Capture Zone Evaluation Report

Tronox LLC
Henderson, Nevada

December 10, 2010

Prepared For:

Tronox LLC
560 West Lake Mead Parkway
Henderson, Nevada 89015

Prepared By:

Northgate Environmental Management, Inc.
300 Frank H. Ogawa Plaza, Suite 510
Oakland, California 94612

Deni Chambers, CEM
Principal Hydrogeologist

Josh Otis, CEM
Project Geologist

Mary Stallard
Associate Hydrogeologist

2027.02 T28

Capture Zone Evaluation Report

Tronox LLC
Henderson, Nevada

Responsible CEM for this project

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and, to the best of my knowledge, comply with all applicable federal, state and local statutes, regulations and ordinances.

Susan M. Crowley, CEM 1428 Exp.:03/08/11
Crowley Environmental LLC

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Purpose and Overview 1
1.2 Background 1
1.3 Report Organization 5
2 CAPTURE ZONE EVALUATION STEPS 6
2.1 Review Site Data, Conceptual Site Model, and Remedy Objectives (Step 1) 6
2.2 Define Site-Specific Target Capture Zone(s) (Step 2) 6
2.3 Interpret Water Levels (Step 3) 7
2.4 Perform Calculations (Step 4) 7
2.5 Evaluate Concentration and Mass Trends (Step 5) 8
2.6 Interpret Capture and Identify Next Steps (Step 6) 8
3 SITE CONCEPTUAL MODEL 9
3.1 Setting 9
3.2 Sources of Contaminants 9
3.2.1 Constituents of Concern 11
3.2.2 Off-Site Sources 12
3.3 Hydrogeologic Framework 13
3.3.1 Geologic Units 13
3.3.2 Hydrogeologic Units 14
3.4 Hydrogeologic Properties 14
3.4.1 Hydraulic Conductivity 14
3.4.2 Porosity 15
3.4.3 Storage Coefficients 15
3.5 Groundwater Occurrence and Movement 17
3.5.1 Aquifer Thickness 17
3.5.2 Hydraulic Gradients and Flow Direction 18
3.5.3 Influencing Factors on Flow 19
3.6 Conceptual Water Budget 21
3.7 Nature and Extent of Perchlorate and Chromium Contamination 22
3.8 Fate and Transport of Chromium and Perchlorate 23
3.9 Potential Exposure Routes and Receptors 24
3.9.1 Previous Site Risk Assessments 25
3.9.2 Potential Groundwater Exposure Pathways 25
4 TARGET CAPTURE ZONE DEVELOPMENT 27
4.1 Groundwater Extraction System Goals 27
4.2 3-Dimensional Plume Definition Dataset and Modeling Method 27
4.3 3-Dimensional Plume Maps 29
5 WATER LEVEL INTERPRETATION 31
5.1 Data Selection 31
5.2 Methodology 32
5.2.1 Potentiometric Surface and Horizontal Gradients 32
5.2.2 Vertical Gradients 33

5.3 Analysis ... 33
5.3.1 Interceptor Well Field ... 33
5.3.2 Athens Road Well Field ... 34
6 GROUNDWATER FLOW MODEL AND RELATED CALCULATIONS ... 35
6.1 Estimated Flow Rate and Capture Zone Width Calculations ... 35
6.2 Capture Zone Analysis Using Flow Model ... 36
6.2.1 Model Domain ... 37
6.2.2 Model Discretization ... 37
6.2.3 Model Boundary Conditions ... 37
6.2.4 Hydraulic Parameters and Model Calibration ... 38
6.2.5 Use of Plume Model in Capture Zone Evaluation ... 38
6.2.6 Capture Zone Evaluation by Endpoint Analyses ... 39
6.2.7 Three Dimensional Visualization of the Capture Zone ... 41
6.2.8 Capture Efficiencies of the Well Fields ... 41
7 CONCENTRATION TREND EVALUATION ... 44
7.1 Concentration Trends Downgradient of the Interceptor Well Field ... 45
7.2 Concentration Trends Downgradient of the Athens Road Well Field ... 47
7.3 Concentration Trends Downgradient of the Seep Well Field ... 48
8 CAPTURE ZONE EVALUATION RESULTS SUMMARY ... 49
8.1 Evaluation of Capture with Current Operation ... 49
8.2 Capture Enhancements ... 51
8.3 Ongoing Capture Zone Evaluations ... 52
9 REFERENCES ... 53

TABLES

1-1 Average Extraction and Injection Rates, Third Quarter 2010
3-1 Historical Potential Source Areas of Chromium and Perchlorate Contamination
3-2 Well Construction Information
3-3 Measurements of Hydraulic Conductivity in the StudyArea
3-4 Laboratory Measurements of Vertical Hydraulic Conductivity and Porosity at the Site
3-5 Well Cluster Vertical Hydraulic Gradients
3-6 Estimates of Recharge to the Shallow WBZ
4-1 Perchlorate Groundwater Plume Mass Estimates
5-1 Well Construction Details and Water Level Measurements
5-2 Data for Vertical Gradient Calculations
5-3 Head Difference and Vertical Gradient Results
6-1 Flow Rate and Capture Zone Width Calculations
6-2 Capture Efficiency of Well Fields (embedded within text)
7-1 Performance Monitoring Well Information
8-1 Lines of Evidence for Groundwater Capture (embedded within text)

