



Denison Mines (USA) Corp.
1050 17th Street, Suite 950
Denver, CO 80265
USA

Tel : 303 628-7798
Fax : 303 389-4125

www.denisonmines.com

November 21, 2008

VIA FEDERAL EXPRESS

Mr. Dane L. Finerfrock
Executive Secretary
Utah Radiation Control Board
Department of Environmental Quality
168 North 1950 West
PO Box 144810
Salt Lake City, Utah 84114-4810

Re: Nitrate Contamination Investigation and Corrective Action Plan, White Mesa Uranium Mill near Blanding, Utah. Request for Voluntary Plan and Schedule to Investigate and Remediate

Dear Mr. Finerfrock:

Reference is made to your letter of September 30, 2008 which documents Denison Mines (USA) Corp's commitment to submit, on or before December 15, 2008, a Plan and Schedule for completion and submittal of:

- a Contaminant Investigation Report; and
- a Groundwater Corrective Action Plan,

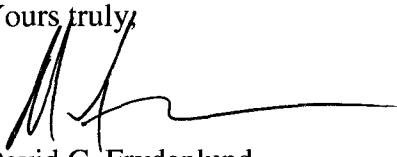
relating to observed nitrate contamination in the perched groundwater zone at the White Mesa Mill site.

In satisfaction of the foregoing commitment, we submitted two copies of the *Plan and Schedule for Nitrate Contamination Investigation Report and Groundwater Corrective Action Plan; White Mesa Uranium Mill Site Blanding Utah*, November 2008, prepared on our behalf by INTERA, Inc., for your review and approval, under cover of a letter dated November 19, 2008.

Enclosed please find a CD containing a pdf version of the subject Plan and Schedule.

If you have any questions or require any further information, please contact me.

Yours truly,

A handwritten signature in black ink, appearing to be 'David C. Frydenlund', with a long horizontal flourish extending to the right.

David C. Frydenlund
Vice President, Regulatory Affairs and Counsel

cc: Ron F. Hochstein
Harold R. Roberts
Steven D. Landau
David E. Turk

Plan and Schedule for Nitrate Contamination Investigation Report And Groundwater Corrective Action Plan

**White Mesa Uranium Mill Site
Blanding, Utah**

Prepared for:



**Denison Mines (USA) Corp.
1050 17th Street, Suite 950
Denver, Colorado 80265**

Prepared by:



**6000 Uptown Blvd. NE, Suite 100
Albuquerque, New Mexico 87110**

November 2008

TABLE OF CONTENTS

TABLE OF CONTENTS.....	1
LIST OF FIGURES	2
LIST OF ATTACHMENTS	2
LIST OF ACRONYMS AND ABBREVIATIONS	3
1. PROJECT DESCRIPTION.....	4
1.1. Introduction	4
1.2. Purpose of this Plan	5
2. CONTAMINATION INVESTIGATION REPORT UAC R317-6-6.15 (D) 5	
2.1. Documents Incorporated by Reference	5
2.2. Characterization of Pollution	6
2.2.1. The Amount, Form, Concentration, Toxicity, Environmental Fate and Transport, and Other Significant Characteristics of Substances Present, for Both Ground Water Contaminants and any Contributing Surficial Contaminants.....	6
2.2.2. The Areal and Vertical Extent of the Contaminant Concentration, Distribution and Chemical Make-Up	7
2.2.3. The Extent to Which Contaminant Substances have Migrated and are Expected to Migrate.....	8
2.3. Characterization of the Facility	9
2.3.1. Contaminant Substance Mixtures Present and Media of Occurrence	9
2.3.2. Hydrogeologic Conditions Underlying and, Upgradient and Downgradient of the Facility	9
2.3.3. Surface Waters in the Area.....	10
2.3.4. Climatologic and Meteorologic Conditions in the Area of the Facility	10
2.3.5. Type, Location and Description of Possible Sources of the Pollution at the Facility	10
2.3.6. Groundwater Withdrawals, Pumpage Rates, and Usage Within a 2- Mile Radius.....	10
2.4. Report of data used and data gaps.....	10
2.5. Endangerment Assessment	11
2.6. Other Information	11
2.7. Submittal of CIR.....	11
3. PROPOSED CORRECTIVE ACTION PLAN UAC R317-6-6.15 (D).....	11
4. QUARTERLY REPORTS	12
5. SUMMARY OF REPORTS TO BE DELIVERED, BENCHMARKS AND PROPOSED SCHEDULE.....	13
6. ANALYSIS OF POTENTIAL SOURCES AND SAMPLE PLAN 14	
6.1. Preliminary Source Review	14
6.2. Known Distribution of Nitrate in Groundwater	15
6.3. Potential Tailings Cell Source	15
6.4. Potential Mill Circuit Source	16
6.5. Potential Fly Ash Pond Source	17

6.6.	Potential Septic System Sources.....	17
6.7.	Potential Frog Pond Water Sources	18
6.8.	Wildlife Ponds and Historic Pond.....	19
6.9.	Plan to Address Data Gaps	19
6.10.	Sampling and Analysis Plan	21
6.10.1.	Well Drilling, Completion and Development	21
6.10.2.	Sampling Design	22
6.10.3.	Sampling Quality Assurance/Quality Control.....	23
6.10.4.	Laboratory QA/QC and Reporting	23
7.	REFERENCES	24

LIST OF FIGURES

Figure 1	Mill Site Map, with Relevant Monitoring Wells
Figure 2	Nitrate Concentration Map
Figure 3	Proposed Well Locations

LIST OF ATTACHMENTS

Attachment 1	Calculation to Evaluate Potential Tailings Cell Source
Attachment 2	Preliminary Source Report
Attachment 3	White Mesa Uranium Mill Ground Water Monitoring Quality Assurance Plan (QAP) State of Utah Groundwater Discharge Permit No. UGW370004. Denison Mines (USA) Corp. March 14, 2008.

LIST OF ACRONYMS AND ABBREVIATIONS

CAP	Corrective Action Plan
CIR	Contamination Investigation Report
DRC	Division of Radiation Control
DUSA	Denison Mines (USA) Corp.
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
GWDP	Groundwater Discharge Permit No. UGW370004
GWQS	Groundwater Quality Standard
INTERA	INTERA, Inc.
Mill	White Mesa Mill Site
NRC	U.S. Nuclear Regulatory Commission
QA/QC	quality assurance/ quality control
UAC	Utah Administrative Code
UDEQ	Utah Department of Environmental Quality

1. PROJECT DESCRIPTION

1.1. Introduction

Denison Mines (USA) Corp. (DUSA) received a Request for Voluntary Plan and Schedule to Investigate and Remediate Nitrate Contamination at the White Mesa Mill (the "Mill") site, near Blanding, Utah (the "Request"). The Request was dated September 30, 2008 and was received from Dane Finerfrock, Co-Executive Secretary (the "Executive Secretary") of the Utah Water Quality Board and the Utah Radiation Control Board, of the Utah Department of Environmental Quality (UDEQ).

In the Request the Executive Secretary noted that on a review of the 13 quarterly groundwater monitoring reports for the Mill, submitted by DUSA to the Utah Division of Radiation Control (DRC) since the second quarter of 2005, groundwater nitrate levels have exceeded the State water quality standard of 10 mg/L in certain monitoring wells at the Mill site. Specifically, the Executive Secretary noted that:

- 1) Nitrate concentrations have exceeded the Ground Water Quality Standard (GWQS) in the groundwater at the facility in five monitoring wells, most of which are not located within the confines of the known chloroform groundwater plume (MW-30, MW-31, TW4-22, TW4-24, and TW4-25);
- 2) For the monitor wells in question multiple samples in each have been found in excess of the nitrate GWQS, beginning as early as June 22, 2005 (2nd quarter 2005 monitoring event);
- 3) The nitrate plume has migrated in a different direction than the chloroform plume;
- 4) The physical boundaries of the nitrate plume are not fully defined; and
- 5) The source(s) of the nitrate contamination are currently unknown.

As a result of the Request, DUSA and DRC agreed that:

- 1) On or before December 15, 2008, DUSA would submit a plan of action and schedule for Executive Secretary approval, for completion and submittal of:
 - A. a Contamination Investigation report (CIR); and
 - B. a Groundwater Corrective Action Plan (CAP);
- 2) DUSA would show good faith in submittal of the plan and schedule above, in a timely manner and with appropriate content, so as to allow the Executive Secretary to fully review and evaluate the proposal before December 15, 2008;

- 3) DUSA would receive Executive Secretary approval of the proposed plan of action and schedule cited in Item 1), above, on or before December 15, 2008; and
- 4) DUSA would enter into a Stipulated Consent Agreement by January 15, 2009 with the Executive Secretary, including defined milestones, deadlines, deliverables, and stipulated penalties related to the approved plan of action and schedule.

INTERA, Inc. (INTERA) was tasked by DUSA to prepare this plan of action and schedule (the "Plan") for the investigation of nitrate contamination at the Mill in accordance with DUSA's commitment referred to above.

1.2. Purpose of this Plan

The purpose of this Plan is to outline the steps to be taken and the schedule for completion and submittal of a CIR and a groundwater CAP for nitrate in groundwater at the Mill. The CIR and CAP will follow the requirements found in UAC R317-6-6.15(D). The following sections outline the requirements for a CIR and a CAP under UAC R317-6-6.15 (D), and the plan of action and schedule associated with each requirement for this project. A proposed schedule for the completion and submittal of the CIR and the CAP, including defined milestones, deadlines and deliverables, is set out in Section 5 below.

2. CONTAMINATION INVESTIGATION REPORT UAC R317-6-6.15 (D)

This Section reviews the requirements in UAC R317-6-6.15 that must be addressed by the CIR and sets out a plan of action and schedule for satisfying those requirements and completion and submittal of the CIR.

2.1. Documents Incorporated by Reference

The Mill has been the subject of numerous studies. According to UAC R317-6-6.15 (C), the CIR or the CAP may incorporate by reference information already provided to the Executive Secretary. As described in more detail below, DUSA will summarize and incorporate by reference in the CIR and CAP information from a number of documents, which may include the following:

- White Mesa Uranium Mill; Environmental Report in Support of License Renewal Application, February 28, 2007, prepared by DUSA (the "2007 ER");
- Environmental Report, White Mesa Uranium Project San Juan County, Utah, dated January 1978, prepared by Dames & Moore;

- Final Environmental Statement for the Mill prepared by the Nuclear Regulatory Commission, 1979;
- Summary of Work Completed, Data Results, Interpretations and Recommendations for the July 2007 Sampling Event at the Denison Mines, USA, White Mesa Uranium Mill Near Blanding Utah, prepared by T. Grant Hurst and D. Kip Solomon, Department of Geology and Geophysics, University of Utah, May 2008 (the "University of Utah Study");
- Revised Background Groundwater Quality Report; Existing Wells For Denison Mines (USA) Corp.'s White Mesa Mill Site, San Juan County, Utah, Prepared by INTERA, Inc., October 2007 (the "Background Report");
- Revised Addendum: Evaluation of Available Pre-Operational and Regional Background Data; Background Groundwater Quality Report: Existing Wells For Denison Mines (USA) Corp.'s White Mesa Mill Site, San Juan County, Utah, prepared by INTERA, Inc., November 16, 2007; and
- Revised Addendum: Background Groundwater Quality Report: New Wells For Denison Mines (USA) Corp.'s White Mesa Mill Site, San Juan County, Utah, prepared by INTERA, Inc., April 30, 2008.

2.2. Characterization of Pollution

As required by R317-6-6.15 D 1. a., the characterization of pollution in the CIR will include a description of the following items:

2.2.1. The Amount, Form, Concentration, Toxicity, Environmental Fate and Transport, and Other Significant Characteristics of Substances Present, for Both Ground Water Contaminants and any Contributing Surficial Contaminants

The contaminant of concern has been identified as nitrate in the perched aquifer at the Mill site. As a result, the form, toxicity, environmental fate and transport and other significant characteristics of nitrate are known and will be described in the CIR. All potential contributing surficial contaminants (that could generate nitrate in the perched aquifer) that have been identified to date have been described in Sections 2 and 3 of the Preliminary Source Review Report dated November 19, 2008, prepared by Ms. Jo Ann Tischler (the "Preliminary Source Report"), a copy of which is appended to this Plan as Attachment 1. That information will be included in the CIR. No further investigations

are required or planned in relation to the form, toxicity and environmental fate and transport of nitrate and any contributing surficial contaminants.

However, the amount and concentration of nitrate in groundwater cannot be determined until the nitrate plume has been fully bounded and characterized. The proposed sample plan (the "Sample Plan") described in Sections 6.9 and 6.10 below is aimed at providing the information necessary to fully bound and characterize the plume. Results from the Sample Plan, together with existing characterization data, will be used to calculate the amount and concentration of nitrate in the plume. That information will be included in the CIR.

2.2.2. The Areal and Vertical Extent of the Contaminant Concentration, Distribution and Chemical Make-Up

Groundwater at the Mill has been monitored for the past 27 years; therefore certain characteristics of pollution have already been determined. The plume is well constrained in the downgradient direction (Figure 2). It has clear boundaries to the west and to the south. On the east side, apparently it partially comingles with nitrate associated with the chloroform plume. Groundwater extraction for remediation of chloroform may have caused additional comingling in this area obscuring any relationship that may have existed between the two plumes. The primary data gap that hampers complete definition of the nitrate plume is lack of information to the north and northeast in the direction of the presumed source.

The Sampling Plan will define the north and northeast boundary of the nitrate plume. Under the Sampling Plan, the following schedule has been set, which will result in the following deliverables:

- Drilling will commence on four temporary monitoring wells (TWN-1, TWN-2, TWN-3 and TWN-4) on or before March 2, 2009. This will allow drilling to commence as early as reasonable practicable in 2009 following winter conditions at the Mill;
- Those four wells will be developed and sampled for nitrate on or before March 30, 2009;
- A recovery test and aquifer testing to determine hydraulic conductivity will be performed on each of the four wells on or before June 1, 2009;

- A hydrogeological report (a "New Well Hydrogeological Report") which will include the results from the recovery tests and aquifer testing on the four wells will be prepared on or before June 1, 2009;
- A Report (a "New Well Report") that summarizes and analyzes the initial sampling results for the four wells, and makes a determination whether or not the plume is bounded or further wells must be drilled, and proposing the number and locations of any such further wells will be submitted to the Executive Secretary on or before June 1, 2009. The New Well Hydrogeological Report will be appended to the New Well Report. The New Well Report will also include a data summary table presenting the analytical results from the sampling and figures depicting the concentration isopleths of nitrate;
- If DUSA or the Executive Secretary determines that any further wells should be installed and sampled for nitrate, DUSA will:
 - commence drilling of such wells within 60 days after any such determination (provided that the drilling will not be performed during winter conditions);
 - develop and sample the wells within 30 days after commencement of drilling; and
 - prepare and submit a New Well Report (with attached New Well Hydrogeological Report) for the new wells within 60 days after completion of sampling of such wells; and
- If any investigations, other than installing and sampling additional monitoring wells as discussed above, are required by DUSA or the Executive Secretary, DUSA will perform such investigations in accordance with a schedule to be agreed upon between DUSA and the Executive Secretary, on a case by case basis.

In addition, DUSA will submit quarterly reports (the "Nitrate Monitoring Reports") summarizing sample results, as described in more detail in Section 4 below.

2.2.3. The Extent to Which Contaminant Substances have Migrated and are Expected to Migrate

The downgradient boundary of the nitrate plume has already been defined. Therefore, the extent to which the nitrate has migrated has already been established and will be

described in the CIR. Similarly, the extent to which the plume is expected to migrate beyond the downgradient boundary of the plume can be determined based on existing hydrogeological data from monitoring wells located in and downgradient of the plume, and will be described in the CIR. A determination of the extent to which the plume is expected to migrate in groundwater located closer to the source of the nitrate will be made once the source is identified and hydrogeological data from new wells is obtained. This information and analysis will also be included in the CIR.

2.3. Characterization of the Facility

As required by R317-6-6.15 D 1. b., the characterization of pollution in the CIR will include a description of the following items:

2.3.1. Contaminant Substance Mixtures Present and Media of Occurrence

The contamination has been identified as a nitrate plume in the perched aquifer at the Mill site. The Preliminary Source Report has analyzed all potential contaminant substance mixtures at the Mill site and surrounding properties, identified to date, that could have generated nitrate in the perched aquifer. This information, along with any additional relevant information gathered during the investigation, will be included in the CIR.

2.3.2. Hydrogeologic Conditions Underlying and, Upgradient and Downgradient of the Facility

Hydrogeologic conditions at the Mill have been the subject of numerous studies. The results of these studies have been summarized in the 2007 ER. The most recent comprehensive study, entitled Site Hydrogeology and Estimation of Groundwater Travel Times in the Perched Zone; White Mesa Uranium Mill Site Near Blanding, Utah, was prepared by Hydro Geo Chem, Inc. on February 26, 2007. That study will be updated (the "Updated Hydrogeological Report"), based on the hydrogeological analysis that will be performed as described in Section 2.2.2 above. The CIR will include a summary of hydrogeological conditions underlying and upgradient and downgradient of the Mill facility, based on the existing descriptions in the 2007 ER, as updated by the Updated Hydrogeological Report. The Updated Hydrogeological Report will be appended to the CIR.

2.3.3. Surface Waters in the Area

Surface waters in the area have been described in the 2007 ER. This description will be summarized and/or incorporated by reference into the CIR. In addition, as part of the Sampling Plan, nitrate samples will be taken quarterly from the waters in the Upper Wildlife Pond for four quarters commencing with the 1st quarter of 2009. Recent sample results of waters in the two other wildlife ponds at the site were taken by Kip Solomon's team from the University of Utah and summarized in the University of Utah Study, but nitrate was not sampled in the Upper Wildlife Pond as part of that study. The nitrate results from the samples taken from the Upper Wildlife Pond will be include in the CIR.

2.3.4. Climatologic and Meteorologic Conditions in the Area of the Facility

The climatologic and meteorological conditions in the area of the facility as described in the 2007 ER will be updated to include on-site meteorological monitoring data for 2008, as reported in the Mill's semi-annual meteorological reports. This information will be summarized and/or incorporated by reference in the CIR.

2.3.5. Type, Location and Description of Possible Sources of the Pollution at the Facility

A preliminary analysis of the type, location and description of possible sources of the pollution at the facility has been performed and is described in the Preliminary Source Report which is appended to this Plan. The Preliminary Source Report will be updated, as needed, to reflect any additional information gained through implementation of the Sample Plan or otherwise in the course of the investigation and preparation of the CIR. This will result in a Final Source Report, which will be appended to the CIR.

2.3.6. Groundwater Withdrawals, Pumpage Rates, and Usage Within a 2-Mile Radius

A description of groundwater withdrawals, pumpage rates, and usage within a 2-mile radius of the nitrate plume will be included in the CIR.

2.4. Report of data used and data gaps

Data used for the CIR and CAP will consist of existing data and new data collected specifically for the nitrate investigation. All data collected for use in the CIR and the CAP, as well as in the New Well Reports and in the quarterly Nitrate Monitoring Reports will be submitted as appendices to the reports. The data packages will include laboratory analytical reports and QA/QC reports. Data used in the reports will be

presented in tabular form with a narrative of how the data were interpreted and analyzed. This narrative will include a description of any data gaps encountered, how those gaps affect the analysis, and any plans to fill those gaps.

2.5. Endangerment Assessment

If, based on the results of the CIR, the CAP proposes standards under UAC R317-6-6.15F.2 or Alternate Corrective Action Concentration Limits that are higher than the applicable GWQS, an endangerment assessment will be performed. The endangerment assessment will contain any risk evaluation necessary to support a proposal for a standard under UAC R317-6-6.15F.2 or Alternate Corrective Action Concentration Limits that are higher than the groundwater quality standards. The schedule for completion of any such endangerment analysis will be agreed between DUSA and the Executive Secretary prior to commencement of the analysis.

2.6. Other Information

The CIR will include such other information as the Executive Secretary may require, based on a review of the New Well Reports, the Nitrate Monitoring Reports, or otherwise.

2.7. Submittal of CIR

The CIR will be submitted to the Executive Secretary within 90 days after the nitrate plume has been bounded in all directions and the Executive Secretary has agreed that the source or sources of the plume have been identified. The nitrate plume will be considered to have been bounded when the concentrations of nitrate in monitoring wells upgradient, downgradient and in both crossgradient directions are less than 10 mg/L.

3. PROPOSED CORRECTIVE ACTION PLAN UAC R317-6-6.15 (D)

The proposed CAP will include an explanation of the construction and operation of the proposed corrective action, addressing the factors to be considered by the Executive Secretary as specified in R317-6-6.15.E and will include such other information as the Executive Secretary requires. It will also include a proposed schedule for completion of the proposed corrective action.

The proposed CAP will be submitted to the Executive Secretary at the same time as the CIR.

4. QUARTERLY REPORTS

Commencing with the 1st quarter of 2009, DUSA will prepare quarterly Nitrate Monitoring Reports, which will include the following reporting format and content:

- a) Introduction
- b) Sampling and Monitoring Plan:
 - i. Description of monitor wells sampled;
 - ii. Description of sampling methodology, equipment and decontamination procedures;
 - iii. Identification of all quality assurance samples, e.g., equipment blanks, duplicate samples, etc.
- c) Data Interpretation:
 - i. Interpretation of groundwater levels, gradients, and flow directions. The interpretation will include a discussion on: 1) a current site groundwater contour map, 2) hydrographs to show groundwater elevation in each monitor well over time, 3) depth to groundwater measured and groundwater elevation from each monitor well summarized in a data table, that includes historic groundwater level data for each well;
 - ii. Interpretation of all analytical results for each well, including a discussion on: 1) a current nitrate isoconcentration map, 2) graphs showing nitrate concentration trends in each well through time and, 3) analytical results for each well summarized in a data table, that includes historic analytical results for each well; and
 - iii. An electronic copy of all laboratory results for groundwater quality monitoring conducted during the quarter will be provided to the Executive Secretary.
- d) Conclusions and Recommendations
- e) Copies of DUSA field reports, laboratory reports, and chain of custody forms.

The monitoring wells that will be included and reported on in the quarterly Nitrate Monitoring Reports will be all new and existing monitor wells on site (including MW and TW wells) that are within the nitrate plume or that define a boundary of the nitrate plume. The nitrate plume is defined to include any monitoring well that has a concentration of nitrate in excess of 10 mg/L. For so long as the Upper Wildlife Pond is sampled for nitrate, the results of such sampling will also be included in the quarterly Nitrate Monitoring Reports.

Quarterly Nitrate Monitoring Reports will be submitted to the Executive Secretary within 45 days after each calendar quarter.

5. SUMMARY OF REPORTS TO BE DELIVERED, BENCHMARKS AND PROPOSED SCHEDULE

The following Table 1 summarizes the reports to be delivered and other benchmarks to be achieved by DUSA in preparing and completing the CIR and CAP, and the proposed schedule for each such deliverable and benchmark.

Table 1. Schedule and Benchmarks

Description	Due Date
1. Submittal of this Plan	December 15, 2008
2. DUSA and Executive Secretary enter into Stipulated Consent Agreement	January 15, 2009
3. Commence Drilling TWN-1, TWN-2, TWN-3 and TWN-4	March 2, 2009
4. Develop and sample TWN-1, TWN-2, TWN-3 and TWN-4 and Upper Wildlife Pond	March 30, 2009
5. Submit New Well Report for TWN-1, TWN-2, TWN-3, TWN-4, including sample results for Upper Wildlife Pond	June 1, 2009
6. If additional wells are required at any time, commence drilling such wells	Within 60 days after approval by Executive Secretary of such drilling (provided drilling will not be performed during winter conditions)
7. If additional wells are required at any time, develop and sample such wells	Within 30 days after completion of drilling
8. If additional wells are required at any time, submit New Well Report for such wells	Within 60 days after completion of sampling of such wells
9. If any investigations, other than installing and sampling monitoring wells, are required at any time in connection with the investigation, DUSA will perform and report on any such investigations	In accordance with a schedule to be agreed upon by DUSA and the Executive Secretary for each such investigation
10. Submit CIR (including Updated Hydrogeological Report and Final Source Report) and proposed CAP	Within 90 days after Executive Secretary confirms that nitrate plume is bounded in all directions and that the source or sources of the plume have been identified
11. Ongoing Monitoring for Nitrate in all New Wells	Nitrate will be sampled in all wells drilled under this investigation on a quarterly basis, until advised otherwise by the Executive Secretary. Monitoring for Nitrate in the Upper Wildlife Pond will be performed quarterly for four quarters, unless advised otherwise by the Executive Secretary
12. DUSA will submit to the Executive Secretary a quarterly Nitrate Monitoring Report	Within 45 days after March 31, 2009 and thereafter within 45 days after each subsequent calendar quarter, until such time as the Executive Secretary advises otherwise

6. ANALYSIS OF POTENTIAL SOURCES AND SAMPLE PLAN

Primary data gaps in the characterization of elevated nitrate concentrations in groundwater at the site are:

- The source of elevated nitrate in groundwater has not been identified; and
- There are insufficient monitor wells to characterize nitrate concentrations in groundwater, north and northeast of the nitrate plume, in the direction of the presumed source.

The following discussion provides the rationale behind a plan to fill these data gaps. The following sections review what is currently known about potential sources of nitrate and the distribution of nitrate in groundwater. Each potential source is then evaluated and prioritized for investigation based on the distribution of nitrate in groundwater and likelihood of being able to contribute the observed mass of nitrate to groundwater. Finally, a plan to address each data gap is proposed.

6.1. Preliminary Source Review

As a first step, DUSA prepared a Preliminary Source Report for Nitrate in Groundwater at the White Mesa Mill, which is appended to this report (Attachment 1). Findings of that review include the following possible sources of nitrate in groundwater at the Mill:

- The septic leach fields at the site;
- The municipal sewage plant discharge water used historically as Mill water makeup;
- Livestock activities at the wildlife ponds;
- Livestock activities at the Historic Pond;
- The former Fly Ash Pond;
- Potential historic spills of ammonia-bearing process chemicals;
- Potential breach in the mill circuit floor drains or tailings transfer lines; and
- A potential leak in the Mill's tailings cells.

That report, which reviewed numerous industrial processes that can generate nitrate byproducts, reviewed Mill-related and nearby, off site, activities for evidence of any of those processes, and identified 29 chemicals used in those processes that have or may have been present at or near the Mill site (see Table 2 of the Preliminary Source Report).

Of those chemicals, 18 were present in process types (i.e. insecticides, herbicides, traces of explosives in ore, etc.) generating such small amounts of nitrate that they were unlikely to account for the currently observed mass of nitrate in groundwater (see Table 2 of the Preliminary Source Report). The remaining chemicals can be divided among six possible sources: 1) tailings cells; 2) the Mill circuit itself; 3) the Fly Ash Pond; 4) site septic systems (see Figure 5 of the Preliminary Source Report) 5) sources that may occur by some combination of mechanisms from an offsite pond (the Frog Pond) that captured effluent from a water treatment facility upgradient of the Mill site (see Figure 3 of the Preliminary Source Report); and livestock activities at the Historic Pond and the wildlife ponds(see Figure 6 of the Preliminary Source Report).

6.2. Known Distribution of Nitrate in Groundwater

Figure 2 presents nitrate data from August 2008 contoured by the kriging routine in SURFER 8. Contour levels begin at the nitrate standard of 10 mg/L nitrate as nitrogen and increase in increments of 10 mg/L. This Figure demonstrates that a nitrate plume exists in groundwater that is clearly unrelated to the tailings cells and is apparently moving southwest with groundwater flow from a source northeast of the Mill buildings. The most upgradient location with nitrate values that are a part of the plume is chloroform monitoring well TW4-25, nearly one quarter of a mile upgradient of the tailings cells, where nitrate concentrations are near 20 mg/L. Currently the centroid of the plume is downgradient of the Mill office building, where nitrate concentrations in groundwater are near 40 mg/L.

The current plume configuration appears to approximate “plug-flow” behavior, where a “slug” of contamination moves as a mass with groundwater. If so, the distribution of nitrate concentrations suggests a point source of nitrate contamination that contributed to groundwater for a finite period of time and has subsequently been removed.

6.3. Potential Tailings Cell Source

As noted above, elevated nitrate concentrations in TW4-25 are clearly a part of the plume. This monitoring well is nearly one quarter of a mile upgradient of the tailings cells. It is unlikely that tailings solutions could travel this distance horizontally in the vadose zone.

Other suggested possibilities include a groundwater mound from the tailings cells that might cause elevated nitrate concentrations upgradient. A quick calculation to evaluate this possibility suggests that on the order of eleven percent tailings solution (assuming

the highest recently observed nitrate concentration in the tailings of 290 mg/L) would have to mix with unimpacted groundwater (assuming 1 mg/L) in order to account for the observed mass of nitrate in groundwater (Attachment 1), assuming an average nitrate concentration in the plume above the 20 mg/L isopleth of 30 mg/L.

The size of the nitrate plume above 20 mg/L is approximately 40 acres, or 1,800,000 square feet in map area (Figure 2). Assuming 45 feet of saturation (Chloroform Investigation Report) and a porosity of 0.2, there are 16,200,000 cubic feet or 121,176,000 gallons of groundwater in that area. Eleven percent of that is 13,329,360 gallons (approximately 41 acre feet) which is a conservative estimate of the volume of tailings solution that would have to be mixed with groundwater to account for the mass of nitrate in the portion of the plume above 20 mg/L nitrate. That amount of seepage from the tailings cells would certainly generate a groundwater mound. Such a mound would have to be on the order of 5 feet on average over the entire 40 acres, but would likely be much higher than that at the centroid of the plume and would taper off toward the edges of the plume. However, no such mounding exists under the tailings cells. While groundwater mounding can be observed towards the eastern portion of the site, away from the tailings cells, it is clearly related to the wildlife ponds and not the tailings cells (See figure 2 of the Preliminary Source Report). As a final point, if the concentration of nitrate in tailings documented in the Statement of Basis (24 mg/L) were used in the calculation, no amount of tailings solution would bring the plume concentration to 30 mg/L.

Based on the discussion above and recent studies by the University of Utah (Hurst and Solomon, 2008) indicating that tailings cells have not leaked, tailings cells are unlikely to be the source of nitrate in groundwater and are a low priority for this investigation. This potential source will be addressed by reviewing new data collected during this investigation along with previously collected data.

6.4. Potential Mill Circuit Source

The Mill circuit is located downgradient of high nitrate concentrations at TW4-25, and there is no known history of leaks or spills of the magnitude required to supply the mass of nitrate currently observed in groundwater. Further, as noted in the Preliminary Source Report, spills of these materials are too finite a phenomenon to account for an ongoing plume on their own. Therefore, a Mill circuit source, while possible, is less likely than potential sources upgradient of TW4-25 and is a low priority for this investigation. This

potential source will be addressed by reviewing new data collected during this investigation along with previously collected data.

6.5. Potential Fly Ash Pond Source

The former Fly Ash Pond is also considerably downgradient of TW4-25 (Figure 2) but may have contained fly ash with nitrate concentrations. It may also have been the capture point for any historic spills or process upsets at the Mill. The contents of the Fly Ash Pond were removed and the pond was covered and closed in 1989. The Fly Ash Pond was called a pond because it was located at a low point that collected storm run off water. However, standing water in the pond was pumped regularly to the tailings cells, thereby reducing the pond's ability to drive any recharge to groundwater. Further, a component of fly ash is lime (CaO). This chemical reacts with water (H_2O) to form calcium hydroxide [$\text{Ca}(\text{OH})_2$]. This property of fly ash leads to the formation of a kind of natural cement that would tend to form a barrier to infiltration (Scott and Thomas, 2007), favoring evaporation of pond solutions rather than groundwater recharge. Therefore, a Fly Ash Pond source, while possible, is less likely than potential sources upgradient of TW4-25 and is a low priority for this investigation at this time. This potential source will be addressed by reviewing new data collected during this investigation along with previously collected data.

