation is expected to reduce nitrate concentrations within the entire plume. However, within upgradient portions of the plume that have the highest concentrations, direct

mass removal via pumping will be the primary means to reduce concentrations. In downgradient portions of the plume where concentrations are lower, natural attenuation will be a more important mechanism in reducing concentrations.

### 3.2.3 Summary of Phase III Objectives and Scope

Per the SCA, Phase III is to include a comprehensive long term solution for the nitrate groundwater contamination at the Mill Site. This phase will be undertaken at a later date after public participation and Executive Secretary approval. Phase III may include, but is not limited to: continuation of Phases I and II activities alone or in combination with monitored natural attenuation, evaluation of additional remediation and monitoring technologies/techniques, determination of any additional hydrogeologic characterization, groundwater contaminant travel times and directions, determination of ultimate points of exposure to the public and/or wildlife, appropriate risk analysis, a cost/benefit analysis, and the possible development of and petition to the Board for alternate corrective action concentration limits pursuant to UAC R317 -6-6 .15 (G).

This CAP does not specify the details of Phase III, at this time. A Phase III preliminary plan and schedule for the evaluation of alternatives, for the completion of any further studies, analyses, applications and petitions, and for the ultimate definition of Phase III, may be proposed by Denison at a later date, after completion of such studies and evaluations, followed by submittal of a proposed CAP revision to the Executive Secretary. Until such time, the activities of the Phase I and Phase II remediation will continue as stipulated in the approved CAP.

The CAP is not intended to address contamination located outside the Mill's restricted area and that is not contiguous with groundwater contamination inside the Mill's restricted area. The CAP will therefore evaluate which of the existing monitoring wells will be maintained and which wells (including certain upgradient and off-site wells) can be abandoned, subject to prior Executive Secretary approval.

It should be noted that while Phase II of the CAP requires monitoring of chloride concentrations, the CAP does not explicitly identify measures for controlling chloride levels per se, because there is no health standard for chloride in groundwater. However, as discussed and agreed to with DRC during meetings in October 2011, chloride appears to be co-located with nitrate in groundwater at the Mill and hydrogeological measures to contain nitrate will also contain chloride.

### 3.3 Preliminary Milestones for the CAP

Per the SCA, Denison has committed to the following milestones for corrective action. Dates for the following milestones will be established based on the date of the Executive Secretary's approval of the CAP and issuance of a Consent Order approving the CAP.

- Within 30 calendar days of the Executive Secretary's approval of the CAP, pursuant to UAC R317-6-6.15(E), Denison shall commence implementation and execution of all corrective actions required under a future Consent Order to be issued by the Executive Secretary that addressed the approved CAP. A proposed schedule for implementation of the CAP is included as Table 1 to this CAP.
- Within 60 calendar days of the Executive Secretary's issuance of a future Consent Order regarding the approved CAP, pursuant to UAC R317-6-6.15(E), Denison will submit a revised Reclamation Plan and financial surety cost estimate (Revised Surety), for Executive Secretary review and approval which addresses the groundwater corrective action, with the surety sufficient to recover the anticipated cost and time frame for achieving compliance, before the land is transferred to the federal government for long-term custody. At a minimum, the Denison surety will provide for all costs for Phases I and II of the approved CAP for a period of time until Executive Secretary approval of Phase III of the CAP to restore groundwater to the established site specific groundwater cleanup standards pursuant to UAC R317-6-6.15 before the site is transferred to the federal government for long term custody.



## 4. BACKGROUND

Sections 3.1 through 3.4 provide a brief description of site hydrogeology that is based primarily on TITAN (1994), but includes the results of more recent site investigations. Section 3.5 discusses the occurrence of nitrate in the perched water at the site and focuses on the nitrate plume shown in Figure 1.

### 4.1 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 undeformed. The average elevation of the site is approximately 5,600 feet above mean sea level (ft 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. In portions of the site, a few feet to as much as about 30 feet of Mancos Shale lies between the alluvium and the Dakota Sandstone.

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. Figure 2 is a photograph of the contact between the Burro Canyon Formation and the underlying Brushy Basin Member taken from a location along highway 95 immediately north of the Mill. This photograph illustrates the transition from the cliff-forming sandstone of the Burro Canyon Formation to the slope-forming Brushy Basin Member.

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.

## **4.2 Hydrogeologic Setting**

The site is located within a region that has a dry to arid continental climate, with an average annual precipitation of approximately 13.3 inches, and an average annual lake evaporation rate of approximately 47.6 inches. Recharge to the principal aquifers occurs mainly 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 [ft bls]) makes access difficult. The Navajo/Entrada aquifer is capable of yielding significant quantities of water to wells (hundreds of gallons per minute [gpm]). Water in 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 originate mainly from precipitation and local recharge sources such as unlined reservoirs (Kirby, 2008) and is used on a limited basis to the north (upgradient) of the site because it is more easily accessible than the Navajo/Entrada aquifer. Water quality of the Dakota Sandstone and Burro Canyon Formation is generally poor due to high total dissolved solids (TDS). The saturated thickness of the perched water zone is generally higher to the north of the site.

## **4.3 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 TDS in the range of approximately 1,100 to 7,900 milligrams per liter (mg/L), and is used primarily for stock watering and irrigation in the areas upgradient (north) of the site where generally higher saturated thicknesses increase well yields. Perched water is supported within the Burro Canyon Formation by the underlying, fine-grained Brushy Basin Member. Figure 3 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 between the Burro Canyon Formation and Brushy Basin Member in Figure 3 are based on perched monitoring well drilling and geophysical logs and surveyed land surface elevations. As indicated, the Burro Canyon Formation/Brushy Basin Member contact (although

irregular because it represents an erosional surface) generally dips to the south/southwest beneath the site.

Appendix A contains hydrogeologic cross-sections that intersect within the nitrate plume. These cross-sections show the site lithology above the Brushy Basin Member, perched water within the Dakota Sandstone/Burro Canyon Formation, and the occurrence of nitrate within the perched water.

#### 4.3.1 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 permeabilities of the Dakota Sandstone and Burro Canyon Formation at the site are 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.

##### *4.3.1.1 Dakota*

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%, based on samples collected during installation of wells MW-16 (abandoned) and MW-17 (Figure 1). The average volumetric water content is approximately 3%. The hydraulic conductivity of the Dakota Sandstone based on packer tests in borings installed at the site ranges from approximately  $2.7 \times 10^{-6}$  centimeters per second (cm/s) to  $9.1 \times 10^{-4}$  cm/s, with a geometric average of  $3.9 \times 10^{-5}$  cm/s.

##### *4.3.1.2 Burro Canyon*

The average porosity of the Burro Canyon Formation is similar to that of the Dakota Sandstone. 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%, based on samples collected from the

Burro Canyon Formation at MW-16 (abandoned), located beneath new tailings Cell #4A. TITAN (1994) reported that the hydraulic conductivity of the Burro Canyon Formation ranges from  $1.9 \times 10^{-7}$  to  $1.6 \times 10^{-3}$  cm/s, with a geometric mean of  $1.1 \times 10^{-5}$  cm/s, based on the results of 12 pumping/recovery tests performed in monitoring wells and 30 packer tests performed in borings prior to 1994. Subsequent hydraulic testing of perched zone wells has yielded a range of  $2 \times 10^{-7}$  to 0.01 cm/s (HGC, 2009a).

In general, the highest permeabilities and well yields are in the area of the site immediately northeast and east (upgradient to cross gradient) of the tailings cells. A relatively continuous, higher permeability zone that is associated with the chloroform plume (HGC, 2007b) has been inferred to exist in this portion of the site. Analysis of drawdown data collected from this zone during long-term pumping of MW-4, MW-26, and TW4-19 (Figure 1) yielded estimates of hydraulic conductivity ranging from  $4 \times 10^{-5}$  to  $1 \times 10^{-3}$  cm/s (HGC, 2004). The decrease in perched zone permeability south to southwest of this area indicates that this higher permeability zone “pinches out” (HGC, 2007b).

Permeabilities downgradient of the tailings cells are generally low. Hydraulic tests at wells located at the downgradient edge of the cells, and south and southwest of the cells yielded geometric average hydraulic conductivities of  $2.3 \times 10^{-5}$  and  $4.3 \times 10^{-5}$  cm/s depending on the testing and analytical methods. The low permeabilities and shallow hydraulic gradients downgradient of the tailings cells result in average perched groundwater pore velocity estimates that are among the lowest on site (approximately 1.7 ft/yr to 3.2 ft/yr based on calculations presented in HGC, 2009a).

Permeabilities within the general area of the nitrate plume are based primarily on analysis of slug tests at wells MW-27, MW-30, MW-31, TW4-20, TW4-21, TW4-22, TW4-24, TW-25, TWN-1, TWN-2, TWN-3, and TWN-18 (HGC, 2005 and HGC, 2009a). The permeability at MW-11 was based on a pumping test reported by UMETCO (1993) and the permeability at TW4-19 was based on long-term pumping of that well for chloroform removal (HGC, 2004). Permeability estimates range from approximately  $2.7 \times 10^{-5}$  to  $1.4 \times 10^{-3}$  cm/s, and have a geometric average of  $1.2 \times 10^{-4}$  cm/s, assuming unconfined conditions (Table 2). The transmissivities of many wells within the nitrate plume are similar to wells that are pumped for chloroform removal.

#### 4.3.2 Perched Groundwater Flow

Perched groundwater flow at the site has historically been to the south/southwest (HGC, 2007b). Figure 4 is a perched groundwater elevation contour map for the third quarter of 2011. These contours are based on water levels measured in the perched groundwater monitoring wells shown in the figure. Local depression of the perched water table occurs near wells MW-4, TW4-4,

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 as discussed in HGC (2007a).

A dry area to the southwest of Cell 4B is defined by the area where the kriged Brushy Basin contact elevation rises above the kriged perched water level elevation. The lateral extent of the dry area shown in Figure 4 is currently under investigation. The installation of wells along the southern and western margins of Cell 4B in August, 2010 and April, 2011 indicate that the dry zone extends at least from the southwest central portion of Cell 4B to the southwest corner of Cell 4B.

Beneath and downgradient of the tailings cells, on the west side of the site, perched water flow is south-southwest to southwest. On the eastern side of the site perched water flow is more southerly. Because of mounding near wildlife ponds, flow direction ranges locally from westerly (west of the ponds) to easterly (east of the ponds). Perched zone hydraulic gradients currently range from a maximum of approximately 0.07 ft/ft east of tailings Cell #2 (near well TW4-14) to approximately 0.01 ft/ft downgradient of the tailings cells. Gradients may be steeper locally near pumping wells (for example near TW4-20, where the gradient reaches approximately 0.09 ft/ft)

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 closest discharge points downgradient of the tailings cells are Westwater Seep (approximately 2800 feet downgradient) and Ruin Spring (approximately 9,400 feet downgradient [HGC, 2010]).

### 4.3.3 Saturated Thickness

The saturated thickness of the perched zone as of the third quarter of 2011 ranges from approximately 92 feet in the northeastern portion of the site to less than 5 feet in the southwest portion of the site (Figure 5). A saturated thickness of approximately 2 feet occurs in well MW-34 along the south dike of new tailings Cell 4B, and the perched zone is apparently dry at MW-33 located at the southwest corner of Cell 4B. Depths to water range from approximately 17 to 18 feet in the northeastern portion of the site (near the wildlife ponds) to approximately 114 feet at the southwest margin of tailings Cell #3 (Figure 6). The relatively large saturated thicknesses in the northeastern portion of the site are likely related to seepage from the wildlife ponds located northeast and east of the tailings cells.

Although sustainable yields of as much as 4 gpm have been achieved in wells intercepting the larger saturated thicknesses and higher permeability zones in the northeast portion of the site, perched zone well yields are typically low (<0.5 gpm) due to the generally low permeability of

the perched zone. Sufficient productivity can generally be obtained only 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, but has not been used downgradient of the site.

#### **4.4 Summary**

Perched groundwater at the site is hosted primarily by the Burro Canyon Formation, which consists of a relatively hard to hard, fine- to medium-grained sandstone containing siltstone, shale and conglomeratic materials. The Burro Canyon Formation is separated from the underlying regional Navajo/Entrada aquifer by approximately 1,000 to 1,100 feet of Morrison Formation and Summerville Formation materials having a low average vertical permeability. The Brushy Basin Member of the Morrison Formation is a bentonitic shale that lies immediately beneath the Burro Canyon Formation and forms the base of the perched water zone at the site. Figure 2 is a photograph of the contact between the Burro Canyon Formation and the underlying Brushy Basin Member taken from a location along highway 95 immediately north of the Mill. This photograph illustrates the transition from the cliff-forming sandstone of the Burro Canyon Formation to the slope-forming Brushy Basin Member. Based on hydraulic tests at perched zone monitoring wells, the hydraulic conductivity of the perched zone ranges from approximately  $2 \times 10^{-7}$  to 0.01 cm/s.

Perched water flow is generally from northeast to southwest across the site. Beneath and downgradient of the tailings cells, on the west side of the site, perched water flow is south-southwest to southwest. On the eastern side of the site perched water flow is more southerly. Because of mounding near wildlife ponds, flow direction ranges locally from westerly (west of the ponds) to easterly (east of the ponds). Perched water generally has a low quality, with total dissolved solids ranging from approximately 1,100 to 7,900 mg/L, and is used primarily for stock watering and irrigation north (upgradient) of the site.

Depths to perched water range from approximately 17 to 18 feet near the wildlife ponds in the northeastern portion of the site to approximately 114 feet at the southwestern margin of tailings Cell #3. Saturated thicknesses range from approximately 92 feet near the wildlife ponds to less than 5 feet in the southwest portion of the site, downgradient of the tailings cells. A saturated thickness of approximately 2 feet occurs in well MW-34 along the south dike of new tailings Cell 4B, and the perched zone is apparently dry at MW-33 located at the southwest corner of Cell 4B. Although sustainable yields of as much as 4 gpm have been achieved in wells penetrating higher transmissivity zones, well yields are typically low (<0.5 gpm) due to the generally low permeability of the perched zone.

Hydraulic testing of perched zone wells has yielded a range of approximately  $2 \times 10^{-7}$  to 0.01 cm/s. In general, the highest permeabilities and well yields are in the area of the site immediately northeast and east (upgradient to cross gradient) of the tailings cells. A relatively continuous, higher permeability zone associated with the chloroform plume has been inferred to exist in this portion of the site. Analysis of drawdown data collected from this zone during long-term pumping of MW-4, TW4-19, and MW-26 (TW4-15) yielded estimates of hydraulic conductivity ranging from  $4 \times 10^{-5}$  to  $1 \times 10^{-3}$  cm/s.

Permeabilities downgradient of the tailings cells are generally low. Hydraulic tests at wells located at the downgradient edge of the cells, and south and southwest of the cells yielded geometric average hydraulic conductivities of  $2.3 \times 10^{-5}$  and  $4.3 \times 10^{-5}$  cm/s depending on the testing and analytical method. The low permeabilities and shallow hydraulic gradients downgradient of the tailings cells result in average perched groundwater pore velocity estimates that are among the lowest on site.

Permeabilities within the general area of the nitrate plume are based primarily on analysis of hydraulic tests as discussed in Section 4.3. Permeability estimates ranged from approximately  $2.7 \times 10^{-5}$  to  $1.4 \times 10^{-3}$  cm/s, and have a geometric average of  $1.2 \times 10^{-4}$  cm/s, assuming unconfined conditions. The transmissivities of many wells within the nitrate plume are similar to wells that are pumped for chloroform removal.

#### **4.5 Nitrate Occurrence**

Nitrate within the area shown in Figure 1 was first detected in wells TW4-19, TW4-22, TW4-24, and TW4-25 that were installed as part of the investigation of a chloroform plume first discovered at perched well MW-4 in 1999. Investigation of nitrate has included the installation of 19 temporary (TWN-series) perched zone nitrate monitoring wells to delineate and monitor the nitrate (Figure 1). The extent of nitrate contamination is described below and in further detail in Section 5.1 and its associated figures.

Nitrate concentrations in the perched zone as of the third quarter of 2011 are shown in Figure 7. Nitrate concentrations in the perched zone have ranged from non-detect to a maximum of 69 µg/L at well TWN-2 in the second and third quarters of 2010. Nitrate concentrations at downgradient wells MW-30 and MW-31 have been relatively stable, ranging from 15 to 17 mg/L at MW-30 and from 20 to 22 mg/L at MW-31 between the first quarter of 2010 through the third quarter of 2011.

Constituents associated with the nitrate include chloride, and in the east-central portion of the plume, chloroform. The association of nitrate with chloroform is discussed in HGC, 2007b.

#### 4.5.1 Source Areas

As discussed above, a number of potential Mill and non-Mill sources were identified in the December 2009 *Source Review Report for Nitrate and Chloride in Groundwater at the White Mesa Mill* (INTERA, 2009), and in the subsequent August 2011 *Nitrate Investigation Revised Phases 2 through 5 Work Plan* (INTERA, 2011), as listed below:

1. Main leach field (also known as leach field east of scale house, 1985 to present)
2. Sewage vault/lift station (currently active)
3. Scale house leach field, (also known as leach field south of scale house, 1977-1979)
4. Former office leach field
5. Ammonia tanks
6. SAG leach field (leach field north of Mill building, 1998 to 2009)
7. Cell 1 leach field (leach field east of Cell #1, up to 1985)
8. Fly Ash Pond
9. Sodium chlorate tanks (as a potential chloride source)
10. Ammonium sulfate crystal tanks
11. Lawzy sump
12. Lawzy Lake
13. Former vault/lift station (to former office leach field, 1992 to 2009)
14. Truck shop leach field (1979-1985)
15. New Counter Current Decant/Solvent Extraction (“CCD/SX”) leach field (currently active)
16. Historical Pond
17. Wildlife pond
18. CCD (included inadvertently and eliminated)
19. YC Precip Mini-Lab
20. V2O5 Mini-Lab & V2O5 Precip
21. SX Mini-Lab
22. Chem Lab
23. Met Lab
24. V2O5 oxidation tanks
25. Natural nitrate reservoir
26. – 32. Seven other ponds or pond-like sources

Figure 8 shows the locations of potential source areas 1 through 24.