FIGURES AND PLATES

1-1 Tronox Site Location
1-2 Interceptor Well Field
1-3 Athens Road Well Field
3-1 Location Map: Cross-Sections
3-2 Historical Potential Source Areas of Contaminants
3-3 Well Locations Within the Study Area
3-4 West-East Hydrogeologic Cross-Section A-A' – Interceptor Well Field
3-5 West-East Hydrogeologic Cross-Section B-B' – Athens Road Well Field
3-6 West-East Hydrogeologic Cross-Section C-C' – Seep Well Field
3-7 QAL-UMCf Contours and Paleo-Channel Network
3-8 Potentiometric Surface Map, Shallow Water Bearing Zone, Third Quarter 2010
3-9 Vertical Gradient Well Pairs
3-10 Monthly Precipitation, Well Hydrographs, and Applied Water
3-11 Distribution of Perchlorate in Shallow Water Bearing Zone
3-12 Distribution of Chromium in Shallow Water Bearing Zone
3-13 Conceptual Site Model
4-1 Perchlorate Plume Map
4-2 SiteWide Perchlorate Plume
4-3 Chromium Plume Map
4-4 Site Wide Chromium Plume
5-1 Hydrographs for Select Site Monitoring Wells
5-2 Potentiometric Surface Map, Shallow Water-Bearing Zone, Third Quarter 2010, Interceptor Well Field

5-3 Potentiometric Surface Map, Shallow Water-Bearing Zone, Third Quarter 2010, Athens Road Well Field
6-1 Comparison of Simulated to Measured Heads
6-2 Endpoint Analyses- Layer 1: Regional Groundwater Model
6-3 Endpoint Analyses- Layer 2: Regional Groundwater Model
6-4 Endpoint Analyses- Layer 3: Regional Groundwater Model
6-5 Endpoint Analyses- Layer 4: Regional Groundwater Model
6-6 Endpoint Analyses- Layer 5: Regional Groundwater Model
6-7 Reverse Particle Tracking, Interceptor Well Field Sub-Domain Model- 3D Capture
6-8 Reverse Particle Tracking, Athens Road Well Field Sub-Domain Model- 3D Capture
6-9 Mass Flux Analysis – Layer 3: Regional Groundwater Model
7-1 Concentration vs Time Plots- Wells Immediately Downgradient of the Infiltration Trenches
7-2 Concentration vs Time Plots - Wells Located Approximately 1,000 Feet North of the Interceptor Well Field
7-3 Concentration vs Time Plots - Wells Located Downgradient of the Interceptor Well Field at Warm Springs Road
7-4 Concentration vs Time Plots - Athens Road Piezometer Wells
7-5 Concentration vs Time Plots - City of Henderson Wells
7-6 Concentration vs Time Plots - Lower Pond Wells
7-7 Concentration vs Time Plots- Wells Downgradient of theSeep Well Field
8-1 Endpoint Analysis- Layer 2: Capture Enhancements, Regional Groundwater Model
8-2 Endpoint Analysis- Layer 3: Capture Enhancements, Regional Groundwater Model

APPENDICES

A Final Response to January 26, 2010 NDEP Comments on *Interim Capture Zone Evaluation and Vertical Delineation Report*
B CZE Data Gaps Investigation Data
C Slug Test Analysis
D Barrier Wall Investigation Status Report
E Hydrogeologic Model Report
F Perchlorate and Chromium Data Used for 3-D Plume
G Response to Comments- Model Input Memo

1 INTRODUCTION

1.1 Purpose and Overview

Northgate Environmental Management, Inc. (Northgate) has prepared this report on behalf of Tronox LLC, for the Tronox facility located in Henderson, Nevada (Site; Figure 1-1). The purpose of this report is to present the results of a revised capture zone evaluation (CZE) for the groundwater extraction and treatment systems (GWETS) at the Tronox Site. This CZE has been revised from the previous evaluation presented in *Interim Capture Zone Evaluation and Vertical Delineation Report* (Northgate, 2010c) to address January 26, 2010 comments from the Nevada Division of Environmental Protections (NDEP, 2010a). As requested by NDEP in their final comments on the interim CZE report (NDEP, 2010c), Northgate's previous responses to the January 26 comments (Northgate, 2010b) have been updated and are resubmitted as Appendix A to this document.