6.6. Potential Septic System Sources

A number of septic leach fields exist at the Mill site (see Figure 5 of the Preliminary Source Report), and septic systems have caused regional nitrate contamination in many areas (McQuillan, 2004). Figure 5 of the Preliminary Source Report shows five separate leach fields at the Mill site along with associated piping. Two of the site leach fields, the Former Office Leach Field and the Scale House Leach Field, apparently gave rise to the chloroform plume that is currently under remediation. However, these leach fields along with the Cell 1 Leach Field would appear to be located too far south to be the source of the nitrate plume subject to this investigation and are a low priority. These potential sources will be addressed by reviewing new data collected during this investigation along with previously collected data.

It is likely that any nitrate signature from a potential source at the Main Leach Field (see Figure 5 of the Preliminary Source Report) would be captured by chloroform monitor wells such as TW4-21 or TW4-18 (see Figure 1 of the Preliminary Source Report). However, given changes in flow directions over time it is possible that the Main Leach

Field could be a source of nitrate concentrations in groundwater. Therefore, this potential source is assigned a moderate priority and will be addressed by installation of a monitoring well (TWN-1) near the former sample plant building, roughly half way between chloroform monitoring well TW4-25 and the Main Leach Field. This well will also serve to test any nitrate that might come from the low priority, historic landfill north of the Main Leach Field (see Figure 5 of the Preliminary Source Report).

The SAG Leach Field is located approximately 150 feet north of the Mill building (see Figure 5 of the Preliminary Source Report). Based on the distribution of nitrate concentrations, this will be a high priority location during the contamination investigation. This potential source will be addressed by installation of a monitoring well (TWN-2) north of the Mill building in the vicinity of the SAG Leach Field.

6.7. Potential Frog Pond Water Sources

The waste water treatment facility described in the Preliminary Source Report is located several miles upgradient of the Mill site but discussions with Mill staff indicate that effluent from that facility was allowed to flow to a pond (Frog Pond) near the Mill boundary where it was subsequently piped to the Upper Wildlife Pond at the site and to another holding pond on site for Mill makeup water (Lawzy Lake, see Figure 5 of the Preliminary Source Report). The Mill staff reports that this water had a bad odor and may have had a high sludge content. Nitrates are commonly associated with wastewater treatment effluent (McQuillan, 2004).

This potential source term will be a high priority during this contamination investigation for several reasons. The period of Mill use of water from the waste water treatment plant was from the mid 1980s to about 1991 or 1992 when it was replaced with water from Recapture Reservoir. As documented in the Background Report, groundwater levels at the site have been influenced by the Wildlife Ponds so we know that the head in those ponds has been sufficient to drive infiltration to the water table.

The "slug" like character of the nitrate plume is consistent with a nitrate source that has been removed. The distances from the Upper Wildlife Pond and Lawzy Lake to the centroid of the nitrate plume are approximately 2300 feet and 2100 feet, respectively. Assuming 26 years since nitrate laden water entered the system, groundwater would have had to travel at an average velocity of 88 feet per year from the Upper Wildlife Pond and 81 feet per year from Lawzy Lake to account for the current distribution of nitrate concentrations. The velocity of 88 feet per year from the Upper Wildlife Pond is a

relatively high velocity compared to other values that have been calculated for the site, but possible given the high gradient in this limited portion of the site due to mounding at the wildlife ponds. Further, the eastern portion of the site is known to have higher permeabilities than the western portion (see the Chloroform Contaminant Investigation Report). The Lawzy Sump is even closer to the plume.

For the above reasons Lawzy Lake, the Lawzy Sump and the Upper Wildlife Pond will be High priorities as potential sources. These potential sources will be addressed by installation of two monitoring wells. One (TWN-3) will be installed half way along a line between the north end of the Mill building and Lawzy Lake. The other monitoring well (TWN-4) will be installed on a line approximately half way between the north end of the Mill building and the Upper Wildlife Pond. The Lawzy Sump will be addressed by the same monitoring well (TWN-2) north of the Mill building that is designed to test the SAG leach field.

6.8. Wildlife Ponds and Historic Pond

The Upper Wildlife Pond was a stock watering pond for years prior to construction of the Mill. The Historic Pond, which no longer exists, but was located where the Mill's sulfuric acid tank is currently located, pre-existed construction of the Mill by several decades, tracing back possibly to the 1920s.

Livestock will generate nitrate in and around stock watering ponds, and the water head in the ponds could potentially drive those nitrates into the groundwater. As both of these potential sources are upgradient of the nitrate plume, they are considered to be moderate priorities in this investigation.

However, any infiltration of nitrates from past and current livestock activity near the Upper Wildlife Pond will be captured by TWN-4 and any infiltration of nitrates from past livestock activity near the Historic Pond will be captured by TWN-2. It is therefore not necessary to install any further wells at this time to address these potential sources.

6.9. Plan to Address Data Gaps

Of the potential sources listed above, the only potential sources that originate up gradient of the nitrate plume are the waters from the Frog Pond (including potential livestock activity near the wildlife ponds and the Historic Pond) and possible influences from septic leach fields at the site, in particular the SAG Leach Field and possibly the

Main leach field. Table 2 is a summary of potential sources of nitrate in groundwater, the investigation priority assigned to each, and the proposed action to address each potential source.

Table 2. Actions to be Taken to Address Potential Sources

Potential Source	Investigation Priority	Action to Address Potential Source
<i>Tailings Cells</i>	Low	Review data collected during investigation
<i>Mill Circuit</i>	Low	Review data collected during investigation
<i>Fly Ash Pond</i>	Low	Review data collected during investigation
<i>Historic Pond</i>	Moderate	Monitor well (TWN-2) north of Mill building
<i>Site Septic Systems</i>		
<i>Former Office Leach Field</i>	Low	Review data collected during investigation
<i>Scale House Leach Field</i>	Low	Review data collected during investigation
<i>Cell 1 Leach Field</i>	Low	Review data collected during investigation
<i>Main Leach Field</i>	Moderate	Monitor well (TWN-1) near sample plant building
<i>SAG Leach Field</i>	High	Monitor well (TWN-2) north of Mill building
<i>Frog Pond Water</i>		
<i>Upper Wildlife Pond</i>	High	Monitor well (TWN-4) between Mill building and Upper Wildlife Pond
<i>Lawzy Lake</i>	High	Monitor well (TWN-3) between Mill building and Lawzy Lake
<i>Lawzy Sump</i>	High	Monitor well (TWN-2) north of Mill building

Based on the Preliminary Source Report and the analysis presented above, DUSA proposes the following observational approach to filling data gaps for characterizing nitrate concentration levels in groundwater at the site:

- Initially, four monitoring wells (TWN-1, TWN-2, TWN-3 and TWN-4) will be installed at locations designed to fill data gaps upgradient of chloroform monitoring well TW4-25. Tentative locations of these wells are displayed in Figure 3.
- Newly installed wells will be sampled and analyzed for nitrate.

- In addition, if possible, two existing piezometers (Piez-2 and Piez-3) south of the Upper Wildlife Pond will be sampled and analyzed for nitrate to provide additional delineation of the plume. Repeated samples of these piezometers will not be taken if initial results indicate background concentrations of nitrate.
- All existing chloroform monitoring wells will continue to be sampled quarterly for nitrate;
- All existing GWDP monitoring wells that are within the nitrate plume (10 mg/L nitrate or higher) or that define a boundary of the plume will continue to be sampled quarterly for nitrate. These are MW-5, MW-11, MW-25, MW-26, MW-27, MW-28, MW-29, MW-30, MW-31 and MW-32; and
- If necessary, additional monitoring wells will be installed based on information gathered during the first round of sampling. If nitrate concentrations in samples from initially installed monitoring wells indicate a source that is still farther upgradient, well locations will step out until the source is identified or the property boundary is reached. If nitrate concentrations in samples from initially installed monitoring wells are low and no source can be identified, additional monitoring locations will step toward the parts of the plume that have already been identified.

6.10. Sampling and Analysis Plan

This section describes the requirements for the following:

- Well Drilling, Completion and Development
- Sampling Design and Field Activities
- Sample Handling and Custody
- Laboratory quality assurance/quality control (QA/QC) and Reporting

6.10.1. Well Drilling, Completion and Development

TWN-1, TWN-2, TWN-3, TWN-4 and any other monitoring wells installed as part of the nitrate investigation will be drilled, completed and developed in the same manner as the chloroform investigation wells have been drilled, completed and developed under the Chloroform Investigation.

6.10.2. Sampling Design

Sample collection has been determined based on concentrations of nitrate from previous analytical results, including quarterly groundwater and chloroform reports. Ground water samples will be collected according to Section 6 “Ground Water Sampling and Measurement of Field Parameters” of the QAP (DUSA, 2008, Attachment 2). Figure 3 illustrates the sample locations. Sample locations and parameters are listed in Table 3 below:

For the initial investigation, one round of samples will be collected from each location in Table 3 below. After interpretation of the analytical results, modifications may be made to this Plan if more sample locations are warranted. Nitrate monitoring wells will continue to be sampled quarterly after installation, unless DUSA is advised otherwise by the Executive Secretary, except that continued sampling will not be performed for any nitrate monitoring wells that do not define a boundary of the nitrate plume and that demonstrate background concentrations of nitrate.

Table 3: Sampling and Analysis Summary

Sample Location	Analysis	Notes
New Monitoring Well TWN-1	Nitrate	Test Main Leach Field as source and fill data gap to east of TW4-25
New Monitoring Well TWN-2	Nitrate	Test SAG Leach Field, Lawzy Sump and Historic Pond as sources and fill data gap to north of TW4-25
New Monitoring Well TWN-3	Nitrate	Test Lawzy Lake as source and fill data gap to north of TW4-25
New Monitoring Well TWN-4	Nitrate	Test Upper Wildlife Pond as source and fill data gap to northeast of TW4-25
TW4-3, TW4-5, TW4-9, TW4-10, TW4-12, TW4-18, TW4-19, TW4-20, TW4-21, TW4-22, TW4-23, TW4-24, TW4-25	Nitrate	Provide current and quarterly concentrations of nitrate in chloroform wells.
MW-5, MW-11, MW-25, MW-26, MW-27, MW-28, MW-29, MW-30, MW-31 and MW-32	Nitrate	Provide current and quarterly concentrations of nitrate in monitoring wells
Piezometer 2	Nitrate	If able to sample – additional groundwater sampling point
Piezometer 3	Nitrate	If able to sample – additional groundwater sampling point

Table 1 of the QAP (DUSA, 2008, Attachment 2) presents the analytical method, reporting limit, maximum holding time, and sample preservation requirements (including temperature) for nitrate samples.

6.10.3. Sampling Quality Assurance/Quality Control

Field duplicates (FD) and Equipment Rinsates (ER) will be collected in accordance with Section 8.1 of the QAP (DUSA 2008, Attachment 2).

Sample Handling and Custody

Sample handling and custody will adhere to Section 7.0 "Sample Documentation Tracking and Record Keeping" of the QAP (DUSA, 2008, Attachment 2).

Sample Identification

Each sample collected at the Mill during this investigation will be identified using a unique sample identification (ID) number. The description of the sample type and the point name will be recorded on the field sampling forms. In general, samples will be identified by their name (TW4-25, Upper Wildlife Pond, etc.).

In addition to the name, each individual sample will be identified by date and time. Sample IDs will be listed on the sample labels and the chain-of-custody (COC) forms submitted to the laboratory, and will be cross-referenced to the name on the field sampling forms.

Sample Shipment

Sample shipment procedures are described in Section 6.2.12 of the QAP (DUSA, 2008, Attachment 2).

6.10.4. Laboratory QA/QC and Reporting

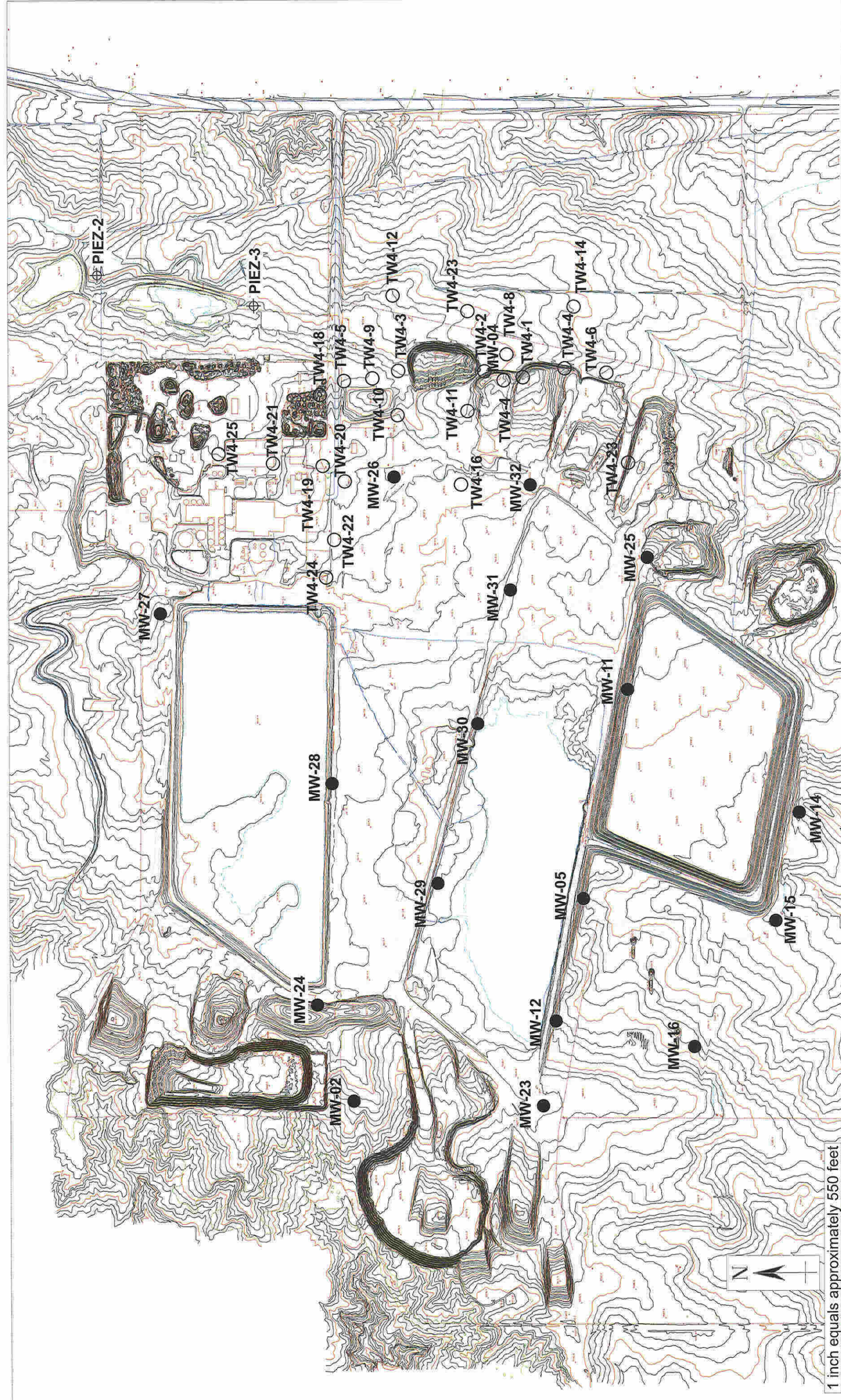
To ensure quality of laboratory analysis, the analytical laboratory (Energy Laboratories, Inc.) will be required to analyze QA/QC samples as specified by the analytical method. This QA/QC will be performed in the same manner as the quarterly groundwater and chloroform analysis, and according to the QAP (DUSA, 2008, Attachment 2).

Laboratory analytical reports will be submitted to DUSA and INTERA in the form of an Electronic Data Deliverable (EDD) which will be verified by INTERA.

7. REFERENCES

- Denison Mines (USA) Corp., March, 14 2008. *White Mesa Uranium Mill Ground Water Monitoring Quality Assurance Plan (QAP) State of Utah Groundwater Discharge Permit No. UGW370004*.
- Hydro Geo Chem, 2007, Preliminary Contaminant Investigation Report, White Mesa Uranium Mill Near Blanding Utah, Prepared for Denison Mines, Inc., by Hydro Geo Chem, November 20, 2007.
- INTERA, Inc., December 2006. *Background Groundwater Quality report: Existing Wells for Denison Mines (USA) Corp.'s White Mesa Uranium Mill Site, San Juan County, Utah*.
- INTERA, Inc., October, 2007. *Revised Background Groundwater Quality report: Existing Wells for Denison Mines (USA) Corp.'s White Mesa Uranium Mill Site, San Juan County, Utah*.
- McQuillan, Dennis, 2004, Ground-Water Quality Impacts from On-Site Septic Systems, Proceedings, National Onsite Wastewater Recycling Association, 13th Annual Conference, Albuquerque, NM, November 7-10, 2004
- Scott, Allan N.; and Thomas, Michael D. A. (January/February 2007). "Evaluation of Fly Ash From Co-Combustion of Coal and Petroleum Coke for Use in Concrete". *ACI Materials Journal* **104** (1): 62–70. American Concrete Institute

Figures



1 inch equals approximately 550 feet

- ⊕ Piezometer
- Chloroform Monitoring Well
- Compliance Monitoring Well



Figure 1
White Mesa Mill Site Map with
Relevant Monitoring Well Locations





Figure 3
White Mesa Mill
Proposed Nitrate Monitoring Well Locations



Attachment 1
Calculation to Evaluate Potential Tailings Cell Source

- Attachment 1: Calculation to Evaluate Potential Tailings Cell Source
- Assume:
- Nitrate Concentration in Tailings Solution = 290 mg/L
- Nitrate Concentration in un-impacted Groundwater = 1 mg/L
- Average Plume Concentration = 30 mg/L
- Mixing Equation: $C_t \cdot V_t + C_g \cdot V_g = C_m \cdot V_m$ (eq 1)
- Where: C_t = Concentration of nitrate in tailings solutions
- V_t = Volume of tailings solutions
- C_g = Concentration of nitrate in unimpacted groundwater
- V_g = Volume of unimpacted groundwater
- C_m = Concentration of nitrate in mixture
- V_m = Volume of mixture
- Another Equation: $V_t + V_g = V_m$ (eq 2)
- Substituting eq2 in eq1: $C_t \cdot V_t + C_g \cdot V_g = C_m \cdot (V_t + V_g)$ (eq 3)
- Substitute Nitrate Concentrations in eq3
- $290 \cdot V_t + 1 \cdot V_g = 30 \cdot (V_t + V_g)$
- $290 \cdot V_t + 1 \cdot V_g = 30 \cdot V_t + 30 \cdot V_g$
- $260 \cdot V_t = 29 \cdot V_g$
- $V_t = 29/260 \cdot V_g = 0.11 \cdot V_g$
- The volume of tailings solution would have to be eleven percent of the volume of unimpacted groundwater in the mixture.

Attachment 2
Preliminary Source Report

MEMORANDUM

To: Denison Mines (USA) Corp.
From: Jo Ann Tischler
Date: November 19, 2008
Subject: Preliminary Source Review Report for Nitrate in Groundwater at the White Mesa Mill

Introduction

In correspondence dated September 15 and September 30, 2008, the Utah Division of Radiation Control (DRC) noted that on a review of the 13 quarterly groundwater monitoring reports for the White Mesa Mill (Mill), submitted by Denison Mines (USA) Corp. (Denison) to DRC since the second quarter of 2005, groundwater nitrate levels have exceeded the State water quality standard of 10 mg/L in certain monitoring wells at the Mill site. Specifically, DRC noted that:

1. Nitrate concentrations have exceeded the Ground Water Quality Standard (GWQS) in the groundwater at the facility in five monitoring wells, most of which are not located within the confines of the known chloroform groundwater plume (MW-30, MW-31, TW4-22, TW4-24, and TW4-25);
2. For the monitor wells in question multiple samples in each have been found in excess of the nitrate GWQS, beginning as early as June 22, 2005 (2nd quarter 2005 monitoring event);
3. The nitrate plume has migrated in a different direction than the chloroform plume;
4. The physical boundaries of the nitrate plume are not fully defined; and
5. the source(s) of the nitrate contamination are currently unknown.

A map indicating the location of all monitoring wells under the Mill's Groundwater Discharge Permit (GWDP) and chloroform investigation, which includes the five monitoring wells in question, is attached to this report as Figure 1. A map indicating the 1st Quarter 2008 water levels and direction of groundwater flow in the perched aquifer is attached to this report as Figure 2.

In response to DRC's observations, Denison agreed to submit to DRC, on or before December 15, 2008, a plan of action and schedule for Executive Secretary approval, for completion and submittal of a Contaminant Investigation Report (CIR) and a Groundwater Corrective Action Plan (CAP), that fulfill the requirements of UAC R317-6-6.15(D).

The purpose of this report is to perform a preliminary evaluation of the "type, location and description of possible sources of pollution at the facility," which is required by R317-6-6.15b.(4) to be included in the CIR. This preliminary evaluation will be used to

aid Denison in developing a field sampling plan (the "Sampling Plan") and otherwise performing the contaminant investigation required for the CIR. It is expected that the preliminary findings set out in this report may be modified or expanded based on the results of the Sampling Plan and other investigations. The final evaluation of the type, location and description of possible sources of pollution at the facility will be included in the CIR and will contain all available information as at the date of the CIR.

To perform this preliminary evaluation, I have considered:

1. What are the current and historic sources of nitrogen-bearing chemicals and biological nitrogen at the Mill?
2. What off-site sources of chemical and biological nitrogen exist within proximity of the Mill?
3. Do mechanisms exist for the nitrogen to reach groundwater?
4. Do mechanisms exist for the nitrogen to reach groundwater as nitrate?
5. Are the known volumes and concentration of the sources consistent with ongoing nitrogen presence in groundwater?

1.0 Basis and Limitations of this Evaluation

This evaluation was limited to a qualitative process source review. That is, it considered a broad range of nitrogen sources present on or in the vicinity of the Mill and narrowed them down to those most likely to affect groundwater. The review did not limit the potential sources based on quantitative factors in groundwater hydrogeology or geochemistry.

The evaluation in this report is based on the following information:

1. Interviews with Denison corporate staff during October 2008, to gather information on nitrogen-bearing materials used or present on site throughout the Mill's operating history.
2. Interviews with Denison corporate staff during October 2008, to gather information on historical use of pits, ponds, landfills, and offsite water sources at the Mill.
3. Current and historic site maps provided by Denison corporate staff.
4. The Mill's process and equipment description from Denison's Radioactive Materials License renewal application dated February 2007.
5. Tailings solution sample data provided by Denison corporate staff.

6. Reagent, Laboratory Chemical Inventory, and Petroleum Products tables from the White Mesa Mill Spill Prevention, Control, and Countermeasures (SPCC) Plan (2001).
7. DRC Draft Request for Additional Information (RFI) regarding nitrate exceeding Utah GWQSs dated September 15, 2008, and DRC Request for Voluntary Plan and Schedule to Investigate and Remediate dated September 30, 2008.
8. *Summary of Work Completed, Data Results, Interpretations and Recommendations for the July 2007 Sampling Event at the Denison Mines, USA, White Mesa Uranium Mill Near Blanding Utah*, prepared by T. Grant Hurst and D. Kip Solomon, Department of Geology and Geophysics, University of Utah, May 2008.
9. *Revised Background Groundwater Quality Report; Existing Wells For Denison Mines (USA) Corp.'s White Mesa Mill Site, San Juan County, Utah*, Prepared by INTERA, Inc., October 2007.
10. *Revised Addendum: Evaluation of Available Pre-Operational and Regional Background Data; Background Groundwater Quality Report: Existing Wells For Denison Mines (USA) Corp.'s White Mesa Mill Site, San Juan County, Utah*, prepared by INTERA, Inc., November 16, 2007.
11. *Revised Addendum: Background Groundwater Quality Report: New Wells For Denison Mines (USA) Corp.'s White Mesa Mill Site, San Juan County, Utah*, prepared by INTERA, Inc., April 30, 2008).
12. Data from the 2nd Quarter 2008 Chloroform Monitoring Report – White Mesa Uranium Mill.
13. Reference documents cited at the end of this report.

2.0 Overview of Environmental and Human (Anthropogenic) Nitrogen Sources

In both the natural and industrial environments, nitrogen exists in three chemical forms: either as free nitrogen gas (N₂), “fixed” in inorganic compounds or “bound” into organic compounds, as discussed below.

2.1 Biological Nitrogen Cycle

Apart from free atmospheric nitrogen (gaseous N₂), nitrogen exists in the natural environment in four chemical forms:

- Organic nitrogen (urea, uric acid, amines, amino acids, nucleic acids, alkaloids, proteins, etc.);

- Inorganic free ammonia, that is present in equilibrium between its non-ionic form (NH_3) at high pH, and ionized form (NH_4OH) at neutral and low pH;
- Inorganic nitrite, an intermediate oxidized form (NO_2); and
- Inorganic nitrate, a stable oxidized form (NO_3).

Nitrogen is ubiquitous in the living environment and is part of the living tissues, digestive wastes, and decomposition products of every living thing on the earth's surface. As a result, there are many natural sources that mobilize nitrates into surface water and many mechanisms for nitrates to enter groundwater.

Nitrogen is continuously converted and recycled through the biosphere in a series of processes that comprise the nitrogen cycle. The wastes from living things and the proteins in dead plant and animal tissues are decomposed by ammonification bacteria to form ammonia. Specialized nitrifying bacteria convert the available ammonia to nitrite and/or nitrate in aquatic environments and soils. Nitrite is relatively short-lived in water and hydrated environments because aquatic bacteria convert it rapidly to nitrate. Organisms such as fungi and denitrifying bacteria use the nitrates as a source of oxygen, releasing the bound nitrogen back to the atmosphere as gaseous nitrogen.

In aquatic environments, the least stable form of nitrogen in water is ammonia. In oxygenated aquatic environments, it is readily converted to nitrite and nitrate. In oxygen-deficient waters it may be converted to nitrogen gas and hydrogen ions.

2.2 Anthropogenic Nitrogen

Nitrogen compounds are some of the most widely synthesized, converted, and consumed materials in every human industrial, commercial, and domestic activity. Human activity introduces nitrogen into the environment from four major types of sources:

- Agricultural;
- Combustion-related;
- Sewage and septic-related; and
- Industrial chemicals.

Agricultural

By far the largest source of nitrogen compounds introduced to the environment by human activity are from agricultural sources. Per the US EPA, the largest loads of ammonium and nitrite/nitrate nitrogen reach the environment from agricultural, domestic and commercial runoff to surface water bodies and infiltration to groundwater from overuse of fertilizers, as well as feedlots, cattle yards, slaughterhouses and dairies. In the western US particularly, nitrate/nitrite overloads from agricultural sources far outweigh by several orders of magnitude all the chemical/industrial loads to most surface receiving waters.

Combustion

The second largest source is the combustion of fossil fuels, resulting in atmospheric nitrogen both from the nitrogen bound in the fuel (particularly in coal) and the conversion of atmospheric nitrogen to oxygenated compounds at combustion temperatures in motor vehicles, power plants, boilers, incinerators, kilns, and other fired heaters. In stationary equipment, depending on the efficiency of combustion, some nitrate may remain bound in compounds in the resulting fly ash and/or bottom ash.

Per even the oldest literature on the topic, all coal sources worldwide average from 1.0 to 1.5 percent (10,000 to 15,000 ppm or 10,000,000 to 15,000,000 ppb) bound nitrogen. More modern data indicates the range to be as wide as 0.5 to 2 percent. Nitrogen in coal is generally bound into complex heterocyclic molecules (ring compounds containing both carbon and nitrogen). The nitrogen content of ash resulting from coal combustion varies, and may have even higher levels, depending on the type of burner and type of emissions control. Both stack gases and residual ash exhibit nitrogen in oxidized form, as nitrite/nitrate. In fact, historically, the earliest industrial attempts at synthesis of ammonia and nitrate compounds for the chemical industry were based on converting this nitrogen content of coal.

Sewage and Septic Sources

The third largest sources are from septic systems and sewage plant byproducts. Ubiquitous and relatively uncontrolled leach fields and septic systems load nitrogen in a variety of compounds and forms (from sanitary wastes, food wastes, detergents, and cleaning chemicals) directly to surface and subsurface soils. Both the US EPA and US Geological Survey consider septic systems to be one of the largest uncontrolled threats to surface water and drinking water quality nationwide. Recent source investigations for nearly 1,200 water wells in New Mexico indicated that, in that setting, on-site septic systems contaminated more acre-feet of groundwater, and more public supply systems, than all other sources in the region combined.

Land disposal or land application of sludges and solids from aerators, digesters, and other municipal sewage treatment plant processes, which convert, dewater, and concentrate multiple forms of nitrogen from treated influent water have a comparable or greater effect on receiving soils. Wastewater plants also add nitrogen to the atmosphere through the off-gases from driers, digesters and open process equipment.

Table 1 presents data on nitrate levels in influent liquids and residual solids from a wide range of municipal sewage treatment plants as studied by Metcalf and Eddy. Both primary sludges and digester sludges range as high as 60,000 mg/L (ppm) of total nitrogen.

Industrial Chemicals

Industrial chemicals and chemical wastes are generally a smaller source than those identified above. In the US chemical industry, non-gaseous industrial nitrogen compounds typically reach the environment through:

- Industrial discharges into municipal wastewater treatment systems followed by treatment and water discharge into surface water bodies;
- On-site wastewater treatment to permit-driven standards and discharge into surface receiving waters;
- Land disposal of the solids and sludges from either of these types of treatments; and
- Direct spills of nitrogen-bearing chemical products or chemical/industrial wastes.

As mentioned above, however, in biotic environments, nearly all inorganic nitrogen compounds, upon exposure to water and oxygen, are readily converted to nitrites, then nitrates, by ubiquitous natural biochemical processes in surface water bodies and runoff channels. Therefore, nearly any industrial spill or release of inorganic nitrogen compounds that is exposed to atmospheric oxygen and soil or water bacteria will eventually be converted to nitrate. For this reason, ammonia nitrogen compounds that reach groundwater through surface spills, will eventually be exhibited in groundwater as nitrate, not ammonia nitrogen.

3.0 Potential Sources of Groundwater Nitrate

Table 2 provides a summary of industrial, commercial, agricultural and municipal sources of nitrogen compounds from which potential candidate sources for the Mill nitrogen can be elicited. The list does not itemize every scientifically known nitrogen compound. That is, it does not include short-lived or rare compounds synthesized solely for research purposes. For brevity, in many cases the list presents a class of compounds or types in lieu of naming every species in the category.

The upper section of the table identifies those compounds and classes of materials that could be expected to be present on the Mill site or in the vicinity of the Mill. The lower section completes a broader survey of compounds and sources and indicates why they are not or are likely not present at or proximal to the Mill.

The potential sources are evaluated and discussed in more detail in the sections below.

3.1 On-Site Sources at the Mill

The Mill commenced operations in May 1980, and operated on a campaign basis at near full capacity on conventional ores from the Colorado Plateau (uranium-vanadium ores) and Arizona Strip (uranium ores) until 1991. The Mill also processed conventional ores

for short durations in 1995 from the Arizona Strip and in 1999 from the Colorado Plateau. In addition, commencing in 1993, the Mill processed finite volumes of alternate feed materials from several Formerly Utilized Sites Remedial Action Program (FUSRAP) sites and from other uranium and metal industry sources. As indicated in my evaluations of alternate feed characteristics since 1997, alternate feed materials have never been an appreciable source of nitrogen compounds, never exhibiting more than ppm levels in finite volumes of materials that have either been stored in closed containers or have remained on the ore pad less than a few months before processing. Based on this history, the potentially larger sources of nitrogen introduction into the Mill likely preceded and were independent of the alternate feed program.

Tables 3a and 3b provide integrated lists of nitrogen-bearing laboratory and bulk reagents stored and used on the Mill site. Nitrogen-bearing compounds are shown highlighted in italics in the lists. Potential sources of groundwater nitrogen from among these and other materials on the Mill site are discussed below.

Septic Leach Fields

As mentioned above, both the US EPA and US Geological Survey consider septic systems to be one of the largest sources of nitrate loads to surface water and groundwater, nationwide. The Mill has several operating or historic septic leach fields. The locations of these leach fields are indicated on the attached Figure 4. Some key facts relating to these leach fields are discussed below.