Based on the investigation and source evaluations completed to date, there are no current unidentified or unaddressed ongoing sources. There appear to have been a number of known and potential historic sources; however, it has not been possible to confirm or quantify the contribution of each. Soil contamination associated with the ammonium sulfate tanks as a potential source to perched groundwater is addressed as Phase I of this CAP.

Although the actual source or sources have not been identified and quantified, based on analysis of the concentrations within and the areal extent of the plume over the past two years, Denison and DRC have concluded there is no significant unaddressed currently active source. That is, analytical results indicate that neither the average concentration within the plume nor the areal extent of the plume has increased during the period it has been monitored. Therefore, although the source or sources have not been definitively determined, sufficient information exists to bound and characterize the plume and plan remedial actions for its control.

#### 4.5.2 Nitrate Concentration Trends

Table 3 provides nitrate concentrations detected at wells within the nitrate plume from the first quarter, 2010 through the third quarter of 2011. Over the last year (between the third quarter, 2010 and third quarter, 2011) three wells decreased in concentration, three increased, and three remained the same. The well with the highest concentrations, TWN-2, decreased from 69 mg/L to 33 mg/L. The average nitrate concentration within the plume decreased from 24.4 mg/L to 19.7 mg/L.

These comparisons indicate that concentrations within the plume are relatively stable but the highest concentrations appear to be declining. Figure 9 compares the extent of the nitrate plumes in the third quarter of 2010 and the third quarter of 2011. As indicated, the plume boundaries are relatively stable, likely the result of the generally low permeability of the perched zone, the ongoing pumping related to the chloroform plume, and the absence of significant continuing sources of nitrate to the perched water.



## 5. CHARACTERIZATION OF STUDY AREA

The study area encompasses a region in the northeastern portion of the site where the nitrate plume (defined by concentrations > 10 mg/L) has been detected and bounded by a series of nitrate and chloroform investigation wells (Figure 1). Wells within the plume are MW-30 and MW-31, and temporary wells TW4-19, TW4-21, TW4-22, TW4-24, TW4-25, TWN-2 and TWN-3. (Figure 7). Wells MW-5, MW-11, MW-25, MW-26, MW-27, MW-28, MW-29, MW-32, TW4-16, TW4-18, TWN-1, TWN-4, TWN-7, and TWN-18 bound the plume. As of the second quarter of 2011, MW-5, MW-11, MW-25, MW-29, and MW-32 were non-detect for nitrate. Hydraulic characterization of the study area has been based on data collected from wells within and near the plume as discussed in Section 4. The extent and hydrogeology of the study area is discussed below.

### 5.1 Extent of Study Area

The nitrate plume that is the focus of this CAP is confined to the region of the perched zone containing nitrate concentrations exceeding 10 mg/L located south of TWN-18 and north of MW-11. The area having nitrate exceeding 10 mg/L, as of the third quarter of 2011, is shown in Figures 1 and 7. This area extends from the northeast portion of the tailings cells to the area upgradient (north-northeast) of the tailings cells. The highest nitrate concentrations have historically been detected at TWN-2, within the northern (upgradient) portion of the plume. TWN-2 is located within the area of the historical pond (Figure 8).

Areas of detectable nitrate that are not continuous with the above defined area exist to the northwest (near TWN-9 and TWN-17) and to the east-southeast associated with the chloroform plume. Nitrate concentrations within these areas are typically less than 10 mg/L although sporadic detections at or slightly above 10 mg/L have occurred at some locations. Areas to the northeast are not a target of this CAP, and nitrate associated with the chloroform plume is addressed by the ongoing chloroform pumping.

The nitrate plume, as defined by the 10 mg/L concentration boundary, is bounded by wells MW-5, MW-11, MW-25, MW-26, MW-27, MW-28, MW-29, MW-32, TW4-16, TW4-18, TWN-1, TWN-4, TWN-7, and TWN-18. As of the second quarter of 2011, MW-5, MW-11, MW-25, MW-29, and MW-32 were non-detect for nitrate. The plume is bounded to the south by MW-5 and MW-11, to the east by MW-27, MW-28, MW-29 and TWN-7, to the north by TWN-18, and to the west by MW-25, MW-26, MW-32, TWN-1, TWN-4, TW4-18, TW4-16, and TW4-20. Additional wells to the south (downgradient) of the plume include MW-3, MW-14, MW-15 and MW-37.

## 5.2 Hydrogeology

A description of the hydrogeology of the site in the vicinity of the nitrate plume is provided in Section 3, and hydrogeologic cross-sections are provided in Appendix A. Perched zone permeabilities in the vicinity of the nitrate plume are in the middle to high end of the range measured at the site. The geometric average of approximately  $1.2 \times 10^{-4}$  cm/s is slightly lower than typical for the area of the chloroform plume located east and southeast of the nitrate plume (Figure 10).

Perched groundwater flow in the area of the nitrate plume is generally southwesterly. Saturated thicknesses in the vicinity of the plume are generally higher than in areas to the south and southwest. In the vicinity of the nitrate plume (Figure 5) they range from a maximum of approximately 87 ft at TW4-25 to approximately 30 ft at MW-30. In general, saturated thicknesses increase toward the northeast, where the wildlife ponds are located, and are locally affected in the vicinity of the plume by pumping at MW-26, TW4-19, and TW4-20.

Permeabilities within the general area of the nitrate plume are based primarily on analysis of slug tests as discussed in Section 3. Permeability estimates range from approximately  $2.7 \times 10^{-5}$  to  $1.4 \times 10^{-3}$  cm/s, and have a geometric average of  $1.2 \times 10^{-4}$  cm/s (Table 2). The transmissivities of many wells within the nitrate plume are similar to wells that are pumped for chloroform removal.

## **6. CORRECTIVE ACTION CONCENTRATION LIMITS**

The corrective action concentration limit for nitrate is 10 mg/L. This concentration is considered to bound the outer extent of the plume and is the ultimate target for reducing nitrate concentrations within the plume. As discussed in Section 9, once the nitrate concentrations in all nitrate monitoring wells are 10mg/L or less, concurrence with DRC will be sought that the plume is remediated and the corrective action complete.



## 7. CORRECTIVE ACTION PLAN – CONSTRUCTION AND OPERATION

The corrective action for the nitrate plume is proposed to occur in three phases.

In Phase I, Denison proposes to construct a sloped, curbed and drained concrete pad of six inches in depth over an area covering at least twice the areal extent of contamination identified during the contamination investigation. Denison also proposes a future removal of contaminated soil at the time of Mill site reclamation and, for conservatism, proposes to revise the reclamation surety estimate to include a volume of soil to be removed and placed in the tailings cells of twice the volume of contaminated soil identified in the contamination investigation.

Phase II will consist of pumping four wells within the nitrate plume (TW4-22, TW4-24, TW-25, and TWN-2). Phase II relies on both pumping and natural attenuation to remove nitrate mass, reduce nitrate concentrations within the plume, and minimize or prevent plume migration. Included in Phase II are continued monitoring within and outside the plume to verify plume boundaries (as defined by a concentration of 10 mg/L), estimate changes in hydraulic capture, and track changes in nitrate concentrations within the plume.

If implemented, Phase III will consist of a transport assessment, a hazard assessment, and an exposure assessment along with a corrective action assessment including an evaluation of best available remedial technologies. Selection of a technology for implementation will be based on an evaluation whether the technology will remediate contamination to as low as is reasonably achievable, if the 10 mg/L standard is not reasonably achievable. One possible outcome of these evaluations could be an application for alternate corrective action concentration limits (ACACL).

After implementation of Phase II and Phase III and once residual concentrations have dropped to 10 mg/L or less at all monitored locations or an ACACL has been granted, concurrence with the Executive Secretary will be sought that the corrective action is complete. Phase II has contingencies to be implemented if needed based on monitoring as discussed in Section 8. The termination of Phase II and implementation of Phase III will be with the concurrence of the Executive Secretary and will be based on assessments conducted during Phase III.

An important goal of Phase III is to ensure that nitrate concentrations exceeding the action level will not migrate to any point of exposure within the applicable regulatory time frame. This migration of the nitrate plume is not expected to occur. However, the decision as to when to terminate Phase II and implement Phase III will be based on Phase II monitoring data and quantitative calculations that indicate that, based on Phase II results, this Phase III goal is attainable.

## 7.1 Phase I Description and Rationale

The potential contamination source to be addressed in Phase I consists of alluvial soil in the area of the Mill's outdoor ammonium sulfate storage tanks as depicted in Figure 11-1. As shown in Figure 11-1, the ammonium sulfate tanks and associated soil contamination are located to the east of the Mill process building. The tanks are currently situated over an uncurbed concrete slab, which has suffered some deterioration over the years. The tank area is bounded to the west by the Mill building, to the south by the V<sub>2</sub>O<sub>5</sub> Mini Lab and Precipitation Area, and to the north by the Mill's Pulp Storage Tanks. That is, the ammonium sulfate tanks are located in a relatively congested and (on three sides) built out area.

The proximity of the Mill building and other tanks precludes the ability to perform an extensive soil excavation/contaminated soil removal at the current time. Therefore, consistent with the SCA, Denison proposes to perform the contaminated soil corrective action phase in two steps; 1) construction of a concrete cover to remain in place during the operating life of the Mill, and 2) a contaminated soil excavation to occur during the Mill reclamation at final Mill closure.

Step 1: Denison proposes to construct a sloped, curbed, and drained concrete pad of six inches in depth over an area covering at least twice the areal extent of contamination identified during the contamination investigation. Because the ammonium sulfate tanks are surrounded by existing concrete structures to the south, west, and north, the new concrete pad will extend to the east of the Mill building. The existing concrete pad will be resurfaced and sloped to drain to the existing collection area/sump inside the Mill building, which returns solutions to the process. This resurfaced area will be constructed with a curb of approximately 6 inches in height. In addition, a new concrete slab will be extended to the eastern edge of the surrounding structures. This new slab will also be sloped to drain to an existing collection area/sump in the Mill building. A rolled curb will be constructed on the east side of this new concrete pad, with an access ramp on each side to allow supplier trucks sufficient access to refill the tanks. The proposed cover design is depicted in Figure 11-2.

Consistent with Section 11A(1)(b)(i) of the SCA, Denison will provide a detailed plan and schedule for construction of the concrete cover to DRC by January 1, 2012.

Denison also proposes a future removal of contaminated soil at the time of Mill site reclamation, and disposal of the removed soil in the tailings cells. To ensure a sufficient surety amount for reclamation of the known contaminated soil volume to the depth of bedrock, Denison proposes to revise the reclamation surety estimate to include a volume of soil of twice the volume of contaminated soil volume identified in the contamination investigation. Consistent with Section 11A(1) of the SCA, Denison will provide the revised surety estimate to DRC by March 4, 2012.

## 7.2 Phase II Description and Rationale

Phase II consists of three active components and one passive component. The active components are:

1. Removal of nitrate mass from the perched zone as rapidly as is practical by pumping from wells located in areas having high nitrate concentrations, relatively high productivities, or both.
2. Perched zone water level and nitrate monitoring to assess changes in nitrate concentrations within the plume, verify the location of the plume boundary over time, and estimate hydraulic capture zones.
3. Abandonment of TWN-series wells not needed for implementation of item 2.

Pumped water will be disposed in the tailings cells. In addition, all samples analyzed for nitrate will also be analyzed for chloride.

The passive component consists of relying on natural attenuation to reduce nitrate concentrations. Physical mechanisms that will reduce nitrate concentrations include processes such as hydrodynamic dispersion, and dilution via mixing with nitrate-free recharge and low nitrate waters outside the plume. Neither biologically mediated decomposition of nitrate nor abiotic chemical decomposition are expected to be significant mechanisms in reducing nitrate concentrations. Furthermore, nitrate is not expected to be retarded by adsorption onto aquifer solids. The combination of pumping, hydrodynamic dispersion, and dilution by recharge are expected to be effective considering that less than an order of magnitude reduction in concentration is needed to reduce the highest detected nitrate concentrations within the plume (approximately 69 mg/L) to the target of 10 mg/L. The downgradient portion of the plume, defined by MW-30 and MW-31, will require reduction in concentration by only a factor of two to meet the 10 mg/L goal.

In general, Phase II is expected to function in a manner similar to ongoing chloroform removal from perched water at the site. Construction and operation will be similar to the chloroform pumping system which consists of five wells (MW-4, MW-26, TW4-4, TW4-19, and TW4-20) located within the chloroform plume that are pumped as continuously as practical and at rates that are as large as practical. Water from those wells is disposed in the tailings cells.

The nitrate pumping system will consist of four wells: TW4-22, TW4-24, TW4-25, and TWN-2 (Figure 1). Water will be pumped from these wells as continuously as practical and at rates as high as practical. These wells were selected for pumping because 1) they are located in middle to upgradient areas of the plume having the highest nitrate concentrations and will minimize the

downgradient migration of these high concentrations, 2) they are expected to have productivities similar to the chloroform pumping wells, 3) pumping these wells is not expected to enhance the downgradient migration of chloroform, and 4) they are temporary chloroform (TW4-series) or nitrate (TWN-series) investigation wells and converting them to pumping wells will not impact tailings cell point of compliance monitoring under the Mill's Groundwater Discharge Permit ("GWDP").

Pumping these wells is expected to remove nitrate mass from the perched zone as rapidly as practical, and flatten hydraulic gradients within the plume to reduce rates of downgradient migration and allow natural attenuation to be more effective. Furthermore, the depression of the water table resulting from pumping in the upgradient portion of the plume will reduce interaction between the perched water and any residual shallow vadose zone sources that may exist. As a result plume migration is expected to be minimal or cease once Phase II is implemented. Currently the plume appears to be changing very slowly. Figure 9 compares the extents of the nitrate plume in the third quarters of 2010 and 2011. Over this period, the plume appears to be relatively stable, having expanded slightly in some areas and contracted slightly in others. The apparent stability of the plume is likely the result of the generally low permeabilities of the perched zone, ongoing pumping within the adjacent chloroform plume, and the absence of significant continuing sources of nitrate to perched water. Implementation of Phase II is expected to further reduce or halt downgradient migration and to reduce concentrations within the plume. If ongoing monitoring indicates the plume continues to migrate, then contingencies will be implemented.

As discussed above, the productivities of the proposed nitrate pumping wells are expected to be similar to those of the chloroform pumping wells. The transmissivities at proposed nitrate pumping wells TW4-22, TW4-24, and TW4-25 are estimated to be between those of chloroform pumping wells MW-26 and TW4-19; and the transmissivity at TWN-2 is estimated to be about one third that of chloroform pumping well TW4-20 (Table 4). Therefore, the long-term productivities of TW4-22, TW4-24, and TW4-25 are expected to be between those of MW-26 and TW4-19; and the long-term productivity of TWN-2 is expected to be about one third that of TW4-20. Although expected pumping rates at TWN-2 will be relatively low, the high concentrations detected at that well will result in relatively high nitrate removal rates.

The potential interaction of the chloroform plume with the nitrate pumping system is of concern. Figure 10 shows the locations of the nitrate and chloroform plumes as of the third quarter of 2011. The chloroform plume is located generally east-southeast of the nitrate plume, but the plumes mingle in the vicinity of TW4-19, TW4-20 and TW4-22 (northeast corner of tailings Cell #2). Pumping the proposed nitrate wells will impact chloroform migration to some extent, and

any pumping that enhances downgradient migration of chloroform is undesirable. It is expected that pumping the proposed wells will at most draw chloroform cross-gradient to the west-northwest. However, pumping of any wells to the southwest of the chloroform plume (such as MW-30 and MW-31) would have the undesirable impact of enhancing the downgradient migration of chloroform, and is not considered to be an option. Furthermore, converting MW-30 or MW-31 to nitrate pumping wells would degrade the usefulness of these wells for tailings cell point of compliance monitoring under the GWDP.

Data collected during Phase II monitoring will be used to estimate the extent of the capture zone, and to calculate nitrate mass removal rates by pumping. Denison will calculate the capture zones after four quarters of water level measurements have been taken, and will include the calculations, with figures, in the next quarterly nitrate monitoring report. Numerical and/or analytical models will be used if needed to assist in evaluating the data and estimating natural attenuation.

It is expected that the four pumping wells, in combination with the existing chloroform pumping wells, will adequately capture the nitrate plume, such that concentrations of nitrate in excess of the 10 mg/L standard are not expected to migrate beyond the current boundaries of the plume. Based on experience from the chloroform pumping results to date, it is expected that the capture zone from the four nitrate pumping wells will, by themselves extend more than 400 feet downgradient of TW4-22 and TW4-24. For example, the downgradient extent of the combined capture zone of chloroform pumping wells MW-26, TW4-19, and TW4-20 (Figure 12) extends more than 400 feet downgradient of MW-26. The capture zone from the four nitrate pumping wells alone is expected to likewise extend at least 400 feet southwest of TW4-22 and TW4-24, encompassing by themselves approximately three quarters of the plume (Figure 13). However, the proportion of the nitrate plume under hydraulic capture is expected to be larger than this estimate as the nitrate capture zone merges and is enhanced by the chloroform capture zone. The result is that either complete hydraulic capture will be achieved, or if not achieved, concentrations of nitrate in excess of 10 mg/L are not expected to migrate beyond the current boundaries of the plume. Hydraulic capture will be considered successful if the concentrations of nitrate in MW-30 and MW-31 remain stable or decline and concentrations of nitrate in downgradient wells MW-5 and MW-11 do not exceed the 10 mg/L standard.