In response to the January NDEP comments, the evaluation presented in this report follows the six steps defined in the 2008 United States Environmental Protection Agency (USEPA) CZE guidance (USEPA, 2008). Also in response to the comments, Northgate prepared a *CZE Work Plan* (Northgate, 2010d), approved by NDEP May 24, 2010, and a *Hydrogeologic Modeling Work Plan* (Northgate, 2010e), approved by NDEP on July 27, 2010. The work described in these plans has been implemented over the past several months. Northgate used the new data generated from the CZE field work in conjunction with existing data to refine previous evaluations of groundwater flow and perchlorate and hexavalent chromium distributionin the Study Area shown in Figure 1-1. To support the CZE, Northgate constructed a three-dimensional hydrogeologic model (Step 4 in the 2008 USEPA guidance) encompassing all three well fields, and drawing on both Site-specific and the BMI Complex Study Area data. In addition to being a key element of this capture zone evaluation, Northgate anticipates that this model will be an important tool for ongoing optimization of the GWETS and other predictive scenarios.

1.2 Background

Tronox operates three GWETS associated with its facility: (1) the onsite Interceptor Well Field (IWF) and barrier wall, (2) the Athens Road Well Field (AWF), and (3) the Seep Well Field (SWF) (Figure 1-1). Hexavalent chromium in groundwater from the IWF and AWF is reduced to trivalent chromium through a ferrous sulfate treatment system, and perchlorate in groundwater from all three systems is treated using perchlorate-reducing bacteria in a fluidized bed reactor. Following treatment, the groundwater is discharged to the Las Vegas Wash under a National Pollutant Discharge Elimination System (NPDES) permit.

In accordance with the Consent Order for remediation of chromium-impacted groundwater finalized on September 9, 1986, and the Administrative Order on Consent for remediation of perchlorate-impacted groundwater in the Henderson area, Tronox conducts an annual groundwater monitoring event that includes both water level measurements and groundwater sampling for perchlorate, hexavalent chromium, chlorate, nitrate, and total dissolved solids (TDS) analyses, and that is coordinated with several neighboring companies. Groundwater monitoring results and details regarding the remediation systems' operations are provided in annual remediation performance reports (e.g., Northgate, 2010h). Additional monitoring of the groundwater remediation system is conducted quarterly and monthly. These monitoring results indicate significant capture and ongoing reduction of the perchlorate and hexavalent chromium plumes. The ultimate measure of the success of these GWETS is perchlorate loading in the Las Vegas Wash, which has declined by nearly 94% over the last 10 years of groundwater capture system operation (Northgate, 2010h). While this loading includes the Tronox plume, the AMPAC plume to the west, and other sources to the east, this reduction in loading is due almost exclusively to capture of the Tronox plume.

Since the beginning of the GWETS operation, Tronox has periodically evaluated their effectiveness, as reported in groundwater monitoring reports. In commenting on the Tronox *Semi-Annual Remedial Performance Report for Chromium and Perchlorate* dated February 28, 2007, NDEP (NDEP 2007a) requested that Tronox evaluate the effectiveness of its groundwater capture systems by considering at least three of six "lines of evidence" defined by U.S. Environmental Protection Agency (USEPA) guidance available at that time (USEPA 2002, 2005). In response to that request, a draft work plan was provided to NDEP on May 30, 2007 (ENSR 2007a). On June 26, 2007, NDEP provided comments on the *Draft Work Plan to Evaluate Effective Groundwater Capture at Tronox Extraction Systems* (NDEP 2007b). Additionally, McGinley also provided a report dated June 30, 2007, describing the results of capture analysis using both an analog approach and a numerical groundwater model constructed for the AWF. In that report, McGinley evaluated well field capture efficiency and provided recommendations to further evaluate the capture zone at Athens Road. Following discussions with NDEP, and in response to their June 2007 comments, and in consideration of the recommendations provided by McGinley (2007), a revised work plan (ENSR 2007b) was prepared and submitted on August 29, 2007. Subsequently, NDEP provided additional comments on October 3, 2007 (NDEP, 2007c). On November 28, 2007, Tronox provided a letter responding to the additional NDEP comments (Tronox, 2007). On December 11, 2007, NDEP approved the revised work plan with a few exceptions noted for the administrative record (NDEP 2007d). Field work consisting of borehole drilling, lithologic sample description, geotechnical sampling, well completion, well development, and well testing was completed by March 2008.

On August 25, 2008, Tronox submitted the Groundwater Capture Evaluation as Appendix B of the *Annual Remedial Performance Report for Chromium and Perchlorate, July 2007-June 2008* (ENSR, 2008). Additional drilling of two soil borings and completion of one recovery well (I-AB) at the west end of the barrier wall was proposed in this report, and was completed in mid-2009.

On October 6, 2008, NDEP provided comments on the Annual Remedial Performance Report and the Groundwater Capture Evaluation, requesting submission of a stand-alone Revised Groundwater Capture Evaluation Report (NDEP, 2008). A monitoring well completion program for eight Middle water-bearing zone (WBZ) wells, for the dual purpose of further delineating the vertical extent of contaminant plumes and vertical hydraulic gradients at the Site, was added to the scope of work in October 2008. These wells were completed in September and October 2009. The information and analyses from these new wells were incorporated into the *Interim Groundwater Capture Evaluation and Vertical Delineation Report* (Northgate, 2010c).