The Former Office Leach Field (located south east of the Mill's Administration Building) is no longer in use. It was used in the early 1980's to accept septic waste from the Mill's administration building. For a short period of time, it also accepted wastes from the Mill's chemical and metallurgical laboratories, until Cell 1 was completed in 1981;

The Scale House Leach Field (located south west of the Scale House) may no longer be in use (see discussion under Main Leach Field below). It was used until the mid 1980's to accept septic waste from the restroom in the Scale House. It also accepted laboratory wastes from the temporary laboratory in the Scale House from around 1977 until the main laboratories in the Mill's administration building were commissioned in 1980;

The Cell 1 Leach Field (located just east of Cell 1) is currently used to accept septic wastes from the restrooms in the Mill's Central Control Room and SX Building;

The SAG Leach Field (located just north of the Mill building) was used to accept septic waste from the restroom in the Shifter's Office near the SAG Mill. It is currently operable, but that office and restroom have been closed since the 1999 Mill run. The toilet at that location is currently not operable.

The Main Leach Field (located east of the ore pad) was put into use in the mid 1980's and is currently in use. Septic wastes from the restrooms in the Administration Building, the Maintenance Shop, the Warehouse and the Changing/Shower rooms are piped to the Sewage Vault, located under the current yellowcake storage area, where it is pumped to the Main Leach Field. There is a pipe from the Scale House to the Sewage Vault; however, effluent is not entering the Sewage Vault from that pipe, which suggests that the waste from the Scale House restroom is still being discharged into the Scale House Leach Field, or there could possibly be a breach in the pipe somewhere and the Scale House waste may be discharging at that point.

Two of these leach fields (the Scale House Leach Field, and the Former Office Leach Field) are believed to be the source of the existing chloroform contamination at the Mill, due to the historic disposal of laboratory wastes in those leach fields (see the discussion below relating to Mill Laboratories). Nitrate, along with chloroform, has been sampled in all of the chloroform investigation wells as part of the chloroform investigation. Attached as Table 4 to this report is a list of all chloroform and nitrate sample results from the chloroform investigation, as taken from the Mill's 2nd Quarter 2008 Chloroform Monitoring Report. Attached as Table 5 to this report is a table prepared by DRC and attached to the draft September 15, 2008 Request for Additional Information, which shows nitrate concentrations in monitoring wells within the chloroform contamination plume and highlights in yellow nitrate concentrations in those wells that have exceeded the GWQS of 10 mg/L.

In addition, as described below, prior to the construction of Cell 1, the Mill laboratories have also discharged a variety of non-septic nitrogen-bearing chemical solutions to several of the leach fields.

From this information, it is clear that the Scale House Leach Field and Former Office Leach Field have contributed Nitrate to groundwater at the site. It is possible that the other septic leach fields alone, or in conjunction with these two leach fields have given rise to or contributed to the nitrate contamination that is the subject of this report. A number of these other leach fields are either upgradient or cross-gradient to such nitrate contamination. In particular, the SAG Leach Field is located upgradient of the nitrate plume. The Main Leach Field has been the Mill's main septic leach field since the mid 1980's, and is located upgradient/crossgradient of the nitrate plume.

Because the SAG Leach Field is upgradient of the nitrate plume and the Main Leach Field is located upgradient/crossgradient of the nitrate plume, they should be given a high priority in the Sampling Plan.

Frog Pond

Until the early 1990s, process water for the Mill was limited to the deep water supply wells on site, and the Mill sought additional sources of process water. Recapture Reservoir was not constructed until 1988-1989, and the pipeline from Recapture Reservoir to the Mill was not completed until around 1991-1992. From the mid 1980s

until the Recapture Reservoir water was first piped to the Mill in 1991-1992, effluent from the regional sewage treatment plant, north-east and upgradient of the Mill site served as an additional water source for Mill operations.

The two ponds associated with the water treatment facility are unlined. Effluent and seepage from the water treatment plant flows to Corral Canyon, just east of the Mill site. This flow was dammed by local ranchers prior to construction of the Mill to form a pool just north of the entrance to Corral Canyon. This pool exists today and is referred to as the "Frog Pond". Discussions with personnel at the City of Blanding have confirmed that the water in the Frog Pond is fed by the water treatment facility.

At the Frog Pond an electric pump carried the water for use at the Mill via an underground pipe to the old irrigation ditch along the ridge west of current Mill air particulate monitoring station BHV-1 at the rate of about 200 gallons per minute (gpm). The water was discharged into this ditch, which flowed south toward the Mill area. Just north of the Mill's restricted area, the water could be diverted to either the northern most wildlife pond (the "Upper Wildlife Pond") or to a secondary pond, referred to as "Lawzy Lake". At the Upper Wildlife Pond a diesel pump was activated when water was needed in the Mill. Water was then pumped from the Upper Wildlife Pond to the Mill's pre-leach tanks, which acted as water storage for the Mill. The water in Lawzy Lake was gravity fed via a pipe to a sump (the "Lawzy Sump") within the restricted area. Once the water reached the Lawzy Sump, it was pumped via a pipe to the pre-leach tanks for water storage. None of the ditches, the Upper Wildlife Pond or Lawzy Lake are lined.

The locations of the water treatment ponds, the Frog Pond, the Upper Wildlife Pond and Lawzy Lake are shown on Figure 3. The various ditches and pipelines connecting Lawzy Lake to Lawzy Sump, the wildlife ponds to the SAG leach field, and the sewage vault to the Main Leach Field are shown on the attached Figures 4 and 5.

Water was pumped from the Frog Pond to the Upper Wildlife Pond and/or Lawzy Lake as needed during operations. During periods of full operations, those ponds were filled with water from the Frog Pond several times per year, and sometimes several times per month.

Anecdotal evidence suggests that the waste treatment facility experienced upsets and leakages in their post-treatment sludge ponds, resulting in discharges of sewage sludge and/or sludge-laden water from the plant to the Frog Pond. The sludge-laden waters exhibited a strong septic/sewage odor in the channel, in each ponded area, in the Lawzy Sump, and where it entered the uranium leach circuit. Various Mill staff described adding the sludge-laden water to the Mill process at rates varying from 25 to 200 gpm depending on the specific needs of the ore run (at normal operating rates the Mill consumes and evaporates approximately 650 gpm). This use of pond water was finite and lasted until about 1992, when Recapture Reservoir water became available.

As discussed above, sanitary sewage byproducts are extraordinarily high in nitrates and other nitrogen-bearing compounds concentrated in the precipitation, concentration and

digestion steps of the sewage treatment process. As mentioned in Table 1, typical sludge exhibits nitrogen contents ranging up to 60,000 ppm. Because sewage sludge has already undergone chemical treatment and, in some plants, bio-oxidation, the majority of the nitrogen content is present in the nitrated form.

This source review did not include any study of the size, process configuration or operational practices of the regional sewage treatment plant at the time of reuse of its effluent at the Mill. It is not known whether the plant had primary (suspended solids), secondary (biological treatment and disinfection), or tertiary (color, odor and polishing) treatment. Based on the location and time period under consideration it is likely the plant was limited to primary and/or secondary treatment. The data in Table 1 is relevant and representative because it represents an overview of nationwide treatment plants, including some of greater sophistication, collected in the late 1970s through 1980, the same approximate period as the source considered here was likely constructed.

Although the Mill's use of sewage-based water ceased in the early 1990's, sediments and residuals from the Frog Pond and transfer ponds remained and may still be detectable by soil sampling or additional groundwater sampling. However, nitrate concentrations would be expected to diminish significantly over time due to natural biodegradation, and current nitrate levels would be expected to be lower than when these structures were actively used.

This source could be the sole or a significant contributor to the nitrate plume at the Mill site, and is upgradient to the most upgradient well in question (TW4-25). Furthermore, the fact that the water from the Frog Pond was conveyed on the surface, via pipeline or irrigation ditch, to the Mill site, could explain why high nitrate concentrations have not been observed in the Mill's most upgradient monitoring wells, MW-1, MW-18 and MW-19, as noted by DRC.

For these reasons, the Upper Wildlife Pond, Lawzy Lake and the Lawzy Sump should be given a high priority in the Sampling Plan.

Fly Ash Pond

From 1980 to 1989, the Mill used a coal-fired steam boiler for operations. Fly ash and bottom ash from combustion of bituminous Colorado Plateau coal were disposed of primarily in tailings Cell 2. However, the ash disposal system did not always work as intended, due to the high clinker volume in the ash. In upset situations, the fly ash was disposed of in a pit referred to as the "Fly Ash Pond" that was located just north of TW4-24. The Fly Ash Pond was originally built to hold construction water. The location of the Fly Ash Pond is indicated on Figures 4 and 5.

The Fly Ash pond was located in the area of the Mill close to tailings Cell 1 that was designed to catch surface runoff from the site and direct it into the tailings cells, that is, it was a low area. As a result, the pit was often filled with water after rainfalls, and came to be referred to as a pond. Because it was often the focal point for runoff from the Mill's

ore pad and process facilities, it may also have accumulated any runoff from surface spills of re-agents or process streams that could potentially have occurred during the history of Mill operations. For example, any potential upsets in the nearby vanadium circuit (which could contain nitrates, as discussed below) that may have resulted in spills to the surface could have potentially impacted the Fly Ash Pond.

The Fly Ash pond was emptied out and the deposited fly ash was disposed of in Cell 2 in 1989. The emptied pit was filled with random fill and use of the pit ceased at that time. However, because the area where the Fly Ash Pond had been located is at a relatively low point, it has until recently continued to pool rainwater and has frequently been covered in standing water during storms, overflowing onto the surrounding surface. This area was re-graded and re-contoured in 2007 in an effort to better direct the runoff water to tailings Cell 1 and to thereby minimize this pooling.

As discussed in Section 2, above, coal and coal-based combustion ash may exhibit up to percent levels (tens of thousands of ppm) of bound or oxidized nitrogen. As also mentioned, oxidized, distilled, and treated coal residuals were the chemical industry's most important source of nitrogen chemicals before the advent of high pressure synthesis technology. The Fly Ash Pond could therefore be considered to be a potential source for nitrate contamination in groundwater at the site. However, because the Fly Ash Pond is located several hundred feet downgradient of TW4-25 and the upgradient boundary of the plume, the Fly Ash Pond should not be considered to be a first priority in the Sample Plan.

Potential Spills from Uranium and Vanadium Circuit Chemicals

The Mill uses ammonia or amine compounds at several points in the processing circuits. A summary of nitrogen-bearing compounds used in the Mill's processes, from the Operations Chemical Inventory in the Mill's SPCC Plan is provided in Table 3a. Anhydrous ammonia is stored as a gas in the tank farm before it is volatilized in a vaporizer for 1) introduction to the yellowcake precipitation area and 2) pH adjustment in the vanadium circuit. In these circuits, ammonia is dissolved into aqueous process streams as ammonium hydroxide.

Ammonium sulfate, purchased and stored both as powdered solid and aqueous solution, is added to the vanadium precipitation circuit. An organic amine, purchased and stored as a liquid, is added to the solvent extraction (SX) circuit; however it is present in only trace amounts in both the SX and counter-current decantation (CCD) areas.

Spills and overflows of these materials within the process buildings enter the floor drains and are transferred to the tailings system. The process circuits and floor drains and sumps that could historically have held or carried these solutions are designated on Figure 5.

Based on information from Mill personnel, there has been no history of failures or upsets of the storage tanks, drums, or powder containers of the liquid or solid materials in the

tank farm or in transfer to the Mill buildings. Although some of these materials contain high concentrations of fixed or bound nitrogen, spills of these materials are too finite a phenomenon to account for an ongoing plume on their own.

There is no history of spills or upsets of the anhydrous ammonia tank system. If an upset were to occur in this system it would, in any case, generate primarily a gaseous emission, not a liquid or solid discharge to the tank farm pads and berms.

The only potential ongoing source within the current Mill operations is theoretically the vanadium and/or uranium circuit floor drain systems. Within the process buildings, spills, overflows, wash-downs and other process waters containing ammonium hydroxide (generated from the anhydrous ammonia), ammonium sulfate, and organic amine enter the floor drain system from time to time and are transferred by above-ground pipe to the tailings system. The floor drains are typical concrete box channels with top gratings, designed to receive, collect, and channel spills, vessel overflows and drain-outs, and wash-down waters to the tailings transfer lines. The types of activities that transfer nitrogen-bearing solutions to the floor drains are ongoing and can be relatively frequent during operational periods.

At the current time, there is no reason to expect that there are breaches or breaks in the floor drains or the tailings transfer lines. As a result, the floor drains and transfer system are an unconfirmed potential source.

However, for the foregoing reasons, and because all of the process circuits, floor drains and sumps are located downgradient of TW4-25 and the upgradient boundary of the plume, these should be considered to be low priority potential sources and hence given a low priority in the Sample Plan.

Mill Laboratories

Table 3b lists nitrogen-bearing chemicals used and stored in small quantities in the Mill's on-site chemical and metallurgical laboratories. The laboratories stored and used small (from 100ml vials to kilogram and liter quantities) of a variety of nitrogen-bearing compounds as reagents, titrants, indicators, separating agents, and surfactants, for sample preparation, extraction, and testing steps and received additional nitrogen-bearing process samples from various points in the vanadium circuit for QC testing. Testing materials, residuals, rinsates and other chemicals that reached the lab sinks and lab drain systems were, as required by the Mill's license conditions, discharged to the tailings system commencing in June 1981, after completion of tailings Cell 1. Between around May 1980 and June 1981, laboratory wastes were discharged to the Former Office Leach Field. Some nitrogen may therefore have been discharged to the Former Office Leach Field prior to June 1981. In addition, potential leaks or breaches in the lab drain system could also theoretically be a potential source of groundwater nitrogen, in part due to the sheer number of different types of nitrogen compounds they may have transported. However, the mass of nitrogen contained in the small volumes of bottled reagents and process samples in the labs, even if their contents entered the drains in their entirety, are

likely too insignificantly small to account for the observed nitrate plume. Furthermore, the Mill's laboratory is located downgradient of TW4-25 and the upgradient boundary of the nitrate plume. Therefore, the laboratory areas should be given a relatively low priority in the Sample Plan.

Tailings

The Mill's tailings cells contain nitrogen in both the ammonia and nitrate forms. Mill tailings solutions have been sampled from time to time over the Mill's history. Care must be taken in interpreting sample results, because the concentrations of analytes in tailings solutions can vary significantly from one sample event to another, depending on:

- whether or not the Mill is operating,
- whether or not it is re-circulating tailings solutions into the process or adding fresh water to the process, and
- the extent to which evaporation or rainfall have affected concentration or dilution prior to sampling.

The Statement of Basis for the Mill's GWDP reports that sample data from September 1980 through March 2003 showed a range for nitrite /nitrate in the Mill's tailings solutions of 17.0 mg/L to 49.2 mg/L, with an average of 30.91 mg/L. Recent sample results obtained in September 2006 show concentrations of nitrite and nitrate in the solutions in the slimes drain for Cell 2 of 30.9 mg/L that are consistent with these historic results. The average concentrations for nitrite and nitrate in the pond solutions in Cells 1 and 3 were 254 mg/L and 102 mg/L, respectively, which are somewhat higher than those historic numbers, possibly demonstrating the results of evaporation in those ponded areas prior to sampling.

The presence of nitrate, as well as ammonia, in the Mill's tailings is reasonable and expected for the reasons discussed above, and summarized here:

- The Mill uses ammonia and amine nitrogen in several locations in the process and re-circulates solutions of these materials to the tailings system – yielding large masses and concentrations of ammonia nitrogen in tailings;
- The Mill introduced nitrate nitrogen, albeit for a finite period of two years, into the uranium circuit and ultimately to the tailings system – yielding smaller masses and concentrations of nitrate nitrogen in tailings; and
- Other sources of nitrogen (such as fly ash) and surface runoff containing nitrogen compounds, were exposed to atmospheric oxidizing conditions before they were transferred to tailings – yielding smaller masses and concentrations of nitrate nitrogen in tailings.

As a result, it is reasonable to expect and detect both a low level of nitrate and a higher level of ammonia nitrogen in the tailings.

As discussed above, in biotic systems, ammonia nitrogen is readily converted to nitrite and nitrate. In abiotic (non-living) systems, such as the tailings, this is not the case. Ammonia nitrogen is soluble and stable in water in a non-living, non-oxidized system. It remains in water in either ionized or unionized form, switching easily between the two, depending on the pH of the solution. In aqueous systems with high pH, ammonia remains in the non-ionized NH_3 form. At neutral pHs and in low pH (acidic) systems such as tailings, ammonia is present primarily in the ammonium ion form (NH_4^+). In the abiotic, hot, acidic, low-oxygen, nutrient- and microbe-deficient environment of the tailings solutions, ammonia nitrogen is not converted to nitrate (however, nitrate that enters the system as nitrate remains as nitrate).

Like abiotic aqueous systems, groundwater also does not normally exhibit either the aggressive chemical oxidizing or biologically enzyme-catalyzed conditions to convert ammonia nitrogen into nitrite/nitrate. Hence, ammonia nitrogen that reaches groundwater directly through failure of surface impoundment or structure liners, which has not been exposed to atmospheric oxygen and bacteria *before* reaching groundwater, generally would be expected to remain and be detected as ammonia or ammonia nitrogen, not nitrate/nitrite, in groundwater.

In order for an ammonia nitrogen source to appear in groundwater as nitrate, it would need to reach groundwater via a surface spill in which it would have time to be converted to nitrate by chemical or biological processes *before* reaching groundwater.

Because the Mill's tailings contain nitrate, the tailings cells are included here as a potential source of nitrate in groundwater. However, given that:

- recent studies have indicated that the Mill's tailings cells are not leaking , (including the July 2007 Hurst and Solomon Mill sampling event summary, the INTERA Revised Background Groundwater Quality Report, November 2007 INTERA Revised Evaluation of Pre-Operational Background Data, and the April 2008 INTERA Revised Background Groundwater Quality Report).
- the nitrate plume has been detected in high concentrations in TW4-25, which is almost a quarter of a mile upgradient of the Mill's tailings cells;
- There appears to be no groundwater mounding under the tailings cells (see Figure 2),

it would appear that although the Mill's tailings cells are a potential source of the nitrate contamination, they are not a likely source of the contamination and should not be given a high priority in the Sample Plan.

Other Surface Disposal Areas

During the Mill's earlier history, the site contained a short-lived landfill for non-contaminated Mill solid wastes. The landfill received non-hazardous debris and office trash until it was shutdown in approximately 1982. All of the contents of that landfill were excavated and disposed of in the solid waste disposal area of tailings Cell 2.

The location of this landfill is indicated on Figures 4 and 5.

While the landfill may have contained nitrogen-bearing compounds from food waste, soap containers, and organic garbage, it would have been present at minutely low levels. Unless chemical materials or sewage related solids were inadvertently placed there, it is unlikely that the former landfill could pose an important source for the groundwater nitrate plume, and should not be given a high priority in the Sample Plan.

Historic Pre-Mill Sources

Prior to construction of the Mill and related facilities, the Mill property was privately owned and was used for cattle grazing. A barn and corral were located in the area close to the current dike between Cell 1 and Cell 2, west of monitoring well TW4-24. Also, a stock watering pond (the "Historic Pond") was located northwest of the Mill's administration building, where the Mill's sulfuric acid tank is currently located. There was no irrigation or agriculture on the land. An aerial photo depicting the land use prior to construction of Mill facilities is attached as Figure 6.

The Historic Pond was dammed and put in place many years prior to construction of the Mill. In fact, it had the recognition of being the first dam built in Utah by a gas-powered tractor, so it probably dates back to approximately the 1920s. The Historic Pond was displaced by Mill facilities when the Mill was constructed. The main sulfuric acid tank at the Mill currently located on the site of the former Historic Pond. Many years of livestock watering at the Historic Pond could have contributed significant amounts of nitrate to the local soils and the pond. Pooled water in the pond could have provided a sufficient head to drive this nitrate to groundwater. As the Historic Pond is a reasonable source of nitrate over many years, and is located upgradient of the nitrate plume, it should be given a priority in the Sample Plan.

It is also possible that the historic barn and corral could have been a source of nitrate at the site. However, in the absence of standing water at that location, it is not likely that such a source could have impacted groundwater. Also, the location of this potential source is downgradient of the upgradient boundary of the current nitrate plume. For these reasons, this potential historic source of nitrate should not be given a high priority in the Sample Plan.

3.2 Offsite Sources

The Mill is located south of Blanding, Utah in a rural agricultural region of the state. Land uses proximal to the Mill include farming, ranching, cattle grazing, feed and grain silos, and the municipal wastewater treatment plant that serves Blanding and some of the surrounding area. A substantial number of farms and ranches are likely not connected to the municipal treatment facility and likely use septic systems for domestic sewage. Direct fertilization with swine or cattle manure is also still practiced in rural Utah. The town of Blanding, population 3,162 (2000 census), is approximately 5 miles north-northeast of the Mill boundary.

One potential offsite source of nitrate is the management of livestock on properties adjacent to the Mill's restricted area, which are subject to cattle grazing leases. Such cattle use the wildlife ponds for drinking water, and may have contributed nitrate to the wildlife pond area. However, any addition of nitrate into the wildlife ponds from livestock would be commingled with, and minimal compared to, the addition of nitrate into the wildlife ponds from the Frog Pond waters. Therefore there is no need to perform any additional investigations relating to livestock influences at the wildlife ponds. If the wildlife ponds are determined to be the source of the nitrate plume, then it would be reasonable to assume that the nitrate in the wildlife ponds could have originated from a combination of the Frog Pond Water and these livestock activities.

It should be noted that nitrate in surface waters, estuarine, riparian, and humic surfaces is a plant nutrient (hence the widespread use of nitrate fertilizers in agriculture). Nitrate in these environments will be uptaken and converted by terrestrial and aquatic plants, plankton, and algae in a cycle over time (nitrates are stable and non-volatile so they do not vaporize directly to air from aqueous solutions). The total nitrate mass in such a system is re-distributed among the sediments and precipitates, benthic materials, aquatic plants and microorganisms, terrestrial plants and microorganisms, and macro-organisms in the system in a cycle, whether the nitrate entered the system through aqueous transport or soil deposition. Therefore the wildlife ponds could once have exhibited higher concentrations of nitrate and been the source or contributor to a nitrate plume, even though the current water in the wildlife ponds does not presently demonstrate high concentrations of nitrate.

Although this study did not include a rigorous itemization of all regulatory-listed sites or contamination sources upgradient and side gradient of the Mill, overall, there are many potential past and ongoing agricultural and domestic sources that may also affect the nitrogen balance in groundwater entering the Mill boundary. However, because upgradient monitoring wells MW-1, MW-18, and MW-19 do not indicate high concentrations of nitrate, it is unlikely that any of these offsite sources are a continuing source of the nitrate contamination. While it is possible that agricultural practices on neighboring properties that occurred at some time in the past (but which no longer occur) could have contributed a slug of nitrate contamination to groundwater that has passed by the upgradient monitoring wells and that now forms the nitrate plume at the site, this would appear to be unlikely and should not be a high priority in the investigation.

4.0 Conclusions

Based on the foregoing information, it can be concluded that:

1. There are several reasonable potential sources for nitrates in Mill groundwater:

- The septic leach fields at the site;
- The municipal sewage plant discharge water used historically as Mill water makeup;
- Livestock activities at the wildlife ponds;
- Livestock activities at the Historic Pond;
- The former Fly Ash Pond;
- Potential historic spills of ammonia-bearing process chemicals;
- Potential breach in the vanadium circuit floor drains or tailings transfer lines; and
- A potential leak in the Mill's tailings cells.

To date, the nitrate plume has been identified to extend as far as TW4-25, but is still unbounded at the upgradient edge. Of the potential sources listed above, the only ones that originate upgradient of the plume are:

1. the waters from the Frog Pond (the Upper Wildlife Pond, Lawzy Lake and the Lawzy Sump), including potential livestock activity near the wildlife ponds;
2. possible livestock activity near the Historic Pond; and
3. possible influences from septic leach fields at the site, in particular the SAG Leach Field and the Main Leach Field.

The other on-site potential sources would not appear to be able to explain the nitrate contamination in TW4-25 or further upgradient. In addition, contamination due to spills would appear to be too small and infrequent to give rise to the plume, and there is no apparent reason to expect a breach in process facilities and drains that would give rise to the plume.

5.0 Recommendations

As a result of the findings in this report, it is recommended that a groundwater sampling program should be developed to confirm or eliminate some of the sources enumerated above. Attention should be focused initially on defining the north and northeast (upgradient) boundaries of the nitrate plume, and in so doing further investigate the possibility of contamination from the Frog Pond (and livestock), the Historic Pond and/or the SAG and Main Leach fields as the source of the nitrate contamination in the groundwater. If the results of those investigations prove to be inconclusive, then further investigations would be warranted.

JoAnn Tischler

Jo Ann Tischler
Consulting Chemical Engineer

cc: David C. Frydenlund
Steven D. Landau
Harold R. Roberts
Ron F. Hochstein

Enclosures: Attachments

References

1. Davidson, Robert. Nitrogen in Coal. Center for Applied Energy Research. January 1994.
2. Haber, Fritz. The Synthesis of Ammonia from Its Elements. Nobel Prize Lecture June 2, 1920.
3. Metcalf and Eddy, Inc. Revised by George Tchobanoglous. Wastewater Engineering: Treatment, Disposal, Reuse. Second Edition. New York. McGraw-Hill. 1979
4. McQuillan, Dennis. Ground-Water Quality Impacts from On-Site Septic Systems. Proceedings, National Onsite Wastewater Recycling Association, 13th Annual Conference. Albuquerque. November 2004.
5. Sax, N. Irving, and Lewis, Richard J. Sr. Editors. Hawley's Condensed Chemical Dictionary, Eleventh Edition. New York. Van Nostrand Reinhold Company. 1987
6. United Kingdom, Department of Environment, Food and Rural Affairs. Nitrogen Dioxide in the United Kingdom. Accessed October 27, 2008 at <http://www.defra.gov.uk/environment/airquality/publications/nitrogen-dioxide/nd-chapter2.pdf>
7. US EPA. Consumer Factsheet on: Nitrates/Nitrites. Accessed October 15, 2008 at <http://epa.gov/volunteer/stream/vms57.html>
8. US EPA. Monitoring and Assessing Groundwater Quality 5.7 Nitrates. Accessed October 15, 2008 at <http://epa.gov/safewater/dwh/c-ioc/nitrates.html>
9. US EPA. Technical Factsheet on: Nitrate/Nitrite. Accessed October 15, 2008 at <http://epa.gov/safewater/dwh/c-ioc/nitrates.html>
10. U.S.Geological Survey. BASIN: General Information on Nitrogen. Accessed October 10, 2008 at <http://bcn.boulder.co.us/basin/data/NUTRIENTS/info/NO3+NO2.html>
11. U.S.Geological Survey. USGS Nitrate Study Shows Water Supply Threatened from Residential Septic Systems. Accessed October 28, 2008 at <http://www.usgs.gov/newsroom/article.asp?ID=1816>

Table 1: Nitrogen from Sewage Sources

	Sewage Plant Influent		Sewage Plant Primary Sludges			Sewage Plant Primary Sludges			Sewage Plant Digested Sludge			Sewage Plant Digested Sludge		
	Range (mg/L or ppm)	Mean (mg/L or ppm)	Range (percent)	Typical (percent)	Range (mg/L or ppm)	Typical mg/L or ppm)	Range (percent)	Typical (percent)	Range (percent)	Typical (percent)	Range (mg/L or ppm)	Typical mg/L or ppm)	Range (mg/L or ppm)	Typical mg/L or ppm)
Organic N	8 to 35	21.5	---	---	---	---	---	---	---	---	---	---	---	---
Free Ammonia	12 to 50	31	---	---	---	---	---	---	---	---	---	---	---	---
Nitrite	0	0	---	---	---	---	---	---	---	---	---	---	---	---
Nitrates	0	0	---	---	---	---	---	---	---	---	---	---	---	---
Total N	20 to 85	52.5	1.5 to 6.0	2.0	15000 to 60,000	20,000	1.6 to 6.0	4.0	16000 to 60,000	40,000	---	---	---	---

Source: Metcalf & Eddy. Wastewater Engineering Treatment/Disposal/Reuse Second Edition