### 7.2.1 Well Abandonment

Currently there are 19 TWN-series wells that were installed for the investigation of nitrate at the site. Wells in the vicinity of the nitrate plume will be retained for monitoring. TWN-series wells located north-northeast of TWN-18 are not needed for this purpose and all are therefore selected for abandonment. Wells proposed for abandonment are TWN-5, TWN-6, TWN-8, TWN-9,

TWN-10, TWN-11, TWN-12, TWN-13, TWN-14, TWN-15, TWN-16, TWN-17, and TWN-19. These wells will be abandoned within one year from the date of approval of this CAP, in accordance with applicable regulations. A well abandonment report will be submitted to the Executive Secretary within 15 months after the date of approval of this CAP.

### 7.2.2 Groundwater Pumping System

The Phase II corrective action groundwater pumping system will consist of wells TW4-22, TW4-24, TW4-25, and TWN-2 (Figure 1). Each well will be equipped with a Grundfos submersible pump. To prevent damage to the pumps, each will operate on a cycle that allows pumping only when sufficient water is present in the well. The capacity of each pump will be greater than the sustainable pumping rate for each well. Therefore, the average amount of water pumped from each well will be, in general, the maximum practical. These wells were selected for pumping because they are located in areas of the perched zone having both high nitrate concentrations and relatively high transmissivities that allow relatively high rates of mass removal, and because they are not expected to have a negative impact on chloroform migration from the adjacent chloroform plume.

Water pumped from each well will be routed by discharge lines to the tailings cells for disposal. The discharge line near each wellhead will be equipped with an in-line flow meter and totalizer. Readings from each totalizer will be used to report quarterly pumped volumes and average pumping rates.

Operation of the nitrate wellfield will be similar to that for the chloroform wellfield. The contingencies described in Section 8 will be implemented should nitrate mass removal rates drop significantly due to losses in well productivity.

### 7.2.3 Water Level Monitoring

Water levels will be monitored weekly in each of the four nitrate pumping wells. Water levels in the remaining wells listed in Table 3 will be monitored monthly for the first twelve months after commencement of Phase II pumping, and thereafter quarterly. Depths to water will be measured using an electric water level meter in the same way they are currently collected. Hydraulic capture zones will be estimated from water level contour maps generated quarterly from the water level data, with the first capture zones estimated after twelve months of data have been obtained. The contingencies described in Section 8 will be implemented should the proportion of the remaining nitrate plume that is under hydraulic capture shrink significantly.

#### 7.2.4 Water Quality Monitoring

Pumping wells TW4-22, TW4-24, TW4-25, and TWN-2, and the other wells listed in Table 3, will be monitored quarterly. Sampling and analytical procedures will be the same as currently employed for the nitrate monitoring as described in the quarterly monitoring reports submitted by Denison to DRC. Each well will be sampled for the following constituents with respect to monitoring the nitrate plume:

- Chloride
- Nitrogen, Nitrate + Nitrite as N

Existing nitrate and chloride monitoring will continue in each other monitoring well at the site at the frequency required under the GWDP or the chloroform investigation, as the case may be.

Should concentrations within the plume begin to generally increase (disregarding short-term fluctuations), or the plume boundaries begin to expand, the contingencies discussed in Section 8 will be implemented.

#### 7.2.5 Reporting

Reporting is proposed to occur quarterly, using a format and content similar to the quarterly chloroform monitoring reports submitted by Denison to DRC. The quarterly reports will include the following details:

1. calculation of quarterly nitrate mass removed by pumping,
2. comparison of the current areal extent of the nitrate plume from the latest quarter with the latest quarter of the previous reporting period, and
3. discussion of any contingencies to be implemented.

### **7.3 Phase III**

Phase III may be implemented at the discretion of Denison at any time if Denison determines that continuation of Phase II is not necessary or appropriate. If Denison decides to implement Phase III, Denison will submit a revised CAP to the Executive Secretary for approval, which incorporates Phase III. Phase II will continue until Phase III is approved by the Executive Secretary.

If implemented, Phase III will consist of a transport assessment, a hazard assessment, and an exposure assessment along with a corrective action assessment including an evaluation of best available remedial technologies. Selection of a technology for implementation will be based on an evaluation whether the technology will remediate contamination to as low as is reasonably

achievable, if the 10 mg/L standard is not reasonably achievable. One possible outcome of these evaluations could be an application for alternate corrective action concentration limits (ACACL). As required by UAC R317-6-6.15(G), the proposed ACACL must be protective of human health, and the environment, and must utilize best available technologies. If an ACACL is proposed, the revised CAP will include the information required, under UAC R317-6-6.15(G), and any ACACL would require the approval of the Utah Water Quality Board.

The transport assessment will identify any data gaps that exist and develop work plans to collect any data needed to support hydrologic and geochemical modeling. Such modeling will consist of appropriate quantitative models to predict flow paths, travel times, and potential points of exposure of nitrate contaminated groundwater. Any potential geochemical reactions or other attenuation mechanisms will also be identified. The transport assessment will inform the hazard assessment and the exposure assessment.

The hazard assessment will identify the risks and hazards to human health and the environment associated with nitrate to determine whether an ACACL should be proposed, if the subsequent exposure assessment concludes that an exposure is reasonably likely.

The purpose of the exposure assessment is to evaluate the potential harm to human health and the environment from the hazards identified in the hazard assessment. The exposure assessment takes into account site-specific circumstances that may reduce or enhance the potential for exposure to nitrate. This assessment identifies and evaluates exposure pathways, and provides forecasts of human and environmental population responses, based on the projected constituent concentrations, and available information on the chemical toxicity effects of the constituents. The assessment also addresses the underlying assumptions, variability, and uncertainty of the projected health and environmental effects. Exposure pathways are identified and evaluated using water classification and water use standards, along with existing and anticipated water uses.

The corrective action assessment consists of a review of ground-water corrective action alternatives in conjunction with the hazard assessment and the exposure assessment. Past, current, and proposed practicable corrective actions will be identified and evaluated against the costs and benefits associated with implementing each corrective action alternative. If ACACLs are identified as the proposed alternative, the corrective action assessment will demonstrate that the proposed ACACL is as low as is reasonably achievable, considering practicable corrective actions, and is therefore conservative and cost-effective, and would be granted with good cause. A principal way of demonstrating this is by estimating and comparing the benefits imparted by a corrective action measure against the cost of implementing that measure.

### 7.3.1 Water Level and Water Quality Monitoring

Water level and water quality monitoring plans will be proposed in the revised Phase III CAP prior to implementation of any proposed corrective action alternative.



## **8. ASSESSMENT OF CORRECTIVE ACTION AND PROTECTION OF PUBLIC HEALTH AND THE ENVIRONMENT**

The effectiveness of Phase II of the corrective action will be assessed based on the following criteria:

1. stability of plume boundaries
2. concentration trends within the plume
3. nitrate mass removal rates resulting from pumping, and
4. stability of capture zones.

Plume boundaries and capture zones will be considered stable if concentrations of nitrate in excess of the 10 mg/L standard do not migrate beyond the current boundaries of the plume. Hydraulic capture will be considered successful if the concentrations of nitrate in MW-30 and MW-31 remain stable or decline and concentrations of nitrate in downgradient wells MW-5 and MW-11 do not exceed the 10 mg/L standard.

The criteria for assessment of the effectiveness of Phase III of the corrective action will be determined once the elements of Phase III have been developed. As discussed in Section 3.2.3, Phase III will be undertaken at a later date after public participation and Executive Secretary approval. Phase III may include, but is not limited to: continuation of Phases I and II activities alone or in combination with monitored natural attenuation, evaluation of additional remediation and monitoring technologies/techniques, determination of any additional hydrogeologic characterization, groundwater contaminant travel times and directions, determination of ultimate points of exposure to the public and/or wildlife, appropriate risk analysis, a cost/benefit analysis, and the possible development of and petition to the Board for alternate corrective action concentration limits pursuant to UAC R317 -6-6 .15 (G).

This CAP does not specify the details of Phase III, at this time. A Phase III preliminary plan and schedule for the evaluation of alternatives, for the completion of any further studies, analyses, applications and petitions, and for the ultimate definition of Phase III, may be proposed by Denison at a later date, after completion of such studies and evaluations, followed by submittal of a proposed CAP revision to the Executive Secretary.

### **8.1 Stability of Plume Boundary (Phase II)**

The stability of the plume boundary, based on Phase II CAP monitoring activities discussed in Sections 7 and 10, will be used to determine the following:

- Whether any additional pumping wells are needed, and
- The need to reevaluate the Phase II strategy.

Under conditions where the plume boundaries remain stable or contract, no additional pumping wells will be needed, and no reevaluation of Phase II will be needed. Under conditions where the plume migrates, with the concurrence of the Executive Secretary, one or more additional pumping wells will be added, if suitable wells are available, to slow the migration rates and/or to bring more of the plume under hydraulic capture. The installation of additional downgradient monitoring wells is not anticipated because two lines of wells currently exist downgradient of the nitrate plume. Any such additional pumping wells will be added in accordance with a schedule to be approved by the Executive Secretary. If the plume continues to migrate, or suitable additional pumping well locations are not available, then Phase II will be reevaluated, which may include commencement of Phase III. Analytical or numerical models will be used if needed in the reevaluation to develop a response. The reevaluation process will be completed in accordance with a schedule to be approved by the Executive Secretary.

## **8.2 Concentration Trends within the Plume (Phase II)**

Concentration trends within the plume will be used to determine the need for reevaluation of Phase II. Concentration trends will be based on analytical data collected through Phase II CAP monitoring.

Under conditions where concentrations within the plume are stable or declining, no reevaluation will be required. Should concentrations within the plume begin to generally increase (disregarding short term fluctuations), then reevaluation of Phase II will be required. Analytical or numerical models will be used in the reevaluation if needed to develop a response. The reevaluation process will be completed in accordance with a schedule to be approved by the Executive Secretary. Anticipated responses to this condition would likely include adding existing or new wells to the pumping network, if suitable well locations are available, or other measures designed to achieve a more rapid rate of mass reduction. If suitable well locations are not available, then Phase III will be considered.

## **8.3 Nitrate Mass Removal Rates Resulting from Pumping (Phase II)**

Under conditions where nitrate mass removal rates by pumping drop substantially as a result of reduced concentrations within the plume, no action will be taken. Under conditions where nitrate mass removal rates by pumping drop substantially as a result of lost well productivities, then an evaluation of the lost productivity will be undertaken. If the lost productivity is determined to be a well efficiency problem, the inefficient wells will be re-developed or replaced in accordance

with a schedule to be approved by the Executive Secretary. Should the lost productivity be determined to be due to a general reduction in saturated thickness, analytical or numerical models will be used to evaluate the potential effectiveness of adding existing or new wells to the pumping network to improve overall productivity, if suitable well locations are available. If the analysis indicates that overall productivity will not improve significantly by adding wells, or if suitable well locations are not available, then no action will be taken.

A loss in productivity due to a general decrease in saturated thickness will likely be offset by the benefits of the reduced saturated thickness. First, this condition would indicate that removal of a substantial amount of nitrate laden water had already taken place. Second, the reduced saturated thickness within the nitrate plume would reduce average hydraulic gradients and reduce the potential for downgradient migration. These factors will be considered in any reevaluation that may be performed.

#### **8.4 Stability of the Proportion of the Nitrate Plume under Hydraulic Capture (Phase II)**

Under conditions where concentrations of nitrate in excess of the 10 mg/L standard migrate beyond the current boundaries of the plume, as evidenced by concentrations of nitrate in MW-30 and MW-31 increasing and/or concentrations of nitrate in downgradient wells MW-5 and MW-11 exceeding the 10 mg/L standard, an evaluation of the factors resulting in this condition will be undertaken. If the condition is determined to result from lost productivity of the pumping wells due to well efficiency problems, the inefficient wells will be re-developed or replaced in accordance with a schedule to be approved by the Executive Secretary. Should the loss in capture be determined to result from other conditions, then Phase II will be reevaluated, which may include commencement of Phase III. Analytical or numerical models will be used in the reevaluation if needed to develop a response. The reevaluation process will be completed in accordance with a schedule to be approved by the Executive Secretary.

Anticipated responses to this condition would likely include adding existing or new wells to the pumping network to bring a larger proportion of the plume within hydraulic capture, if suitable well locations are available. If suitable well locations are not available, then Phase III will be considered.

#### **8.5 Phase III**

As discussed in Section 3.2.3, Phase III will be undertaken at a later date after public participation and Executive Secretary approval. Phase III may include, but is not limited to: continuation of Phases I and II activities alone or in combination with monitored natural

attenuation, evaluation of additional remediation and monitoring technologies/techniques, determination of any additional hydrogeologic characterization, groundwater contaminant travel times and directions, determination of ultimate points of exposure to the public and/or wildlife, appropriate risk analysis, a cost/benefit analysis, and the possible development of and petition to the Board for alternate corrective action concentration limits pursuant to UAC R317 -6-6 .15 (G).

This CAP does not specify the details of Phase III, at this time. A Phase III preliminary plan and schedule for the evaluation of alternatives, for the completion of any further studies, analyses, applications and petitions, and for the ultimate definition of Phase III, may be proposed by Denison at a later date, after completion of such studies and evaluations, followed by submittal of a proposed CAP revision to the Executive Secretary. Until such time, the activities of the Phase I and Phase II remediation will continue as stipulated in the approved CAP.

## **8.6 Permanent Effect of Corrective Action**

Phase II, Phase III, and the contingencies outlined above (Sections 8.1 through 8.5) are designed to protect the public health and the environment by containing the nitrate plume within the site property boundary and reducing nitrate concentrations within the plume to the concentration limit of 10 mg/L. As concentrations will then continue to be reduced by natural attenuation, the corrective action will have a permanent effect.

## **8.7 In-Place Contaminant Control**

As discussed in Section 7, the corrective action relies on active and passive strategies to meet CAP objectives. The passive strategy includes in-place contaminant control by reducing nitrate concentrations via natural attenuation.

## **9. IMPACTS OF OFFSITE ACTIVITIES**

As discussed in Section 7, nitrate will be treated in place by natural attenuation and removed from the perched zone by pumping. Because all pumped water will be disposed onsite in the tailings cells, there will be no offsite impacts resulting from CAP implementation.



## 10. PROPOSED PLUME CORRECTIVE ACTION ACTIVITIES

Phase II and Phase III corrective action activities and contingencies are discussed in detail in Sections 7 and 8. These activities are summarized in Sections 10.1 and 10.2 below.

### 10.1 Phase I

The Phase I source control action was discussed in Section 7.1, above.

### 10.2 Phase II

Phase II corrective action activities include pumping of wells TW4-22, TW4-24, TW4-25, and TWN-2, monitoring and maintenance of the pumping system, water level monitoring, monitoring for nitrate and chloride, estimation of hydraulic capture, implementation of contingencies as needed, and reporting.

#### 10.2.1 Groundwater Pumping

Wells TW4-22, TW4-24, TW4-25, and TWN-2 (Figure 1) will be pumped at the maximum practical rates. Pumped water will be disposed in the tailings cells. The wellfield will be operated and maintained in the same fashion as the chloroform removal wellfield. Monitoring will include pumping rates and volumes for each well.

#### 10.2.2 Water Level Monitoring

Water level monitoring will consist of weekly water level monitoring of pumping wells TW4-22, TW4-24, TW4-25, and TWN-2, and, for the first twelve months after approval of this CAP, monthly monitoring of non-pumped wells MW-27, MW-30, MW-31, TW4-21, TWN-1, TWN-3, TWN-4, TWN-7, and TWN-18 (Figure 1). Thereafter, water level monitoring of those non-pumping wells will continue quarterly. Water level contour maps of the data will be generated quarterly.

#### 10.2.3 Water Quality Monitoring

Water quality monitoring for pumped wells TW4-22, TW4-24, TW4-25, and TWN-2 and all other wells listed on Table 3 will be quarterly. Samples will be analyzed for chloride, and for nitrogen (nitrate and nitrite as N) (Section 6.2.4). Water quality monitoring for nitrate and chloride for all other wells at the site will continue at the frequency required under the GWDP or chloroform investigation, as the case may be.

#### 10.2.4 Estimation of Capture Zones

Hydraulic capture zones will be generated from the quarterly water level contour maps in the same manner as they are currently generated for the chloroform pumping.

#### 10.2.5 Estimation of Pumped Nitrate Mass

Quarterly estimates of nitrate mass removed by pumping will be made based on cumulative pumped volumes at each pumped well and nitrate concentrations at each pumped well.

#### 10.2.6 Reporting

Quarterly reports will be prepared that contain the same elements of the current chloroform corrective action monitoring reports submitted by Denison to DRC and will include the following:

1. quarterly nitrate mass removed by pumping,
2. comparison of the areal extent of the nitrate plume from the latest quarter with the latest quarter of the previous reporting period, and
3. discussion of any contingencies implemented or to be implemented.

#### 10.2.7 Additional Measures

Based on Phase II monitoring, and the criteria discussed in Section 8, contingencies that include potential installation of additional wells, well rehabilitation or replacement, potential expansion of the pumping well network, if suitable well locations are available, and reevaluation of the Phase II strategy and consideration of commencement of Phase III activities will be implemented as needed. Factors that could trigger the implementation of contingencies include 1) expansion of the plume boundaries, 2) generally increasing nitrate concentrations within the plume, 3) reductions in nitrate mass removal rates due to losses in pumping well productivities, and 4) decreases in the effectiveness of hydraulic capture.

### **10.3 Phase III**

As discussed in Section 3.2.3, Phase III will be undertaken at a later date after public participation and Executive Secretary approval. Phase III may include, but is not limited to: continuation of Phases I and II activities alone or in combination with monitored natural attenuation, evaluation of additional remediation and monitoring technologies/techniques, determination of any additional hydrogeologic characterization, groundwater contaminant travel times and directions, determination of ultimate points of exposure to the public and/or wildlife, appropriate risk analysis, a cost/benefit analysis, and the possible development of and petition to

the Utah Water Quality Board for alternate corrective action concentration limits pursuant to UAC R317 -6-6 .15 (G).