As described in Section 1.1 above, additional CZE field work has been conducted and a hydrogeologic model has been constructed over the past several months in response to remaining NDEP comments on the interim CZE report. As described in the CZE work plan (Northgate, 2010c), the CZE field work included scope to:

1. Update and improve the existing GWETS, including replacement or re-establishment of previous piezometers/monitoring wells and connection of existing but unused recovery wells;
2. Address remaining CZE data gaps identified by Northgate and NDEP; and
3. Collect additional data to enhance the CZE.

Data generated during this CZE field work are included in Appendices B and C. The following paragraphs provide a brief description of each of the three well fields and summary of the CZE field work for each. Table 1-1 lists the operating extraction wells for the IWF, AWF, and SWF and their average pumping rates for the third quarter of 2010.

Interceptor Well Field – A bentonite-slurry barrier wall was constructed as a physical barrier across the higher concentration portion of the perchlorate/chromium plume on the Tronox property. The barrier wall is 1,600 feet long, about 60 feet deep, and is combined with a series of 23 operating groundwater extraction wells that are located immediately upgradient (south) of the barrier wall (Table 1-1). The IWF currently pumps about 72 gallons per minute (gpm) from the Shallow WBZ, dewatering the Qal and the upper portion of the Upper Muddy Creek formation (UMCf) in the vicinity of the pumping wells. Most of the wells comprising the IWF are between

35 to 50 feet deep and completed in both the Qal and unconfined portions of the UMCf. Approximately 250 feet downgradient of the barrier wall, Lake Mead water is injected into the Qal along a 800-foot long trench at a rate of approximately 57 gpm.

In addition to replacing/re-establishing monitoring wells as needed, the CZE investigation fieldwork associated with the IWF included (Figure 1-2): (1) installing eleven piezometers adjacent to extraction wells to provide additional water level measuring points for evaluating capture; (2) installing twelve new UMCf wells singly and in clusters to improve spatial definition of hydraulic conductivity, hydraulic gradient, and contaminant distribution in the UMCf near and upgradient of the wall; and, (3) conducting a barrier wall investigation, including permeability testing of the wall material and pumping/monitoring of four new temporary extraction wells downgradient of the wall (see Appendices B through D for additional information on these investigations). Two new extraction wells (I-AC and I-AD) were also installed to improve capture at the east end of the barrier wall/well field. Connecting these two new wells and five additional recently-installed extraction wells to the IWF recovery system has been delayed due to soil remediation activities in the area, but is expected to be accomplished by the end of 2010. The five additional extraction wells include three new wells within the interior of the well field (I-W, I-X and I-Y) and two wells to improve capture at the west end of the barrier wall/well field (I-AA and I-AB), as described in the Interim CZE report (Northgate, 2010c).

Athens Road Well Field – Located approximately 8,200 feet north (downgradient) of the barrier wall and IWF, the AWF consists a series of 14 groundwater extraction wells at seven paired well locations. The wells span roughly 1,200 feet of the alluvial paleochannels and pump from the Shallow WBZ at a combined rate of about 280 gpm (Table 1-1). The extraction wells are screened across the thickness of the saturated Qal. In addition to replacing/re-establishing monitoring wells as needed, the CZE investigation fieldwork in the AWF included (Figure1-3): (1) installing ten new monitoring wells to provide additional definition of water levels and contaminant distribution in the Qal channels and adjacent UMCf; and, (2) replacing a low-producing extraction well with a deeper well to improve production.

Seep Area Collection System – Located near the Las Vegas Wash approximately 4,500 feet north (downgradient) of the AWF, the system includes a surface pump (sump) for the intermittent surface stream (seep) flow and nine groundwater extraction wells in the SWF to capture subsurface flow. The extraction wells are completed in the Qal and pump from the Shallow WBZ at a combined rate of about 530 gpm. As part of the CZE investigation, Tronox

planned to install three new monitoring wells to improve definition of groundwater flow in the SWF, but access was not granted by Basic Management Incorporated (BMI).

1.3 Report Organization

In addition to this Introduction, this report comprises the following sections:

- Section 2 provides an overview of the capture zone evaluation steps, as defined in EPA's guidance for CZE (EPA, 2008).
- Sections 3 through 7 describe the site conceptual model, target capture zone definition, methods for estimating hydraulic capture, and resulting lines of evidence to evaluate the effectiveness of the pump and treat systems in meeting remedial goals. The sections follow Steps 1 through 5, respectively, as defined in the EPA guidance (EPA, 2008).
- Section 8 combines the capture zone results based upon the three-dimensional flow model with additional lines of evidence, and discusses discrepancies and uncertainties in the analyses. Section 8 also summarizes the modeled capture zones in terms of plume mass captured. Recommendations for further evaluations using the numerical model to improve and/or optimize the GWETS system are provided.
- Section 9 lists references cited in the document.
- Appendices to the report include updated response to NDEP comments on the previous CZE report (Northgate, 2010c), data and results from the CZE Workplan (Northgate, 2010d), the groundwater modeling report, perchlorate and chromium data sets used to develop the 3-D plumes, and response to NDEP comments on the *Hyrdogeologic Groundwater Model Inputs* technical memorandum dated October 26, 2010.