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Adogen 283, 382, 2364, 2382	Fabric softeners, ore separation, detergents, corrosion inhibitors, bactericides, inks, antislip agent, waterproofing, chemical intermediates.	Yes. Process reagent.	Yes	None identified.
Aluminum nitrate		Yes. Process reagent.	Yes	None identified.
Ammonia and ammonium hydroxide	As a fertilizer or in synthesis of fertilizer compounds. Manufacture of nitric acid, hydrazine hydrate, hydrogen cyanide, urethanes, acrylonitriles, fuel cells. Used as refrigerant, in nitriding steel, developing diazo films, dyeing, as a condensation catalyst, yeast nutrient, latex preservative, neutralizer in the petroleum industry. Used in synthesis of synthetic fibers, urea formaldehyde, nitroparaffins, melamine, ethylenediamine, rocket fuel.	Yes. Anhydrous used in vanadium circuit and yellowcake precipitation.	Yes	Wastewater plant and sludge overflow, agricultural sources.
Ammonio-cupric sulfate (ammoniated copper sulfate)	Calico printing, manufacture of copper arsenate, insecticide, fiber treatment.	No. None of these processes are present at the Mill.	Yes	Possible. Agricultural sources.
Ammonium dimethyldithiocarbamate	Fungicide	Not used at the Mill.	Yes	Possible. Agricultural sources.
Ammonium dinitro-o-cresolate	Herbicide	Not used at the Mill.	Yes	Possible. Agricultural sources.
Ammonium linoleate	Emulsifier for oils, waxes, hydrocarbon solvents, detergents, water-repellants, surface tension reducer.	No. None of these processes are present at the Mill.	Yes	Wastewater plant and sludge overflow.
Ammonium nitrate NH_4NO_3	Fertilizer, explosives, pyrotechnics, herbicide, insecticide, synthesis of nitrous oxide, solid rocket proellant, freezing mixtures, nutrient for antibiotic and yeast synthesis.	Possibly. 1. Trace quantities only in ore. 2. Trace quantities only in lawn care and topsoil fertilizing.	Yes	Wastewater plant and sludge overflow, agricultural sources.
Ammonium polyphosphate (urea ammonium polyphosphate)	Liquid fertilizer.	Possibly.	Yes	Wastewater plant and sludge overflow, agricultural sources.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Ammonium sulfate (NH ₄) ₂ SO ₄	Fertilizers, water treatment, fermentation, fireproofing compounds, viscose rayon, tanning, food additive.	Yes. Used in vanadium precipitation.	Yes	Possible. Agricultural sources.
Ammonium vanadate (ammonium metavanadate)	Catalyst as vanadium pentoxide, dyes, varnishes, indelible inks, drier for inks and paints, photography, analytical reagent.	Yes. Intermediate in vanadium circuit.	Yes.	None identified.
Ammonium chlorate	Explosives.	Yes. Possibly trace levels in ores.	Yes	None identified.
Barbituric Acid	Indicator, dyes, polymerization agent, pharmaceuticals	Yes. Lab reagent.	Yes.	None identified.
Barium diphenylamine sulfonate	Separation agent	Yes. Process and lab reagent.	Yes.	None identified.
Brucine sulfate	Separation agent	Yes. Lab reagent.	Yes.	None identified.
Calcium ammonium nitrate CaNH ₄ NO ₃	As 60% ammonium nitrate, 40% limestone in fertilizers	Possibly. Trace quantities only in lawn care and topsoil fertilizing.	Yes	Wastewater plant and sludge overflow, agricultural sources.
Calcium nitrate Ca(NO ₃) ₂ H ₂ O	Salt peter. Pyrotechnics, explosives, matches, fertilizers, preparation of C-14 for nuclear irradiation.	only in ore. 2. Trace quantities only in lawn care and topsoil fertilizing.	Yes	Wastewater plant and sludge overflow, agricultural sources.
Cationic polyacrylamides	Thickening agent, suspending agent, adhesive additive, food additive.	Yes. Process reagent.	Yes.	None identified.
Coal and coal combustion products	Formerly widely used in utility, industrial and residential heaters, boilers, and direct firing. Historically, destructive distillation of coal was significant source of coal tar compounds, ammonia nitrogen, pharmaceutical, and other organic compounds. Used as source of coke for iron and steel manufacture, synthetic fuels, oils, synthesis gas (CO and H ₂).	Yes. Former coal fired burners and coal flyash pond near process buildings.	Yes	None identified.
Dicaphon (CH ₂ O) ₂ P(S)OC ₆ H ₃ (Cl)NO ₃	Insecticide	No. Not used at Mill.	Yes	Wastewater plant overflow, wastewater sludge overflow, agricultural sources.
Dipyridyl a	Reagent for iron determination	Yes. Lab reagent.	Yes.	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Hydrazine	Rocket fuel, oxygen scavenger in boiler water treatment.	Yes. Small quantities in drummed solutions used in boiler area. Sulfate form used in lab.	Yes	None identified.
Nitrites	Corrosion inhibitors in boilers and process water treatment.	Yes. Low levels in boiler area.	Yes	None identified.
o-Nitrobiphenyl/nitro diphenyl	Dyes, fungicide, plasticizer for cellulose, wood preservative.	No. None of these processes are present at the Mill.	Yes	Wastewater plant overflow, wastewater sludge overflow, agricultural sources.
Nitrofurantoin (furazolidone)	Former antibiotic drug for cows.	No. Not used at Mill.	Yes	Possible. Agricultural sources.
Nitrofurantoin	Antibacterial agent.	No. Not used at Mill.	Yes	Possible in wastewater plant overflow, wastewater sludge overflow.
Nitroglycerin	Explosives, medicinals.	Yes. Possible trace levels in ores.	Yes	None identified.
Nitro toluenes (mono, di and tri)	Explosives, urethane synthesis, organic synthesis, toluidines, dyes.	Yes. Possible trace levels in ores.	Yes	None identified.
Other organo amines	Water treatment, enhancement of solvent extraction	Yes, Used in Mill's SX circuit.	Yes	None identified.
Other organo ureas, amino acids, proteins	Ubiquitous in human waste, animal waste, food decomposition, domestic sewage.	Yes. In leach fields, sewage sludge overflow ponds.	Yes	Wastewater plant overflow, wastewater sludge overflow, agricultural sources.
Potassium nitrate KNO ₃	Pyrotechnics, explosives, matches, fertilizer, meat curing, tobacco, glass manufacture, tempering steel.	Possibly. 1. Trace quantities only in ore. 2. Trace quantities only in lawn care and topsoil fertilizing.	Yes	Wastewater plant overflow, wastewater sludge overflow, agricultural sources.
Potassium thiocyanate	Manufacture of sulfocyanides, thioureas, textile dyeing, photofinishing, dyestuffs, medicine.	Yes. Process and lab reagent.	Yes	None identified.
Silver Nitrate	Photofilm, catalyst for ethylene oxide, silverplating, inks, mirror plating, hair dye, germicide, antiseptic and cauterizing agent, lab reagent.	Yes. Process and lab reagent.	Yes	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Sodium nitrate NaNO ₃	Solid rocket fuel, fertilizer, solder flux, glass manufacture, refrigerant, matches, dynamite and gunpowder, pharmaceuticals, aphrodisiac, color fixative/preservative for meat and fish, enamel for pottery, tobacco products.	Yes. Process and lab reagent. Also possibly in fertilizer.	Yes	Wastewater plant overflow, wastewater sludge overflow, agricultural sources.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Ammonio ferric sulfate (ferric ammonium sulfate)	Medicine, textile dyeing.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium acetate	Analytical reagent, drugs, textile dyeing, meat preserving, foam rubber, vinyl plastics, explosives.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium benzene sulfonate	Igniter, chemical synthesis.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium benzoate	Medicine, latex preservative.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium bicarbonate	Production of ammonium salts, dyes, leavening for cookies, crackers, pastry dough, fire extinguishers, pharmaceuticals, foam rubber blowing, boiler scale removal, compost treatment, degreasing textiles.,	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium bifluoride	Ceramics, reagent, glass etching, laundry sour, brewery and dairy sterilizer, beryllium electroplating.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium bioxalate	Analytical reagent, ink removal from fabrics.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium bisulfate	Catalyst in organic synthesis, permanent wave hair solutions.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium bitartrate	Baking powder.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium borate	Fireproofing compounds, electrical condensers, herbicide.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium bromide	Photographic silver precipitation, medicine, engraving, textile finishing, fire retardant, anticorrosive agents, analytical chemistry.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium cadmium bromide (cadmium ammonium bromide)	Plating and preparation of metals.	No. None of these processes are present at the Mill.	NA	Agricultural sources.
Ammonium caprylate	Pesticide, photo emulsions, chemical intermediate.	No. None of these processes are present at the Mill.	NA	Agricultural sources.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Ammonium carbamate	Fertilizer.	No. None of these processes are present at the Mill.	NA	Agricultural sources.
Ammonium carbonate	Ammonium salts, medicine, baking powder, smelling salts, fire extinguishers, pharmaceuticals, textiles, wine fermentation, ceramics, wool washing, organic synthesis.	No. None of these processes are present at the Mill.	NA	Agricultural sources.
Ammonium chloride	Dry batteries, dye and printing mordant, solderflux, synthesis of ammonia compounds, fertilizer, pickling agent in zinc processing, electroplating, washing powders, melt retardant for snow treating, urea formaldehyde resins, bakery products.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium chromate	Dye mordant, photographic coatings, analytical reagent, catalyst, corrosion inhibitor.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium chromium sulfate (chromium ammonium sulfate)	Dye mordant, tanning.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium citrate	Pharmaceuticals, rustproofing, cotton printing, plasticizer, analyzing phosphate in fertilizer.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium cobaltous phosphate (cobaltous ammonium phosphate)	Plant nutrient, glass coloring, glazes, enamels, analytical chemistry.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium cobalt sulfate	Ceramics, cobalt plating, catalyst.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium dichromate (ammoniumbichromate)	Dyeing, pigments, manufacture of alizarin, chrome alum, oil purification, pickling, manufacture of catalysts, tanning, perfumes, photography, engraving, lithography, chromic oxide, pyrotechnics.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium dithiocarbamate	Synthesis of heterocyclic compounds, analytical reagent.	No. None of these processes are present at the Mill.	NA	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Ammonium fluoride	Fluoride synthesis, analytical chemistry, disinfectant in brewing, glass etching, textile mordant, wood preserving, mothproofing.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium fluosilicate	Laundry sours, mothproofing, disinfectant in brewing, glass etching, electroplating, light metal casting.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium formate	Analytical chemistry for precipitating metals.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium gluconate	Emulsifying agent in cheese and salad dressing.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium glutamate (sodium glutamate)	Flavor enhancer in foods.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium hexachlorosmate	Plating.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium hexachloroplatinate	Plating, platinum sponge.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium hexafluoro germanate	Plating.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium hydroxide	Textiles, rayon, rubber, fertilizers, refrigeration, condensation polymerization, photography, pharmaceuticals, soaps, lubricants, fireproofing, ink, explosives, ceramics, ammonium compounds, saponifying fats and oils, detergents, food additives, household cleansers, organic synthesis.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium hypophosphite (phosphine)	Organic preparations, doping agent for semiconductors, polymerization initiator, condensation catalyst.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium ichthosulfonate (ichthammol)	Pharmaceutical preparations, cosmetic preparations, dermatological soaps.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium iodate	Oxidizing agent.	No. Mill does not use this oxidizer.	NA	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Ammonium iodide	Iodides, medicine, photography.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium laurate	Production of oil-water emulsions, cosmetics.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium lignin sulfate (lignin sulfonate)	Dispersing agent in concrete and rubber mixes, tanning, oil well drilling mud, ore flotation, production of vanillin, industrial cleaners, gypsum, dyes, pesticides.	No. Not used in ore flotation at the Mill. None of these processes are present at the Mill.	NA	None identified.
Ammonium molybdate	Reagent, pigments, dehydrogenation and desulfurization catalyst in petroleum refining, production of molybdenum.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium-12-molybdophosphate	Reagent, ion exchange columns, photographic additive, water resistance additive.	No. None of these processes are present at the Mill. Not used in Mill's ion exchange	NA	None identified.
Ammonium-12-molybdosilicate	Catalyst, reagent, precipitant and ion exchange medium in nuclear fuel cycle, photofixing and photo-oxidizing agent.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium nickel chloride	Electroplating, dyeing.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium nickel sulfate	Electroplating.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium nitroso-b-phenylhydroxyl amine (cupferron)	Analytical reagent for separation of metals (copper, vanadium, iron).	Not used at the Mill.	Yes	None identified.
Ammonium oleate	Emulsifying agent in cosmetics.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium oxalate	Analytical chemistry, safety explosives, manufacture of oxalates, rust and scale removal.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium palmitate	Thickening agent of petroleum-derived solvents and lubricants, waterproofing agent.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium pentaborate	Intermediate for boron chemicals, power level controller in nuclear submarine reactors.	No. None of these processes are present at the Mill.	NA	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Ammonium perchlorate	Explosives, pyrotechnics, etching and engraving, analytical chemistry, rocket and jet propellant.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium permanganate	Strong oxidizer.	No. Mill does not use this oxidizer.	NA	None identified.
Ammonium persulfate	Mild oxidizer.	No. Mill does not use this oxidizer.	NA	None identified.
Ammonium phosphate (monobasic, hemibasic, dibasic)	Oxidizer, bleaching agent, photography, printed circuit board etching, copper plating, deodorizing and bleaching oils, analine dyes, food preservative, washing yeast, depolarizing batteries.	No. Mill does not use this oxidizer. None of these processes are present at the Mill.	NA	None identified.
Ammonium phosphite	Wood flameproofing, matches, fertilizer, feed additive, plant nutrient, manufacture of yeast, vinegar, bread, solder flux, fortin, copper, brass, zinc, purifying sugar, toothpastes, pH buffer, metal cleaning.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium phosphotungstate	Reducing agent, corrosion inhibitor added to lubricants and greases.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium picrate	Chemical reagent, ion exchange media.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium polymanuronate (ammonium alginate)	Pyrotechnic, explosives.	Possibly traces in ore.	Yes	None identified.
Ammonium polysulfide	Thickening agent and food stabilizer.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium selenate	Analytical reagent, insecticide.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium selenite	Mothproofing.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium stearate	Alkaloid testing, glass coloring.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium sulfamate	Vanishing creams, shaving cream, cosmetics, waterproofing of cements, concrete, stucco, paper, textiles.	No. None of these processes are present at the Mill.	NA	None identified.
	Flameproofing of textiles and paper, weed and brush killer, electroplating, production of nitrous oxide.	No. None of these processes are present at the Mill.	NA	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Ammonium sulfate nitrate	Strong oxidizer.	No. Mill does not use this oxidizer.	NA	None identified.
Ammonium sulfide	Textiles, photo developer, brass and bronze coloring, soda ash production, synthetic flavors.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium sulfite	Chemical intermediate, medicine, permanent wave solutions, photography, metal lubricant.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium sulforicinate	Medicine, furniture polish.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium tartrate	Textiles, medicine.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium tetrahydroxydianhydride chromate (Reinecke salt)	Precipitating agent for organic bases in pharmaceuticals, amines, amino acids, mercury.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium tetrathionate	Producing high purity tungsten disulfide for catalysts, lubricants, semiconductors.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium thiocyanate	photography, freezing solutions, rocket propellants, zinc coating, weed killer, soil sterilization, defoliant, iron pickling, electroplating, polymerization catalyst, separator for gold, iron, hafnium, zirconium.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium thioglycolate	Hair waving, hair removal.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium thiosulfate	Photographic fixer, reagent, fungicide, reducing agent, silverplating, zinc and metal casting cleaner, fog screens, hair waving solutions.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium titanium oxalate	Cellulose and leather dyeing.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium tungstate	Preparation of tungsten compounds.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium valerate	Flavoring material	No. None of these processes are present at the Mill.	NA	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Ammonium zirconium fluoride (zirconium ammonium fluoride)	Chemical reagent.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonium zirconyl carbonate	Water repellant for paper and textiles, catalyst, latex paint stabilizer, floor wax additive, glass fiber fabrication.	No. None of these processes are present at the Mill.	NA	None identified.
Ammonobasic mercuric chloride (ammoniated mercury)	Topical germicide, medicines.	No. None of these processes are present at the Mill.	NA	None identified.
Amobarbital	Medicine, pharmaceutical, hypnotic.	No. None of these processes are present at the Mill.	NA	None identified.
Aniline	Dyestuffs, rubber accelerators and antioxidants, shoe polish, photographic chemicals, isocyanates for urethanes, explosives, petroleum refining, synthesis of pharmaceuticals, phenolics, herbicides, fungicides.	No. None of these processes are present at the Mill.	NA	None identified.
Beryllium nitrate BeNO ₃	Oxidizer	No beryllium oxidizers used in Mill circuit.	NA	None identified.
Cellulose nitrate/nitrocellulose	Auto lacquers, explosives, colloid for wound dressing and gun cotton, rocket fuel, printing ink, bookbinder's cloth, leather finishing, celluloid film, flashless powder.	No. None of these processes are present at the Mill.	NA	None identified.
Ceric ammonium nitrate.	Oxidant for organic compounds, azide manufacture, polymerization catalyst for polyolefins.	No. None of these processes are present at the Mill.	NA	None identified.
4-Chloro-3-nitrobenzoic acid	Dyes, perfumes, flavors, pharmaceuticals.	No. None of these processes are present at the Mill.	NA	None identified.
2-Chloro-3-nitrobenzene sulfonamide	Dyes, pharmaceuticals	No. None of these processes are present at the Mill.	NA	None identified.
6-Chloro-3-nitro benzene sulfonic acid sodium salt	Dyes, pharmaceuticals	No. None of these processes are present at the Mill.	NA	None identified.
4-Chloro-3-nitro benzoic trifluoride	Dyes, synthesis of agricultural chemicals, pharmaceuticals.	No. None of these processes are present at the Mill.	NA	None identified.
4 Chloro -2 nitrophenol	Dyes, synthesis of amino chlorophenols	No. None of these processes are present at the Mill.	NA	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Chromium nitrate/chromic nitrate	Catalyst, corrosion inhibitor.	No. No catalysts used. No chrome-based inhibitors used.	NA	None identified.
Di-isocyanates	Synthesis of urethane plastics and foams, cross-linking agent for nylon.	No. None of these processes are present at the Mill.	NA	None identified.
Dinitrogen tetroxide	Primarily synthesized as hydrazine oxidizer in rocket fuels.	No. None of these processes are present at the Mill.	NA	None identified.
Ferric nitrate	Dyes, tanning, analytical chemistry.	No. None of these processes are present at the Mill.	NA	None identified.
Lithium nitrate	Ceramics, pyrotechnics, salt baths, refrigeration, heat exchange media, rocket propellant.	No. No refrigeration fluids or heat exchange salts used at Mill. No other uses at Mill.	NA	None identified.
Magnesium nitrate	Pyrotechnics, synthesis of concentrated nitric acid.	No. None of these processes are present at the Mill.	NA	None identified.
Manganous nitrate	Ceramics, catalyst, chemical intermediate.	No. None of these processes are present at the Mill.	NA	None identified.
Nitric acid	Manufacture of ammonium nitrate fertilizer, explosives, dyes, drugs, cellulose nitrate, photoengraving, etching steel, ore flotation, urethanes, rubber, spent nuclear fuel.	No. Leach circuit is based on sulfuric acid, no nitric used. No ore flotation conducted at mill. No spent fuel reprocessing is conducted at the Mill. No other processes are present at the Mill.	NA	None identified.
Strontium nitrate	Oxidizer, pyrotechnics, railroad flares, matches, marine signals.	No. None of these processes are present at the Mill.	NA	None identified.
Thallium Nitrate	Analysis, green pyrotechnics	No. None of these processes are present at the Mill.	NA	None identified.
Silver nitrate	Photofilm, ethylene oxide catalyst, inks, silverplating, mirrors, germicide (wall spray), dyes, antiseptic, wound cauterization, lab reagent.	No. None of these processes are present at the Mill.	NA	None identified.
Silver nitrite	Alcohol synthesis, preparation of oliphatic nitrogen compounds, standards for water analysis.	No. None of these processes are present at the Mill.	NA	None identified.
Nitroacetanilide $\text{NO}_2\text{C}_6\text{H}_4\text{NHCOCH}_3$	Manufacture of nitroaniline.	No. None of these processes are present at the Mill.	NA	None identified.
p-Nitro o-aminophenol $\text{O}_2\text{NC}_6\text{H}_4\text{NH}_2$	Dyes.	No. None of these processes are present at the Mill.	NA	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
m-Nitroaniline	Dye intermediate.	No. None of these processes are present at the Mill.	NA	None identified.
o-Nitroaniline	Dye, synthesis of phlogographic antifog, coccidiostats, o-phenylenediamine	No. None of these processes are present at the Mill.	NA	None identified.
p-Nitroaniline	Dye intermediate, corrosion inhibitors, gasoline gum inhibitors, antioxidants.	No. None of these processes are present at the Mill.	NA	None identified.
o-nitroanisole $C_6H_4OCH_3NO_2$	Dyes, pharmaceuticals.	No. None of these processes are present at the Mill.	NA	None identified.
p-nitroanisole $C_6H_4OCH_3NO_2$	Dyes.	No. None of these processes are present at the Mill.	NA	None identified.
Nitrobenzaldehyde	Dyes, pharmaceuticals, surface active agents (surfactants), mosquito repellent, vapor phase corrosion inhibitor.	No. None of these processes are present at the Mill.	Yes.	None identified.
Nitrobenzene $C_6H_5NO_2$	Manufacture of aniline, cellulose ether solvent, cellulose acetate, metal polish, shoe polish, manufacture of benzidine, quinoline.	No. None of these processes are present at the Mill.	NA	None identified.
Nitrobenzene azo resorcinol	Determination of magnesium.	No. None of these processes are present at the Mill.	NA	None identified.
m-Nitrobenzene sulfonic acid	Organic synthesis, anti-reduction agent.	No. None of these processes are present at the Mill.	NA	None identified.
6-Nitrobenzimidazole	Photo antifogging agent.	No. None of these processes are present at the Mill.	NA	None identified.
Nitrobenzoic acid $C_6H_4(NO_2)COOH$	Dyes, reagent for alkaloids, organic synthesis.	No. None of these processes are present at the Mill.	NA	None identified.
m-Nitrobenzoyl chloride	Dyes, photochemicals, pharmaceuticals.	No. None of these processes are present at the Mill.	NA	None identified.
p-Nitrobenzyl chloride	Dyes, photochemicals, intermediate for procaine hydrochloride (novocaine).	No. None of these processes are present at the Mill.	NA	None identified.
p-Nitrobenzyl cyanide	Dyes, pharmaceuticals, synthesis of p-nitro phenyl acetic acid	No. None of these processes are present at the Mill.	NA	None identified.
Nitrobromoform (bromo picrin)	Military poison, organic synthesis	No. None of these processes are present at the Mill.	NA	None identified.
2-Nitro, 1-butanol	Organic synthesis	No. None of these processes are present at the Mill.	NA	None identified.
Nitro carbon nitrate	Strong oxidizer.	No. Not used at Mill.	NA	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
Nitro chlorobenzene (Chloro nitrobenzene)	Dyes, parathion manufacture, agricultural chemicals, rubber chemicals.	No. None of these processes are present at the Mill.	NA	None identified.
2-Nitro p-cresol	Chemical synthesis intermediate.	No. None of these processes are present at the Mill.	NA	None identified.
o-Nitro diphenylamine	Chemical synthesis intermediate; stabilizer for nitroglycerine.	No. None of these processes are present at the Mill.	NA	None identified.
Nitroethane	Solvent for nitrocellulose, cellulose acetate, dyes, vinyl and alkyd resins, waxes, fats. Used as fuel additive.	No. None of these processes are present at the Mill.	NA	None identified.
2-Nitro-2-ethyl-1,3-propanediol	Organic synthesis.	No. None of these processes are present at the Mill.	NA	None identified.
Nitrous oxide (N ₂ O or laughing gas)	Anaesthetic	No. None of these processes are present at the Mill.	NA	None identified.
Picramic acid	Azo dye synthesis, reagent for aluminum	No. None of these processes are present at the Mill.	NA	None identified.
Picric acid	Explosives, matches, electric batteries, etching of copper, textile dyeing.	No. None of these processes are present at the Mill.	NA	None identified.
Picrolinic acid	Analytical chemistry for estimation of calcium, identification of alkaloids	No. None of these processes are present at the Mill.	NA	None identified.
Picrotoxin	Medicine formulations	No. None of these processes are present at the Mill.	NA	None identified.
Picryl chloride	Explosives	No. This type of explosive is not used in mining.	NA	None identified.
Sodium Azide	Air bag explosive anisters, preservative for diagnostic medicines, intermediate in explosive manufacture.	No. None of these processes are present at the Mill.	NA	None identified.
Toluene diamines	Chain extender and cross linker, synthesis of dyes, polymers, polyurethanes.	No. None of these processes are present at the Mill.	NA	None identified.
Toluidines (amino toluenes)	lignin, reagent for nitrite, vulcanization accelerator.	No. None of these processes are present at the Mill.	NA	None identified.
Zirconium nitrate Zr(NO ₃) ₂ ·5H ₂ O	Preservative.	No. None of these processes are present at the Mill.	NA	None identified.
Zirconium nitride ZrN	Crucibles, cermets, refractories.	No. None of these processes are present at the Mill.	NA	None identified.

Table 2

Nitrogen Compound Sources

Nitrogen Compound or Source ¹	Uses ^{2,3}	Present on Mill Site ⁴	If Present at or Near Mill, Can It Generate Nitrate?	Potential Off Site Sources ⁵
--	---------------------	-----------------------------------	--	---

NOTES

1. Does not include short-lived intermediates and isotopes, research compounds, and insoluble gases.
2. Many of the compounds below, while not synthesized or used regionally or at the Mill, are present at low levels in domestic products in the Mill offices, kitchen areas, shops, and labs.
3. In some cases, only one entry is given for multiple compounds of the same class and same use.
4. Additional chemicals inventoried from 100 ml to kilogram/liter levels at the laboratories are identified in Table 3a.
4. Most nitrogen-bearing organic compounds in sewage plant influent will be present in a converted form as nitrate/nitrite in effluent and sludge.

Table 3a Nitrogen Compounds in Mill Operations Inventory

Adogen 283
 Adogen 382
 Adogen 2364
 Adogen 2382
 Aluminum nitrate solution
 Anhydrous ammonia
 Ammonia inhalants
 Ammonia sulfate
 Ammonia meta-vanadate
 Ammonium hydroxide
 Aqua ammonia
 Barium diphenylamine sulfonate
 Cationic Polyacrylamides
 Silver Nitrate

Table 3b Nitrogen Compounds in Laboratory Inventory

Amino, 4-amino-1-naphthalene sulfonic acid	Hydroxylamine sulfate	
Ammonium acetate	Methyl red	
Ammonium chloride	Methylene blue	
Ammonium hydroxide	Monoethanolamine	
Ammonium iodide	Naphthy, N-(1-naphthy) ethylene-diamine dihydrochloride	
Ammonium meta-vanadate	Nitrazine yellow	
Ammonium molybdate	Nitric acid	
Ammonium nitrate	Nitro-benzene	
Ammonium oxalate, monohydrate	Phenanthroline, 1, 10	
Ammonium persulfate	Phenanthroline, 1, 10 ferrous sulfate	
Ammonium phosphate, dibasic	Phenanthroline, 1, 10 monohydrate	
Ammonium phosphate, monobasic	Phenyl benzohy, N-phenylbenohy-droxamic acid	
Ammonium pyroline, dithiocarbamate	Potassium cyanide	
Ammonium sulfate	Potassium nitrate	
Ammonium thiocyanate	Potassium nitrite	
Ammonium vanadate	Potassium thiocyanate	
Ammonium chloride	Primene, JM-T	solvent
Barbituric acid	Pyridine	
Brucine sulfate	Quinoline	
Cobalt nitrate	Hydroxyquinoline	
Cupferron	Rhodamine	
Cyclohexanedinitrilotetraacetic acid	Silver nitrate	
Diphenylamine sulfonic acid sodium salt	Sodium ammonium phosphate	
Diphenyl, 1,3-diphenyl-1,3-propanedione	Sodium cyanide	
Dipyridyl a	Sodiumnitrate	
Disodium ethylenediamine tetraacetate	Sodium nitrite	
EDTA	Sodium thiocyanate	
Ethylenedinitrilo tetraacetic acid disodium salt	Sulfanilamide	
Ethyl, 1-ethyl-2-[(1,4 dimethyl-2-phenyl-6-pyrimidinylidene)-methyl] quinolone chloride	Sulfanilic acid	
Ferric ammonium sulfate	Thallic nitrate	
Hydrazine sulfate	Tris (hydroxymethyl) aminomethane	
Hydroxyquinolone	Thorin	thorium determination
Hydroxylamine hydrochloride	Urea	

Note to Tables 3a and 3b:

Nitrogen may also be present in adhesives, cements, hardeners, surfactants, detergents, flocculants, paints and cleaning agents used in lab and mill equipment cleaning, and general maintenance.