This CAP does not specify the details of Phase III, at this time. A Phase III preliminary plan and schedule for the evaluation of alternatives, for the completion of any further studies, analyses, applications and petitions, and for the ultimate definition of Phase III, may be proposed by Denison at a later date, after completion of such studies and evaluations, followed by submittal of a proposed CAP revision to the Executive Secretary. Until such time, the activities of the Phase I and Phase II remediation will continue as stipulated in the approved CAP.



## 11. REFERENCES

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## **12. 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**  
**Nitrate Corrective Action Schedule**

<i>STEP OR ACTION</i>	<i>DATE</i>
Executive Secretary Issuance of Consent Order Approving Corrective Action Plan	No set date
Commence Corrective Actions	within 30 days of CAP approval
<i>Phase I</i>	
Submit Phase 1 Plan and Schedule for Ammonium Sulfate Corrective Action	1/1/2012
Submit Revised Reclamation Plan and Financial Surety Estimate for Phase I	3/4/2012
Submit Evidence of Adequate Surety for Phase 1	within 30 days of approval of Phase I revised surety estimate
Construct Ammonium Sulfate Area Cover	as per approved Phase 1 Plan and Schedule
<i>Phase II</i>	
Submit Revised Reclamation Plan and Financial Surety Estimate for Phase I and II	within 60 days of Consent Order
Submit Evidence of Adequate Surety for Phase I and II	within 30 days of approval of Phase I and II revised surety estimate
Submit Nitrate Operations and Maintenance Plan	within 30 days of Consent Order
Install Pumps in Wells TW4-22, TW4-24, TW4-25, and TWN-2	within 30 days of Consent Order
Begin Pumping Wells TW4-22, TW4-24, TW4-25, and TWN-2	within 45 days of Consent Order
Cease Sampling and Level Monitoring of Wells TWN-5, TWN-6, TWN-8, TWN-9, TWN-10, TWN-11, TWN-12, TWN-13, TWN-14, TWN-15, TWN-16, TWN-17, TWN-19	upon issuance of Consent Order
Abandon Wells TWN-5, TWN-6, TWN-8, TWN-9, TWN-10, TWN-11, TWN-12, TWN-13, TWN-14, TWN-15, TWN-16, TWN-17, TWN-19	within 15 months of Consent Order
Reporting of Monitoring and Pumping Data	as part of ongoing quarterly nitrate monitoring reports
Submit Capture Zone Maps	In quarterly report after four quarters of monthly groundwater level data
Submit Well Abandonment Report	within 15 months of Consent Order
<i>Phase III</i>	
To be determined at discretion of Denison	---

**TABLE 2**  
**Hydraulic Conductivity Estimates for Wells in the Nitrate Plume Area**

Well	k (cm/s) <sup>1</sup>	method
MW-11	1.40E-03	pumping
MW-27	8.20E-05	<sup>2</sup> slug
MW-30	1.00E-04	<sup>2</sup> slug
MW-31	7.10E-05	<sup>2</sup> slug
TW4-19	2.50E-04	pumping
TW4-20	5.90E-05	<sup>2</sup> slug
TW4-21	1.90E-04	<sup>2</sup> slug
TW4-22	1.30E-04	<sup>2</sup> slug
TW4-24	1.60E-04	<sup>2</sup> slug
TW4-25	5.80E-05	<sup>2</sup> slug
TWN-1	1.70E-04	<sup>2</sup> slug
TWN-2	1.49E-05	<sup>2</sup> slug
TWN-3	8.56E-06	<sup>2</sup> slug
TWN-18	2.27E-03	<sup>2</sup> slug

<sup>1</sup> hydraulic conductivity in centimeters per second

<sup>2</sup> KGS slug test solution results for automatically logged data

**TABLE 3**  
**Nitrate Concentrations (mg/L) at Wells Within the Nitrate Plume**

well	Q1 2010	Q2 2010	Q3 2010	Q4 2010	Q1 2011	Q2 2011	Q3 2011
MW-30	16.1	15.8	15	16	16	17	16
MW-31	21.7	22.5	21	20	21	22	21
<sup>1</sup> TW4-19	2	4.4	5.9	2.7	17	12	3
TW4-21	8.4	12	14	7	9	12	14
TW4-22	36.6	19	15	16	18	17	15
TW4-24	33.1	30	31	31	31	35	34
TW4-25	14.4	16	14	15	15	16	16
TWN-2	62.1	69	69	48	43	40	33
TWN-3	25.3	26	27	24	24	26	25
average	24.4	23.9	23.5	20.0	21.6	21.9	19.7

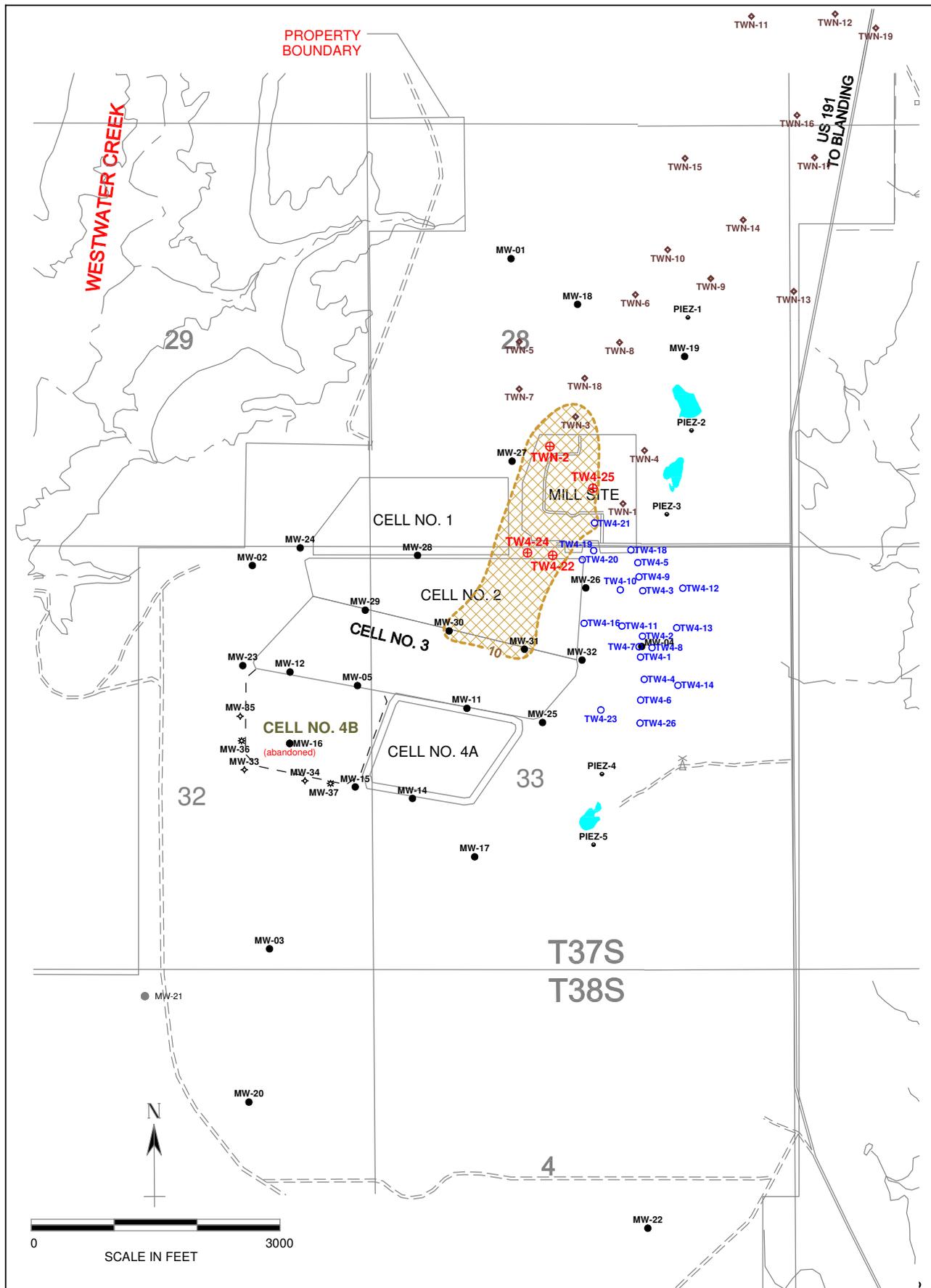
<sup>1</sup> TW4-19 is a chloroform pumping well

**TABLE 4**  
**Comparison of Chloroform Pumping Well Transmissivities to**  
**Proposed Nitrate Pumping Well Transmissivities**

Well	Type	Hydraulic Conductivity (cm/s)	Hydraulic Conductivity (ft/day)	Saturated Thickness <sup>1</sup> (feet)	Transmissivity (ft <sup>2</sup> /day)
MW-4	chloroform pumping	1.00E-04	0.280	40	11
MW-26	chloroform pumping	8.00E-05	0.224	50	11
TW4-4	chloroform pumping	1.70E-03	4.760	22	105
TW4-19	chloroform pumping	2.50E-04	0.700	62	43
TW4-20	chloroform pumping	5.90E-05	0.165	52	9
TW4-22	proposed pumping	1.30E-04	0.364	59	21
TW4-24	proposed pumping	1.60E-04	0.448	57	26
TW4-25	proposed pumping	5.80E-05	0.162	88	14
TWN-2	proposed pumping	1.49E-05	0.042	76	3

<sup>1</sup> estimated non-pumping saturated thickness

## **FIGURES**



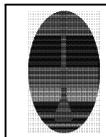
**EXPLANATION**

- MW-20 ● perched monitoring well
- TW4-19 ○ temporary perched monitoring well
- PIEZ-1 ◊ perched piezometer
- TWN-1 ◆ temporary perched nitrate monitoring well
- MW-34 ◊ perched monitoring well installed August/September, 2010
- MW-36 ✱ perched monitoring well installed April, 2011

- TW4-24 ⊕ proposed nitrate extraction well
- ⊞ approximate area of nitrate > 10 mg/L

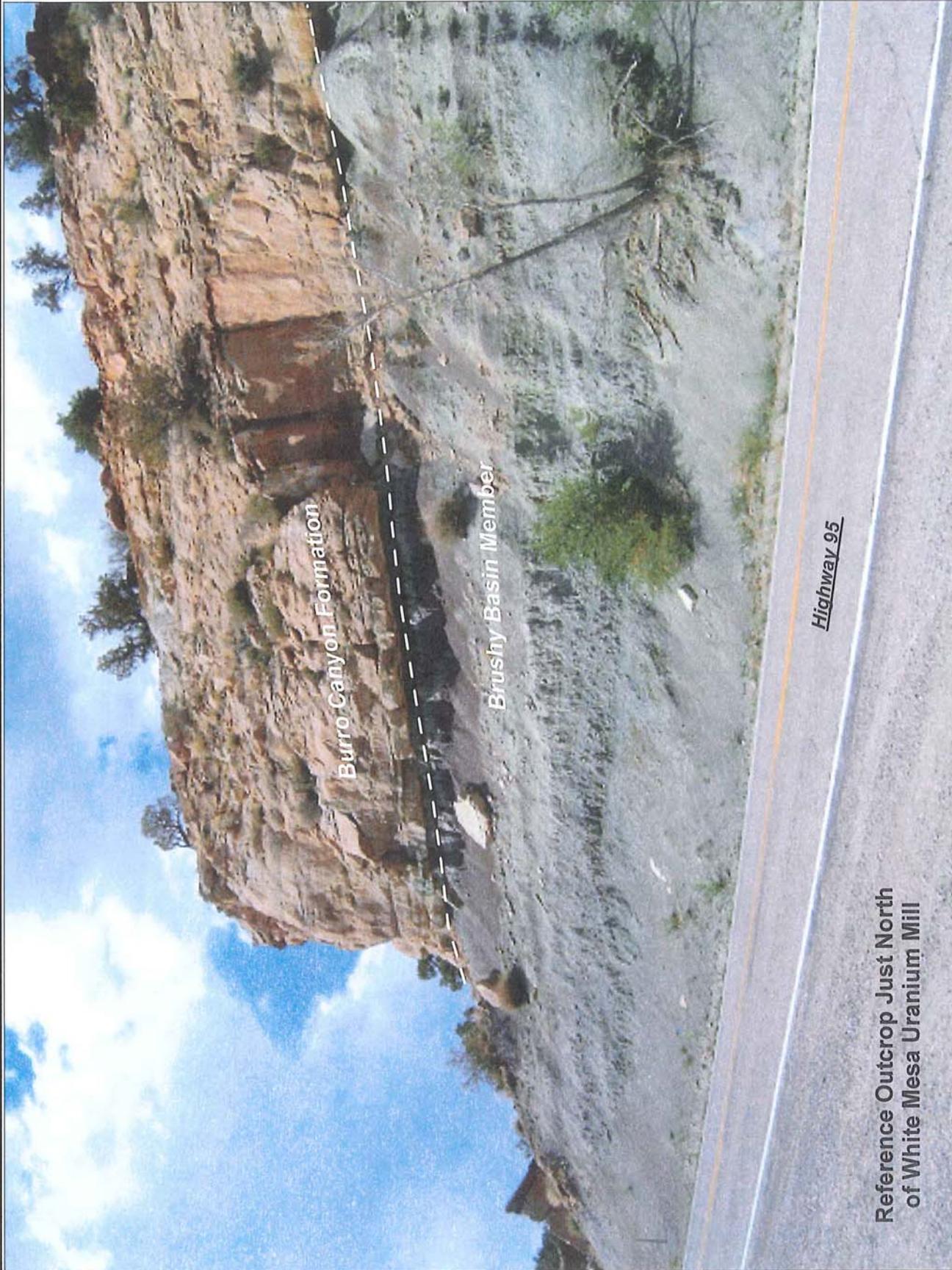


**SITE PLAN SHOWING PERCHED WELL LOCATIONS AND 3rd QUARTER, 2011 NITRATE PLUME EXTENT WHITE MESA SITE**



**HYDRO  
GEO  
CHEM, INC.**

APPROVED SJS	DATE	REFERENCE H:/718000/ nov11/nitrate/nitplume11.srf	FIGURE 1
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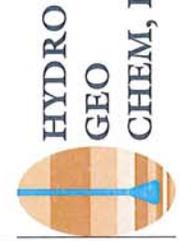


Burro Canyon Formation

Brushy Basin Member

Highway 95

Reference Outcrop Just North  
of White Mesa Uranium Mill



PHOTOGRAPH OF THE CONTACT BETWEEN THE  
BURRO CANYON FORMATION AND THE  
BRUSHY BASIN MEMBER

APPROVED SJS

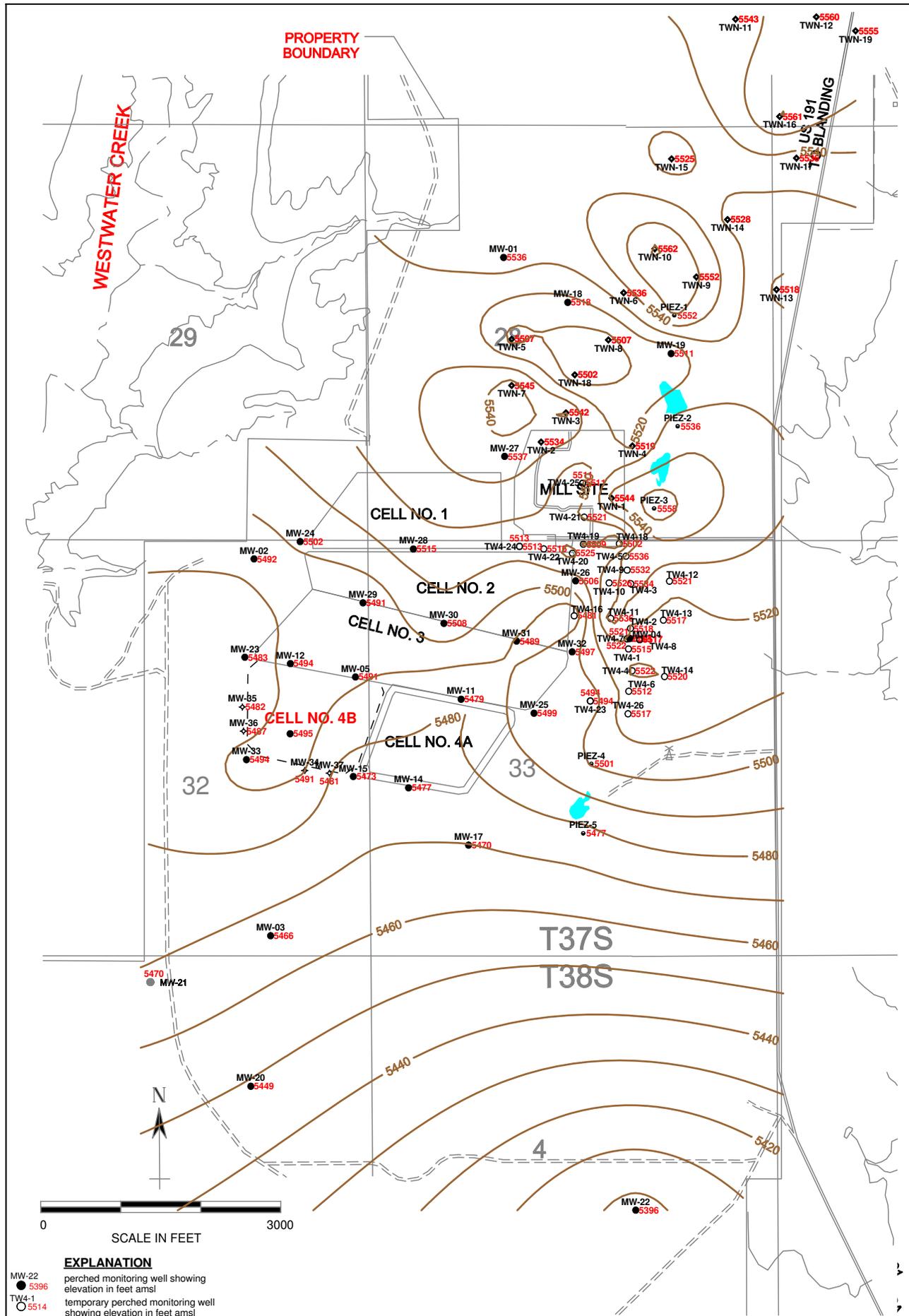
DATE

REFERENCE

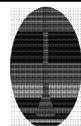
H:7718000/  
cell4bjuly2010/springsQ2/contact.srf