2 CAPTURE ZONE EVALUATION STEPS

As described in Section 1.1, Northgate used existing Site data and the new data collected according to the CZE work plan (Northgate, 2010d), as well as data from the regional database maintained by NDEP, and reports prepared by others within the Study Area, to revise the Site capture zone evaluation following the 2008 USEPA guidance. This evaluation of groundwater capture builds on the previous evaluation presented in the revised *Interim Groundwater Capture Evaluation and Vertical Delineation Report* (Northgate, 2010c) and uses multiple lines of evidence to evaluate hydraulic capture at the well fields. Although capture was examined at all three well fields, this evaluation focused on the IWF and AWF.

The following subsections briefly describe the work associated with each of the six steps for capture zone evaluation that are presented in the 2008 USEPA guidance. As described below, the use of the new groundwater flow model is a key element of this evaluation. The methods and results for Steps 1 through 6 are discussed in detail in Sections 3 through 8, respectively.

2.1 Review Site Data, Conceptual Site Model, and Remedy Objectives (Step 1)

Step 1 of the USEPA capture zone evaluation process includes three parts: 1) evaluating the available plume definition and hydrogeologic data to determine if they are adequate for capture evaluation; 2) confirming that there is an adequate Site Conceptual Model (SCM); and, 3) assessing whether the remedy objective is clear. The first part of Step 1 (i.e., assessing data adequacy) has been under evaluation since at least mid-2007, with a number of identified data gaps already filled, as described in the revised *Interim Groundwater Capture Evaluation and Vertical Delineation Report* (Northgate, 2010c). Additional data collection activities recently conducted to enhance the capture zone evaluation were described in *Capture Zone Evaluation Work Plan* (Northgate, 2010d), and these data have been incorporated into the evaluation. As discussed later in Section 3, previously developed SCMs for the Site (e.g., ENSR International, 2005) have been refined in the CZE to address the second part of Step 1. Regarding the third part of Step 1, Tronox's current groundwater remedy objective is to minimize and continue to reduce the perchlorate loading to the Las Vegas Wash. This is being accomplished through plume containment using the three-well-field GWETS described in Section 1.

2.2 Define Site-Specific Target Capture Zone(s) (Step 2)

Target capture zones have not been formally established for the Site well fields. Recent input from NDEP (NDEP, 2010b) is that Tronox needs to "demonstrate 95% capture" at the IWF and AWF, and that Tronox should "compare specific perchlorate concentrations iso-contours to determine the impact on the percent capture by expanding the capture zone by considering

smaller perchlorate concentrations". Tronox's assessment of these targets is presented in detail in Sections 4 and 6. As agreed to by NDEP (NDEP, 2010d), target capture for the SWF is not addressed in this report.

Site orders require cleanup of both chromium (1986 Consent Order) and perchlorate (2001 Administrative Order on Consent) in groundwater. Perchlorate has been the focus of previous capture zone evaluations and is the focus of this evaluation because it is spatially more extensive and is the only contaminant that presents an imminent threat to human health due to its impact on Lake Mead drinking water source. However, capture of hexavalent chromium is also considered, as discussed in Sections 4 and 6. Site groundwater also contains other contaminants, which originate from both on- and off-Site sources. Capture of these additional chemicals is not evaluated in this report.

2.3 Interpret Water Levels (Step 3)

Water levels measured in existing and new Tronox wells were used for this part of the evaluation. As described in Section 1.2, 24 new piezometers/monitoring wells in the IWF and ten new monitoring wells in the AWF were installed per *Capture Zone Evaluation Work Plan* (Northgate, 2010d) to enhance the water level measuring point network. As described in Section 5, Northgate used Site water level measurements in Step 3 of the CZE for computer-aided interpretations of horizontal capture in the Shallow Water Bearing Zone (WBZ) and evaluation of vertical gradients at closely spaced wells completed within different WBZs. Monitored water levels were interpreted to develop the three dimensional potentiometric surface discussed later in Section 6.

2.4 Perform Calculations (Step 4)

The 3-D groundwater flow model plays the key role in this part of the capture zone evaluation. As described further in Section 6, it was calibrated using the measured Site water levels and contour map, and the water flow budget. In addition to defining capture zones under the current system operation at the IWF, AWF, and SWF, particle tracking was performed using the flow model to:

1) Determine what portion of groundwater flow is and is not being captured at each well field. Interpreted 3D perchlorate envelope was used as the initial condition in transport calculations using the MT3D code (Zhang, 1990).
2) Predict where and when perchlorate originating at various locations and depths within the UMCf will enter the Qal. The purpose of this exercise was to confirm that the perchlorate

will eventually be captured by the Qal recovery wells and to estimate how long it will take for this to happen.

As suggested in the guidance (USEPA, 2008), Northgate also performed simplified analytical calculations for expected capture width and flow rates for comparison with the model.

2.5 Evaluate Concentration and Mass Trends (Step 5)

This step involved expanding and updating the evaluation of perchlorate and hexavalent chromium concentration trends downgradient of the IWF and AWF that was presented in *Interim Groundwater Capture Evaluation and Vertical Delineation Report* (Northgate, 2010c). This evaluation is based on monitoring data collected through May 2010 for remedial performance reports, as well as some more recent data for the newly-installed wells.