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample		CHCl ₃ Values	Nitrate Values	Sampling Event
28-Sep-99	MW-4	6200		Shallow Sample
28-Sep-99		5820		Deep Sample
28-Sep-99		6020		Total Sample
15-Mar-00		5520		Quarterly
15-Mar-00		5430		Quarterly
2-Sep-00		5420	9.63	Quarterly
30-Nov-00		6470	9.37	Quarterly & Split Sample
29-Mar-01		4360	8.77	Quarterly
22-Jun-01		6300	9.02	Quarterly
20-Sep-01		5300	9.45	Quarterly
8-Nov-01		5200	8	UDEQ Split Sampling Event
26-Mar-02		4700	8.19	First 1/4 2002 Sample
22-May-02		4300	8.21	Quarterly
12-Sep-02		6000	8.45	UDEQ Split Sampling Event
24-Nov-02		2500	8.1	Quarterly
28-Mar-03		2000	8.3	Quarterly
30-Apr-03		3300	NA	Well Pumping Event Sample
30-May-03		3400	8.2	Well Pumping Event Sample
23-Jun-03		4300	8.2	2nd Quarter Sampling Event
30-Jul-03		3600	8.1	Well Pumping Event Sample
29-Aug-03		4100	8.4	Well Pumping Event Sample
12-Sep-03		3500	8.5	3rd Quarter Sampling Event
15-Oct-03		3800	8.1	Well Pumping Event Sample
8-Nov-03		3800	8.0	4th Quarter Sampling Event
29-Mar-04			NA	Unable to purge/sample
22-Jun-04			NA	Unable to purge/sample
17-Sep-04		3300	6.71	3rd Quarter Sampling Event
17-Nov-04		4300	7.5	4th Quarter Sampling Event
16-Mar-05		2900	6.3	1st Quarter Sampling Event
25-May-05		3170	7.1	2nd Quarter Sampling Event
31-Aug-05		3500	7.0	3rd Quarter Sampling Event
1-Dec-05		3000	7.0	4th Quarter Sampling Event
9-Mar-06		3100	6.0	1st Quarter Sampling Event
14-Jun-06		3000	6.0	2nd Quarter Sampling Event
20-Jul-06		2820	1.2	3rd Quarter Sampling Event
9-Nov-06		2830	6.4	4th Quarter Sampling Event
15-Aug-07		2600	6.2	3rd Quarter Sampling Event
10-Oct-07		2300	6.2	4th Quarter Sampling Event
26-Mar-08		2400	5.8	1st Quarter Sampling Event
25-Jun-08		2500	6.09	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample		CHCl3 Values	Nitrate Values	Sampling Event
28-Jun-99	TW4-1	1700	7.2	Quarterly
10-Nov-99		5.79		Quarterly
15-Mar-00		1100		Quarterly
10-Apr-00		1490		Grab Sample
6-Jun-00		1530		Quarterly
2-Sep-00		2320	5.58	Quarterly
30-Nov-00		3440	7.79	Quarterly & Split Sample
29-Mar-01		2340	7.15	Quarterly
22-Jun-01		6000	8.81	Quarterly
20-Sep-01			12.8	Quarterly
8-Nov-01		3200	12.4	UDEQ Split Sampling Event
26-Mar-02		3200	13.1	First 1/4 2002 Sample
22-May-02		2800	12.7	Quarterly
12-Sep-02		3300	12.8	UDEQ Split Sampling Event
24-Nov-02		3500	13.6	Quarterly
28-Mar-03		3000	12.4	Quarterly
23-Jun-03		3600	12.5	2nd Quarter Sampling Event
12-Sep-03		2700	12.5	3rd Quarter Sampling Event
8-Nov-03		3400	11.8	4th Quarter Sampling Event
29-Mar-04		3200	11	1st Quarter Sampling Event
22-Jun-04		3100	8.78	2nd Quarter Sampling Event
17-Sep-04		2800	10.8	3rd Quarter Sampling Event
17-Nov-04		3000	11.1	4th Quarter Sampling Event
16-Mar-05		2700	9.1	1st Quarter Sampling Event
25-May-05		3080	10.6	2nd Quarter Sampling Event
31-Aug-05		2900	9.8	3rd Quarter Sampling Event
1-Dec-05		2400	9.7	4th Quarter Sampling Event
9-Mar-06		2700	9.4	1st Quarter Sampling Event
14-Jun-06		2200	9.6	2nd Quarter Sampling Event
20-Jul-06		2840	9.2	3rd Quarter Sampling Event
8-Nov-06		2260	9.2	4th Quarter Sampling Event
15-Aug-07		2300	8.4	3rd Quarter Sampling Event
10-Oct-07		2000	7.8	4th Quarter Sampling Event
26-Mar-08		2000	7.6	1st Quarter Sampling Event
25-Jun-08		1900	8.68	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample		CHCl3 Values	Nitrate Values	Sampling Event
10-Nov-99	TW4-2	2510		Quarterly
2-Sep-00		5220		Quarterly
28-Nov-00		4220	10.7	Quarterly & Split Sample
29-Mar-01		3890	10.2	Quarterly
22-Jun-01		5500	9.67	Quarterly
20-Sep-01		4900	11.4	Quarterly
8-Nov-01		5300	10.1	UDEQ Split Sampling Event
26-Mar-02		5100	9.98	First 1/4 2002 Sample
23-May-02		4700	9.78	Quarterly
12-Sep-02		6000	9.44	UDEQ Split Sampling Event
24-Nov-02		5400	10.4	Quarterly
28-Mar-03		4700	9.5	Quarterly
23-Jun-03		5100	9.6	2nd Quarter Sampling Event
12-Sep-03		3200	8.6	3rd Quarter Sampling Event
8-Nov-03		4700	9.7	4th Quarter Sampling Event
29-Mar-04		4200	9.14	1st Quarter Sampling Event
22-Jun-04		4300	8.22	2nd Quarter Sampling Event
17-Sep-04		4100	8.4	3rd Quarter Sampling Event
17-Nov-04		4500	8.6	4th Quarter Sampling Event
16-Mar-05		3700	7.7	1st Quarter Sampling Event
25-May-05		3750	8.6	2nd Quarter Sampling Event
31-Aug-05		3900	8.0	3rd Quarter Sampling Event
1-Dec-05		3500	7.8	4th Quarter Sampling Event
9-Mar-06		3800	7.5	1st Quarter Sampling Event
14-Jun-06		3200	7.1	2nd Quarter Sampling Event
20-Jul-06		4120	7.4	3rd Quarter Sampling Event
8-Nov-06		3420	7.6	4th Quarter Sampling Event
15-Aug-07		3400	7.3	3rd Quarter Sampling Event
10-Oct-07		3200		4th Quarter Sampling Event
26-Mar-08		3300	6.9	1st Quarter Sampling Event
25-Jun-08		3100	7.44	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample		CHCl3 Values	Nitrate Values	Sampling Event
28-Jun-99	TW4-3	3500	7.6	Quarterly
29-Nov-99		702		Quarterly
15-Mar-00		834		Quarterly
2-Sep-00		836	1.56	Quarterly
29-Nov-00		836	1.97	Quarterly & Split Sample
27-Mar-01		347	1.85	Quarterly
21-Jun-01		390	2.61	Quarterly
20-Sep-01		300	3.06	Quarterly
7-Nov-01		170	3.6	UDEQ Split Sampling Event
26-Mar-02		11	3.87	First 1/4 2002 Sample
21-May-02		204	4.34	Quarterly
12-Sep-02		203	4.32	UDEQ Split Sampling Event
24-Nov-02		102	4.9	Quarterly
28-Mar-03		ND	4.6	Quarterly
23-Jun-03		ND	4.8	2nd Quarter Sampling Event
12-Sep-03		ND	4.3	3rd Quarter Sampling Event
8-Nov-03		ND	4.8	4th Quarter Sampling Event
29-Mar-04		ND	4.48	1st Quarter Sampling Event
22-Jun-04		ND	3.68	2nd Quarter Sampling Event
17-Sep-04		ND	3.88	3rd Quarter Sampling Event
17-Nov-04		ND	4.1	4th Quarter Sampling Event
16-Mar-05		ND	3.5	1st Quarter Sampling Event
25-May-05		ND	3.7	2nd Quarter Sampling Event
31-Aug-05		ND	3.5	3rd Quarter Sampling Event
1-Dec-05		ND	3.3	4th Quarter Sampling Event
9-Mar-06		ND	3.3	1st Quarter Sampling Event
14-Jun-06		ND	3.2	2nd Quarter Sampling Event
20-Jul-06		ND	2.9	3rd Quarter Sampling Event
8-Nov-06		ND	1.5	4th Quarter Sampling Event
28-Feb-07		ND	3.1	1st Quarter Sampling Event
27-Jun-07		ND	3.3	2nd Quarter Sampling Event
15-Aug-2007		ND	3.1.	3rd Quarter Sampling Event
10/10/2007		ND	2.8	4th Quarter Sampling Event
26-Mar-08		ND	2.8	1st Quarter Sampling Event
25-Jun-08		ND	2.85	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample		CHCl3 Values	Nitrate Values	Sampling Event
6-Jun-00	TW4-4	ND		Initial
2-Sep-00		ND		Quarterly
28-Nov-00		3.85	1.02	Quarterly & Split Sample
28-Mar-01		2260	14.5	Quarterly
20-Jun-01		3100	14	Quarterly
20-Sep-01		3200	14.8	Quarterly
8-Nov-01		2900	15	UDEQ Split Sampling Event
26-Mar-02		3400	13.2	First 1/4 2002 Sample
22-May-02		3200	13.4	Quarterly
12-Sep-02		4000	12.6	UDEQ Split Sampling Event
24-Nov-02		3800	13.4	Quarterly
28-Mar-03		3300	12.8	Quarterly
23-Jun-03		3600	12.3	2nd Quarter Sampling Event
12-Sep-03		2900	12.3	3rd Quarter Sampling Event
8-Nov-03		3500	12.2	4th Quarter Sampling Event
29-Mar-04		3200	12.1	1st Quarter Sampling Event
22-Jun-04		3500	11.1	2nd Quarter Sampling Event
17-Sep-04		3100	10.8	3rd Quarter Sampling Event
17-Nov-04		3600	11.6	4th Quarter Sampling Event
16-Mar-05		3100	10	1st Quarter Sampling Event
25-May-05		2400	11.3	2nd Quarter Sampling Event
31-Aug-05		3200	9.9	3rd Quarter Sampling Event
1-Dec-05		2800	10.2	4th Quarter Sampling Event
9-Mar-06		2900	9.5	1st Quarter Sampling Event
14-Jun-06		2600	8.6	2nd Quarter Sampling Event
20-Jul-06		2850	9.7	3rd Quarter Sampling Event
8-Nov-06		2670	10.1	4th Quarter Sampling Event
28-Feb-07		2200	9.0	1st Quarter Sampling Event
27-Jun-07		2400	9.4	2nd Quarter Sampling Event
15-Aug-07		2700	9.5	3rd Quarter Sampling Event
10-Oct-07		2500	9.5	4th Quarter Sampling Event
26-Mar-08		2800	9.2	1st Quarter Sampling Event
25-Jun-08		2500	10.8	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample		CHCl3 Values	Nitrate Values	Sampling Event
20-Dec-99	TW4-5	29.5		Quarterly
15-Mar-00		49		Quarterly
2-Sep-00		124	.86	Quarterly
29-Nov-00		255	3.16	Quarterly & Split Sample
28-Mar-01		236	3.88	Quarterly
20-Jun-01		240	6.47	Quarterly
20-Sep-01		240	2.1	Quarterly
7-Nov-01		260	5.2	UDEQ Split Sampling Event
26-Mar-02		260	2.54	First 1/4 2002 Sample
22-May-02		300	3.05	Quarterly
12-Sep-02		330	4.61	UDEQ Split Sampling Event
24-Nov-02		260	1.1	Quarterly
28-Mar-03		240	1.9	Quarterly
23-Jun-03		290	3.2	2nd Quarter Sampling Event
12-Sep-03		200	4	3rd Quarter Sampling Event
8-Nov-03		240	4.6	4th Quarter Sampling Event
29-Mar-04		210	4.99	1st Quarter Sampling Event
22-Jun-04		200	4.78	2nd Quarter Sampling Event
17-Sep-04		150	4.79	3rd Quarter Sampling Event
17-Nov-04		180	5.1	4th Quarter Sampling Event
16-Mar-05		120	4.9	1st Quarter Sampling Event
25-May-05		113	3.7	2nd Quarter Sampling Event
31-Aug-05		82	6.0	3rd Quarter Sampling Event
1-Dec-05		63	6.0	4th Quarter Sampling Event
9-Mar-06		66	6.0	1st Quarter Sampling Event
14-Jun-06		51	5.9	2nd Quarter Sampling Event
20-Jul-06		53.70		3rd Quarter Sampling Event
8-Nov-06		47.10	2.9	4th Quarter Sampling Event
28-Feb-07		33	7.8	1st Quarter Sampling Event
27-Jun-07		26	7.0	2nd Quarter Sampling Event
15-Aug-07		9.2	7.7	3rd Quarter Sampling Event
10-Oct-07		9.5	8.2	4th Quarter Sampling Event
26-Mar-08		11	7.4	1st Quarter Sampling Event
25-Jun-08		9.3	8.7	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample		CHCl3 Values	Nitrate Values	Sampling Event
6-Jun-00	TW4-6	ND		Initial
2-Sep-00		ND		Quarterly
28-Nov-00		ND	ND	Quarterly & Split Sample
26-Mar-01		ND	.13	Quarterly
20-Jun-01		ND	ND	Quarterly
20-Sep-01		3.6	ND	Quarterly
7-Nov-01		1.00	ND	UDEQ Split Sampling Event
26-Mar-02		ND	ND	First 1/4 2002 Sample
21-May-02		ND	ND	Quarterly
12-Sep-02		ND	ND	UDEQ Split Sampling Event
24-Nov-02		ND	ND	Quarterly
28-Mar-03		ND	0.1	Quarterly
23-Jun-03		ND	ND	2nd Quarter Sampling Event
12-Sep-03		ND	ND	3rd Quarter Sampling Event
8-Nov-03		ND	ND	4th Quarter Sampling Event
29-Mar-04		ND	ND	1st Quarter Sampling Event
22-Jun-04		ND	ND	2nd Quarter Sampling Event
17-Sep-04		ND	ND	3rd Quarter Sampling Event
17-Nov-04		ND	ND	4th Quarter Sampling Event
16-Mar-05		ND	0.2	1st Quarter Sampling Event
25-May-05		ND	0.4	2nd Quarter Sampling Event
31-Aug-05		10.0	0.5	3rd Quarter Sampling Event
1-Dec-05		17.0	0.9	4th Quarter Sampling Event
9-Mar-06		31.0	1.2	1st Quarter Sampling Event
14-Jun-06		19.0	1.0	2nd Quarter Sampling Event
20-Jul-06		11.00	0.6	3rd Quarter Sampling Event
8-Nov-06		42.80	1.4	4th Quarter Sampling Event
28-Feb-07		46	1.5	1st Quarter Sampling Event
27-Jun-07		0.11	0.6	2nd Quarter Sampling Event
15-Aug-07		18	0.7	3rd Quarter Sampling Event
10-Oct-07		18	0.8	4th Quarter Sampling Event
26-3-08		52	1.1	1st Quarter Sampling Event
25-Jun-08		24	0.9	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample		CHCl3 Values	Nitrate Values	Sampling Event
29-Nov-99	TW4-7	256		Quarterly
15-Mar-00		616		Quarterly
2-Sep-00		698		Quarterly
29-Nov-00		684	1.99	Quarterly & Split Sample
28-Mar-01		747	2.46	Quarterly
20-Jun-01		1100	2.65	Quarterly
20-Sep-01		1200	3.38	Quarterly
8-Nov-01		1100	2.5	UDEQ Split Sampling Event
26-Mar-02		1500	3.76	First 1/4 2002 Sample
23-May-02		1600	3.89	Quarterly
12-Sep-02		1500	3.18	UDEQ Split Sampling Event
24-Nov-02		2300	4.6	Quarterly
28-Mar-03		1800	4.8	Quarterly
23-Jun-03		5200	7.6	2nd Quarter Sampling Event
12-Sep-03		3600	7.6	3rd Quarter Sampling Event
8-Nov-03		4500	7.1	4th Quarter Sampling Event
29-Mar-04		2500	4.63	1st Quarter Sampling Event
22-Jun-04		2900	4.83	2nd Quarter Sampling Event
17-Sep-04		3100	5.59	3rd Quarter Sampling Event
17-Nov-04		3800	6	4th Quarter Sampling Event
16-Mar-05		3100	5.2	1st Quarter Sampling Event
25-May-05		2700	5.4	2nd Quarter Sampling Event
31-Aug-05		3100	5.2	3rd Quarter Sampling Event
1-Dec-05		2500	5.3	4th Quarter Sampling Event
9-Mar-06		1900	1.0	1st Quarter Sampling Event
14-Jun-06		2200	4.5	2nd Quarter Sampling Event
20-Jul-06		2140	4.7	3rd Quarter Sampling Event
8-Nov-06		2160	4.6	4th Quarter Sampling Event
28-Feb-07		1800	5	1st Quarter Sampling Event
27-Jun-07		2600	5.1	2nd Quarter Sampling Event
14-Aug-07		2300	4.7	3rd Quarter Sampling Event
10-Oct-07		1900	4.7	4th Quarter Sampling Event
26-Mar-08		2200	4.2	1st Quarter Sampling Event
25-Jun-08		1800	4.8	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-8	CHCl3 Values	Nitrate Values	Sampling Event
29-Nov-99		ND		Quarterly
15-Mar-00		21.8		Quarterly
2-Sep-00		102		Quarterly
29-Nov-00		107	ND	Quarterly & Split Sample
26-Mar-01		116	ND	Quarterly
20-Jun-01		180	ND	Quarterly
20-Sep-01		180	0.35	Quarterly
7-Nov-01		180	ND	UDEQ Split Sampling Event
26-Mar-02		190	0.62	First 1/4 2002 Sample
22-May-02		210	0.77	Quarterly
12-Sep-02		300	ND	UDEQ Split Sampling Event
24-Nov-02		450	ND	Quarterly
28-Mar-03		320	0.8	Quarterly
23-Jun-03		420	ND	2nd Quarter Sampling Event
12-Sep-03		66	ND	3rd Quarter Sampling Event
8-Nov-03		21.0	0.1	4th Quarter Sampling Event
29-Mar-04		24	0.65	1st Quarter Sampling Event
22-Jun-04		110	0.52	2nd Quarter Sampling Event
17-Sep-04		120	ND	3rd Quarter Sampling Event
17-Nov-04		120	ND	4th Quarter Sampling Event
16-Mar-05		10.0	ND	1st Quarter Sampling Event
25-May-05		ND	0.2	2nd Quarter Sampling Event
31-Aug-05		1.1	ND	3rd Quarter Sampling Event
1-Dec-05		ND	ND	4th Quarter Sampling Event
9-Mar-06		1.3	0.3	1st Quarter Sampling Event
14-Jun-06		ND	ND	2nd Quarter Sampling Event
20-Jul-06		ND	0.1	3rd Quarter Sampling Event
8-Nov-06		ND	ND	4th Quarter Sampling Event
28-Feb-07		2.50	0.7	1st Quarter Sampling Event
27-Jun-07		2.5	0.2	2nd Quarter Sampling Event
15-Aug-07		1.5	ND	3rd Quarter Sampling Event
10-Oct-07		3.5	0.5	4th Quarter Sampling Event
26-Mar-08		ND	0.1	1st Quarter Sampling Event
25-Jun-08		ND	ND	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-9	CHCl3 Values	Nitrate Values	Sampling Event
20-Dec-99		4.24		Quarterly
15-Mar-00		1.88		Quarterly
2-Sep-00		14.2		Quarterly
29-Nov-00		39.4	ND	Quarterly & Split Sample
27-Mar-01		43.6	ND	Quarterly
20-Jun-01		59	.15	Quarterly
20-Sep-01		19	0.40	Quarterly
7-Nov-01		49	0.1	UDEQ Split Sampling Event
26-Mar-02		41	0.5	First 1/4 2002 Sample
22-May-02		38	0.65	Quarterly
12-Sep-02		49	0.2	UDEQ Split Sampling Event
24-Nov-02		51	0.6	Quarterly
28-Mar-03		34	0.6	Quarterly
23-Jun-03		33	0.8	2nd Quarter Sampling Event
12-Sep-03		32	1.1	3rd Quarter Sampling Event
8-Nov-03		46	1.1	4th Quarter Sampling Event
29-Mar-04		48	0.82	1st Quarter Sampling Event
22-Jun-04		48	0.75	2nd Quarter Sampling Event
17-Sep-04		39	0.81	3rd Quarter Sampling Event
17-Nov-04		26	1.2	4th Quarter Sampling Event
16-Mar-05		3.8	1.3	1st Quarter Sampling Event
25-May-05		1.2	1.3	2nd Quarter Sampling Event
31-Aug-05		ND	1.3	3rd Quarter Sampling Event
1-Dec-05		ND	1.3	4th Quarter Sampling Event
9-Mar-06		ND	1.5	1st Quarter Sampling Event
14-Jun-06		ND	1.5	2nd Quarter Sampling Event
20-Jul-06		ND	0.9	3rd Quarter Sampling Event
8-Nov-06		ND	0.7	4th Quarter Sampling Event
28-Feb-07		ND	0.6	1st Quarter Sampling Event
27-Jun-07		21	1.3	2nd Quarter Sampling Event
15-Aug-07		9.5	1.8	3rd Quarter Sampling Event
10-Oct-07		8.7	2	4th Quarter Sampling Event
26-Mar-08		1.3	2.1	1st Quarter Sampling Event
25-Jun-08		1.0	2.3	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-10	CHCl3 Values	Nitrate Values	Sampling Event
21-Jan-02		14		Initial Sample
26-Mar-02		16	0.14	First 1/4 2002 Sample
21-May-02		17	0.11	Quarterly
12-Sep-02		6.0	ND	UDEQ Split Sampling Event
24-Nov-02		14	ND	Quarterly
28-Mar-03		29	0.2	Quarterly
23-Jun-03		110	0.4	2nd Quarter Sampling Event
12-Sep-03		74	0.4	3rd Quarter Sampling Event
8-Nov-03		75	0.3	4th Quarter Sampling Event
29-Mar-04		22	0.1	1st Quarter Sampling Event
22-Jun-04		32	ND	2nd Quarter Sampling Event
17-Sep-04		63	0.46	3rd Quarter Sampling Event
17-Nov-04		120	0.4	4th Quarter Sampling Event
16-Mar-05		140	1.6	1st Quarter Sampling Event
25-May-05		62.4	0.8	2nd Quarter Sampling Event
31-Aug-05		110	1.1	3rd Quarter Sampling Event
1-Dec-05		300	3.3	4th Quarter Sampling Event
9-Mar-06		190	2.4	1st Quarter Sampling Event
14-Jun-06		300	3.5	2nd Quarter Sampling Event
20-Jul-06		504.00	6.8	3rd Quarter Sampling Event
8-Nov-06		452.00	5.7	4th Quarter Sampling Event
28-Feb-07		500	7.6	1st Quarter Sampling Event
27-Jun-07		350	5.1	2nd Quarter Sampling Event
15-Aug-07		660	7.3	3rd Quarter Sampling Event
10-Oct-07		470	6.7	4th Quarter Sampling Event
26-Mar-08		620	7.3	1st Quarter Sampling Event
25-Jun-08		720	9.91	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-11	CHCl3 Values	Nitrate Values	Sampling Event
21-Jan-02		4700		Initial Sample
26-Mar-02		4900	9.60	First 1/4 2002 Sample
22-May-02		5200	9.07	Quarterly
12-Sep-02		6200	8.84	UDEQ Split Sampling Event
24-Nov-02		5800	9.7	Quarterly
28-Mar-03		5100	9.7	Quarterly
23-Jun-03		5700	9.4	2nd Quarter Sampling Event
12-Sep-03		4600	9.9	3rd Quarter Sampling Event
8-Nov-03		5200	9.3	4th Quarter Sampling Event
29-Mar-04		5300	9.07	1st Quarter Sampling Event
22-Jun-04		5700	8.74	2nd Quarter Sampling Event
17-Sep-04		4800	8.75	3rd Quarter Sampling Event
17-Nov-04		5800	9.7	4th Quarter Sampling Event
16-Mar-05		4400	8.7	1st Quarter Sampling Event
25-May-05		3590	10.3	2nd Quarter Sampling Event
31-Aug-05		4400	9.4	3rd Quarter Sampling Event
1-Dec-05		4400	9.4	4th Quarter Sampling Event
9-Mar-06		4400	9.2	1st Quarter Sampling Event
14-Jun-06		4300	10	2nd Quarter Sampling Event
20-Jul-06		4080	10	3rd Quarter Sampling Event
8-Nov-06		3660	10	4th Quarter Sampling Event
28-Feb-07		3500	10.1	1st Quarter Sampling Event
27-Jun-07		3800	10.6	2nd Quarter Sampling Event
15-Aug-07		4500	10.2	3rd Quarter Sampling Event
10-Oct-07		4400	9.8	4th Quarter Sampling Event
26-Mar-08		340	7.7	1st Quarter Sampling Event
25-Jun-08		640	7.28	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-12	CHCl3 Values	Nitrate Values	Sampling Event
12-Sep-02	1.5	1.5	2.54	UDEQ Split Sampling Event
24-Nov-02		ND	2.2	Quarterly
28-Mar-03		ND	1.9	Quarterly
23-Jun-03		ND	1.8	2nd Quarter Sampling Event
12-Sep-03		ND	1.8	3rd Quarter Sampling Event
9-Nov-03		ND	1.6	4th Quarter Sampling Event
29-Mar-04		ND	1.58	1st Quarter Sampling Event
22-Jun-04		ND	1.4	2nd Quarter Sampling Event
17-Sep-04		ND	1.24	3rd Quarter Sampling Event
17-Nov-04		ND	1.5	4th Quarter Sampling Event
16-Mar-05		ND	1.4	1st Quarter Sampling Event
25-May-05		ND	1.6	2nd Quarter Sampling Event
31-Aug-05		ND	1.5	3rd Quarter Sampling Event
1-Dec-05		ND	1.4	4th Quarter Sampling Event
9-Mar-06		ND	1.3	1st Quarter Sampling Event
14-Jun-06		ND	1.4	2nd Quarter Sampling Event
20-Jul-06		ND	1.4	3rd Quarter Sampling Event
8-Nov-06		ND	1.4	4th Quarter Sampling Event
28-Feb-07		ND	1.5	1st Quarter Sampling Event
27-Jun-07		ND	1.5	2nd Quarter Sampling Event
Aug-15-07		ND	1.4	3rd Quarter Sampling Event
10-Oct-07		ND	1.4	4th Quarter Sampling Event
26-Mar-08		ND	1.6	1st Quarter Sampling Event
25-Jun-08		ND	2.69	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-13	CHCl3 Values	Nitrate Values	Sampling Event
12-Sep-02		ND	ND	UDEQ Split Sampling Event
24-Nov-02		ND	ND	Quarterly
28-Mar-03		ND	0.2	Quarterly
23-Jun-03		ND	0.2	2nd Quarter Sampling Event
12-Sep-03		ND	ND	3rd Quarter Sampling Event
9-Nov-03		ND	0.9	4th Quarter Sampling Event
29-Mar-04		ND	0.12	1st Quarter Sampling Event
22-Jun-04		ND	0.17	2nd Quarter Sampling Event
17-Sep-04		ND	4.43	3rd Quarter Sampling Event
17-Nov-04		ND	4.7	4th Quarter Sampling Event
16-Mar-05		ND	4.2	1st Quarter Sampling Event
25-May-05		ND	4.3	2nd Quarter Sampling Event
31-Aug-05		ND	4.6	3rd Quarter Sampling Event
1-Dec-05		ND	4.3	4th Quarter Sampling Event
9-Mar-06		ND	4.2	1st Quarter Sampling Event
14-Jun-06		ND	4.9	2nd Quarter Sampling Event
20-Jul-06		ND	4.3	3rd Quarter Sampling Event
8-Nov-06		ND	0.8	4th Quarter Sampling Event
28-Feb-07		ND	4	1st Quarter Sampling Event
27-Jun-07		ND	4.6	2nd Quarter Sampling Event
15-Aug-07		ND	4.4	3rd Quarter Sampling Event
10-Oct-07		ND	4.1	4th Quarter Sampling Event
26-Mar-08		ND	3.8	1st Quarter Sampling Event
25-Jun-08		ND	4.24	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-15	CHCl3 Values	Nitrate Values	Sampling Event
12-Sep-02		2.6	ND	UDEQ Split Sampling Event
24-Nov-02		ND	ND	Quarterly
28-Mar-03		ND	0.1	Quarterly
23-Jun-03		7800	14.5	2nd Quarter Sampling Event
15-Aug-03		7400	16.8	Well Pumping Event Sample
12-Sep-03		2500	2.7	3rd Quarter Sampling Event
25-Sep-03		2600	2.5	Well Pumping Event Sample
29-Oct-03		3100	3.1	Well Pumping Event Sample
8-Nov-03		3000	2.8	4th Quarter Sampling Event
29-Mar-04		NA	NA	Unable to purge/sample
22-Jun-04		NA	NA	Unable to purge/sample
17-Sep-04		1400	0.53	3rd Quarter Sampling Event
17-Nov-04		300	0.2	4th Quarter Sampling Event
16-Mar-05		310	0.3	1st Quarter Sampling Event
30-Mar-05		230	0.2	1st Quarter POC Sampling
25-May-05		442	0.2	2nd Quarter Sampling Event
31-Aug-05		960	0.2	3rd Quarter Sampling Event
1-Dec-05		1000	0.3	4th Quarter Sampling Event
9-Mar-06		1100	0.2	1st Quarter Sampling Event
14-Jun-06		830	0.2	2nd Quarter Sampling Event
20-Jul-06		2170	1.4	3rd Quarter Sampling Event
8-Nov-06		282	0.3	4th Quarter Sampling Event
28-Feb-07		570	0.5	1st Quarter Sampling Event
27-Jun-07		300	0.4	2nd Quarter Sampling Event
15-Aug-07		1400	1	3rd Quarter Sampling Event
10-Oct-07		2000	0.6	4th Quarter Sampling Event
26-Mar-08		930	0.1	1st Quarter Sampling Event
25-Jun-08		1300	0.56	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-16	CHCl3 Values	Nitrate Values	Sampling Event
12-Sep-02		140	ND	UDEQ Split Sampling Event
24-Nov-02		200	ND	Quarterly
28-Mar-03		260	ND	Quarterly
23-Jun-03		370	ND	2nd Quarter Sampling Event
12-Sep-03		350	ND	3rd Quarter Sampling Event
8-Nov-03		400	ND	4th Quarter Sampling Event
29-Mar-04		430	ND	1st Quarter Sampling Event
22-Jun-04		530	ND	2nd Quarter Sampling Event
17-Sep-04		400	ND	3rd Quarter Sampling Event
17-Nov-04		350	ND	4th Quarter Sampling Event
16-Mar-05		240	ND	1st Quarter Sampling Event
25-May-05		212	ND	2nd Quarter Sampling Event
31-Aug-05		85	ND	3rd Quarter Sampling Event
1-Dec-05		14	1.4	4th Quarter Sampling Event
9-Mar-06		39	3.0	1st Quarter Sampling Event
14-Jun-06		13	1.9	2nd Quarter Sampling Event
20-Jul-06		5	2.7	3rd Quarter Sampling Event
8-Nov-06		13.6	5.6	4th Quarter Sampling Event
28-Feb-07		8.70	12.3	1st Quarter Sampling Event
27-Jun-07		2.60	9.9	2nd Quarter Sampling Event
15-Aug-07		7.10	5.4	3rd Quarter Sampling Event
10-Oct-07		1.40	4.4	4th Quarter Sampling Event
26-Mar-08		11.00	ND	1st Quarter Sampling Event
25-Jun-08		ND	1.46	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-17	CHCl3 Values	Nitrate Values	Sampling Event
12-Sep-02		1.6	ND	UDEQ Split Sampling Event
24-Nov-02		ND	ND	Quarterly
28-Mar-03		ND	ND	Quarterly
23-Jun-03		ND	ND	2nd Quarter Sampling Event
12-Sep-03		ND	ND	3rd Quarter Sampling Event
8-Nov-03		ND	ND	4th Quarter Sampling Event
29-Mar-04		ND	ND	1st Quarter Sampling Event
22-Jun-04		ND	ND	2nd Quarter Sampling Event
17-Sep-04		ND	ND	3rd Quarter Sampling Event
17-Nov-04		ND	ND	4th Quarter Sampling Event
16-Mar-05		ND	ND	1st Quarter Sampling Event
30-Mar-05		ND	ND	1st Quarter POC Sampling
25-May-05		ND	ND	2nd Quarter Sampling Event
31-Aug-05		ND	ND	3rd Quarter Sampling Event
1-Dec-05		ND	ND	4th Quarter Sampling Event
9-Mar-06		ND	ND	1st Quarter Sampling Event
14-Jun-06		ND	ND	2nd Quarter Sampling Event
20-Jul-06		ND	ND	3rd Quarter Sampling Event
8-Nov-06		ND	ND	4th Quarter Sampling Event
28-Feb-07		ND	ND	1st Quarter Sampling Event
27-Jun-07		ND	ND	2nd Quarter Sampling Event
15-Aug-07		ND	ND	3rd Quarter Sampling Event
10-Oct-07		ND	ND	4th Quarter Sampling Event
26-Mar-08		ND	ND	1st Quarter Sampling Event
25-Jun-08		ND	ND	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample		CHCl3 Values	Nitrate Values	Sampling Event
12-Sep-02	TW4-18	440	1.49	UDEQ Split Sampling Event
24-Nov-02		240	13.3	Quarterly
28-Mar-03		160	13.1	Quarterly
23-Jun-03		110	19	2nd Quarter Sampling Event
12-Sep-03		68	19.9	3rd Quarter Sampling Event
9-Nov-03		84	20.7	4th Quarter Sampling Event
29-Mar-04		90	14	1st Quarter Sampling Event
22-Jun-04		82	12.2	2nd Quarter Sampling Event
17-Sep-04		38	14.5	3rd Quarter Sampling Event
17-Nov-04		51	17.3	4th Quarter Sampling Event
16-Mar-05		38	14.1	1st Quarter Sampling Event
25-May-05		29.8	12.9	2nd Quarter Sampling Event
31-Aug-05		39	13.3	3rd Quarter Sampling Event
1-Dec-05		14	7.3	4th Quarter Sampling Event
9-Mar-06		12	5.9	1st Quarter Sampling Event
14-Jun-06		12	4.7	2nd Quarter Sampling Event
20-Jul-06		10.80	6.1	3rd Quarter Sampling Event
8-Nov-06		139.00	8.7	4th Quarter Sampling Event
28-Feb-07		9.2	5.1	1st Quarter Sampling Event
27-Jun-07		8.0	4.9	2nd Quarter Sampling Event
15-Aug-07		8.9	5	3rd Quarter Sampling Event
10-Oct-08		7.4	4.4	4th Quarter Sampling Event
26-Mar-08		6.4	0.7	1st Quarter Sampling Event
25-Jun-08		5.7	4.55	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-19	CHCl3 Values	Nitrate Values	Sampling Event
12-Sep-02		7700	47.6	UDEQ Split Sampling Event
24-Nov-02		5400	42	Quarterly
28-Mar-03		4200	61.4	Quarterly
15-May-03		4700	NA	Well Pumping Event Sample
23-Jun-03		4500	11.4	2nd Quarter Sampling Event
15-Jul-03		2400	6.8	Well Pumping Event Sample
15-Aug-03		2600	4	Well Pumping Event Sample
12-Sep-03		2500	5.7	3rd Quarter Sampling Event
25-Sep-03		4600	9.2	Well Pumping Event Sample
29-Oct-03		4600	7.7	Well Pumping Event Sample
9-Nov-03		2600	4.8	4th Quarter Sampling Event
29-Mar-04		NA	NA	Unable to purge/sample
22-Jun-04		NA	NA	Unable to purge/sample
16-Aug-04		7100	9.91	Well Pumping Event Sample
17-Sep-04		2600	4.5	3rd Quarter Sampling Event
17-Nov-04		1800	3.6	4th Quarter Sampling Event
16-Mar-05		2200	5.3	1st Quarter Sampling Event
25-May-05		1200	5.7	2nd Quarter Sampling Event
31-Aug-05		1400	4.6	3rd Quarter Sampling Event
1-Dec-05		2800	ND	4th Quarter Sampling Event
9-Mar-06		1200	4.0	1st Quarter Sampling Event
14-Jun-06		1100	5.2	2nd Quarter Sampling Event
20-Jul-06		1120	4.3	3rd Quarter Sampling Event
8-Nov-07		1050	4.6	4th Quarter Sampling Event
28-Feb-07		1200	4	1st Quarter Sampling Event
27-Jun-07		1800	2.3	2nd Quarter Sampling Event
15-Aug-07		1100	4.1	3rd Quarter Sampling Event
10-Oct-08		1100	4	4th Quarter Sampling Event
26-Mar-08		1800	2.2	1st Quarter Sampling Event
25-Jun-08		1000	2.81	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-20	CHCl3 Values	Nitrate Values	Sampling Event
25-May-05		39000	10.1	2nd Quarter Sampling Event
31-Aug-05		3800	2.9	3rd Quarter Sampling Event
1-Dec-05		19000	1.8	4th Quarter Sampling Event
9-Mar-06		9200	3.8	1st Quarter Sampling Event
14-Jun-06		61000	9.4	2nd Quarter Sampling Event
20-Jul-06		5300	2.9	3rd Quarter Sampling Event
8-Nov-06		11000	3.5	4th Quarter Sampling Event
28-Feb-07		4400	4.2	1st Quarter Sampling Event
27-Jun-07		1800	2.3	2nd Quarter Sampling Event
15-Aug-07		5200	2.1	3rd Quarter Sampling Event
10-Oct-08		9000	5.6	4th Quarter Sampling Event
26-Mar-08		13000	0.9	1st Quarter Sampling Event
25-Jun-08		30000	7.96	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-21	CHCl3 Values	Nitrate Values	Sampling Event
25-May-05		192	14.6	2nd Quarter Sampling Event
31-Aug-05		78	10.1	3rd Quarter Sampling Event
1-Dec-05		86	9.6	4th Quarter Sampling Event
9-Mar-06		120	8.5	1st Quarter Sampling Event
14-Jun-06		130	10.2	2nd Quarter Sampling Event
20-Jul-06		106	8.9	3rd Quarter Sampling Event
8-Nov-06		12.5	5.7	4th Quarter Sampling Event
28-Feb-07		160	8.7	1st Quarter Sampling Event
27-Jun-07		300.0	8.6	2nd Quarter Sampling Event
15-Aug-07		140	8.6	3rd Quarter Sampling Event
10-Oct-07		120	8.3	4th Quarter Sampling Event
26-Mar-08		380	14.3	1st Quarter Sampling Event
25-Jun-08		160	8.81	2nd Quarter Sampling Event