FIGURE

2

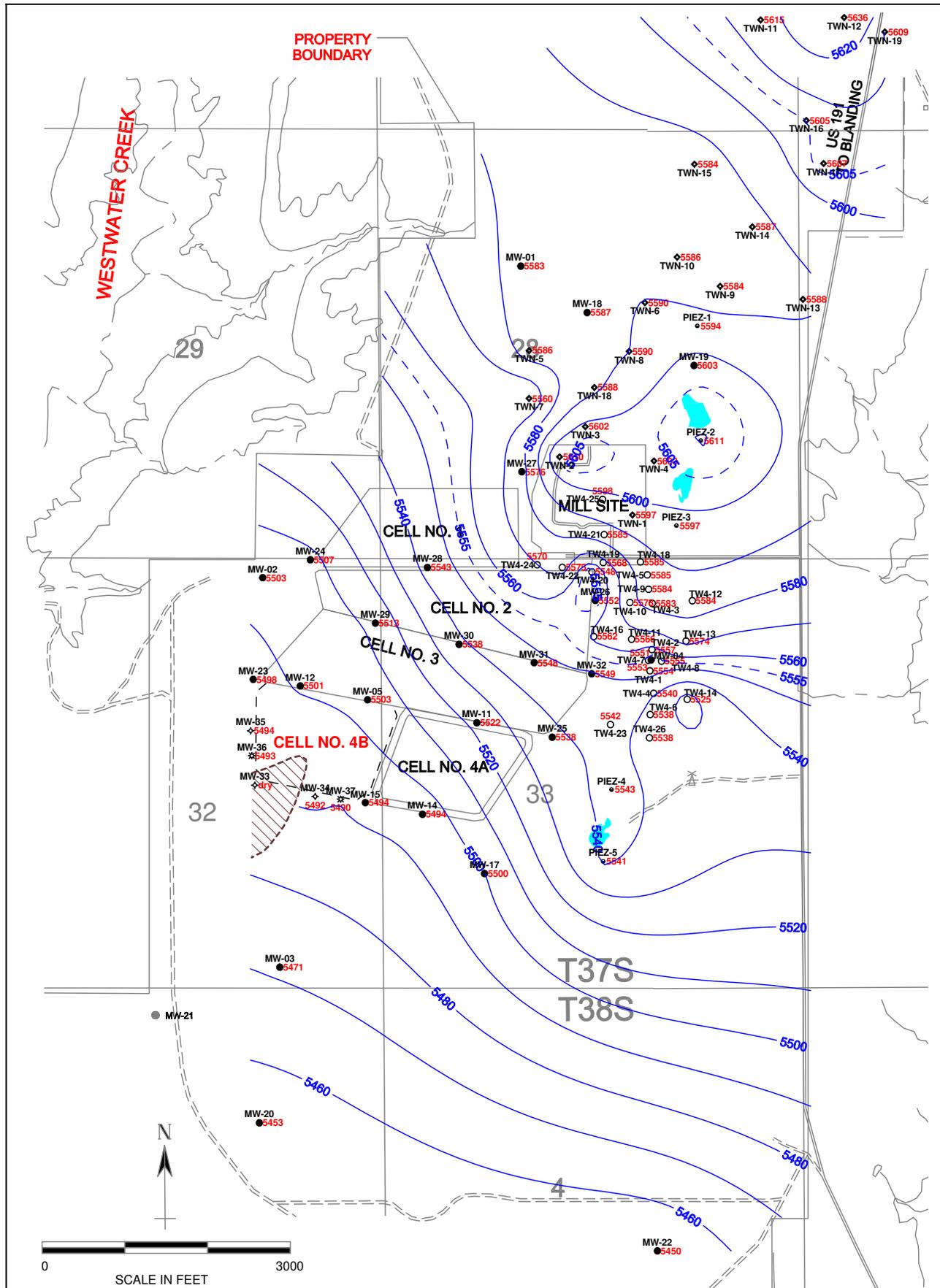


- EXPLANATION**
- MW-22 ● 5396 perched monitoring well showing elevation in feet amsl
  - TW4-1 ○ 5514 temporary perched monitoring well showing elevation in feet amsl
  - PIEZ-1 ● 5552 perched piezometer showing elevation in feet amsl
  - TWN-4 ◆ 5519 temporary perched nitrate monitoring well showing elevation in feet amsl
  - MW-34 ◆ 5491 perched monitoring well installed August/September, 2010 showing elevation in feet amsl
  - MW-36 ◆ 5487 perched monitoring well installed April, 2011 showing elevation in feet amsl



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<b>KRIGED TOP OF BRUSHY BASIN ELEVATIONS WHITE MESA SITE</b>		
APPROVED	DATE	REFERENCE
SJS		H:/718000/nov11/bbel/bbelq211.srf
FIGURE		<b>3</b>



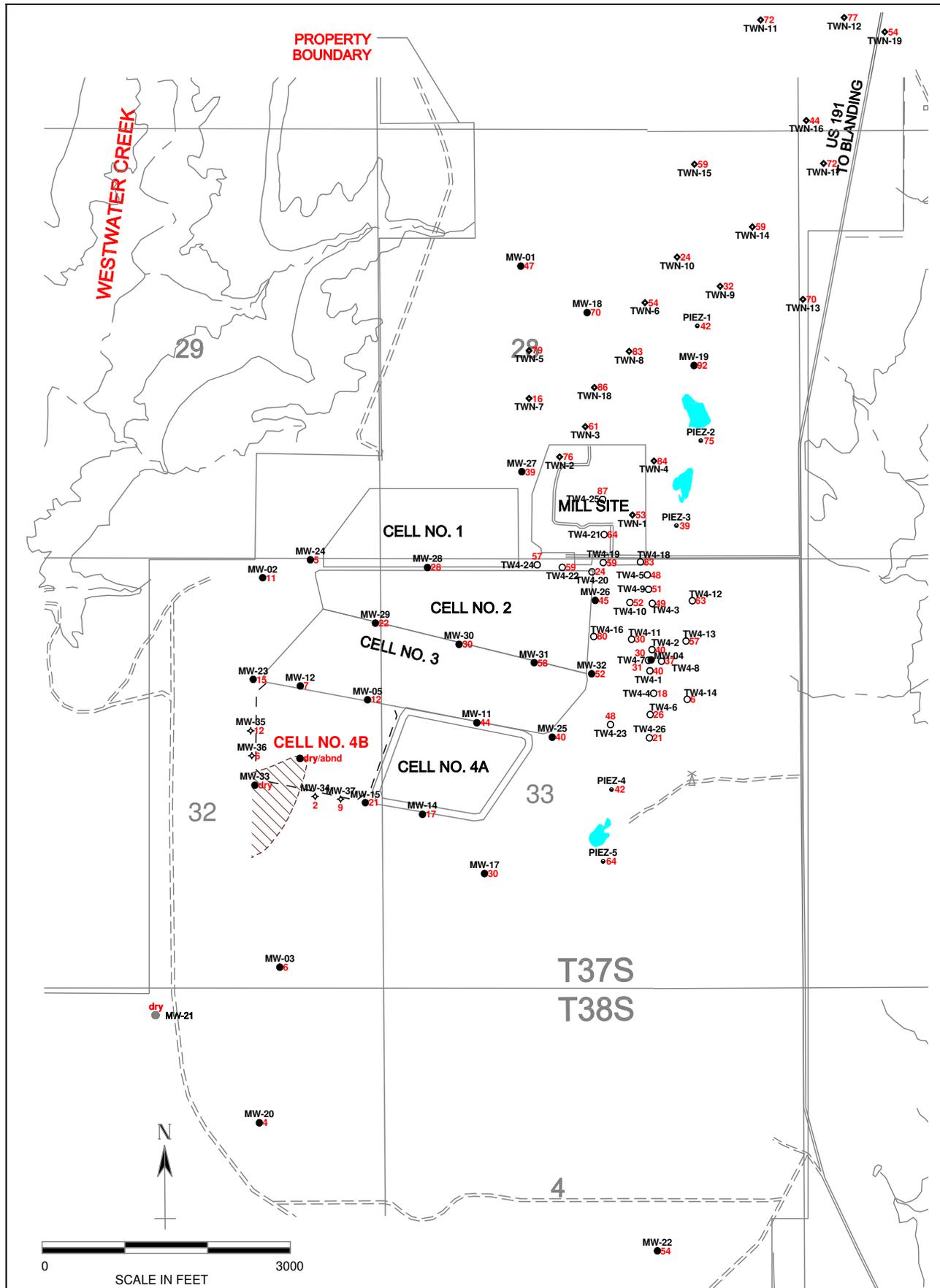
- EXPLANATION**
- MW-22 ● 5450 perched monitoring well showing elevation in feet amsl
  - TW4-1 ○ 5554 temporary perched monitoring well showing elevation in feet amsl
  - PIEZ-1 ● 5594 perched piezometer showing elevation in feet amsl
  - TWN-4 ◆ 5603 temporary perched nitrate monitoring well showing elevation in feet amsl
  - MW-34 ◆ 5492 perched monitoring well installed August/September, 2010 showing elevation in feet amsl
  - MW-36 ✱ 5493 perched monitoring well installed April, 2011 showing elevation in feet amsl

estimated dry area (kriged Brushy Basin elevation > kriged perched water elevation)

NOTE: MW-4, MW-26, TW4-4, TW4-19 and TW4-20 are pumping wells

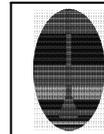
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<b>KRIGED 3rd QUARTER, 2011 WATER LEVELS WHITE MESA SITE</b>			
APPROVED	DATE	REFERENCE	FIGURE
SJS		H:/718000/nov11/nitrate/wl0911d.srf	4



- EXPLANATION**
- MW-22 ● 54 perched monitoring well showing saturated thickness in feet
  - TW4-1 ○ 40 temporary perched monitoring well showing saturated thickness in feet
  - PIEZ-1 ◆ 42 perched piezometer showing saturated thickness in feet
  - TWN-4 ◆ 84 temporary perched nitrate monitoring well showing saturated thickness in feet
  - MW-34 ◆ 2 perched monitoring well installed August/September, 2010 showing saturated thickness in feet
  - MW-36 ◆ 6 perched monitoring well installed April, 2011 showing saturated thickness in feet

estimated dry area (kriged Brushy Basin elevation > kriged perched water elevation)

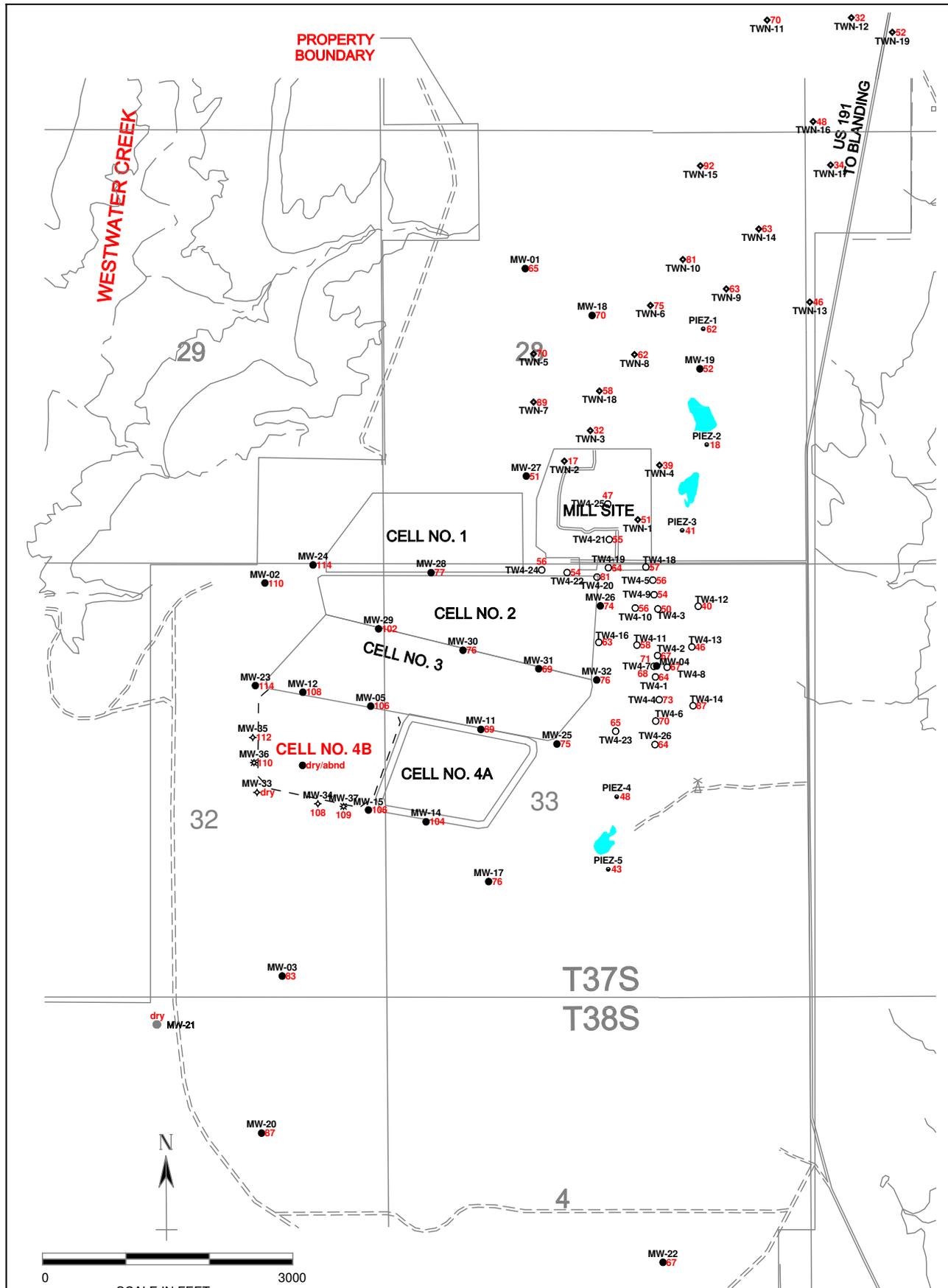


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NOTE: MW-4, MW-26, TW4-4, TW4-19 and TW4-20 are pumping wells

**3rd QUARTER, 2011 SATURATED THICKNESS  
WHITE MESA SITE**

APPROVED	DATE	REFERENCE	FIGURE
SJS		H:/718000/nov11/bbelev/sat0911.srf	5



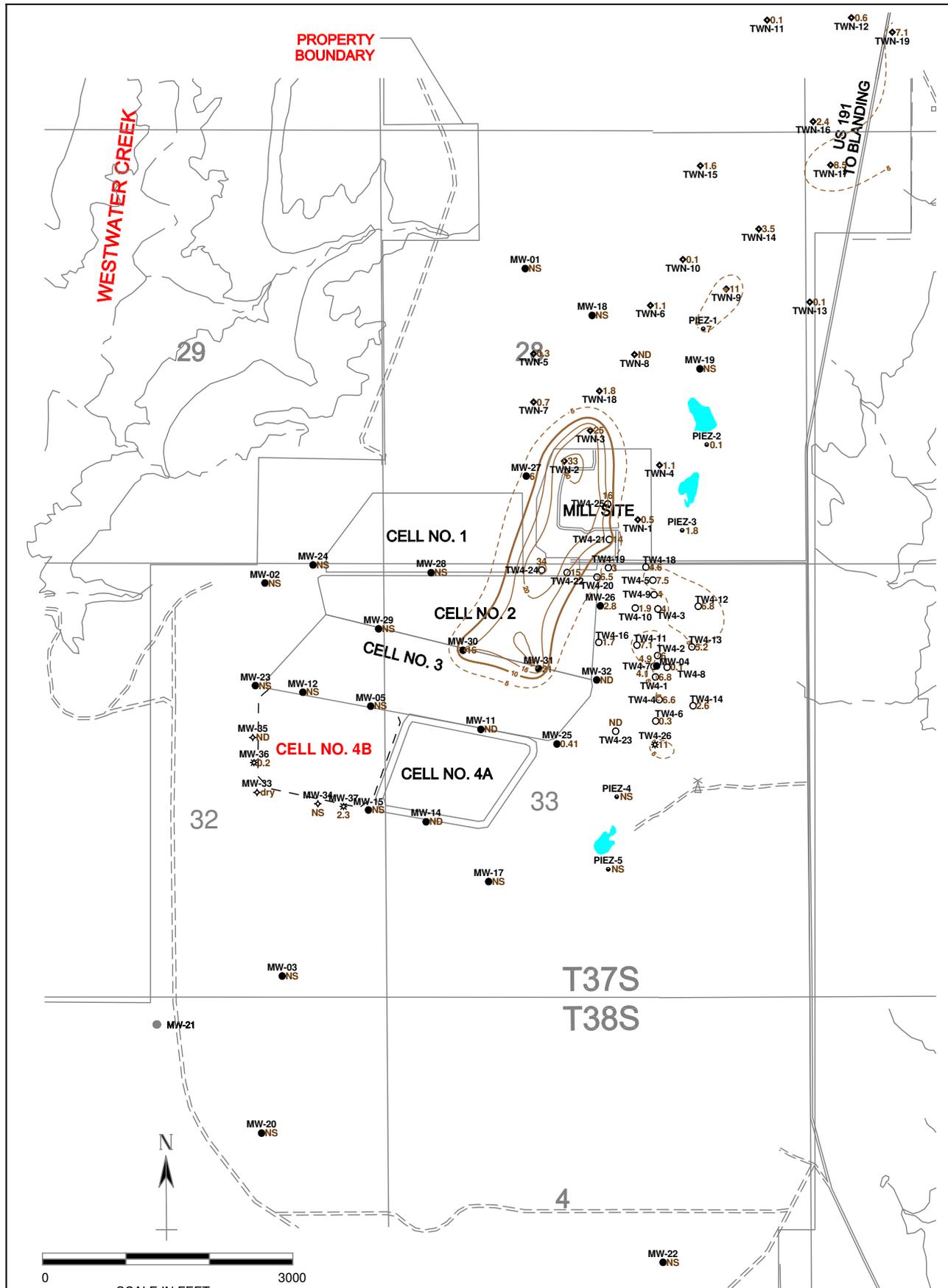
- EXPLANATION**
- MW-22 ● 5450 perched monitoring well showing depth in feet
  - TW4-1 ○ 5554 temporary perched monitoring well showing depth in feet
  - PIEZ-1 ● 5594 perched piezometer showing depth in feet
  - TWN-4 ◆ 5603 temporary perched nitrate monitoring well showing depth in feet
  - MW-34 ◆ 5492 perched monitoring well installed August/September, 2010 showing depth in feet
  - MW-36 ✱ 5493 perched monitoring well installed April, 2011 showing depth in feet
  - dry MW-21 dry
  - dry/abnd MW-36 dry/abnd