2.6 Interpret Capture and Identify Next Steps (Step 6)

The last step described in the USEPA guidance (USEPA, 2008) involves assessing the interpreted capture zones based on Steps 1 through 5 and identifying uncertainties in interpretation, identifying possible data gaps, and determining whether target capture is being achieved. If target capture is not indicated, modifications to achieve target capture are proposed. Uncertainties were evaluated by comparing the results of different lines of evidence for capture and through a sensitivity analysis of the groundwater flow model. Data gaps for assessing capture have been identified and addressed over the past few years and remaining identified gaps for the IWF and AWF have been filled per the approved CZE field work plan (Northgate, 2010d).

The multiple lines of evidence were used to determine what capture is being achieved under current conditions and to confirm that the groundwater flow model can be used to reliably predict the effects of changes to the GWETS. A final step of the capture evaluation uses the groundwater flow model to predict what capture improvement is expected to be achieved after the seven new IWF wells and the deepened AWF well (see Section 1.2) are on-line, additional enhancements to the AWF have been made, and the system has reached steady-state conditions.

3 SITE CONCEPTUAL MODEL

A site conceptual model (SCM) integrates Site information about the setting, the sources of contaminants, the geologic and hydrogeologic conditions, the observed distribution and inferred transport of contaminants, and the potential contaminant exposure routes and receptors. The 'Site' terminology used in this section and illustrated in Figure 1-1 is as follows: the Tronox Property includes the area within the Tronox property boundary; the Site includes the area within the corridor where Tronox has a network of monitoring and extraction wells; and the Study Area includes the area within the domain of the groundwater flow model, which is described further in Section 6. The SCM is used as a basis for establishing the Site remedy, including the specific goals for groundwater capture in the GWETS. A SCM evolves as more information becomes available, and previous information presented in reports (e.g., ENSR, 2005) formed a basis for identifying data gaps and additional evaluation needed to better assess groundwater capture at the IWF and AWF (Northgate, 2010c, d). This SCM is updated by new data collected to better define hydraulic heads, hydraulic properties, and contaminant concentrations in the areas nearby the IWF and AWF. In particular, the SCM focuses on elements pertaining to the Site hydrogeology used as the basis for input to the groundwater flow model presented in Section 6.

3.1 Setting

The Study Area is located in the southeast portion of the Las Vegas Valley near the Las Vegas Wash (Figure1-1). The Study Area includes industrial facilities known as the Black Mountain Industrial Complex (BMI Complex comprised of Tronox, BMI, Chemstar, Pioneer/Olin Chlor-Alkali/Stauffer/Syngenta/Montrose (POSSM), and Titanium Metals Corporation (Timet)), the Henderson wastewater treatment facility, and residential areas (Figure 1-1). The Las Vegas Wash crosses the Study Area along it's northern boundary, and the topography is characterized by a smooth slope from the McCullough Range south of the Study Area northward to the Las Vegas Wash. Ground surface elevations within the Study Area range from approximately 1,875 feet in the south to 1,500 feet (mean sea level) in the north.

3.2 Sources of Contaminants

Industrial activities have occurred on the BMI complex since 1942, which was originally sited and operated for the U.S. government as a wartime magnesium production plant (Kleinfelder, 1993). The BMI magnesium production facility consisted of the following major facilities:

- A brine purification facility that dissolved solar salt and removed calcium, potassium, strontium, sulfate, and bicarbonate impurities via a precipitation and filtering process;

- A chlor-alkali plant to produce sodium hydroxide and chlorine gas from the electrolysis of purified sodium chloride brine;
- A plant that created pellets of magnesium oxide and a carbon source;
- 10 Unit Buildings, each containing chlorinators that created molten magnesium chloride by reacting the magnesium oxide/carbon pellets with chlorine gas at high temperature and banks of electrolytic cells that produced magnesium metal by electrochemical reduction of the molten magnesium chloride;
- An extensive system of surface impoundments that were used to receive process effluent for evaporative disposal. This system originally included the Trade Effluent Ponds, and later included the Upper and Lower BMI Ponds, and the associated Alpha and Beta ditches used to transport effluent to the Ponds; and
- Associated support buildings for the storage and transport of raw materials and the purification and processing of magnesium metal into ingots.

During government operations, extensive volumes of liquid wastes containing dissolved and suspended solids were discharged to four unlined Trade Effluent Ponds. These liquids were generally composed of acid effluent and waste caustic liquor containing high levels of total dissolved solids (TDS), dissolved metals, and to a lesser degree, chlorinated organics (see references in Kleinfelder, 1993). Waste water originating from site processes was also discharged to a storm sewer system that emptied into unlined drainage ditches (e.g., Alpha and Beta Ditches). The unlined drainage ditches routed waste water to a system of unlined ponds currently known as the Upper and Lower BMI ponds. Solid materials were placed in an open area south of the Trade Effluent Settling Ponds and north of the caustic settling ponds (see references in Kleinfelder, 1993). Although originally intended for evaporative disposal, these unlined surface impoundments allowed significant quantities of process effluent to infiltrate into the deep soil and percolated to groundwater.