Table 4: Mill Groundwater Nitrate and Chloroform Quarterly Data

Date of Sample	TW4-22	CHCl3 Values	Nitrate Values	Sampling Event
25-May-05		340	18.2	2nd Quarter Sampling Event
31-Aug-05		290	15.7	3rd Quarter Sampling Event
1-Dec-05		320	15.1	4th Quarter Sampling Event
9-Mar-06		390	15.3	1st Quarter Sampling Event
06/14/06		280	14.3	2nd Quarter Sampling Event
07/20/06		864	14.5	3rd Quarter Sampling Event
11/08/06		350	15.9	4th Quarter Sampling Event
28-Feb-07		440	20.9	1st Quarter Sampling Event
06/27/07		740	19.3	2nd Quarter Sampling Event
Aug-15-07		530	19.3	3rd Quarter Sampling Event
Oct-10-08		440	18.8	4th Quarter Sampling Event
03/26/08		1400	39.1	1st Quarter Sampling Event

Table 5
Nitrate (as N) Concentrations in Wells Inside the 70 µg/L Isoconcentration Boundray Line.
White Mesa Uranium Mill near Blanding Utah

Monitoring Event	Monitor Well											
	MW-4	MW-26	TW4-1	TW4-2	TW4-4	TW4-7	TW4-9	TW4-10	TW4-11	TW4-19	TW4-20	TW4-21
1st Quarter 2005	6.3	0.3	9.1	7.7	10.0	5.2	1.3	1.6	8.7	5.3	WNI	WNI
2nd Quarter 2005	7.1	0.2	10.6	8.6	11.3	5.4	1.3	0.8	10.3	5.7	10.1	14.6
3rd Quarter 2005	7.0	0.2	9.8	8.0	9.9	5.2	1.3	1.1	9.4	4.6	2.9	10.1
4th Quarter 2005	7.0	0.3	9.7	7.8	10.2	5.3	1.3	3.3	9.4	<0.1	1.8	9.6
1st Quarter 2006	6.0	0.2	9.4	7.5	9.5	1.0	1.5	2.4	9.2	4.0	3.8	8.5
2nd Quarter 2006	6.0	0.2	9.6	7.1	8.6	4.5	1.5	3.5	10.0	5.2	9.4	10.2
3rd Quarter 2006	1.2	1.4	9.2	7.4	9.7	4.7	0.9	6.8	10.0	4.3	2.9	8.9
4th Quarter 2006	6.4	0.3	9.2	7.6	10.1	4.6	0.7	5.7	10.0	4.6	3.5	8.7
1st Quarter 2007	6.3	0.6	8.9	7.3	9.0	6.0	0.6	7.3	10.1	4.0	4.2	8.7
2nd Quarter 2007	7.0	0.4	9.0	7.8	9.4	5.1	1.3	5.1	10.6	NS	2.3	8.6
3rd Quarter 2007	6.2	1.0	8.4	7.3	9.5	4.7	1.8	7.3	10.2	4.1	2.1	8.6
4th Quarter 2007	6.2	0.6	7.8	6.9	9.5	4.7	2.0	6.7	9.8	4.0	5.6	8.3
1st Quarter 2008	5.8	0.1	7.6	6.9	9.2	4.2	2.1	7.3	7.7	2.2	0.9	14.3
2nd Quarter 2008	6.1	0.6	8.7	7.4	10.8	4.8	2.3	9.9	7.3	2.8	8.0	8.8

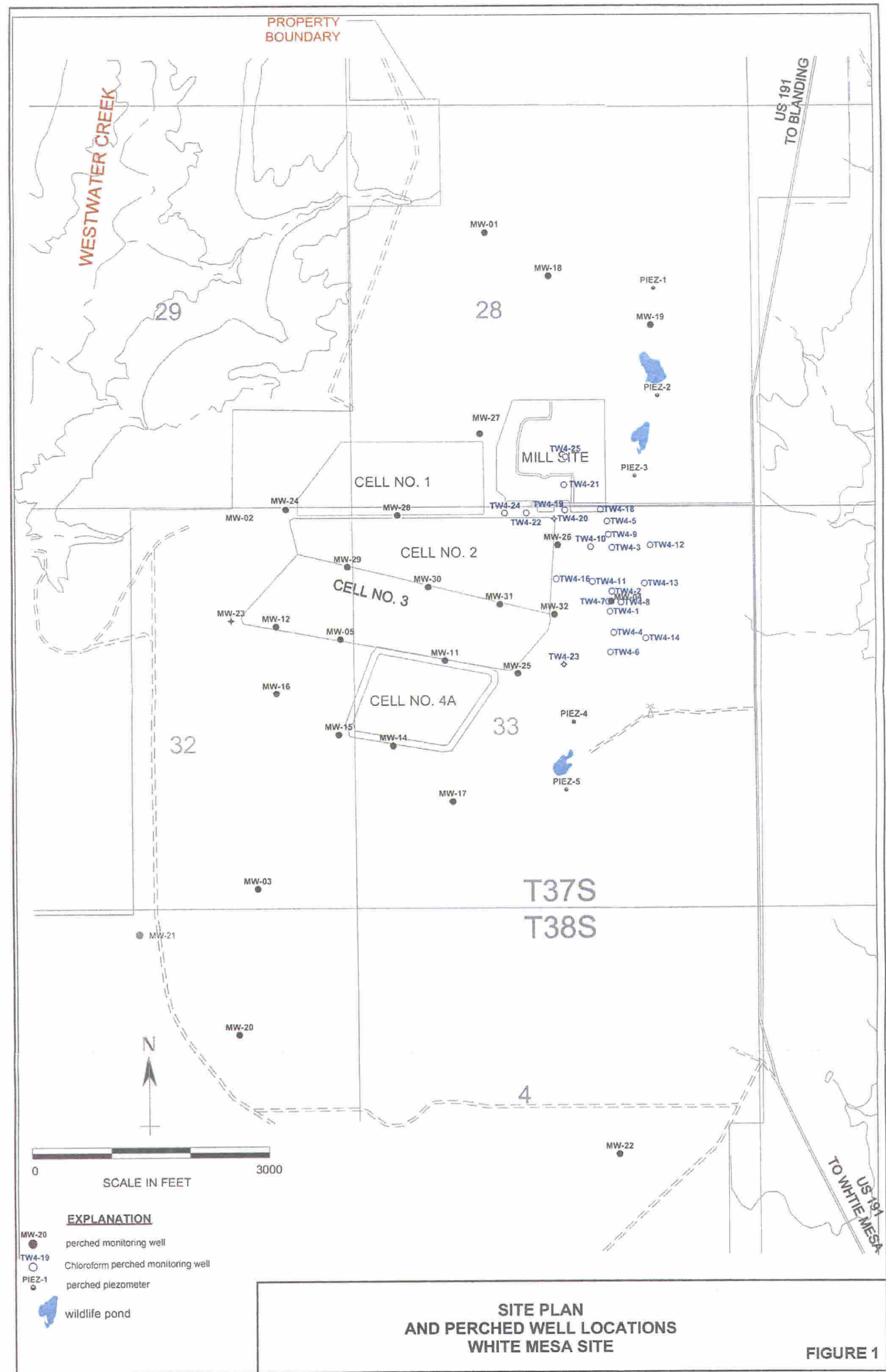
* First monitoring event

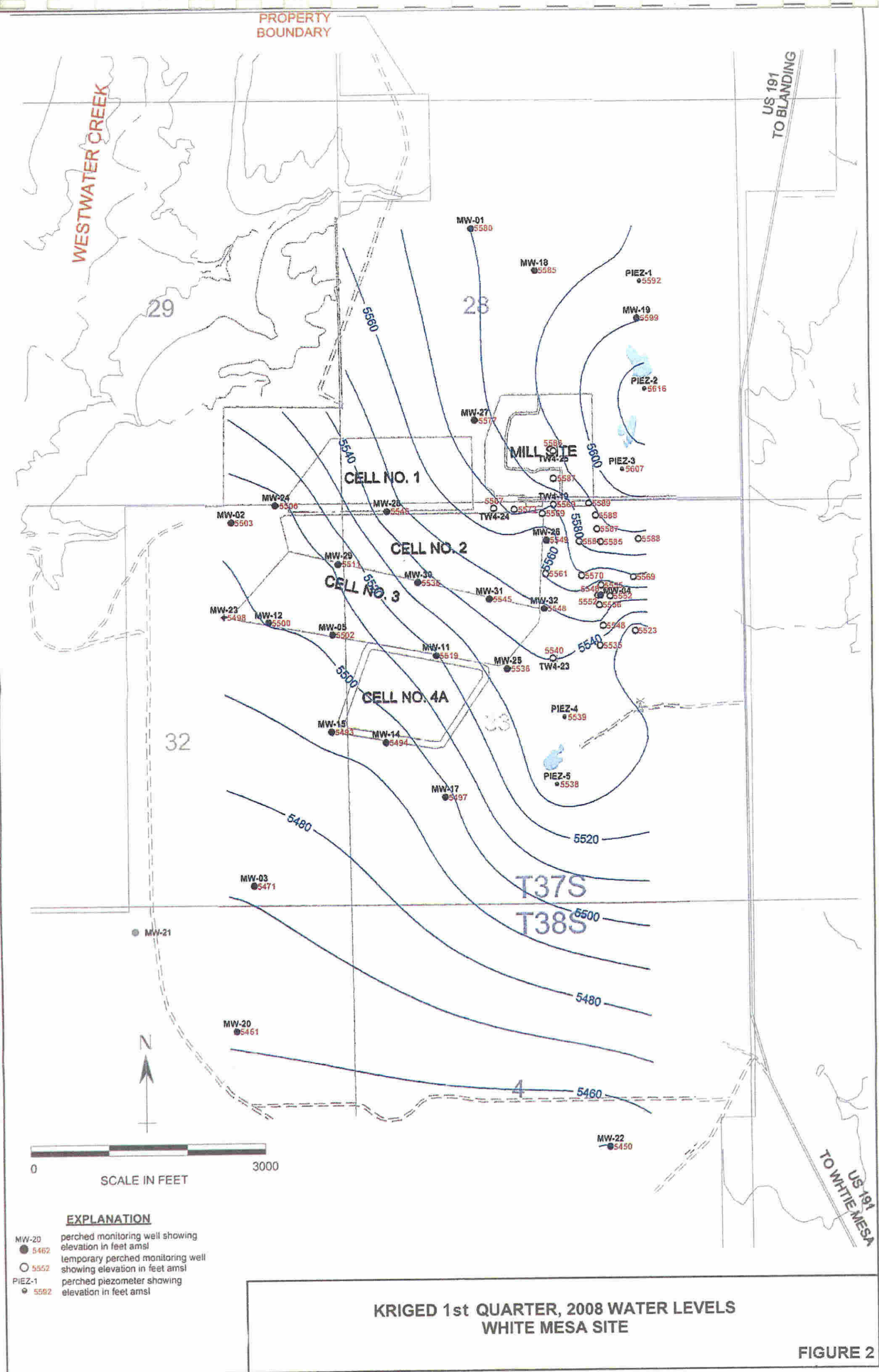
NS = Not sample because of the University of Utah Hydrogeologic Study.

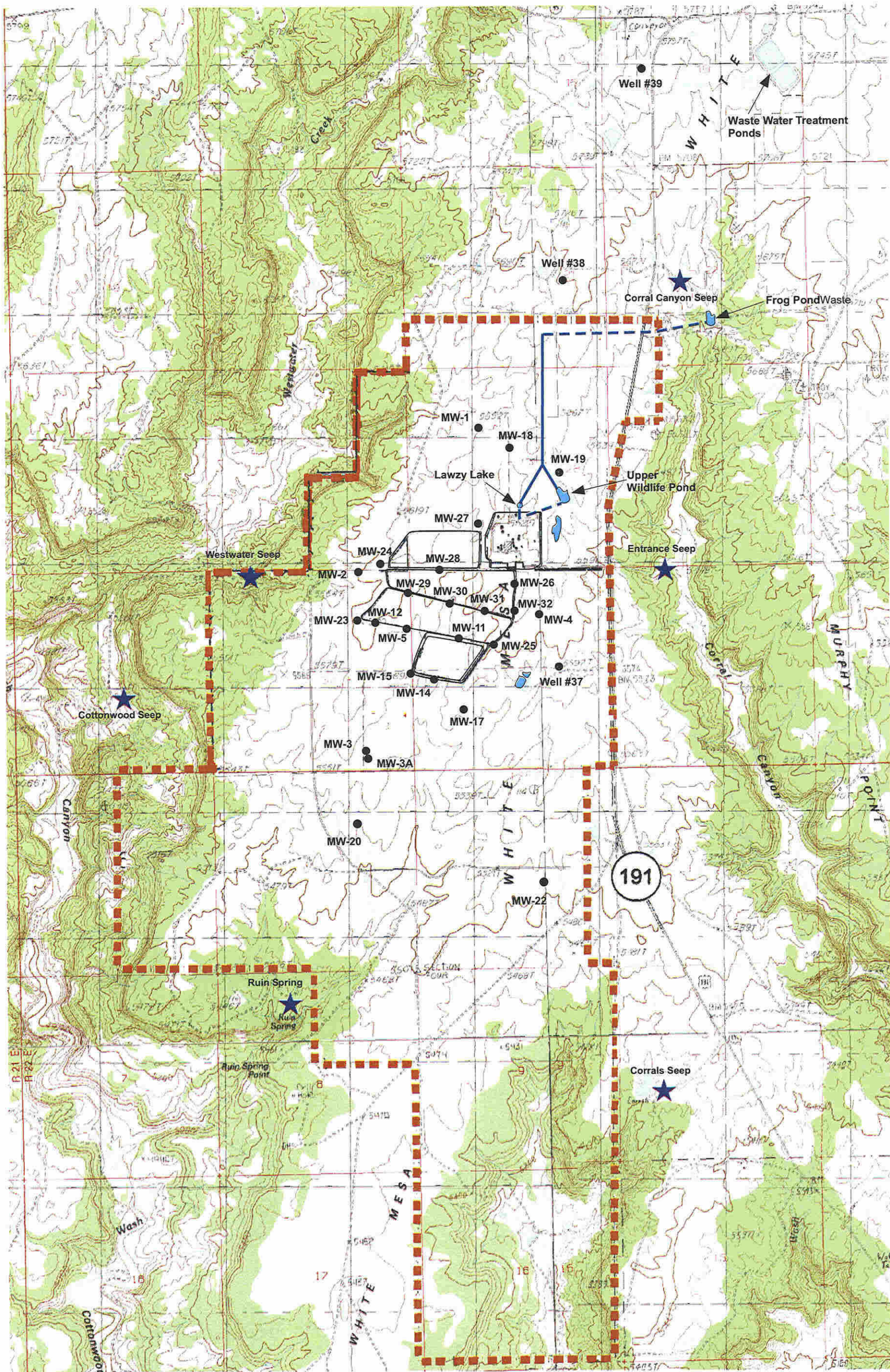
WNI = Well was not installed

High lighted nitrate concentrations = nitrate concentrations that have exceeded the GWQS of 10 mg/L.

Source: appeared as Table 2 in Utah DRC September 15, 2008 Request for Additional Information







- - - DUSA Property Boundary
- ★ Springs/Seeps
- DUSA Wildlife Ponds
- - - Underground Waterline
- Burro Canyon Wells
- Irrigation Ditch

1 inch = Approximately 0.5 miles

Figure 3
White Mesa Mill
Location of Current and Historic Surface Water Features

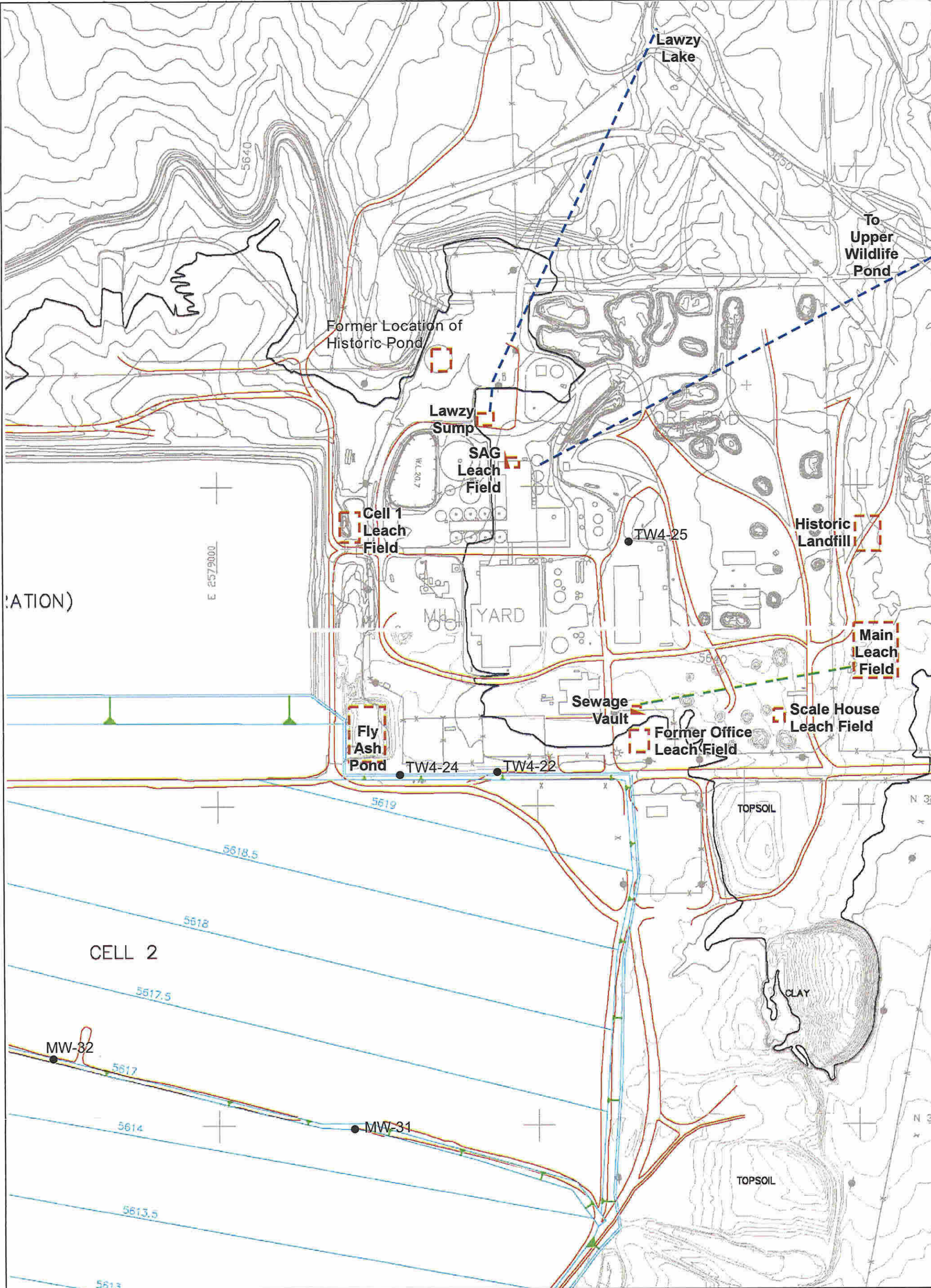
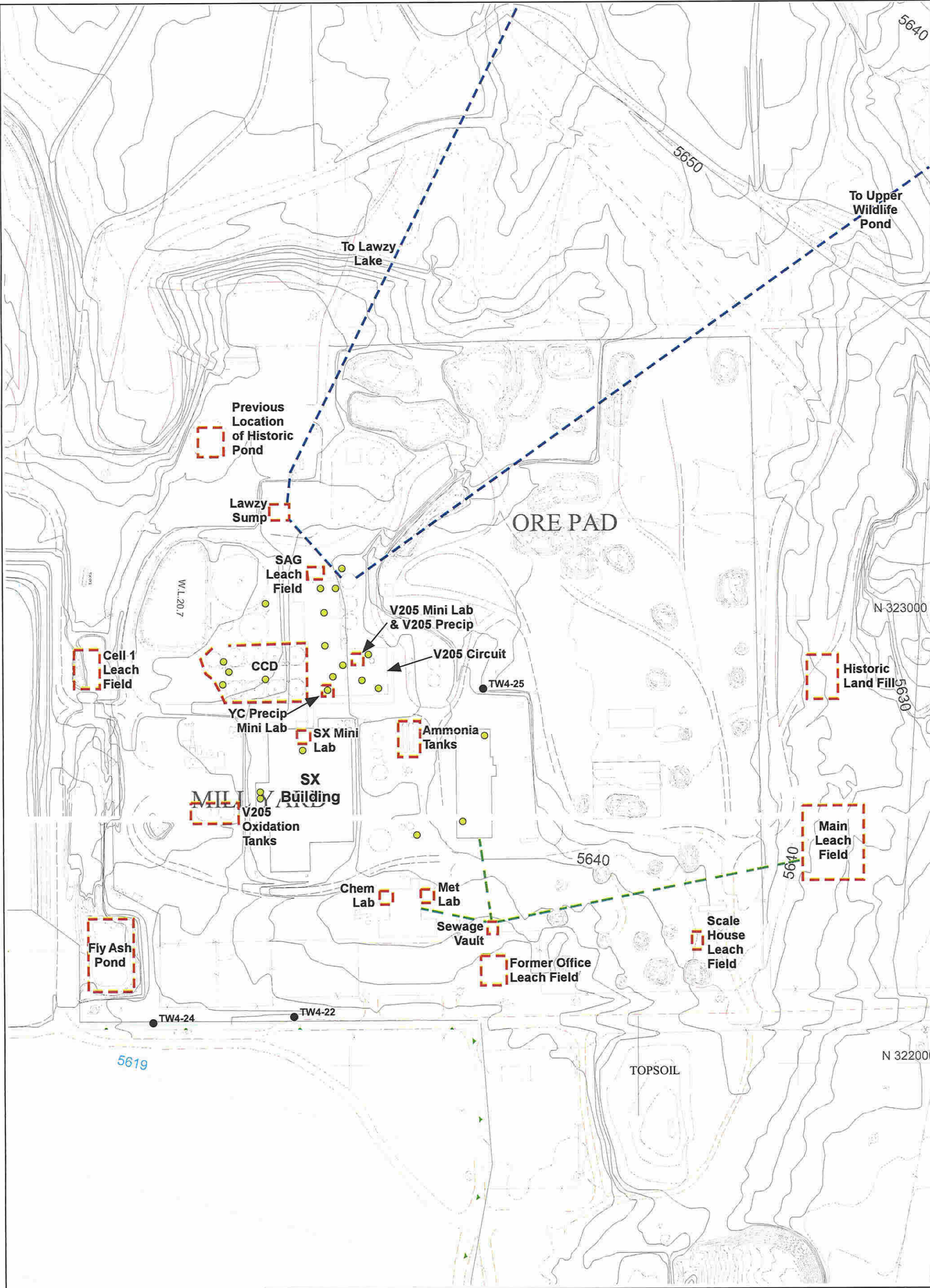









Figure 4
White Mesa Mill
Locations of Leach Fields



- **Potential Nitrate Source Location**
- **Springs/Seeps**
- **DUSA Wildlife Ponds**
- **Underground Waterline**
- **Burro Canyon Wells**
- **Underground Sewerline**
- **Sumps**



1 inch = Approximately 200 feet

Figure 5
White Mesa Mill
Potential Nitrate Source Map



Figure 6
Historic Aerial Photograph (circa. ~1979)
White Mesa Mill Site

Attachment 3

**White Mesa Uranium Mill Ground Water Monitoring Quality Assurance
Plan (QAP) State of Utah Groundwater Discharge Permit No.
UGW370004. Denison Mines (UEA) Corp. March 14, 2008.**

WHITE MESA URANIUM MILL
GROUND WATER MONITORING
QUALITY ASSURANCE PLAN (QAP)

STATE OF UTAH
GROUNDWATER DISCHARGE PERMIT No. UGW370004

Denison Mines (USA) Corp.
P.O. Box 809
Blanding, UT 84511

TABLE OF CONTENTS

	Page
1. INTRODUCTION.....	6
2. ORGANIZATION AND RESPONSIBILITIES.....	6
2.1. Functional Groups.....	6
2.2. Overall Responsibility For the AQ/QC Program.....	6
2.3. Data Requestors/Users.....	6
2.4. Data Generators.....	7
2.4.1. Sampling and QC Monitors.....	7
2.4.2. Analysis Monitor.....	8
2.4.3. Data Reviewers/Approvers.....	8
2.5. Responsibilities of Analytical Laboratory.....	9
3. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT OF DATA...	9
3.1. Precision.....	9
3.2. Accuracy.....	10
3.3. Representativeness.....	10
3.4. Completeness.....	10
3.5. Comparability.....	11
4. FIELD SAMPLING QUALITY ASSURANCE METHODOLOGY.....	11
4.1. Controlling Well Contamination.....	11
4.2. Controlling Depth to Groundwater Measurements.....	11

4.3.	Water Quality QC Samples.....	11
4.3.1.	VOC Trip Blanks.....	11
4.3.2.	Equipment Rinsate Samples.....	12
4.3.3.	Field Duplicates.....	12
4.3.4.	Definition of “Batch”.....	12
5.	CALIBRATION.....	12
5.1.	Depth to Groundwater Measurements.....	13
5.2.	Water Quality.....	13
6.	GROUND WATER SAMPLING AND MEASUREMENT OF FIELD PARAMETERS.....	13
6.1.	Groundwater Head Monitoring.....	13
6.1.1.	Location and Frequency of Groundwater Head Monitoring.....	13
6.1.2.	Equipment Used For Groundwater Head Monitoring.....	14
6.1.3.	Field Sampling Procedure for Groundwater Head Monitoring.....	14
6.2.	Ground Water Compliance Monitoring.....	14
6.2.1.	Location and Frequency of Groundwater Compliance Monitoring.....	14
6.2.2.	Quarterly and Semi-Annual Sampling Required (Paragraphs I.E.1.a) or I.E.1.b) of the GWDP).....	15
6.2.3.	Quarterly or Monthly Sampling Required Under Paragraphs I.G.1 or I.G.2 of the GWDP.....	15
6.2.4.	Sampling Equipment for Groundwater Compliance Monitoring.....	15
6.2.5.	Decontamination Procedure.....	16
6.2.6.	Pre-Purging/Sampling Activities.....	17
6.2.7.	Well Purging/Measurement of Field Parameters.....	17
6.2.8.	Samples to be Taken and Order of Taking Samples.....	20
6.2.9.	Field Duplicate Samples.....	20
6.2.10.	VOCs and Nutrient Sampling.....	21
6.2.11.	Heavy Metals, All Other Non-Radiologics and Gross Alpha Sampling.....	21
6.2.12.	Procedures to Follow After Sampling.....	24
7.	SAMPLE DOCUMENTATION TRACKING AND RECORD KEEPING.....	25
7.1.	Field Data Worksheets.....	25
7.2.	Chain-Of-Custody and Analytical Request Record.....	26
7.3.	Record Keeping.....	26

8.	ANALYTICAL PROCEDURES AND QA/QC.....	27
8.1.	Analytical Quality Control.....	27
8.1.2.	Spikes, Blanks and Duplicates.....	27
8.2.	Analytical Laboratory Procedures.....	28
9.	INTERNAL QUALITY CONTROL CHECKS.....	31
9.1.	Field QC Check Procedures.....	31
9.1.1.	Review of Compliance With the Procedures Contained in this Plan.....	31
9.1.2.	Analyte Completeness Review.....	31
9.1.3.	Blank Comparisons.....	31
9.1.4.	Duplicate Sample Comparisons.....	31
9.2.	Analytical Laboratory QA Reviews.....	32
9.3.	QA Manager Review of Analytical Laboratory Results and Procedures.....	33
9.4.	Analytical Data.....	34
10.	CORRECTIVE ACTION.....	34
10.1.	When Corrective Action is Required.....	34
10.2.	Procedure for Corrective Action.....	35
11.	REPORTING.....	35
12.	SYSTEM AND PERFORMANCE AUDITS.....	36
12.1.	QA Manager to Perform System Audits and Performance Audits.....	36
12.2.	System Audits.....	36
12.3.	Performance Audits.....	37
12.4.	Follow-Up Actions.....	37
12.5.	Audit Records.....	37
13.	PREVENTIVE MAINTENANCE.....	37

14.	QUALITY ASSURANCE REPORTS TO MANAGEMENT.....	38
14.1.	Ongoing QA/QC Reporting.....	38
14.2.	Periodic Reporting to Management.....	38
15.	AMENDMENT.....	39
16.	REFERENCES.....	39

Appendices

Appendix A- Chloroform Investigation Monitoring Quality Assurance Program

1. INTRODUCTION

This Groundwater Monitoring Quality Assurance Plan (the “Plan”) details and describes all sampling equipment, field methods, laboratory methods, qualifications of environmental analytical laboratories, data validation, and sampling and other corrective actions necessary to comply with UAC R317-6-6.3(I) and (L) at the White Mesa Uranium Mill (the “Mill”), as required under paragraph I.H.6 of State of Utah Groundwater Discharge Permit No. UGW370004 (the “GWDP”) for the Mill. This Procedure incorporates the applicable provisions of the United States Environmental Protection Agency (“EPA”) *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (OSWER-9950.1, September, 1986), as updated by EPA’s *RCRA Ground-Water Monitoring: Draft Technical Guidance* (November 1992).

Activities in an integrated program to generate quality data can be classified as management (i.e., quality assurance or “QA”) and as functional (i.e., quality control or “QC”). The objective of this Plan is to ensure that monitoring data are generated at the Mill that meet the requirements for precision, accuracy, completeness, representativeness and comparability required for management purposes and to comply with the reporting requirements established by applicable permits and regulations.

2. ORGANIZATION AND RESPONSIBILITIES

2.1. Functional Groups

This Plan specifies roles for a QA Manager as well as representatives of three different functional groups: the data users; the data generators, and the data reviewers/approvers. The roles and responsibilities of these representatives are described below.

2.2. Overall Responsibility For the QA/QC Program

The overall responsibility for ensuring that the QA/QC measures are properly employed is the responsibility of the QA Manager. The QA Manager is typically not directly involved in the data generation (i.e., sampling or analysis) activities. At the Mill, the QA Manager is the Mill’s Radiation Safety Officer (“RSO”) or other qualified person designated by Denison Mines (USA) Corp. (“DUSA”) corporate management.

2.3. Data Requestors/Users

The generation of data that meets the objectives of this Plan is necessary for management to make informed decisions relating to the operation of the Mill facility, and to comply with the reporting requirements set out in the GWDP and other permits and applicable regulations. Accordingly, the data requesters/users (the “Data Users”) are therefore DUSA’s corporate

management and regulatory authorities through the implementation of such permits and regulations. The data quality objectives (“DQOs”) required for any groundwater sampling event, such as acceptable minimum detection limits, are specified in this Plan.

2.4. Data Generators

The individuals who carry out the sampling and analysis activities at the request of the Data Users are the data generators. For Mill activities, this involves sample collection, record keeping and QA/QC activities conducted by one or more sampling and quality control/data monitors (each a “Sampling and QC Monitor”). The Sampling and QC Monitors are radiation and environmental technicians or other qualified Mill personnel as designated by the QA Manager. The Sampling and QC Monitors perform all field sampling activities, collect all field QC samples and perform all data recording and chain of custody activities in accordance with this Plan. Data generation at the contract analytical laboratory (the “Analytical Laboratory”) utilized by the Mill to analyze the environmental samples is performed by or under an employee or agent (the “Analysis Monitor”) of the Analytical Laboratory, in accordance with specific requirements of the Analytical Laboratory’s own QA/QC program.