NOTE: MW-4, MW-26, TW4-4, TW4-19 and TW4-20 are pumping wells



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<b>3rd QUARTER, 2011 DEPTHS TO WATER WHITE MESA SITE</b>		
APPROVED SJS	DATE	REFERENCE H:/718000/nov11/bbelev/dtw0911.srf
		FIGURE <b>6</b>

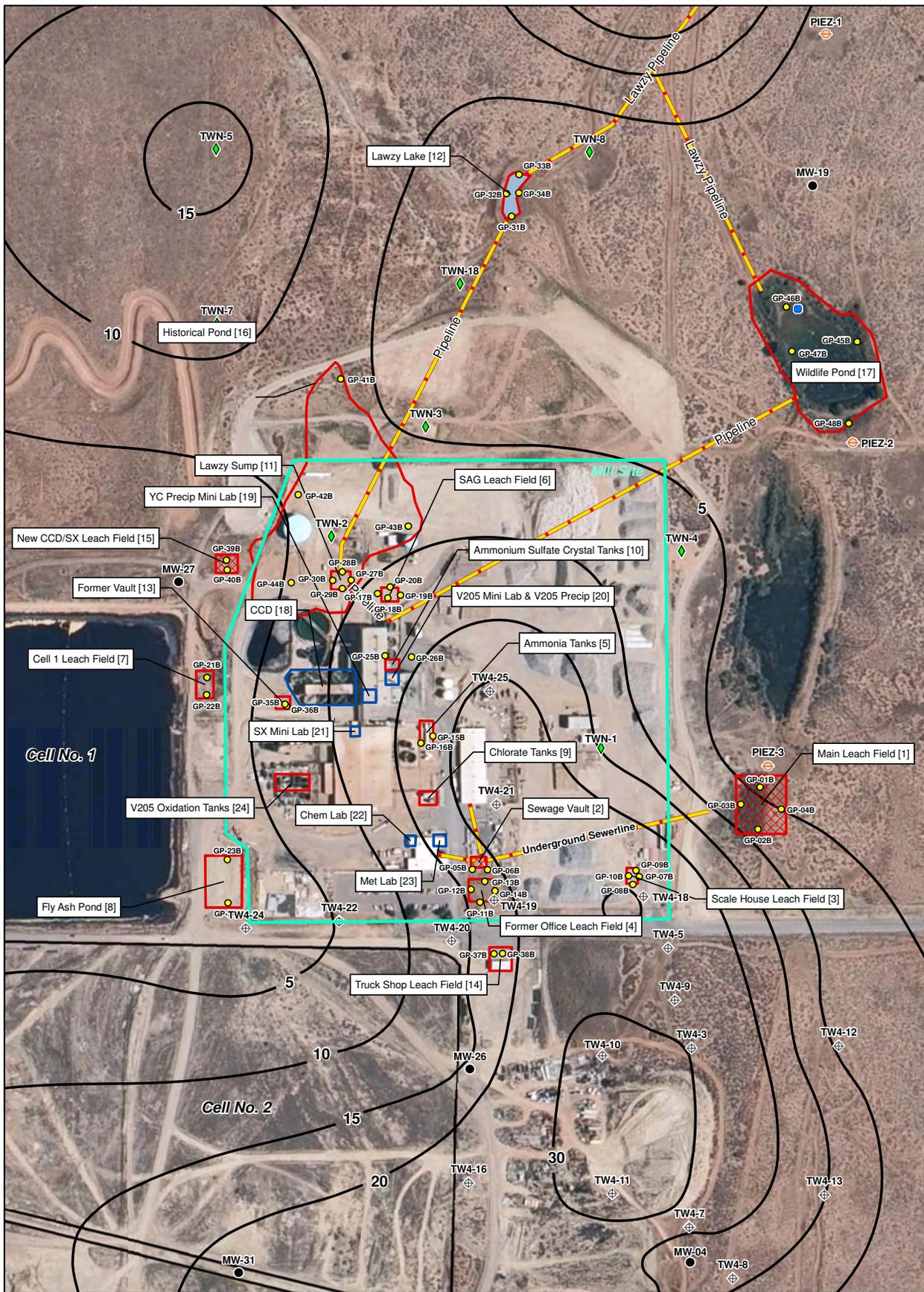


- EXPLANATION**
- MW-4 ● 4.9 perched monitoring well showing concentration in mg/L
  - TW4-1 ○ 6.8 temporary perched monitoring well showing concentration in mg/L
  - PIEZ-1 ● 7 perched piezometer showing concentration in mg/L
  - TWN-1 ◆ 0.5 temporary perched nitrate monitoring well showing concentration in mg/L
  - MW-35 ◆ ND perched monitoring well installed August/September, 2010 showing concentration in mg/L
  - MW-36 ◆ 0.2 perched monitoring well installed April, 2011 showing concentration in mg/L

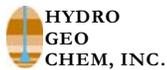
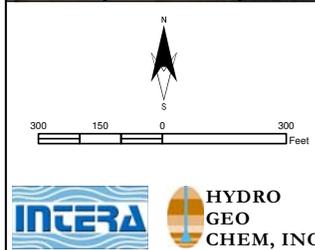
**HYDRO  
GEO  
CHEM, INC.**

NOTE: MW-4, MW-26, TW4-4, TW4-19 and TW4-20 are pumping wells

<b>KRIGED 3rd QUARTER, 2011 NITRATE (mg/L) (NITRATE + NITRITE AS N) WHITE MESA SITE</b>	
APPROVED SJS	DATE
REFERENCE H:/718000/ nov11/nitrate/nit0911.srf	FIGURE 7

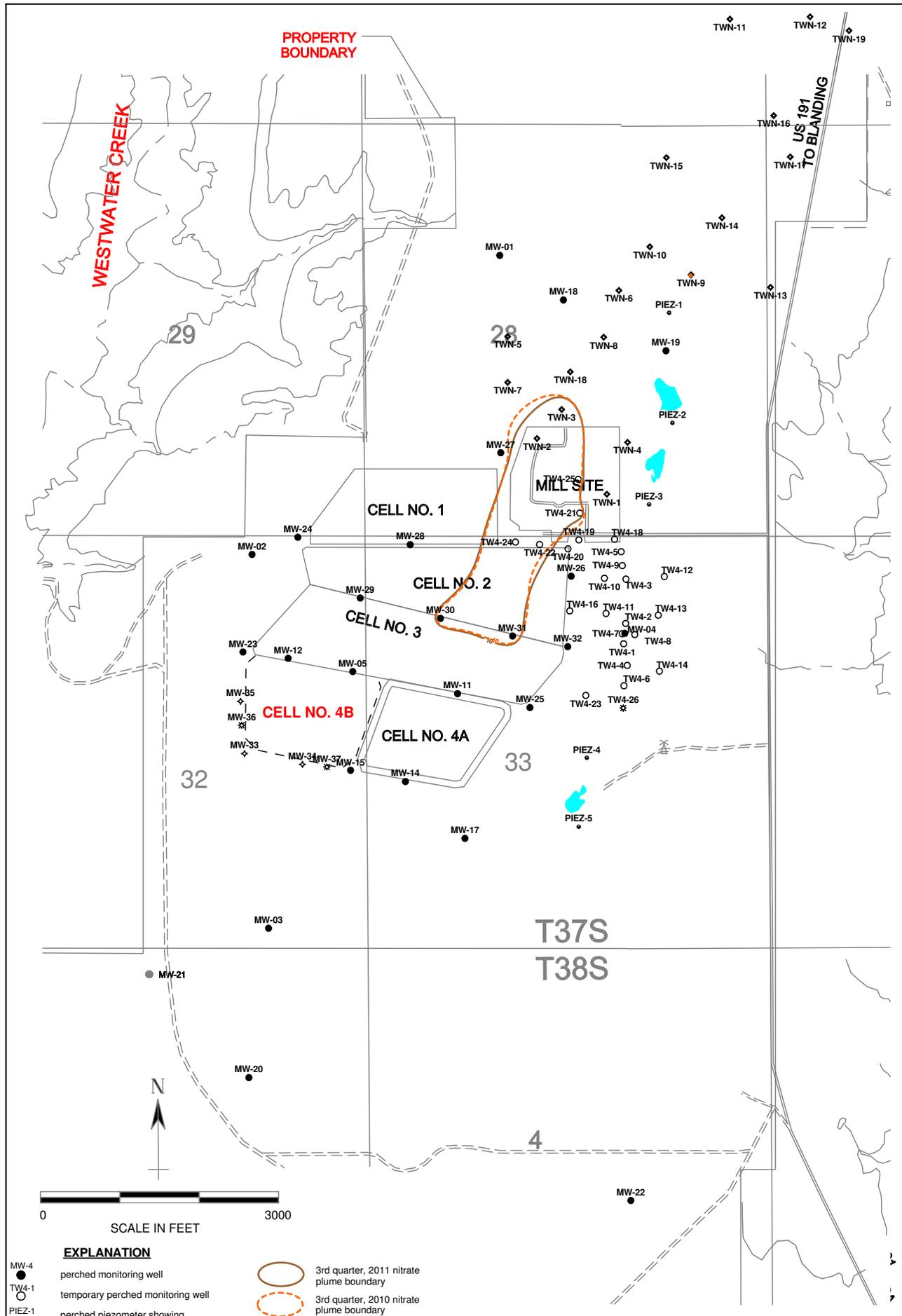


Sources: Aerial - Utah GIS Portal website, dated 2009;  
Wells - HGC, May 2008 Report



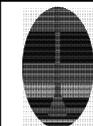
Legend	
	Pipeline
	Potential Nitrate and Chloride Sources
	Leach Field (currently in operation)
	Leach Field - Geoprobe Boring and Core Drilling Location
	Potential Source Location - No Geoprobe Boring or Core Boring
	Monitoring Well
	Piezometer
	Surface Water
	Chloroform Monitoring Well
	Nitrate Monitoring Well
	Geoprobe Boring

**FIGURE 8**  
Potential Nitrate Source Areas and Geoprobe Locations Showing the Thickness of the Mancos Shale



- EXPLANATION**
- MW-4 ● perched monitoring well
  - TW4-1 ○ temporary perched monitoring well
  - PIEZ-1 ◆ perched piezometer showing
  - TWN-1 ◆ temporary perched nitrate monitoring well
  - MW-35 ◆ perched monitoring well installed August/September, 2010
  - MW-36 ✱ perched monitoring well installed April, 2011

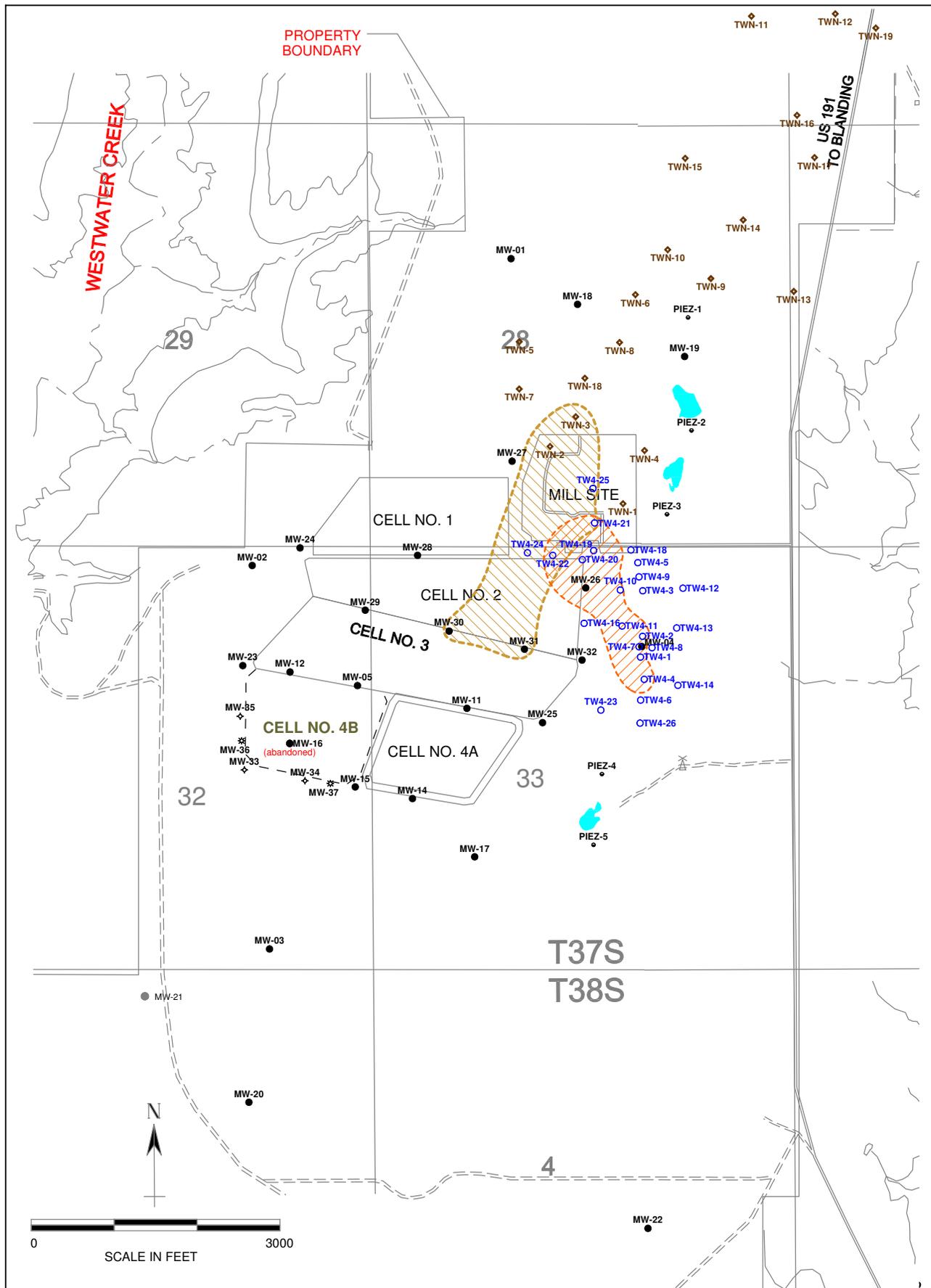
- 3rd quarter, 2011 nitrate plume boundary
- 3rd quarter, 2010 nitrate plume boundary



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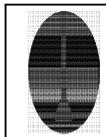
**COMPARISON OF NITRATE PLUME BOUNDARIES  
3rd QUARTER 2010 AND  
3rd QUARTER 2011**

APPROVED SJS	DATE	REFERENCE H:/718000/ nov11/nitrate/nitcomp.srf	FIGURE 9
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- EXPLANATION**
- MW-20 ● perched monitoring well
  - TW4-19 ○ temporary perched monitoring well
  - PIEZ-1 ◊ perched piezometer
  - TWN-1 ◆ temporary perched nitrate monitoring well
  - MW-34 ◊ perched monitoring well installed August/September, 2010
  - MW-36 ✱ perched monitoring well installed April, 2011

- approximate area of nitrate > 10 mg/L
- approximate area of chloroform > 70 µg/L



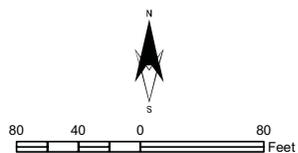
**HYDRO  
GEO  
CHEM, INC.**

<b>3rd QUARTER, 2011</b>		<b>NITRATE AND CHLOROFORM PLUMES</b>		<b>WHITE MESA SITE</b>	
APPROVED	DATE	REFERENCE	H:/718000/ nov11/nitrate/nitch11.srf	FIGURE	10
SJS					



Sample ID	Collection Date	Ammonia as N mg/l	Nitrate/Nitrite as N mg/l
<i>UCLs</i>		0.142	0.097
GP-25B-5.5-6.5	6/8/2011	46.3	6.72
GP-25B-13-14	6/8/2011	58.5	1.2
GP-25B-13-14D	6/8/2011	55.7	1.2
GP-25B-18-19	6/8/2011	71.1	0.804
GP-26B-4.5-5.5	6/9/2011	53.6	0.227
GP-26B-10-11	6/9/2011	40.6	0.0134
GP-26B-15-16	6/9/2011	68.5	0.268

Source(s): Aerial – Utah GIS Portal website, dated 2009; Wells – HGC, Inc., May 2008 report.