Following the end of magnesium production in 1944, the BMI complex was subdivided into three primary production areas. The facilities that comprise the present Site include: six process unit buildings (Units 1 through 6) and their attached chlorination buildings, rectifier buildings, motor generator buildings, and bridges; a flux plant; peat storage areas; an area with a salt storage building, pulverizer building, tunnel kiln building, rotary kiln building, pellet storage building, and magnesite silos; various other buildings and open storage areas; and an area occupied by two and one-fifth of the original four Trade Effluent Disposal Ponds.

Process activities at the Site since 1945 include the production of chlorate and perchlorate compounds, boron and boron-related compounds, and refined manganese oxide. From 1945 until

the mid-1970s, process effluents were sent to the unlined Upper and Lower BMI Ponds via the Beta Ditch and manganese-related wastes were disposed in onsite leach beds. In the early 1970s, under the federal NPDES program, the industries at the BMI Complex curtailed waste discharges to the Upper and Lower BMI Ponds. Following 1976, process effluents were sent to onsite lined surface impoundments to comply with zero-discharge standards. Several of these lined surface impoundments reported a number of known releases and liner failures and were eventually replaced with more effective double-lined systems.

3.2.1 Constituents of Concern

The primary constituents of concern associated with the groundwater containment and extraction systems have been chromium and perchlorate. Tronox (then Kerr-McGee) began extracting and treating groundwater at the Site for hexavalent chromium at the IWF in accordance with a 1986 Consent Order. Following the discovery of perchlorate in groundwater at the Site during the late 1990s, the AWF and SWF were constructed, and a bentonite-slurry barrier wall was constructed downgradient of the Interceptor wells to improve capture there. While perchlorate and chromium are the constituents driving the groundwater remediation, the compliance monitoring described in the annual reports (e.g., Northgate, 2010a) also includes TDS, nitrate, and chlorate. In addition, the Phase A, Phase B, and other available data show that Shallow WBZ groundwater at the Site and vicinity has also been impacted by a wide variety of other chemicals, including other metals, volatile organic compounds (VOCs), and organochlorine pesticides (OCPs). While capture of these constituents was not explicitly evaluated in this CZE, their distribution and fate-and-transport were considered, and they may be more explicitly addressed in future evaluations.

3.2.1.1 Hexavalent Chromium Source Areas

Hexavalent chromium in the form of sodium dichromate ($Na_2Cr_2O_7$) was used extensively at the Site in the production of sodium chlorate. Sodium dichromate comprised 0.5 weight percent of sodium chlorate and sodium perchlorate process solutions, and was added to reduce cathode corrosion, increase current efficiencies, and to prevent anodic oxygen generation (Kleinfelder, 1993). Multiple source areas exist for the release of hexavalent chromium into Site groundwater including process units, surface impoundments, and on-site areas where chromium-containing process waste was stored or disposed of. These potential source areas, with brief descriptions, are listed in Table 3-1 and shown on Figure 3-2. There were no off-site sources of hexavalent chromium identified; however, it may have been present in wastewater discharged east of the Site.

3.2.1.2 Perchlorate Source Areas

Perchlorate materials were manufactured at the Site from 1945 until approximately 1993 (Kleinfelder, 1993). Because hexavalent chromium was an ingredient of sodium chlorate and perchlorate solutions, these contaminants generally tend to be comingled in Site groundwater. Multiple source areas exist for the release of perchlorate into groundwater beneath the Tronox property. These source areas include process units, surface impoundments, and on-site areas where perchlorate-containing process waste was stored or disposed of. These potential source areas, with brief descriptions, are listed in Table 3-1 and shown on Figure 3-2. No potential offsite sources that could lead to perchlorate contamination of groundwater on the Tronox property have been identified. Perchlorate releases to groundwater at the former Pepcon Plant site, located west of Tronox, however, is a potential offsite source for groundwater contaminants within the Study Area (Figure 1-1).

3.2.2 Off-Site Sources

The Pioneer/Olin Chlor-Alkali/Stauffer/Syngenta/Montrose (POSSM) property to the west of the Site occupies the location of the former BMI Complex chlor-alkali production facility. Post-1945 process activities on the POSSM property include operation of the chlor-alkali facility to produce chlorine gas, hydrochloric acid, and sodium hydroxide. In 1947, additional manufacturing facilities were constructed to produce pesticides and chlorinated organic compounds. Production of agricultural chemicals and organic compounds ceased in 1983, and production facilities were demolished and removed from the POSSM site in 1984. Operation of the chlor-alkali facility is ongoing at the POSSM property. Since 1945, extensive volumes of process effluents and solid wastes were disposed in onsite unlined ponds and buried on the property. These wastes contained high levels of TDS, chlorinated organic compounds, and extensive amounts of phosphoric acid. Prior to 1976, certain process effluents were routed to the Upper and Lower BMI Ponds. These waste streams included large volumes of sulfuric and hydrochloric acid, as well as sulfonated metabolites of DDT (Hargis and Associates, 2010).