The responsibilities of the data generators are as follows:

2.4.1. Sampling and QC Monitors

The Sampling and QC Monitors are responsible for field activities. These include:

- a) Ensuring that samples are collected, preserved, and transported as specified in Plan;
- b) Checking that all sample documentation (labels, field data worksheets, chain-of-custody records, packing lists) is correct and transmitting that information, along with the samples, to the Analytical Laboratory in accordance with this Plan;
- c) Maintaining records of all samples, tracking those samples through subsequent processing and analysis, and, ultimately, where applicable, appropriately disposing of those samples at the conclusion of the program;
- d) Preparing quality control samples for field sample collection during the sampling event;
- e) Preparing QC and sample data for review by the QA Manager; and
- f) Preparing QC and sample data for reporting and entry into a computer data base, where appropriate.

2.4.2. Analysis Monitor

The Analysis Monitor is responsible for QA/QC activities at the Analytical Laboratory. These include:

- a) Training and qualifying personnel in specified Analytical Laboratory QC and analytical procedures, prior to receiving samples;
- b) Receiving samples from the field and verifying that incoming samples correspond to the packing list or chain-of-custody sheet; and
- c) Verifying that Analytical Laboratory QC and analytical procedures are being followed as specified in this Plan, by the Analytical Laboratory's QA/QC program, and in accordance with the requirements for maintaining National Environmental Laboratory Accreditation Program ("NELAP") and/or National Voluntary Laboratory Accreditation Program ("NAVLAP") certification.

2.4.3. Data Reviewers/Approvers

The QA Manager has broad authority to approve or disapprove project plans, specific analyses and final reports. In general, the QA Manager is responsible for reviewing and advising on all aspects of QA/QC, including:

- a) Ensuring that the data produced by the data generators meet the specifications set out in this Plan;
- b) Making on-site evaluations and submitting audit samples to assist in reviewing QA/QC procedures;
- c) Determining (with the Sampling and QC Monitor and Analysis Monitor) appropriate sampling equipment and sample containers, in accordance with this Plan, to minimize contamination; and
- d) Supervising all QA/QC measures to assure proper adherence to this Plan and determining corrective measures to be taken when deviations from this Plan occur.

The QA Manager may delegate certain of these responsibilities to one or more Sampling and QC Monitors or to other qualified Mill personnel.

2.5. Responsibilities Of Analytical Laboratory

Unless otherwise specified by DUSA corporate management, all environmental analysis of groundwater sampling required by the GWDP or by other applicable permits, will be performed by a contract Analytical Laboratory.

The Analytical Laboratory is responsible for providing sample analyses for groundwater monitoring and for reviewing all analytical data to assure that data are valid and of sufficient quality. The Analytical Laboratory is also responsible for data validation in accordance with the requirements for maintaining NELAP and/or NAVLAP certification.

In addition, to the extent not otherwise required to maintain NELAP and or NAVLAP certification, the Analytical Laboratory must adhere to U. S. EPA Guideline SW-846 and, to the extent consistent with NELAP and EPA practices, the applicable portions of NRC Regulatory Guide 4.14.

The Analytical Laboratory will be chosen by DUSA and must satisfy the following criteria: (1) experience in analyzing environmental samples with detail for precision and accuracy, (2) experience with similar matrix analyses, (3) operation of a stringent internal quality assurance program meeting NELAP and/or NAVLAP certification requirements and that satisfies the criteria set out in Section 8 below, (4) ability to satisfy radionuclide requirements as stipulated in the applicable portions of NRC Regulatory Guide 4.14, and (5) certified by the State of Utah for and capable of performing the analytical methods set out in Table 1. The analytical procedures used by the Analytical Laboratory will be in accordance with Utah Administrative Code R317-6-6.3L.

3. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT OF DATA

The objective of this Plan is to ensure that monitoring data are generated at the Mill that meet the requirements for precision, accuracy, representativeness, completeness, and comparability required for management purposes and to comply with the reporting requirements established by applicable permits and regulations (the Field and Analytical QC samples described in Sections 4.3 and 8.1 below are designed to ensure that these criteria are satisfied). Data subject to QA/QC measures are deemed more reliable than data without any QA/QC measures.

3.1. Precision

Precision is defined as the measure of variability that exists between individual sample measurements of the same property under identical conditions. Precision is measured through the analysis of samples containing identical concentrations of the parameters of concern. For duplicate measurements, precision is expressed as the relative percent difference ("RPD") of a data pair and will be calculated by the following equation:

$$RPD = [(A-B)/\{(A+B)/2\}] \times 100$$

Where A (original) and B (duplicate) are the reported concentration for field duplicate samples analyses (or, in the case of analyses performed by the Analytical Laboratory, the percent recoveries for matrix spike and matrix spike duplicate samples) (EPA SW-846, Chapter 1, Section 5.0, page 28).

3.2. Accuracy

Accuracy is defined as a measure of bias in a system or as the degree of agreement between a measured value and an accepted or measured value. The accuracy of laboratory analyses is evaluated based on analyzing standards of known concentration both before and during analysis. Accuracy will be evaluated by the following equation (EPA SW-846, Chapter 1, Section 5.0, page 24):

$$\% \text{ Recovery} = (|A-B|/C) \times 100$$

Where:

A = the concentration of analyte in a sample

B = the concentration of analyte in an unspiked sample

C = the concentration of spike added

3.3. Representativeness

Representativeness is defined as the degree to which a set of data accurately represents the characteristics of a population, parameter, conditions at a sampling point, or an environmental condition. Representativeness is controlled by performing all sampling in compliance with this Plan.

3.4. Completeness

Completeness refers to the amount of valid data obtained from a measurement system in reference to the amount that could be obtained under ideal conditions. Laboratory completeness is a measure of the number of samples submitted for analysis compared to the number of analyses found acceptable after review of the analytical data. Completeness will be calculated by the following equation:

$$\text{Completeness} = (\text{Number of valid data points}/\text{total number of measurements}) \times 100$$

Where the number of valid data points is the total number of valid analytical measurements based on the precision, accuracy, and holding time evaluation. Completeness is determined at the conclusion of the data validation.

Executive Secretary approval will be required for any completeness less than 100 percent.

3.5. Comparability

Comparability refers to the confidence with which one set of data can be compared to another measuring the same property. Data are comparable if sampling conditions, collection techniques, measurement procedures, methods, and reporting units are consistent for all samples within a sample set.

4. FIELD SAMPLING QUALITY ASSURANCE METHODOLOGY

4.1. Controlling Well Contamination

Well contamination from external surface factors, is controlled by installation of a cap over the surface casing and cementing the surface section of the drill hole. Wells have surface covers of mild steel with a lockable cap cover. Radiation Safety staff has access to the keys locking the wells.

Subsurface well stagnation, for pumped wells, is reduced by pumping two well casing volumes of water from the wells, to the extent practicable. This ensures, to the extent practicable, that the aquifer zone water is being drawn into the well and is a representative sample.

4.2. Controlling Depth to Groundwater Measurements

Monitoring of depth to groundwater is controlled by comparing historical field log data to actual measurement depth. This serves as a check of the field measurements.

4.3. Water Quality QC Samples

Quality assurance for ground water monitoring consists of the following QC samples:

4.3.1. VOC Trip Blanks

Trip blanks will be used to assess contamination introduced into the sample containers by volatile organic compounds ("VOCs") through diffusion during sample transport and storage. At a minimum (at least) one trip blank will be in each shipping container containing samples to be analyzed for VOCs. Trip blanks will be prepared by the Analytical Laboratory, transported to the sampling site, and then returned to the Analytical Laboratory for analysis

along with the samples collected during the sampling event. The trip blank will be unopened throughout the transportation and storage processes and will accompany the technician while sampling in the field (DTG, Field and Laboratory Quality Assurance/Quality control, 7.8, pages 7-30, 7-31)

4.3.2. Equipment Rinsate Samples

Where a portable (non-dedicated) pump is used, a rinsate sample will be collected prior to using and after decontaminating the sampling equipment at the beginning of each sampling event and at the beginning of each day of the sampling event (TEGD) Field QA/QC Program, page 119). Where a non-dedicated bailer is used a rinsate sample will be collected prior to any well sampling or purging and after decontamination at the beginning of each sampling event and at the beginning of each day of the sampling event. In the case of equipment rinsate blank samples for a pump, the sample will be prepared by pumping de-ionized water into the sample containers. In the case of equipment rinsate blank samples for a non-disposable or non-dedicated bailer, the sample will be prepared by pouring de-ionized water over and through the bailer and into the sample containers. . During quarterly/semi-annual monitoring events, equipment rinsate blanks will need to be analyzed only for the contaminants required during the accelerated monitoring event.

4.3.3. Field Duplicates

One Duplicate set of samples submitted with each Batch (defined in Section 4.3.4) of samples (DTG, Field and Laboratory Quality Assurance/Quality Control, 7.8), taken from one of the wells being sampled and will be submitted to the Analytical Laboratory and analyzed for all contaminants listed in Table 2 of the GWDP (EPA SW-846, Chapter 1, Section 3.4.1).

4.3.4. Definition of "Batch"

For the purposes of this Plan, a Batch is defined as 20 or fewer samples (PA SW-846, Chapter 1, Section 5.0, page 23).

5. CALIBRATION

A fundamental requirement for collection of valid data is the proper calibration of all sample collection and analytical instruments. Sampling equipment shall be calibrated in accordance with manufacturers' recommendations, and Analytical Laboratory equipment shall be calibrated in accordance with Analytical Laboratory procedures.

5.1. Depth to Groundwater Measurements

Equipment used in depth to groundwater measurements will be checked prior to each use to ensure that the Water Sounding Device is functional.

5.2. Water Quality

The Field Parameter Meter will be calibrated prior to each sampling event and at the beginning of each day of the sampling event according to manufacturer's specifications (for example, by using two known pH solutions and one specific conductance standard.) Temperature will be checked comparatively by using a thermometer. Calibration results will be recorded on the Field Data Worksheet.

6. GROUND WATER SAMPLING AND MEASUREMENT OF FIELD PARAMETERS

6.1. Groundwater Head Monitoring

6.1.1. Location and Frequency of Groundwater Head Monitoring

Depth to groundwater shall be measured quarterly in the following wells and piezometers:

- a) All Point of Compliance wells listed in paragraphs 6.2.1 a), b) and c) below;
- b) Monitoring wells MW-20 and MW-22;
- c) All piezometers (P-1, P-2, P-3, P-4 and P-5);
- d) All chloroform contaminant investigation wells required to be monitored during the quarter under State of Utah Notice of Violation and Groundwater Corrective Action Order UDEQ Docket No. UGQ-20-01, not already included in paragraph (a). On November 17, 2006, such chloroform contaminant investigation wells were the following:

- | | |
|---------|----------|
| • MW-4 | • TW4-10 |
| • TW4-1 | • TW4-11 |
| • TW4-2 | • TW4-12 |
| • TW4-3 | • TW4-13 |
| • TW4-4 | • TW4-14 |
| • TW4-5 | • TW4-16 |
| • TW4-6 | • TW4-18 |
| • TW4-7 | • TW4-19 |
| • TW4-8 | • TW4-20 |

- TW4-9
- TW4-21
TW4-22;

- e) In any other wells or piezometers required by the Executive Secretary of the Utah Radiation Control Board, as indicated by the Mill's RSO.

6.1.2. Equipment Used For Groundwater Head Monitoring

Measurement of depth to groundwater is accomplished by using a Solinst – IT 300 or equivalent device (the “Water Sounding Device”).

6.1.3. Field Sampling Procedure for Groundwater Head Monitoring

In the case of any well that is being sampled for groundwater quality, depth to groundwater is measured prior to sampling.

Depth to groundwater is measured from the top of the inner well casing, or for the piezometers, from the top of the casing, and is recorded on the Field Data Worksheet for Groundwater described in Section 7.1 (the “Field Data Worksheet”). Readings are taken by lowering the Water Sounding Device into the casing until the Device alarms, indicating that the water surface has been reached. The depth to groundwater is then determined by reference to the distance markings on the line attached to the Device. Data is recorded on the Field Data Worksheet as Depth to Water, to the nearest 0.01 of a foot.

6.2. Ground Water Compliance Monitoring

6.2.1. Location and Frequency of Groundwater Compliance Monitoring

Groundwater quality shall be measured in the following wells at the following frequencies:

- a) Semi-annually in the following Point of Compliance wells: MW-1, MW-2, MW-3, MW-5, MW-12, MW-15, MW-17, MW-18 and MW-19;
- b) Quarterly in the following Point of Compliance wells: MW-11, MW-14, MW-20, MW-22, MW-26 and MW-32; and
- c) Quarterly in the following new Point of Compliance wells, until 8 quarters of background data are obtained: MW-23, MW-24, MW-25, MW-27, MW-28, MW-29, MW-30 and MW-31. Thereafter, these wells will be sampled on a quarterly or semi-annual basis, as required by the GWDP.

- d) Chloroform Investigation sampling will collected from the locations and at the frequencies listed at Item 2) in the Chloroform Investigation Monitoring Quality Assurance Program (Appendix A to this document)

In addition, quarterly or monthly sampling may be required for certain parameters in certain wells for which accelerated monitoring is required under paragraph I.G.1 or I.G.2 of the GWDP. It is important to confirm with the Mill's RSO prior to conducting any monitoring well sampling, whether or not any parameters in any wells are subject to this accelerated monitoring.

6.2.2. Quarterly and Semi-Annual Sampling Required Under Paragraphs I.E.1.a) or I.E.1.b) of the GWDP

All quarterly and semi-annual samples collected under paragraphs 6.2.1 a), b) and c) above (paragraphs I.E.1.a) or I.E.1.b) of the GWDP) shall be analyzed for the following parameters:

- a) Field parameters – depth to groundwater, pH, temperature, specific conductance, redox potential (Eh) and turbidity in the manner specified in paragraph 6.2.7 d) (v); and
- b) Laboratory Parameters:
 - (i) All parameters specified in Table 2 of the GWDP; and
 - (ii) General inorganics – chloride, sulfate, carbonate, bicarbonate, sodium potassium, magnesium, calcium, and total anions and cations.

6.2.3. Quarterly or Monthly Sampling Required Under Paragraphs I.G.1 or I.G.2 of the GWDP

Any quarterly or monthly sampling required under paragraphs I.G.1. or I.G.2. of the GWDP shall be in the wells and for the specific parameters required by those paragraphs of the GWDP, as specified by the Mill's RSO.

6.2.4. *Sampling Equipment for Groundwater Compliance Monitoring*

. All equipment used for purging and sampling of groundwater which enters the well or may otherwise contact sampled groundwater, shall be made of inert materials.

For the purposes of this QAP the following equipment definitions shall apply:

- Dedicated Bailer: A bailer that is dedicated to be used at one specific well for the use of purging or sampling. Said bailer well remain with and in side the well casing suspended and secured.
- Non – Dedicated Bailer: A bailer that is used for purging and sampling at one or more well.
- Dedicated Pump: A pump that is dedicated to one specific well for the use of purging or sampling. Said pump well remain with and in side the well casing suspended and secured.
- Non – Dedicated Pump: A pump that is used for purging and sampling at one or more wells.

Groundwater compliance monitoring is accomplished by using the equipment, or the equivalent listed below

- a) Bailer made of inert materials for purging (DTG, 7.3, page 7-10)
- b) If a dedicated pump is installed in the well, use the dedicated pump, otherwise use a 1.8 inch (outside diameter) air-driven sampling pump, or equivalent;
- c) 150 psi air compressor and ancillary equipment, or equivalent;
- d) Field parameters shall be measured using a YSI-556 with Flow Cell Multi-Parameter Meter system or equivalent that allows a continuous stream of water from the pump to the meter that enables measurements to be taken on a real-time basis without exposing the water stream to the atmosphere. The Field Parameter Meter measures the following parameters:
 - (i) Water temperature;
 - (ii) Specific conductivity;
 - (iii) Total Dissolved Solids (TDS);
 - (iv) Standard pH;
 - (v) Redox potential (Eh).

Field parameters are measured by using a flow cell system that enables the measurements to be taken on a real-time basis without exposing the water stream to the atmosphere;

- e) Turbidity measuring instrument capable of determining if turbidity is ≤ 5 NTU;
- f) 0.45 micron high capacity disposable inline filters;
- g) Field preservation chemicals (as provided by the Analytical Laboratory);
- h) Five gallon calibrated sample bucket;
- i) Stopwatch;
- j) Sealed sterile Polyethylene sample containers as provided by the Analytical Laboratory;
- k) De-ionized water;
- l) One new, unused, clean disposable single check valve bailer, or the equivalent, for each well to be sampled for VOCs; and
- m) If any portable (non-dedicated) pumps are used, the following equipment, supplies and solutions, or the equivalent, necessary for decontamination procedures:
 - (i) 15 gallons of de-ionized water
 - (ii) 5 gallons of de-ionized water/nonphosphate detergent (such as Liqui-Nox);
 - (iii) 5 gallons of de-ionized water/HNO₃ solution (a mixture of approximately 4 and 1/2 gallons of de-ionized water and 1/2 gallon of HNO₃);
 - (iv) Rubber gloves; and
 - (v) Sterile sample containers from the Mill laboratory.

6.2.5. Decontamination Procedure

If a portable (non-dedicated) pump is to be used, prior to each sampling event, at the beginning of each day during the sampling event, and between each sampling location (well), decontaminate the portable (non-dedicated) sampling pump prior to its use for purging or sampling using the following procedure:

- a) wash the pump probe, probe sheath and other pump equipment that may come in contact with the sampling well inner casing or well water (the "Sampling Equipment") with a nonphosphate detergent;
- b) rinse the Sampling Equipment with de-ionized water;
- c) rinse the Sampling Equipment with dilute (.1N) hydrochloric or nitric acid; and

- d) rinse the Sampling Equipment with de-ionized water.

The probe should then be placed in the decontaminated probe sheath, or otherwise protected from contamination until used for purging or sampling.

All water produced during decontamination will be containerized. Containerized water will be disposed of in Tailings Cell 1.

All sampling and purging equipment that has been decontaminated as per the foregoing procedure shall be covered with a plastic sheet to shield such equipment from dust or other materials that may contaminate the equipment when traveling to and between purging/sampling locations.

6.2.6. Pre-Purging/ Sampling Activities

- a) If a portable (non-dedicated) pump is to be used, prior to commencing the event's sampling activities, check the pumping equipment to ensure that no air is leaking into the discharge line, in order to prevent aeration of the sample;
- b) If a portable (non-dedicated) pump is to be used, prior to each sampling event and at the beginning of each day during the sampling event, decontaminate the sampling pump using the procedure set forth in Section 6.2.5;
- c) If a portable (non-dedicated) pump is to be used, after completion of decontamination and prior to the beginning of each day of each sampling event, prepare one Equipment Rinsate Sample by following the procedure set forth in Section 4.3.2; and
- d) Prior to leaving the Mill office, place the Trip Blank(s) into a cooler that will preserve the VOC samples. The Trip Blank(s) will accompany the groundwater samplers throughout the monitoring event.

6.2.7. Well Purging/Measurement of Field Parameters

- a) Remove the well casing cap and measure and record depth to groundwater by following the procedures set out in paragraph 6.1.3 above;
- b) Determine the casing volume (V) in gallons, where h is column height of the water in the well (calculated by subtracting the depth to groundwater in the well from the total depth of the well), $V = 0.653 * h$, for a 4" casing volume and $V = .367 * h$ for a 3" casing volume. Record the casing volume on the Field Data Worksheet;
- c) If the RSO has advised the field technician that immiscible contaminants (i.e., LNAPLs or DNAPLs) are known to occur or could potentially occur in the

subsurface at the location of the well, follow the additional procedures, to be provided by the RSO, prior to well purging;

- d) Purging, Where Use of Pump is Effective (See paragraph 6.2.7 e)) below, where bailer is required)

If a portable (non-dedicated) pump is used, ensure that it has been decontaminated in accordance with Section 6.2.5 since its last use in a different well, lower the pump into the well, making sure to keep the pump at least five feet from the bottom of the well. Be sure never to drop the pump into the well, as this will cause degassing of the water upon impact. Once the pump is lowered into the well, or if the well has a dedicated pump, perform the following steps:

- (i) Commence pumping;
- (ii) Determine pump flow rate by using a stopwatch and a calibrated bucket by measuring the number of seconds required to fill to the one-gallon mark. Record this in the "pumping rate" section of the Field Data Worksheet;
- (iii) Calculate the amount of time to evacuate two casing volumes;
- (iv) Evacuate two casing volumes (if possible) by pumping for the length of time determined in paragraph (iii);
- (v) Take measurements of field parameters (pH, specific conductance, temperature, redox potential and turbidity) during well purging, using the Field Parameter Meter and turbidity measuring instrument. These measurements will be recorded on the Field Data Worksheet. Purging is completed after two casing volumes have been removed and the field parameters pH, temperature, specific conductance, redox potential (Eh) and turbidity have stabilized to within 10% over at least two consecutive measurements. The groundwater in the well should recover to within at least 90% of the measured groundwater static surface before sampling. In addition, turbidity measurement in the water should be ≤ 5 NTU prior to sampling (DTG Well Development 6.7, page 6-48) unless the well is characterized by water that has a higher turbidity. A flow-cell needs to be used for field parameters. If the well is purged to dryness or is purged such that full recovery exceeds two hours, the well should be sampled as soon as a sufficient volume of groundwater is available to fill sample containers (DTG, Well Purging, 7.2.4, page 7-9);
- (vi) If the well yields two casing volumes, the individual performing the sampling should immediately proceed to Section 6.2.8);

(vii) If the well cannot yield two casing volumes,

- A. Evacuate the well to dryness and record the number of gallons evacuated on the Field Data Worksheet; and
- B. Prior to sampling, measure and record depth to groundwater on the Field Data Worksheet following the procedures set out in paragraph 6.1.3 above;

e) Purging, Where Use of Pump is Not Effective

For wells where a pump is not effective for purging and/or sampling (wells with shallow water columns, i.e., where the water column is less than five feet above the bottom of the well casing or the well takes over two days to recover from purging), a disposable bailer, made of inert materials, may be used. If a bailer is used, the following procedure will be followed:

- (i) Use the sound level instrument to determine the water column and figure the amount of water that must be evacuated;
- (ii) Attach a 3" disposable bailer to a rope and reel;
- (iii) Lower the bailer into the well and listen for contact with the solution. Once contact is made, allow the bailer to gradually sink in the well, being careful not to allow the bailer to come in contact with the bottom sediment;
- (iv) After the bailer is full, retrieve the bailer and discharge the water from the bailer into 5 gallon buckets. By doing this, one can record the number of gallons purged;
- (v) After the bailer is emptied, lower the bailer back into the well and gain another sample as before. This process will continue until the two casing volumes have been collected or until no more water can be retrieved. When the process is finished for the well, the bailer will be disposed of; and
- (vi) Take field measurements referred to in paragraph 6.2.7 (v) above from the water in the buckets;

6.2.8. Samples to be taken and order of taking samples

For each sampling event, unless sampling for a specific parameter under the accelerated monitoring requirements of paragraphs I.G.1 or I.G.2 of the GWDP as specified by the RSO, the following separate samples shall be taken in the following order from each monitoring well:

- a) VOCs, 3 sample containers, 40 ml each, (a bailer is used);
- b) Nutrients (ammonia, nitrate and nitrite), 1 sample container, 100 ml (a bailer is used);
- c) Heavy metals, 1 sample container, 250 ml, filtered;
- d) All other non-radiologics (fluoride, general inorganics, TDS, total cations and anions), 1 sample container, 250 ml, filtered; and
- e) Gross alpha, 1 sample container, 1,000 ml, filtered.
- f) The sample collection containers and sample volumes for chloroform sampling are specified at Item 3) of the Chloroform Investigation Monitoring Quality Assurance Program (Appendix A to this document)

The number of sample containers and the quantities taken shall be as set out above, unless otherwise dictated by the Analytical Laboratory, as specified by the RSO.

6.2.9. Field Duplicate Samples

- a) One duplicate set of samples is required for each Batch of samples (see Section 4.3.4) for definition of Batch) (EPA SW-846, Chapter 1, Section 3.4.1). Field duplicate samples will be analyzed for the contaminants listed in Table 2 of the GWDP;
- b) The duplicate samples should be as near to split samples as reasonably practicable, rather than merely taking a second set of samples from the same well after the field samples have been taken from that well. This can be accomplished by alternately partially filling the field sample containers and duplicate containers until both sets of containers are full.

6.2.10. VOCs and Nutrient Sampling

When sampling for VOCs and Nutrients, the following procedure shall be followed:

- a) Obtain specifically identified sample containers for the type of sample to be taken, as provided by the Analytical Laboratory;
- b) Add the quantity of specified preservative provided by the Analytical Laboratory to each sample container;
- c) Sample the well using an unused, clean, disposable, single check valve bailer, or the equivalent;
- d) Sample water should be transferred to sample containers in a controlled manner that will minimize sample agitation and aeration;
- e) In the case of VOC samples, be sure that the sample containers are filled as full as possible with no airspace in the containers;
- f) After each sample container is filled, rinse the lid of the container with water, and tighten lid onto container; and,
- g) Discard the bailer.

6.2.11. Heavy Metals, All Other Non-Radiologics and Gross Alpha Sampling

When sampling for heavy metals, all other non-radiologics and for gross alpha, the following procedure shall be followed:

- a) Obtain the specifically identified sample container for the type of sample to be taken, as provided by the Analytical Laboratory;
- b) Add the quantity of specified preservative provided by the Analytical Laboratory to each sample container;
- c) When using a pump to sample (wells without shallow water columns, i.e., where the water column is more than five feet above the bottom of the well casing or the well takes less than two days to recover from purging):
 - (i) Place a new 0.45 micron filter on the sample tubing;

- (ii) Pump the sample through the filtration unit, and into the sample container at the same rate or a lesser pumping rate than was used to purge the well;
 - (iii) The pump should be operated in a continuous manner so that it does not produce samples that are aerated in the return tube or upon discharge;
 - (iv) Remove pump from the well; and
 - (v) If using a portable (non-dedicated pump), decontaminate pump as per Section 6.2.5. Do not place decontaminated pump on the ground or on other contaminated surfaces;
- d) When using a bailer to sample (wells with shallow water columns, i.e., where the water column is less than five feet above the bottom of the well casing or the well takes over two days to recover from purging), then one of the following two procedures will be used:
- (i) Filtering Water Samples at the Well Head
 - A. The sample water is collected by use of a 3 inch Teflon bailer, or the equivalent, that is capable of being attached to a hand-operated pressure pump, or the equivalent. Only disposable parts of the pressure pump may come into contact with the sample water;
 - B. Attach the pump to the disposable bailer and activate the pump in accordance with manufacturer's instructions, such that the sample water in the bailer is forced through a clean, un-used, disposable 0.45 micron filter into a clean previously unused sample container, in a manner such that only disposable parts of the pump mechanism come into contact with the sample water;
 - C. Sample water should be transferred to sample containers in a controlled manner that will minimize sample agitation and aeration;
 - D. Rinse lid of sample container with any remaining filtered water, after container is filled with filtered water, and tighten lid onto container;
 - E. Unless dedicated to a particular well, dispose of the bailer, filter and any parts of the pump mechanism that come into contact with the sample water; and
 - F. No rinsate sample is needed, because everything that comes into contact with the sample water is clean and unused prior to sampling, and disposed of after sampling the well;
 - (ii) Filtering Water Samples at the Mill Laboratory

- A. A new, clean 1 gallon raw sample container must be used to capture waters needed to be filtered;
- B. The sample water is collected by use of a 3 inch Teflon bailer, or the equivalent, and then discharged into the 1 gallon container;
- C. After all the samples have been collected for the well and placed in the field sample container, which contains blue ice to keep the samples at the required temperature, the sampler will then proceed directly back to the Mill laboratory and perform the filtration on the sample;
- D. Unless the bailer is dedicated to a particular well, it will be disposed of after completion of sampling in the well;
- E. Upon arrival at the administration building, all other samples from the well (that do not require filtration) will be placed in the sample holding refrigerator in the locked sample storage room;
- F. The sampler will then carry the sample that requires filtration in the cooler to the laboratory and set up the equipment to be used for filtration of the sample;
- G. The equipment needed for this process consists of:
 - 2000 ml glass filter flask
 - 250 ml bell and glass frit for a micro-filtration 0.45 micron filter setup
 - 0.45 micron filter paper
- H. The glass filter flask and micro-filtration equipment will go through a cleaning and rinsate process. The processing will included the following:
 - Rinsing of the equipment using DI water
 - Rinsing the equipment with a mixture of DI water and HNO_3
 - Rinsing the equipment with a mixture of DI water and Liqui-Nox soap
 - Rinsing the equipment with DI water
 - Finally the collection of the final process rinsate solutions are placed in the sample collection cooler and labeled as a filtration equipment rinsate sample;
- I. The flask is attached to the vacuum system in the laboratory using Tygon Vacuum Tubing, or the equivalent;
- J. The micro-filtration system is then inserted into the filter flask;
- K. A 0.45 micron filter paper is then placed between the bell and the glass frit and clamped in place to prevent solution leaking out;
- L. The water sample is then slowly added into the bell and the vacuum is turned on;
- M. As the vacuum draws the water through the filter paper, additional solutions are added until the flask is full;

- N. When the flask is full, the vacuum is turned off and the bell is unclamped from the frit. The Tygon tubing is then removed from the flask. The glass frit is then pulled out of the flask;
- O. The filtered solutions are then poured into the various remaining sample collection bottles. Sample water should be transferred to sample containers in a controlled manner that will minimize sample agitation and aeration;
- P. Rinse lid of sample container with any remaining filtered water, after container is filled with filtered water, and tighten lid onto container;
- Q. If additional filtered water is required to complete the sample requirements, the sample bottles will be placed in the field cooler along with the raw sample and housed there while the filtration system is being hooked back up and the procedures set out in paragraphs I to P above are repeated until sufficient sample water has been filtered to fill up the required number of sample bottles;
- R. After all samples from the well that require filtration have been filtered in accordance with the foregoing procedure and placed in the proper sample bottles, the remainder of the raw sample is then discharged into the laboratory sink, which runs to tails; and
- S. The filtered samples are then transported to the locked sample storage room and placed in the sample holding refrigerator.

The time lapse between the actual sampling times to the completion of the filtration process is approximately ½ hour. Samples are always in the field sample container, except for when the raw sample is pulled from the cooler and poured in the bell on the filter flask.

6.2.12. Procedures to Follow After Sampling

- a) In each case, once a sample is taken, identify and label the sample container with:
 - Sample location/facility
 - Date and time of sample
 - Any preservation method utilized
 - Sampler's initials
 - Filtered or unfiltered
 - Parameters requested to be analyzed
- b) Place each sample in an ice-packed cooler, immediately upon taking the sample and labeling the sample container;
- c) Replace the casing cap on the well. Lock the well;

- d) Before leaving the sampling location, thoroughly document the sampling event on the Field Data Worksheet, by recording the items required in paragraph 7.1; and
- e) Upon returning to the office, the samples must be stored in a refrigerator at no more than 4° C. These samples shall be received by the Analytical Laboratory at no more than 4° C. Samples will then be re-packed in the plastic ice-packed cooler and transported via these sealed plastic containers by postal contract services to the Analytical Laboratory.

7. SAMPLE DOCUMENTATION TRACKING AND RECORD KEEPING

7.1. Field Data Worksheets

Documentation of observations and data from sampling provide important information about the sampling process and provide a permanent record for sampling activities. All observations and field sampling data will be recorded in waterproof ink on the Field Data Worksheets, which will be maintained on file at the Mill.

The Field Data Worksheets will contain the following information:

- Name of the site/facility
- description of sampling event
- location of sample (well name)
- sampler's name(s) and signature(s)
- date(s) and time(s) of well purging and sample collection
- type of well purging equipment used (pump or bailer)
- previous well sampled during the sampling event
- well depth
- depth to groundwater before purging and sampling
- results of in-field measurements (pH, specific conductance, water temperature)
- redox potential (Eh) measurements
- turbidity measurements
- calculated well casing volume
- volume of water purged before sampling
- volume of water purged when field parameters are measured
- type and condition of well pump
- description of samples taken
- sample handling, including filtration and preservation
- volume of water collected for analysis
- types of sample containers and preservatives

- weather conditions and external air temperature
- name of certified Analytical Laboratory.