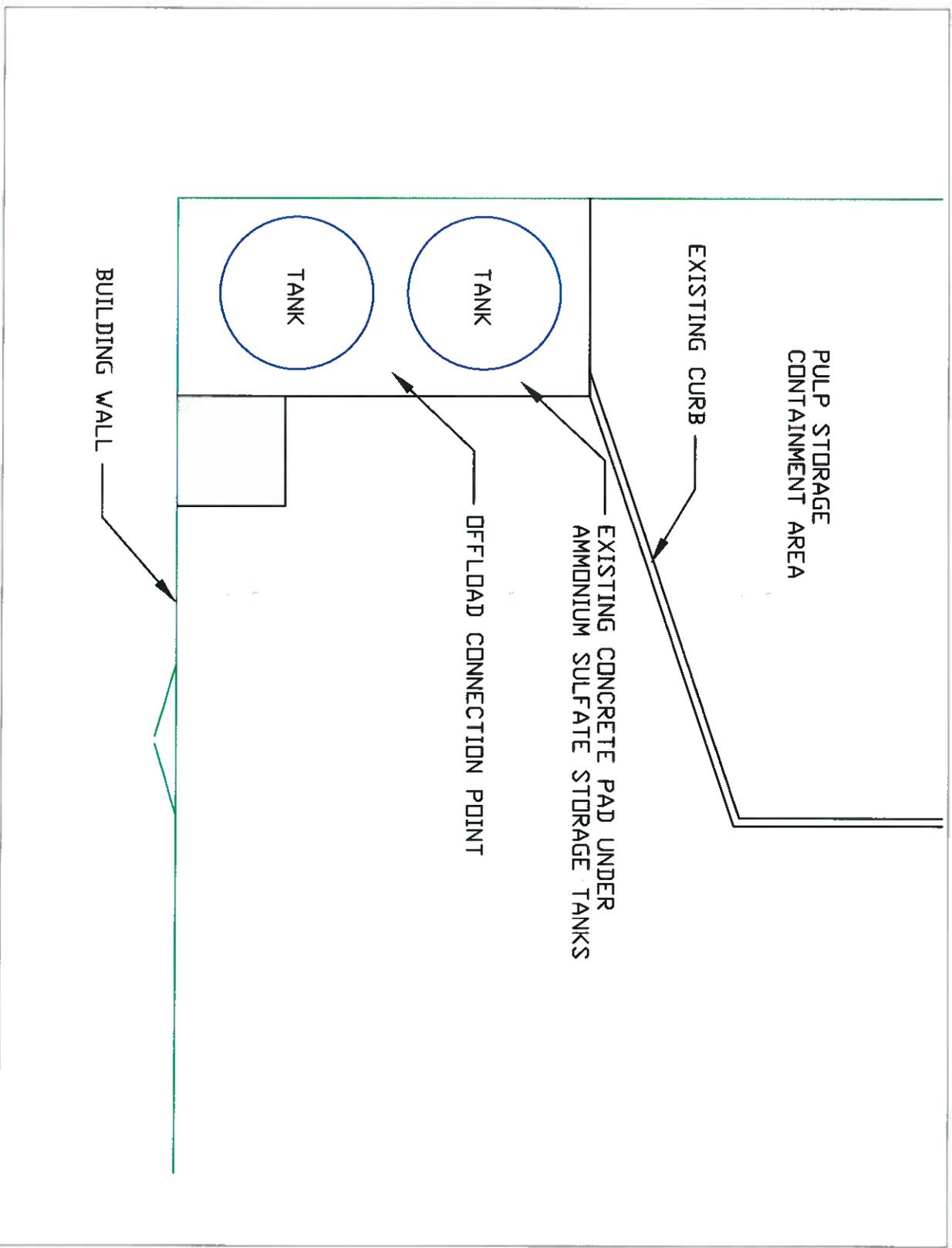
**Legend**

- Geoprobe Boring Location
- Potential Mill Site Source - Geoprobe Boring

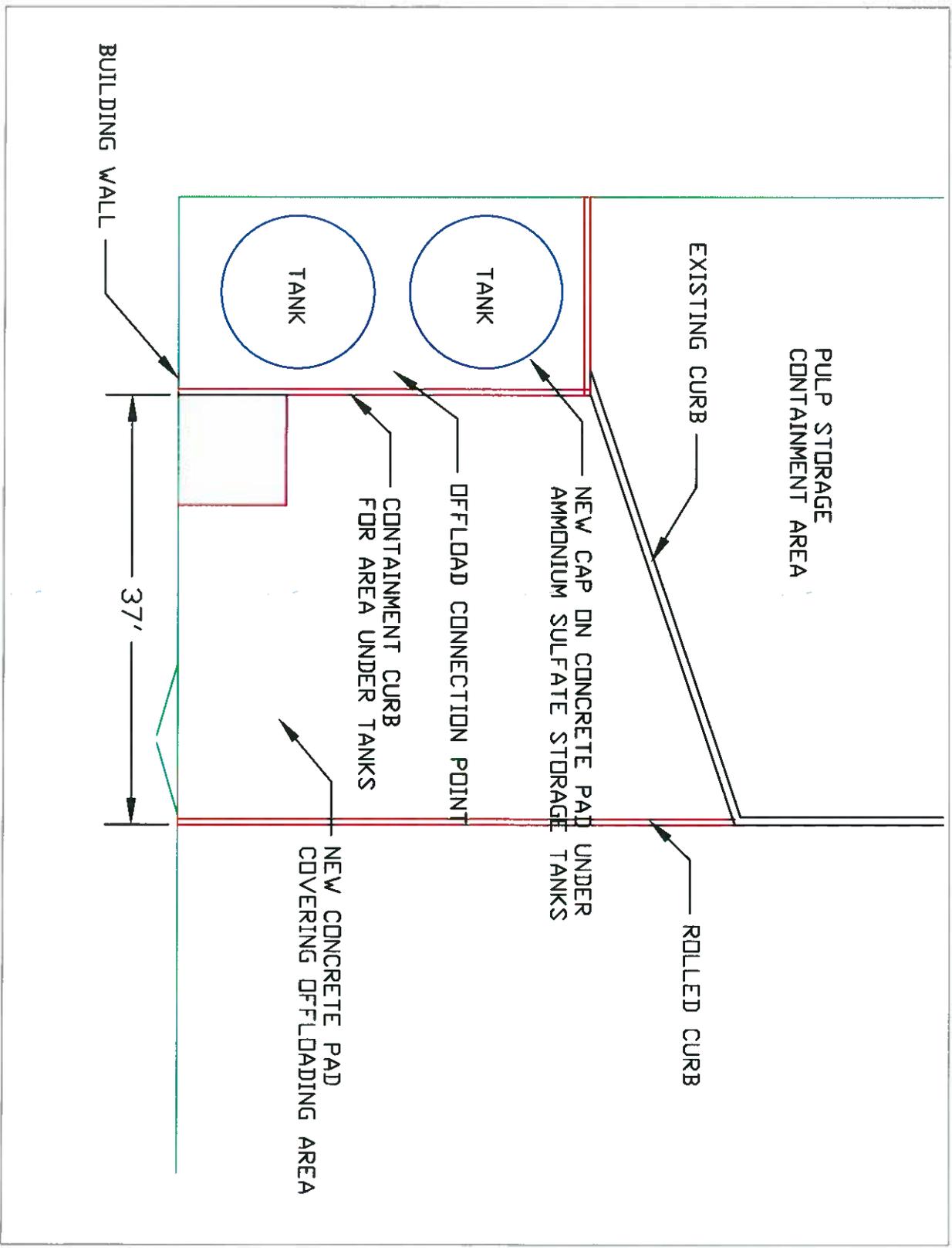
**Figure 11-1**  
Ammonium Sulfate Crystal Tanks

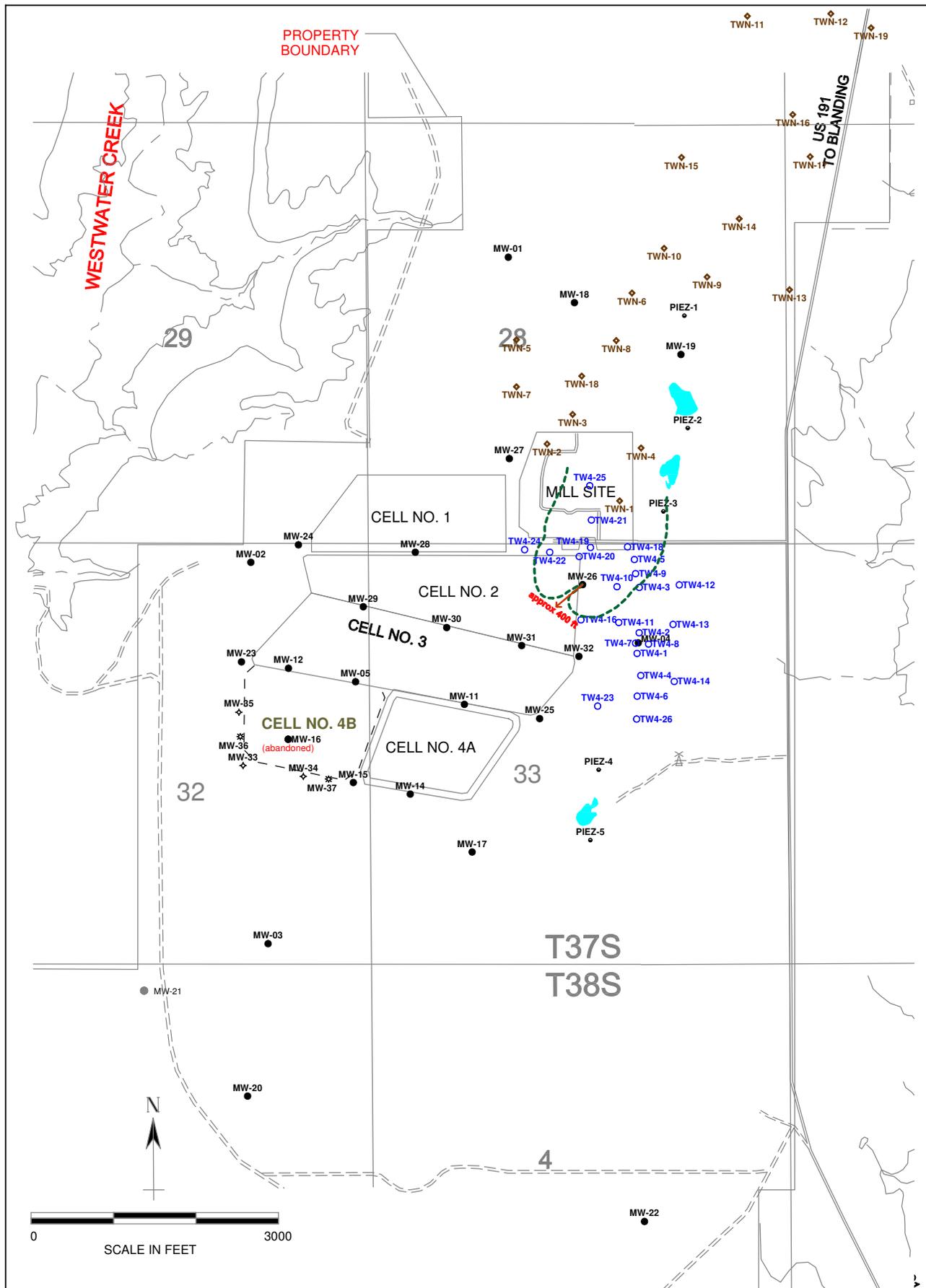


# AMMONIUM SULFATE AREA CONCEPT SKETCH (CURRENT LAYOUT)



# AMMONIUM SULFATE AREA CONCEPT SKETCH (PROPOSED LAYOUT)





- EXPLANATION**
- MW-20 ● perched monitoring well
  - TW4-19 ○ temporary perched monitoring well
  - PIEZ-1 ◊ perched piezometer
  - TWN-1 ◆ temporary perched nitrate monitoring well
  - MW-34 ◊ perched monitoring well installed August/September, 2010
  - MW-36 ✱ perched monitoring well installed April, 2011

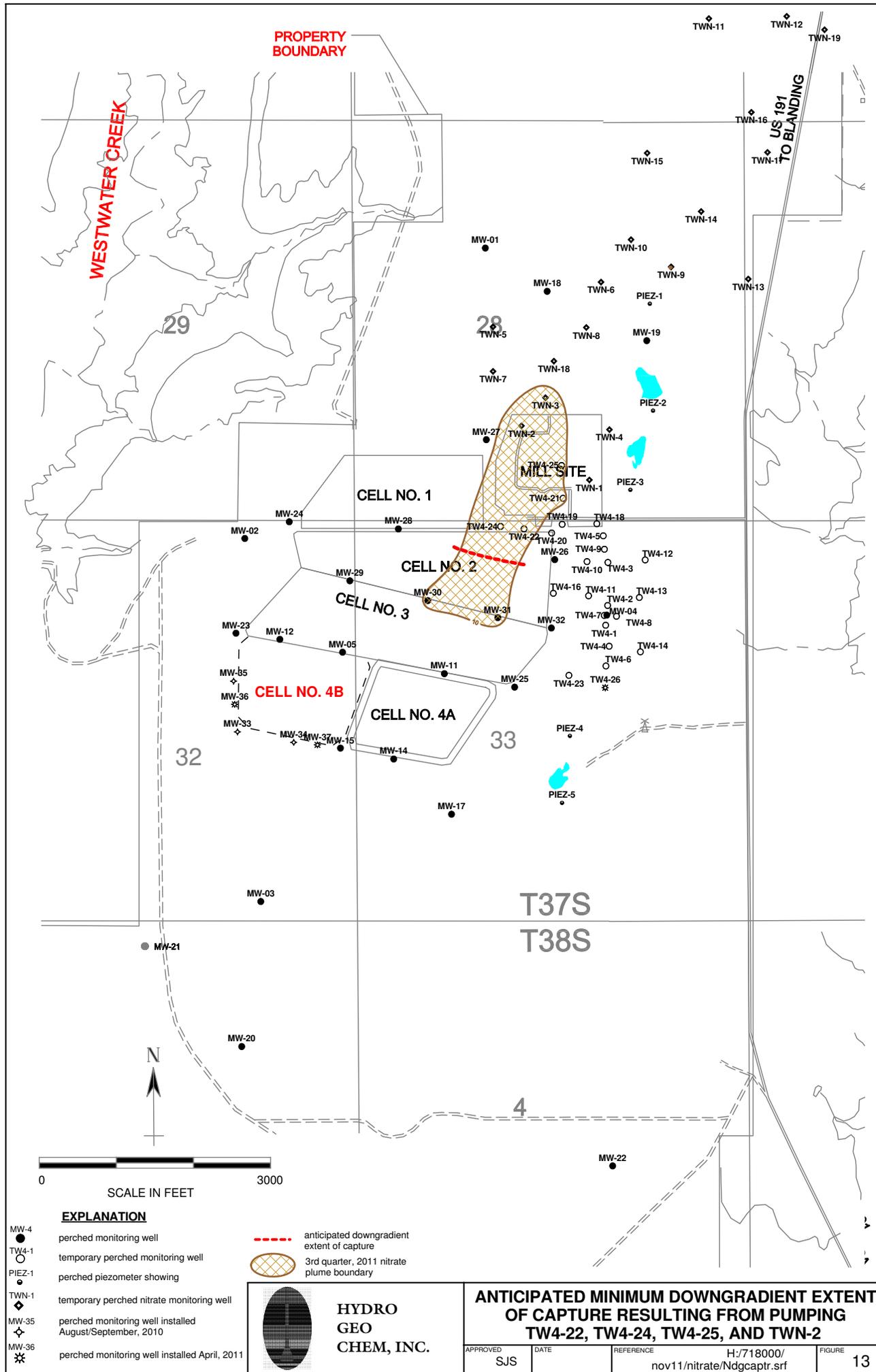
estimated Q3, 2011 extent of capture of chloroform pumping well MW-26



**ESTIMATED EXTENT OF CAPTURE OF CHLOROFORM PUMPING WELL MW-26 3rd QUARTER, 2011**

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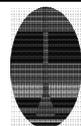
APPROVED SJS	DATE	REFERENCE H:718000/ nov11/nitrate/mw26cap.srf	FIGURE 12
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**EXPLANATION**

- MW-4 ● perched monitoring well
- TW4-1 ○ temporary perched monitoring well
- PIEZ-1 ◇ perched piezometer showing
- TWN-1 ◆ temporary perched nitrate monitoring well
- MW-35 ◇ perched monitoring well installed August/September, 2010
- MW-36 ✱ perched monitoring well installed April, 2011