The Field Data Worksheets will also contain detailed notes describing any other significant factors during the sampling event, including, as applicable: condition of the well cap and lock; water appearance, color, odor, clarity; presence of debris or solids; any variances from this Procedure; and any other relevant feature or condition. An example of a form of Field Data Worksheet that incorporates this information is attached as Attachment 1.

7.2. Chain-Of-Custody and Analytical Request Record

A Chain-of-Custody and Analytical Request Record form (the “COC Form”), provided by the Analytical Laboratory, will accompany the samples being shipped to the Analytical Laboratory. An example of the Analytical Laboratory’s Chain of Custody Form is attached as Attachment 2. If the Chain of Custody Form changes at any time, the Company shall provide a copy of the new or revised Chain of Custody Form to the Executive Secretary and substitute the new form for the old form in Attachment 2. Standard Chain-of-Custody protocol is initiated for each sample set. A COC Form is to be completed for each set of samples collected in a shipping container (cooler) and is to include the following:

- sampler’s name
- company name
- date and time of collection
- sample type (e.g., water)
- sample location
- number of sample containers in the shipping container
- analyses requested
- signatures of persons involved in the chain of possession
- internal temperatures of the shipping container when opened at the laboratory
- remarks section to identify potential hazards or to relay other information to the Analytical Laboratory.

Chain-of-Custody reports will be placed inside a re-sealable bag and taped to the inside lid. Custody seals will be placed on the outside of each cooler.

The person shipping the samples to the Analytical Laboratory will sign the COC Form, document shipment method, and send the original and the second copy of the COC Form with the samples. Upon receipt of the samples, the person receiving the samples will sign the COC Form and return the second copy to the Mill’s RSO.

Copies of the COC Forms and other relevant documentation will be retained at the Mill.

7.3. Record Keeping

The Field Data Worksheets are retained at the Mill.

Original Certificates of Analysis from the Analytical Laboratory, showing the laboratory analytical results for the water samples, are maintained at the Mill.

Once all the data for the quarter (all wells sampled during the quarter) is completed, key data from the Field Data Worksheets and from the Certificates of Analysis are typed into a computer file. Key data entered into the computer file will include well I.D., sample date, depth to groundwater, average field data, and all laboratory analytical data. These computer files are maintained at the Mill.

8. ANALYTICAL PROCEDURES AND QA/QC

Analytical Laboratory QA provides a means for establishing consistency in the performance of analytical procedures and assuring adherence to analytical methods utilized. Analytical Laboratory QC programs include traceability of measurements to independent reference materials and internal controls.

8.1. Analytical Quality Control

Analytical QA/QC will be governed by the QA/QC program of the Analytical Laboratory. In choosing and retaining the Analytical Laboratory, DUSA shall ensure that the Analytical Laboratory is certified by the State of Utah and by NELAP and/or NAVLAP, is capable of performing the analytical procedures specified in Section 8.2, and that the QA/QC program of the Analytical Laboratory includes the spikes, blanks and duplicates described in Section 8.1.2.

8.1.2. Spikes, Blanks and Duplicates

Analytical Laboratory QC samples will assess the accuracy and precision of the analyses. The following describes the type of QC samples that will be used by the Analytical Laboratory to assess the quality of the data. The following procedures shall be performed at least once with each Batch of samples:

a) Duplicate Spike (Matrix Spike)

A split/spiked field sample shall be analyzed with every analytical batch. Analytes stipulated by the analytical method, by applicable regulations, or by other specific requirements must be spiked into the sample. Selection of the sample to be spiked and/or split depends on the information required and the variety of conditions within a

typical matrix. The duplicate spike (matrix spike) sample serves as a check evaluating the effect of the sample matrix on the accuracy of analysis.

b) Blanks

Each batch shall be accompanied by a reagent blank. The reagent blank shall be carried through the entire analytical procedure. Contamination detected in analysis of reagent blanks will be used to evaluate any Analytical Laboratory contamination of environmental samples which may have occurred.

c) Field Samples/Surrogate Compounds

Every blank, standard, and environmental sample (including matrix spike/matrix duplicate samples) shall be spiked with surrogate compounds prior to purging or extraction. Surrogates are organic compounds which are similar to analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. Surrogates shall be spiked into samples according to the appropriate organic analytical methods.

d) Check Sample

Each analytical batch shall contain a number of check samples. For each method, the Analytical Laboratory will normally analyze the following check samples or their equivalents: a method blank, a laboratory control spike, a matrix spike, and a matrix spike duplicate, or the equivalent, with relative percent difference reported.

8.2. Analytical Laboratory Procedures

The analytical procedures to be used by the Analytical Laboratory will be as specified in Table 1, or as otherwise authorized by the Executive Secretary. With respect to Chloroform Investigation sampling, the analytical procedures for parameters monitored under that program are specified at Item 4) of the Chloroform Investigation Monitoring Quality Assurance Program (Appendix A to this document)

Table 1

Contaminant	Analytical Methods to be Used	Reporting Limit¹	Maximum Holding Times	Sample Preservation Requirements	Sample Temperature Requirements
Nutrients					
Ammonia (as N)	A4500-NH ₃ G	0.05 mg/L	28 days	H ₂ SO ₄ to pH<2	4°C
Nitrate & Nitrite (as N)	E353.2	0.1 mg/L	28 days	H ₂ SO ₄ to pH<2	4°C
Heavy Metals					
Arsenic	E200.8	5 µg/L	6 months	HNO ₃ to pH<2	None
Beryllium	E200.8	0.50 µg/L	6 months	HNO ₃ to pH<2	None
Cadmium	E200.8	0.50 µg/L	6 months	HNO ₃ to pH<2	None
Chromium	E200.8	25 µg/L	6 months	HNO ₃ to pH<2	None
Cobalt	E200.8	10 µg/L	6 months	HNO ₃ to pH<2	None
Copper	E200.8	10 µg/L	6 months	HNO ₃ to pH<2	None
Iron	E200.7	30 µg/L	6 months	HNO ₃ to pH<2	None
Lead	E200.8	1.0 µg/L	6 months	HNO ₃ to pH<2	None
Manganese	E200.8	10 µg/L	6 months	HNO ₃ to pH<2	None
Mercury	E200.8	0.50 µg/L	28 days	HNO ₃ to pH<2	None
Molybdenum	E200.8	10 µg/L	6 months	HNO ₃ to pH<2	None
Nickel	E200.8	20 µg/L	6 months	HNO ₃ to pH<2	None
Selenium	E200.8	5 µg/L	6 months	HNO ₃ to pH<2	None
Silver	E200.8	10 µg/L	6 months	HNO ₃ to pH<2	None
Thallium	E200.8	0.50 µg/L	6 months	HNO ₃ to pH<2	None
Tin	E200.8	100 µg/L	6 months	HNO ₃ to pH<2	None
Uranium	E200.8	0.30 µg/L	6 months	HNO ₃ to pH<2	None
Vanadium	E200.8	15 µg/L	6 months	HNO ₃ to pH<2	None
Zinc	E200.8	10 µg/L	6 months	HNO ₃ to pH<2	None
Radiologics					
Gross Alpha	E900.1	1.0 pCi/L	6 months	HNO ₃ to pH<2	None
Volatile Organic Compounds					
Acetone	SW8260B	20 µg/L	14 days	HCl to pH<2	4°C
Benzene	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
2-Butanone	SW8260B	20 µg/L	14 days	HCl to pH<2	4°C

Contaminant	Analytical Methods to be Used	Reporting Limit ¹	Maximum Holding Times	Sample Preservation Requirements	Sample Temperature Requirements
(MEK)					
Carbon Tetrachloride	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Chloroform	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Chloromethane	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Dichloromethane (Methylene Chloride)	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Naphthalene	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Tetrahydrofuran	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Toluene	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Xylenes (total)	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Others					
Field pH (S.U.)	A4500-H B	0.01 s.u.	Immediate	None	None
Fluoride	A4500-F C	0.1 mg/L	28 days	None	None
TDS	A2540 C	10 mg/L	7 days	None	4°C
General Inorganics					
Chloride	A4500-Cl B	1 mg/L	28 days	None	None
Sulfate	A4500-SO4 E	1 mg/L	28 days	None	4°C
Carbonate as CO ₃	A2320 B	1 mg/L	14 days	None	4°C
Bicarbonate as HCO ₃	A2320 B	1 mg/L	14 days	None	4°C
Sodium	E200.7	0.5 mg/L	6 months	HNO ₃ to pH<2	None
Potassium	E200.7	0.5 mg/L	6 months	HNO ₃ to pH<2	None
Magnesium	E200.7	0.5 mg/L	6 months	HNO ₃ to pH<2	None
Calcium	E200.7	0.5 mg/L	6 months	HNO ₃ to pH<2	None

1. The Analytical Laboratory will be required to meet the reporting limits ("RLs") in the foregoing Table, unless the RL must be increased due to sample matrix interference (i.e., due to dilution gain), in which case the increased RL will be used, or unless otherwise approved by the Executive Secretary.

9. INTERNAL QUALITY CONTROL CHECKS

Internal quality control checks are inherent in this Plan. The QA Manager will monitor the performance of the Sample and QC Monitors, and, to the extent practicable, the Analysis Monitor to ensure that they are following this Plan. In addition, either the QA Manager or a Sampling and QC Monitor will review and validate the analytical data generated by the Analytical Laboratory to ensure that it meets the DQOs established by this Plan. Finally, periodic system and performance audits will be performed, as detailed in Section 12 below.

9.1. Field QC Check Procedures

The QA Manager will perform the following QA/QC analysis of field procedures:

9.1.1. Review of Compliance With the Procedures Contained in this Plan

Observation of technician performance is monitored by the QA Manager on a periodic basis to ensure compliance with this Plan.

9.1.2. Analyte Completeness Review

The QA Manager will review all Analytical Results to confirm that the analytical results are complete (i.e., there is an analytical result for each required constituent in each well). The QA Manager shall also identify and report all instances of non-compliance and non-conformance (see Part I.E.1.(a) of the Permit. Executive Secretary approval will be required for any completeness (prior to QA/QC analysis) less than 100 percent. Non-conformance will be defined as a failure to provide field parameter results and analytical results for each parameter and for each well required in Sections 6.2.2 and 6.2.3, for the sampling event, without prior written Executive Secretary approval.

9.1.3. Blank Comparisons

Trip blanks, and equipment rinsate samples will be compared with original sample results. Non-conformance conditions will exist when contaminant levels in the blank(s)/samples(s) are within an order of magnitude of the original sample result. (TEGD, Field QA/QC Program, page 119).

9.1.4. Duplicate Sample Comparisons

The following analyses will be performed on duplicate field samples:

a) Relative Percent Difference.

RPDs will be calculated in comparisons of duplicate and original field sample results. Non-conformance will exist when the RPD $\geq 20\%$, unless the measured activities are less than 5 times the required detection limit (Standard Methods, 1998) (EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, February 1994, 9240.1-05-01, p. 25).

b) Radiologics Counting Error Term

All gross alpha analyses shall be reported with an error term. All gross alpha analysis reported with an activity equal to or greater than the GWCL, shall have a counting variance that is equal to or less than 20% of the reported activity concentration. An error term may be greater than 20% of the reported activity concentration when the sum of the activity concentration and error term is less than or equal to the GWCL.

c) Radiologics, Duplicate Samples

Comparability of results between the original and duplicate radiologic samples will be evaluated by determining compliance with the following formula:

$$|A-B| / (sa^2 + sb^2)^{-2} < 2$$

Where:

A = the first duplicate measurement

B = the second duplicate measurement

sa² = the uncertainty of the first measurement squared

sb² = the uncertainty of the second measurement squared

Non-conformance exists when the foregoing equation is ≥ 2 .

(EPA Manual for the Certification of Laboratories Analyzing Drinking Water, Criteria and Procedures Quality Assurance, January 2005, EPA 815-R-05-004, p. VI-9).

If the QA Managers review finds any situations of non-conformance, see Section 10.

9.2. Analytical Laboratory QA Reviews

Full validation will include recalculation of raw data for a minimum of one or more analytes for ten percent of the samples analyzed. The remaining 90% of all data will undergo a QC review which will include validating holding times and QC samples. Overall data assessment will be a part of the validation process as well.

The Analysis Monitor or data validation specialist will evaluate the quality of the data based on SW-846, the applicable portions of NRC guide 4.14 and on analytical methods used. The reviewer will check the following: (1) sample preparation information is correct and complete, (2) analysis information is correct and complete, (3) appropriate Analytical Laboratory procedures are followed, (4) analytical results are correct and complete, (5) QC samples are within established control limits, (6) blanks are within QC limits, (7) special sample preparation and analytical requirements have been met, and (8) documentation is complete.

The Analytical Laboratory will prepare and retain full QC and analytical documentation. The Analytical Laboratory will report the data as a group of one batch or less, along with the QA/QC data. The Analytical Laboratory will provide the following information: (1) cover sheet listing samples included in report with a narrative, (2) results of compounds identified and quantified, and (3) reporting limits for all analytes. Also to be included are the QA/QC analytical results.

9.3. QA Manager Review of Analytical Laboratory Results and Procedures.

The QA Manager shall perform the following QA reviews relating to Analytical Laboratory procedures:

a) Reporting Limit (RL) Comparisons

The QA Manager shall confirm that all reporting limits used by the Analytical Laboratory are in conformance with the reporting limits set out on Table 1. Non-conformance shall be defined as: 1) a reporting limit that violates these provisions, unless the reporting limit must be increased due to sample matrix interference (i.e., due to dilution gain); or 2) a reporting limit that exceeds the respective GWQS listed in Table 2 of the GWDP.

b) Laboratory Methods Review

The QA Manager shall confirm that the analytical methods used by the Analytical Laboratory are those specified in Table 1, unless otherwise approved by the Executive Secretary. Non-conformance shall be defined when the Analytical Laboratory uses analytical methods not listed in Table 1 and not otherwise approved by the Executive Secretary.

c) Holding Time Examination

The QA Manager will review the analytical reports to verify that the holding time for each contaminant was not exceeded. Non-conformance shall be defined when the holding time is exceeded.

d) Sample Temperature Examination

The QA Manager shall review the analytical reports to verify that the samples were received by the Analytical Laboratory at a temperature no greater than the approved temperature listed in Table 1. Non-conformance shall be defined when the sample temperature is exceeded.

9.4. Analytical Data

All QA/QC data and records required by the Analytical Laboratory's QA/QC program shall be retained by the Analytical Laboratory and shall be made available to DUSA as requested.

Analytical data submitted by the Analytical Laboratory should contain the date/time the sample was collected, the date/time the sample was received by the Analytical Laboratory, the date/time the sample was extracted (if applicable), and the date/time the sample was analyzed.

All out-of-compliance results will be logged by the Analysis Monitor with corrective actions described as well as the results of the corrective actions taken. All raw and reduced data will be stored according to the Analytical Laboratory's record keeping procedures and QA program. All Analytical Laboratory procedures and records will be available for on-site inspection at any time during the course of investigation.

If re-runs occur with increasing frequency, the Analysis Monitor and the Mill's QA Manager will be consulted to establish more appropriate analytical approaches for problem samples.

10. CORRECTIVE ACTION

10.1. When Corrective Action is Required

The Sampling and QC Monitors and Analytical Laboratory are responsible for following procedures in accordance with this Plan. Corrective action should be taken for any procedure deficiencies or deviations noted in this Plan. All deviations from field sampling procedures will be noted on the Field Data Worksheets or other applicable records. Any QA/QC problems that arise will be brought to the immediate attention of the QA Manager. Analytical Laboratory deviations will be recorded by the Analysis Monitor in a logbook as well.

When non-conformance is identified, DUSA shall:

- a) When non-conformance occurs as specified in Sections 9.1.3, 9.1.4 or 9.3, the data shall be qualified to denote the problem. In addition, DUSA shall determine the root cause, and provide specific steps to resolve problems(s) in accordance with the procedure set forth in Section 10.2. Any non-conformance with QAP requirements in a given quarterly ground water monitoring period will be corrected and reported to the Executive Secretary on or before submittal of the next quarterly ground water monitoring report.
- b) When a sample is lost, sample container broken, or the sample or analyte was omitted, resample within 10 days of discovery and analyze again in compliance with all requirements of this Plan. The results for this sample(s) should be included in the same quarterly monitoring report with other samples collected for the same sampling event; and
- c) For any other material deviation from this Plan, the procedure set forth in Section 10.2 shall be followed.

10.2. Procedure for Corrective Action

The need for corrective action for non-conformance with the requirements of this Plan, may be identified by system or performance audits or by standard QA/QC procedures. The procedures to be followed if the need for a corrective action is identified, are as follows:

- a) Identification and definition of the problem;
- b) Assignment of responsibility for investigating the problem;
- c) Investigation and determination of the cause of the problem;
- d) Determination of a corrective action to eliminate the problem;
- e) Assigning and accepting responsibility for implementing the corrective action;
- f) Implementing the corrective action and evaluating its effectiveness; and
- g) Verifying that the corrective action has eliminated the problem.

The QA Manager shall ensure that these steps are taken and that the problem which led to the corrective action has been resolved. A memorandum explaining the steps outlined above will be placed in the applicable monitoring files and the Mill Central Files, and the corrective action will be documented in a Report prepared in accordance with Section 11.

11. REPORTING

As required under paragraph I.F.1 of the GWDP, the Mill will send a groundwater monitoring report to the Executive Secretary on a quarterly basis. Both the Routine Groundwater Monitoring Reports (pertinent to Part I.F.1 of the Permit) and Chloroform Investigation Reports shall be submitted according to the following schedule:

Quarter	Period	Due Date
First	January – March	June 1
Second	April – June	September 1
Third	July – September	December 1
Fourth	October – December	March 1

The Routine Groundwater Monitoring Reports (pertinent to Part I.F.1 of the Permit) will include the following information:

- Description of monitor wells sampled
- Description of sampling methodology, equipment and decontamination procedures to the extent they differ from those described in this Plan
- A summary data table of historic groundwater levels for each monitor well and piezometer
- A summary data table showing the results of the sampling event, listing all wells and the analytical results for all constituents and identifying any constituents that are subject to accelerated monitoring in any particular wells pursuant to Part I.G.1 of the GWDP or are out of compliance in any particular wells pursuant to Part I.G.2 of the GWDP
- Copies of Field Data Worksheets
- Copies of Analytical Laboratory results
- Copies of Chain of Custody Forms
- - A Water Table Contour Map showing groundwater elevation data for the quarter will be contemporaneous for all wells on site, not to exceed a maximum time difference of five calendar days.
- Evaluation of groundwater levels, gradients and flow directions
- Quality assurance evaluation and data validation description (see Section 9 for further details)
- All non-conformance with this Plan and all corrective actions taken.
- Recommendations and Conclusions.

With respect to the chloroform investigation reporting requirements, these are specified at Item 5) of the Chloroform Investigation Monitoring Quality Assurance Program (Appendix A to this document.

In addition, an electronic copy of all analytical results will be transmitted to the Executive Secretary in comma separated values (CSV) format, or as otherwise advised by the Executive Secretary.

Further reporting may be required as a result of accelerated monitoring under paragraphs I.G.1 and I.G.2 of the GWDP. The frequency and content of these reports will be defined by DUSA corporate management working with the Executive Secretary.

12. SYSTEM AND PERFORMANCE AUDITS

12.1. QA Manager to Perform System Audits and Performance Audits

DUSA shall perform such system audits and performance audits as it considers necessary in order to ensure that data of known and defensible quality are produced during a sampling program. The frequency and timing of system and performance audits shall be as determined by DUSA.

12.2. System Audits

System audits are qualitative evaluations of all components of field and Analytical Laboratory QC measurement systems. They determine if the measurement systems are being used appropriately. System audits will review field and Analytical Laboratory operations, including sampling equipment, laboratory equipment, sampling procedures, and equipment calibrations, to evaluate the effectiveness of the QA program and to identify any weakness that may exist. The audits may be carried out before all systems are operational, during the program, or after the completion of the program. Such audits typically involve a comparison of the activities required under this Plan with those actually scheduled or performed. A special type of systems audit is the data management audit. This audit addresses only data collection and management activities.

12.3. Performance Audits

The performance audit is a quantitative evaluation of the measurement systems of a program. It requires testing the measurement systems with samples of known composition or behavior to evaluate precision and accuracy. With respect to performance audits of the analytical process, either blind performance evaluation samples will be submitted to the Analytical Laboratory for analysis, or the auditor will request that it provide results of the blind studies that the Analytical Laboratory must provide to its NELAP and/or NAVLAP accreditation agency on an annual basis. The performance audit is carried out without the knowledge of the analysts, to the extent practicable.

12.4. Follow-Up Actions

Response to the system audits and performance audits is required when deviations are found and corrective action is required. Where a corrective action is required, the steps set out in Section 10.2 will be followed.

12.5. Audit Records

Audit records for all audits conducted will be retained in Mill Central Files. These records will contain audit reports, written, records of completion for corrective actions, and any other documents associated with the audits supporting audit findings or corrective actions.

13. PREVENTIVE MAINTENANCE

Preventive maintenance concerns the proper maintenance and care of field and laboratory instruments. Preventive maintenance helps ensure that monitoring data generated will be of sufficient quality to meet QA objectives. Both field and laboratory instruments have a set maintenance schedule to ensure proper functioning of the instruments.

Field instruments will be maintained as per the manufacturer's specifications and established sampling practice. Field instruments will be checked and calibrated prior to use, in accordance with Section 5. Batteries will be charged and checked daily when these instruments are in use. All equipment out of service will be immediately replaced. Field instruments will be protected from adverse weather conditions during sampling activities. Instruments will be stored properly at the end of each working day. Calibration and maintenance problems encountered will be recorded in the Field Data Worksheets or logbook.

The Analytical Laboratory is responsible for the maintenance and calibration of its instruments in accordance with Analytical Laboratory procedures and as required in order to maintain its NELAP and/or NAVLAP certifications. Preventive maintenance will be performed on a scheduled basis to minimize downtime and the potential interruption of analytical work.

14. QUALITY ASSURANCE REPORTS TO MANAGEMENT

14.1. Ongoing QA/QC Reporting

The following reporting activities shall be undertaken on a regular basis:

- a) The Sample and QC Monitors shall report to the QA Manager regularly regarding progress of the applicable sampling program. The Sample and QC Monitors will

also brief the QA Manager on any QA/QC issues associated with such sampling activities.

- b) The Analytical Laboratory shall maintain detailed procedures for laboratory record keeping. Each data set report submitted to the Mill's QA Manager or his staff will identify the analytical methods performed and all QA/QC measures not within the established control limits. Any QA/QC problems will be brought to the QA Manager's attention as soon as possible; and
- c) After sampling has been completed and final analyses are completed and reviewed, a brief data evaluation summary report will be prepared by the Analytical Laboratory for review by the QA Manager, by a Sampling and QC Monitor or by such other qualified person as may be designated by the QA Manager. The report will be prepared in accordance with NELAP and/or NAVLAP requirements and will summarize the data validation efforts and provide an evaluation of the data quality.

14.2. Periodic Reporting to Management

The QA Manager shall present a report to DUSA's ALARA Committee at least once per calendar year on the performance of the measurement system and the data quality. These reports shall include:

- a) Periodic assessment of measurement quality indicators, i.e., data accuracy, precision and completeness;
- b) Results of any performance audits, including any corrective actions;
- c) Results of any system audits, including any corrective actions; and
- d) Significant QA problems and recommended solutions.

15. AMENDMENT

This Plan may be amended from time to time by DUSA only with the approval of the Executive Secretary.

16. REFERENCES

- 16.1. United States Environmental Protection Agency, November 2004, Test Methods for Evaluating Solid Waste, EPA SW-846.
- 16.2. United States Environmental Protection Agency, September, 1986, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD), Office of Solid Waste and Emergency Response, OSWER-9950.1.
- 16.3. United States Environmental Protection Agency, November 1992, RCRA Ground-water Monitoring Draft Technical Guidance (DTG), Office of Solid Waste.
- 16.4. Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998. American Public Health Association, American Water Works Association, Water Environment Federation. Washington, D.C. p. 1-7.

ATTACHMENT 1
WHITE MESA URANIUM MILL
FIELD DATA WORKSHEET FOR GROUND WATER

Description of Sampling Event: _____
Location (well name) _____ Sampler _____
Name and initials _____
Date and Time for Purging _____ and Sampling (if different) _____
Well Purging Equip. Used: ___ pump or ___ bailer Well Pump (if other than Bennet) _____
Sampling Event _____ Prev. Well Sampled in Sampling Event _____
pH Buffer 7.0 _____ pH Buffer 4.0 _____
Specific Conductance _____ uMHOS/cm Well Depth _____
Depth to Water Before Purging _____ Casing Volume (V) 4" Well: _____ (.653h)
3" Well: _____ (.367h)
Conductance (avg) _____ pH of Water (avg) _____
Well Water Temp. (avg) _____ Redox Potential (Eh) _____ Turbidity _____
Weather Cond. _____ Ext'l Amb. Temp. (prior to sampling event) _____

Time: _____ Gal. Purged _____	Time: _____ Gal. Purged _____
Conductance _____	Conductance _____
pH _____	pH _____
Temperature _____	Temperature _____
Redox Potential (Eh) _____	Redox Potential (Eh) _____
Turbidity _____	Turbidity _____
Time: _____ Gal. Purged _____	Time: _____ Gal. Purged _____
Conductance _____	Conductance _____
pH _____	pH _____
Temperature _____	Temperature _____
Redox Potential (Eh) _____	Redox Potential (Eh) _____

Turbidity _____ Turbidity _____

Volume of Water Purged When Field Parameters are Measured _____

Pumping Rate Calculation

Flow Rate (Q), in gpm.

S/60 = _____

Time to evacuate two casing volumes (2V)

T = 2V/Q = _____

Number of casing volumes evacuated (if other than two) _____

If well evacuated to dryness, number of gallons evacuated _____

Name of Certified Analytical Laboratory if Other Than Energy Labs _____

<u>Type of Sample</u>	<u>Sample Taken (circle)</u>	<u>Sample Volume (indicate if other than as specified below)</u>	<u>Filtered (circle)</u>	<u>Preservative Added (circle)</u>
VOCs	Y N	3x40 ml	Y N	HCL Y N
Nutrients	Y N	100 ml	Y N	H ₂ SO ₄ Y N
Heavy Metals	Y N	250 ml	Y N	HNO ₃ Y N
All Other Non-Radiologics	Y N	250 ml	Y N	No Preservative Added
Gross Alpha	Y N	1,000 ml	Y N	H ₂ SO ₄ Y N
Other (specify)	Y N	Sample volume	Y N	Y N
_____		_____		

				If a preservative is used, Specify Type and Quantity of Preservative: _____

Comments _____

Appendix A
Chloroform Investigation Monitoring
Quality Assurance Program
White Mesa Uranium Mill
Blanding, Utah

Chloroform Investigation Monitoring
Quality Assurance Program
White Mesa Uranium Mill
Blanding, Utah

This document sets out the quality assurance plan to be used by Denison Mines (USA) Corp. for Chloroform Investigation conducted pursuant to State of Utah Notice of Violation and Groundwater Corrective Action Order (UDEQ Docket No. UGW-20-01) (the "Order).

Specifically, the mill will use the same sampling regimen for the Chloroform Investigation that is utilized for groundwater sampling under its groundwater discharge permit, as set forth in the attached groundwater discharge permit Quality Assurance Plan (QAP), except as set forth below:

1) Dedicated Purge Pump

Chloroform Investigation samples are collected by means of dedicated bailer(s) that remain inside the well casing (suspended and secured with a rope) or by means of a disposable bailer used only for the collection of a sample only from an individual well and disposed subsequent to the sampling. The wells are purged by means of a portable pump. Each quarterly pumping and sample collection event begins at the location least affected by chloroform (based on the previous quarters sampling event) and proceeds by affected concentration to the most affected location. -. Decontamination of All sampling equipment will follow the decontamination procedure outlined in section 6.2.5 of the QAP.

2) Chloroform Investigation Sampling Frequency, Order and Locations

The chloroform investigation wells listed below are required to be monitored on a quarterly basis under State of Utah Notice of Violation and Groundwater Corrective Action Order UDEQ Docket No. UGQ-20-01. Chloroform wells shall be collected from the least contaminated to the most contaminated as based on the most recent quarterly results.

- | | |
|---------|-----------|
| • MW-4 | • TW4-11 |
| • TW4-1 | • TW4-12 |
| • TW4-2 | • TW4-13 |
| • TW4-3 | • TW4-14 |
| • TW4-4 | • (MW-26) |
| • TW4-5 | • TW4-16 |
| • TW4-6 | • (MW-32) |
| • TW4-7 | • TW4-18 |
| • TW4-8 | • TW4-19 |

- TW4-9
- TW4-10
- TW4-20
- TW4-21
- TW4-22
- TW4-23
- TW4-24
- TW4-25

Note: Wells MW-26 and MW-32 may be monitored under either the Chloroform Investigation Program or the Groundwater Discharge Permit Monitoring Program.

3) Chloroform Investigation Sample Containers and Collection Volume

The chloroform investigation sampling program requires a specific number of sampling containers and the collection of specific volumes of sample. Accordingly, the following sample volumes are collected by bailer from each sampling location:

- For Volatile Organic Compounds (VOC), collect three samples into three separate 40 ml containers.
- For Nitrate/Nitrite determinations, collect one sample into a 100 ml container.
- For inorganic Chloride, collect one sample into a 100 ml container.

4) Laboratory Requirements

Collected samples which are gathered for chloroform investigation purposes are delivered to an outside laboratory where the requisite analyses are performed. At the laboratory the following analytical specifications must be adhered to:

Analytical Parameter	Analytical Method	Reporting Limit	Maximum Holding Times	Sample Preservation Requirement	Sample Temperature Requirement
Nitrate & Nitrite (as N)	E353.2	0.1 mg/L	28 days	H ₂ SO ₄ to pH<2	4°C
Carbon Tetrachloride	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Chloroform	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Dichloromethane (Methylene Chloride)	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Chloromethane	SW8260B	1.0 µg/L	14 days	HCl to pH<2	4°C
Inorganic Chloride	A4500-Cl B	1 mg/L	28 days	None	4°C

5) Field Parameters

In the case of chloroform pumping wells only one set of field parameters is

required to be measured prior to sampling. This includes the following wells: MW-4, MW-26, TW-4-19 and TW-4-20.

6) Chloroform Investigation Reports

The Chloroform Investigation Reports will include the following information:

- a) Introduction
- b) Sampling and Monitoring Plan
 - Description of monitor wells
 - Description of sampling methodology, equipment and decontamination procedures
 - Identify all quality assurance samples, e.g. trip blanks, equipment blanks, duplicate samples
 -
- c) Data Interpretation
 - Interpretation of groundwater levels, gradients, and flow directions. Interpretations would include a discussion on: 1) A current site groundwater contour map, 2) hydrographs to show groundwater elevation in each monitor well over time, 3) depths to groundwater measured and groundwater elevation from each monitor well summarized in a data table, that includes historic groundwater level data for each well, and 4) an evaluation of the effectiveness of hydraulic capture of all contaminants of concern.
 - Interpretation of all analytical results for each well, including a discussion on: 1) a current chloroform isoconcentration map with one of the isoconcentration lines showing the 70 ug/L boundary, 2) graphs showing chloroform concentration trends in each well thru time and, 3) analytical results for each well summarized in a data table, that includes historic analytical results for each well.
 - Calculate chloroform mass removed by pumping wells. Calculations would include: 1) total historic chloroform mass removed, 2) total historic chloroform mass removed for each pumping well, 3) total chloroform mass removed for the quarter and, 4) total chloroform mass removed from each pumping well for the quarter.
- d) Conclusions and Recommendations
- e) Electronic copy of all laboratory results for groundwater quality monitoring conducted during the quarter.
- f) Copies of DUSA field records, laboratory reports and chain of custody forms.

Except as otherwise specified above, the Mill will follow the procedure set out in the Mill's groundwater discharge permit QAP.