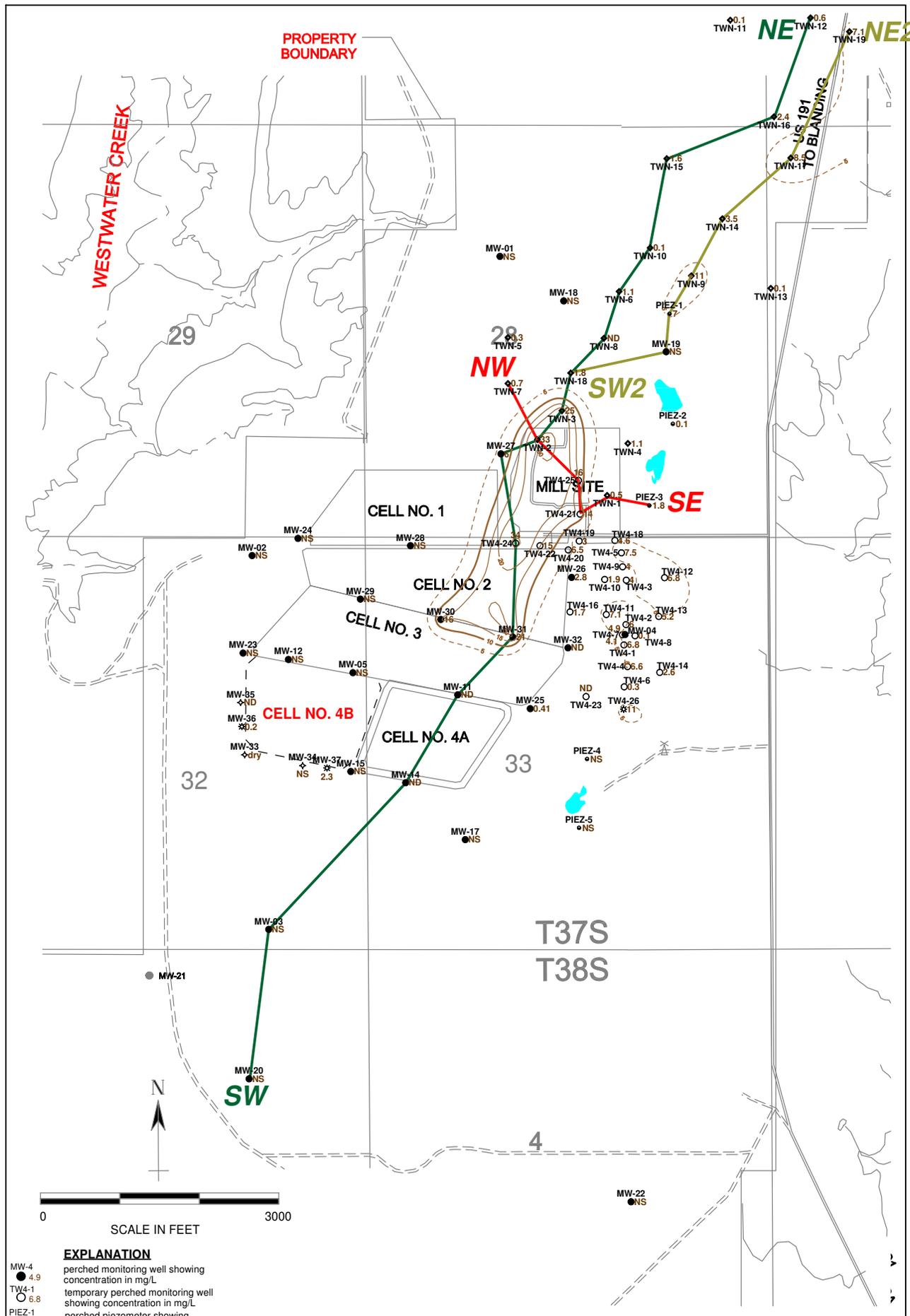
- anticipated downgradient extent of capture
- ▨ 3rd quarter, 2011 nitrate plume boundary



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<b>ANTICIPATED MINIMUM DOWNGRADIENT EXTENT OF CAPTURE RESULTING FROM PUMPING TW4-22, TW4-24, TW4-25, AND TWN-2</b>			
APPROVED	DATE	REFERENCE	FIGURE
SJS		H:/718000/nov11/nitrate/Ndgcaptr.srf	13

**APPENDIX A**  
**HYDROGEOLOGIC CROSS SECTIONS**



- EXPLANATION**
- MW-4 ● 4.9 perched monitoring well showing concentration in mg/L
  - TW4-1 ○ 6.8 temporary perched monitoring well showing concentration in mg/L
  - PIEZ-1 ● 7 perched piezometer showing concentration in mg/L
  - TWN-1 ◆ 0.5 temporary perched nitrate monitoring well showing concentration in mg/L
  - MW-35 ◆ ND perched monitoring well installed August/September, 2010 showing concentration in mg/L
  - MW-36 \* 0.2 perched monitoring well installed April, 2011 showing concentration in mg/L

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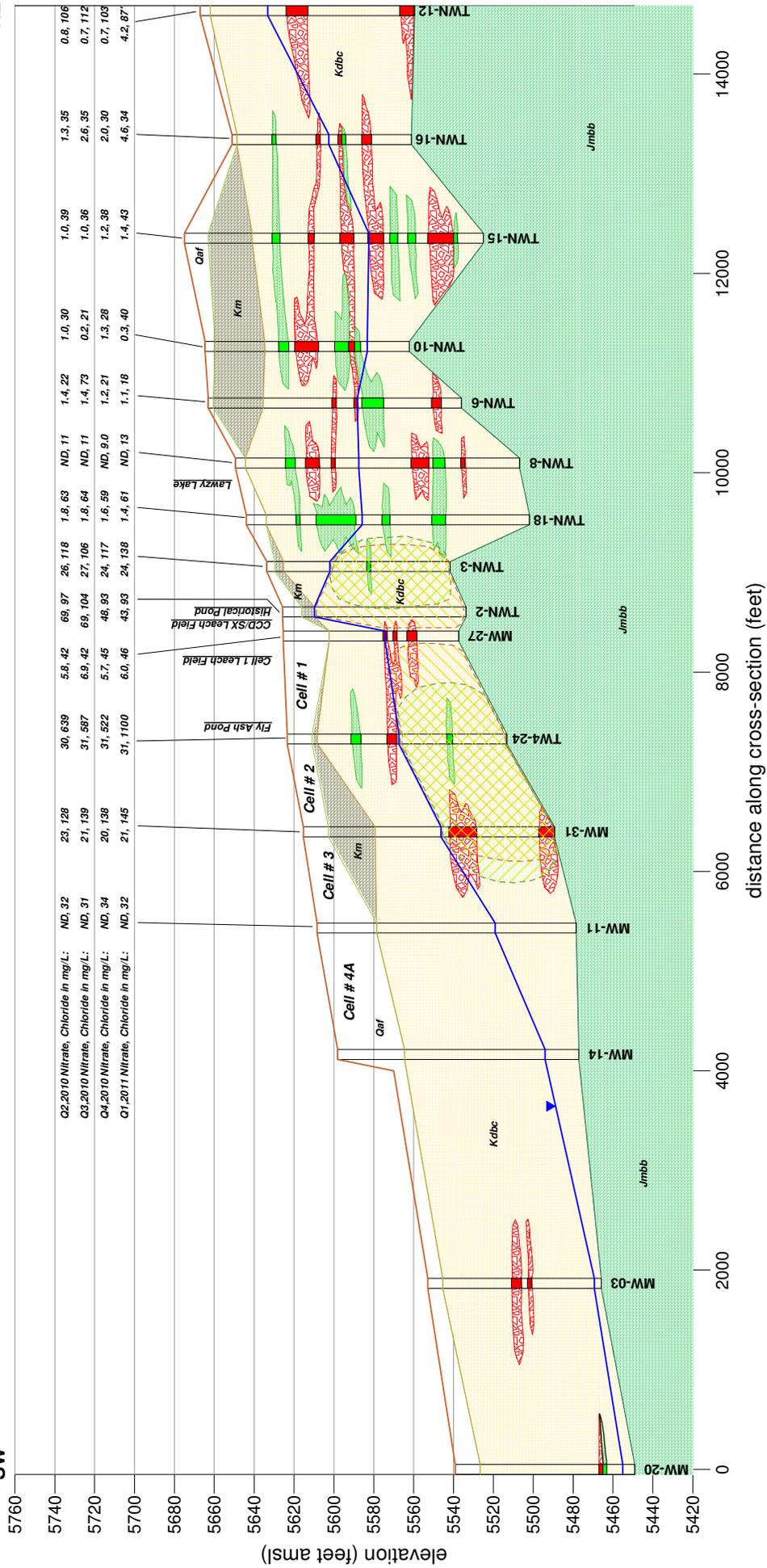


**LOCATIONS OF CROSS SECTIONS  
AND KRIGED 3rd QUARTER, 2011 NITRATE (mg/L)  
(NITRATE + NITRITE AS N)**

APPROVED	DATE	REFERENCE	FIGURE
SJS		H:/718000/nitrate2011/ CAP/AppA/nit0911xs.srf	A.1

NE

SW

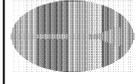


vertical exaggeration = 20 : 1

distance along cross-section (feet)

**EXPLANATION**

- Gar Alluvium/Fill
- Km Mancos Shale
- Kabc Dakota Sandstone/ Burro Canyon Formation
- Jmbb Brushy Basin Member of Morrison Formation
- Piezometric Surface
- Approximate Area > 10 mg/L Nitrate
- Approximate Area > 100 mg/L Chloride

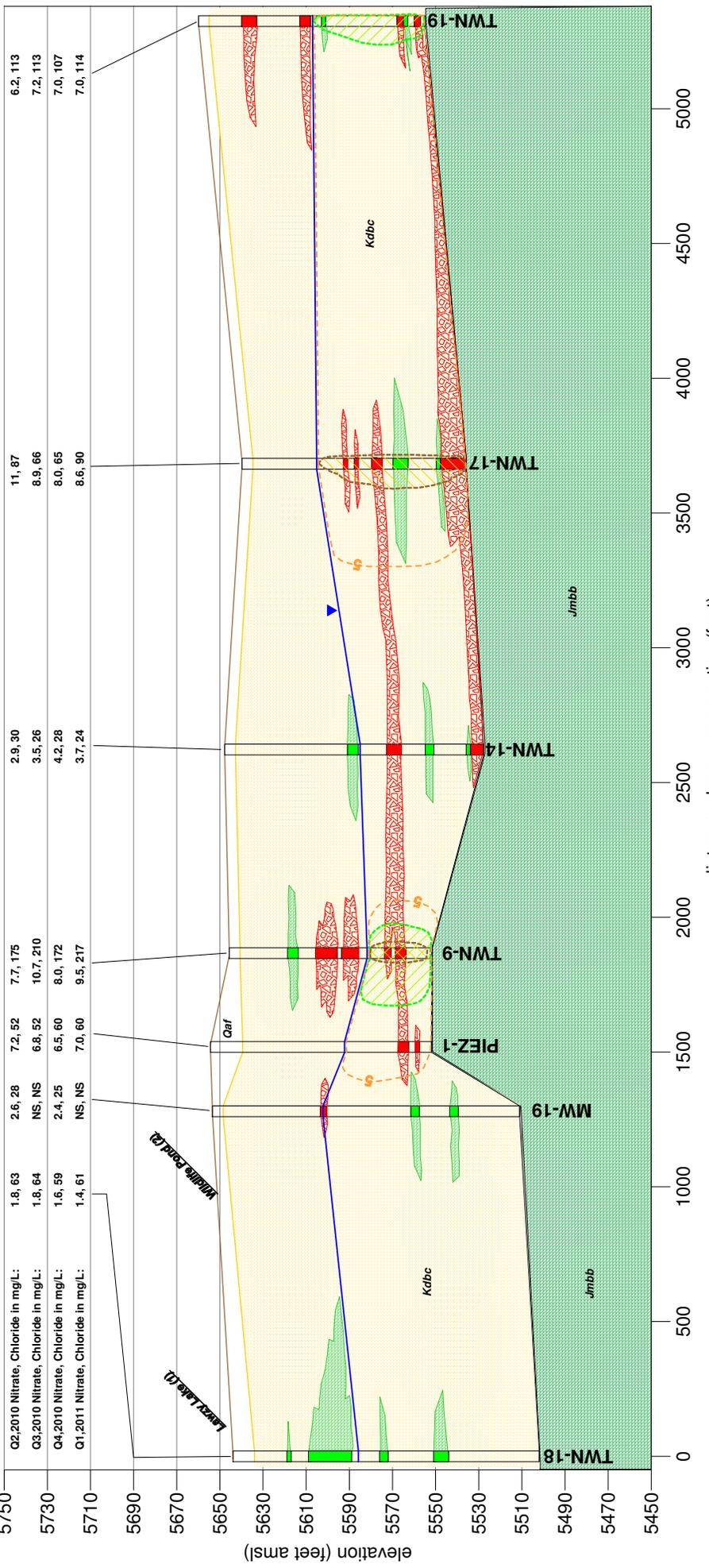


**INTERPRETIVE NORTHEAST-SOUTHWEST CROSS SECTION (NE-SW) WHITE MESA SITE**

APPROVED: SUS DATE: 5/24/11 REFERENCE: H:\718000\nitrate2011\CAP\AppA\CAPxsswms.srf

NE2

SW2



Notes: (1) approximately 200 feet north of cross section  
 (2) approximately 200 feet south of cross section

**EXPLANATION**

- Alluvium/Fill
- Dakota Sandstone/  
Burro Canyon Formation
- Brushy Basin Member of  
Morrison Formation
- Piezometric Surface
- Shale in Dakota /  
Burro Canyon Formation
- Conglomerate or Conglomeratic  
Sandstone in Dakota /  
Burro Canyon Formation
- Approximate 5 mg/L  
Nitrate Isocon
- Approximate Area  
> 10 mg/L Nitrate
- Approximate Area  
> 100 mg/L Chloride

vertical exaggeration = 8 : 1

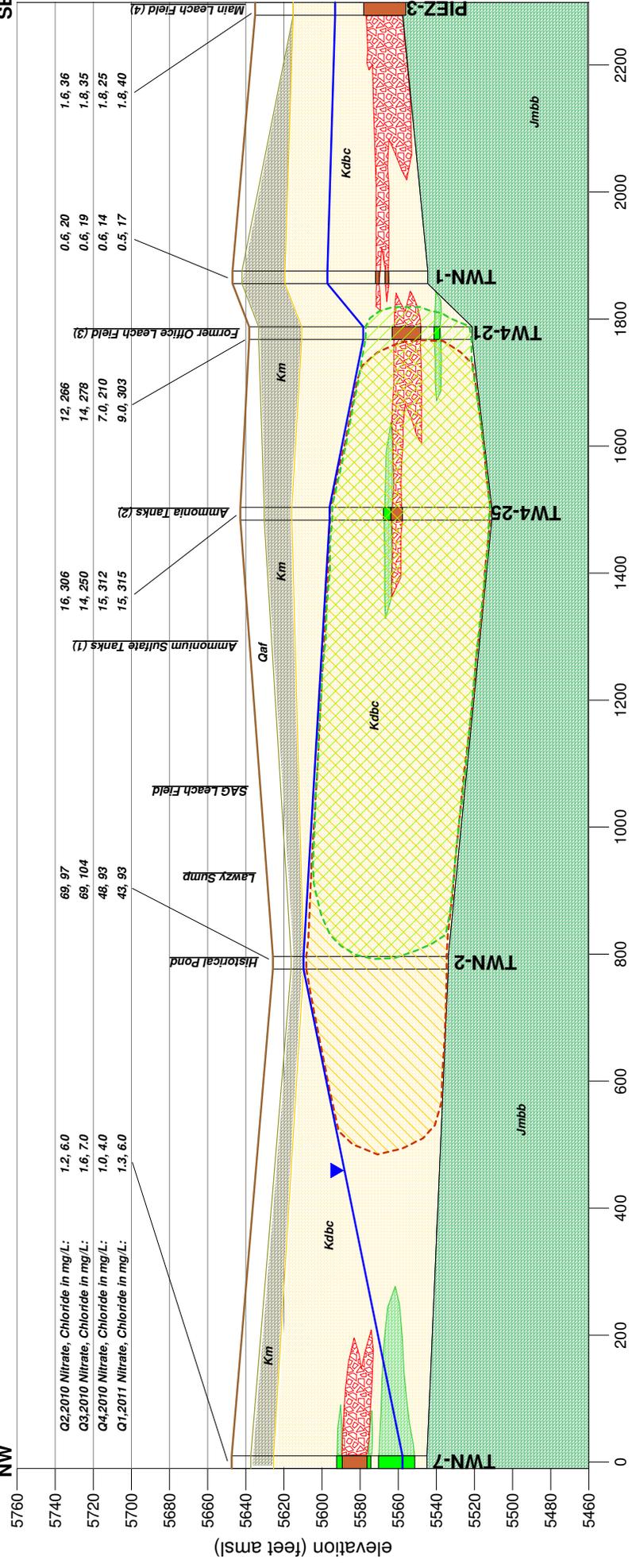
HYDRO  
GEO  
CHEM, INC.

**INTERPRETIVE NORTHEAST-SOUTHWEST  
 CROSS SECTION (NE2-SW2)  
 WHITE MESA SITE**

APPROVED SJS	DATE 5/24/11	REFERENCE H:\718000\nitrate2011\ CAP\AppA\CAP\ssw2ne2.srf	FIGURE A.3
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SE

NW



Location	Q2,2010 Nitrate, Chloride in mg/L:	Q3,2010 Nitrate, Chloride in mg/L:	Q4,2010 Nitrate, Chloride in mg/L:	Q1,2011 Nitrate, Chloride in mg/L:
Ammonium Sulfate Tanks (1)	1.2, 6.0	1.6, 7.0	1.0, 4.0	1.3, 6.0
Ammonia Tanks (2)	16, 306	14, 250	15, 312	15, 315
Former Office Leach Field (2)	12, 266	14, 278	7.0, 210	9.0, 303
Main Leach Field (4)	0.6, 20	0.6, 19	0.6, 14	0.5, 17
SAG Leach Field	69, 97	69, 104	48, 83	43, 93
Lawzy Sump				
Historical Pond				

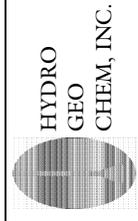
distance along cross-section (feet)

Notes: (1) approximately 115 feet southwest of cross-section  
 (2) approximately 150 feet southwest of cross-section  
 (3) approximately 300 feet south of cross-section  
 (4) immediately south of cross-section

vertical exaggeration = 3 : 1

**EXPLANATION**

- Alluvium/Fill
- Mancos Shale
- Dakota Sandstone/ Burro Canyon Formation
- Brushy Basin Member of Morrison Formation
- Piezometric Surface
- Approximate Area >10 mg/L Nitrate
- Approximate Area >100 mg/L Chloride
- Shale in Dakota / Burro Canyon Formation
- Conglomerate or Conglomeratic Sandstone in Dakota / Burro Canyon Formation



**INTERPRETIVE NORTHWEST-SOUTHEAST CROSS SECTION (NW-SE) WHITE MESA SITE**

APPROVED	SJS	DATE	5/24/11	REFERENCE	H:718000/nitrate2011/ CAP/AppA/CAP_xsmwse.srf	FIGURE	A.4
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