The TIMET property to the east of the Site includes four former BMI process units (Units 7 through 10) and refinery buildings. Activities conducted on what is now the TIMET site have included production of magnesium ingot, titanium tetrachloride, titanium sponge, and titanium ingot. From 1951 until 1972, TIMET disposed of its caustic waste, leach liquor, and other process waste streams to the Upper BMI Ponds via the Beta Ditch. From 1972 until 1976, these waste streams were disposed in unlined surface impoundments on TIMET property. From 1976 to 1982, TIMET built 31 lined surface impoundments on top of the southwestern portion of the Upper Ponds where its process waste streams were discharged. Several of the lined ponds

reported liner failures and were upgraded to double-lined systems. In 2005, a water conservation facility went online and discharge to the ponds ceased. The TIMET process waste streams contained high levels of TDS and dissolved metal chlorides (LAW Engineering, 1993).

3.3 Hydrogeologic Framework

The hydrogeologic framework of the groundwater system within the Study Area consists of it's geologic units and hydrogeologic units The subsurface conditions have been defined by data collected from the numerous borings and wells that have been installed at the Site (Figure 3-3). Site well construction information (e.g. wells owned and monitored by Tronox), including the lithologic unit and hydrogeologic unit (or water bearing zone) in which the wells are screened, are provided in Table 3-2.

3.3.1 Geologic Units

Figures 3-4, 3-5, and 3-6 present geologic cross sections adopted from the 2010 Annual Report (Northgate, 2010h) and updated with boring information and groundwater quality data collected for the CZE Workplan (Northgate, 2010d). As shown in the cross-section location map provided in Figure 3-1, A-A' is a west-east cross section paralleling the IWF (Figure 3-4), B-B' is a west-east cross section paralleling the AWF (Figure 3-5), and C-C' is a west-east cross section paralleling the SWF (Figure 3-6). Alluvial fan deposits (Qal), originating from the McCullough Range underlie the entire Site to depths ranging from 13 feet to more than 50 feet as evidenced in Tronox borings logged at the Site (Table 3-2). The alluvium consists of a heterogeneous mixture of highly permeable, well-graded sand and gravel with lesser amounts of silt, clay and caliche, without continuous or distinct units.

The alluvium is deposited on top of the Upper Muddy Creek Formation (UMCf), an older sedimentary formation consisting of at least two units of fine-grained sediments of clay and silt (the first and second fine-grained facies [fg1 and fg2], respectively) interbedded with at least two thinner units of coarse-grained sediments of sand, silt, and gravel (the first and second coarse-grained facies [cg1 and cg2], respectively). The fine-grained facies (fg1) underlies the alluvium, except where it pinches out approximately 1,000 feet north of Lake Mead Parkway (Figure 3-1). Beneath the Site, the UMCf occurs to depths of more than 385 feet below ground surface in Tronox Site borings.

A major feature of the alluvial sediments deposited during infrequent floods, is the formation of buried alluvial channels, or paleochannels that were eroded into the surface of the Muddy Creek Formation. These deposits vary in thickness, and are narrow and linear. These generally uniform sand and gravel deposits exhibit higher permeability than the adjacent, well-graded deposits. In

general, these paleochannels trend northeastward (ENSR, 2005). The elevation of the top of the Muddy Creek Formation was mapped to assist in locating these paleochannels (Figure 3-7). These contours are based upon the logs from almost 1,200 groundwater wells and soil borings shown on Figure 3-7.

In borings on the Tronox property, the contact between the alluvium and the Upper Muddy Creek Formation is typically marked by the appearance of a well-compacted, moderate brown silt-to-sandy silt or stiff clay-to-sandy clay, whereas near the Las Vegas Wash, the contact is marked by gray-green to yellow-green gypsiferous clays and silts.

3.3.2 Hydrogeologic Units

From north to south, groundwater in the Study Area ranges from 0 to 80 feet below ground surface (bgs) and is first encountered in either the alluvium or in the Upper Muddy Creek Formation. The uppermost, unconfined to partially confined (i.e., leaky) aquifer is referred to as the Shallow WBZ, and it is defined primarily by water level data that show a similar pattern amongst wells completed in this zone. The Shallow WBZ generally occurs above 90 feet bgs. Approximately 86% of the Tronox Site wells are completed in the Shallow WBZ (Qal, UMCf , or xMCf known as transitional Muddy Creek formation; Table 3-2).

Beneath and in hydraulic connection with the Shallow WBZ is the Middle WBZ that extends to approximately 300 feet bgs . Wells completed within this zone are screened within the UMCf (also referred to as the Muddy Creek Formation [MCf]). Approximately 13% of Tronox Site wells are completed in the Middle WBZ (UMCf). There is currently one well completed within the Deep WBZ. The Deep WBZ is defined as the contiguous water-bearing zone that is generally encountered between 300 to 400 feet bgs (NDEP, 2009). The deepest wells within the Study Area are screened within this zone, and in some reference materials it is referred to as the "Shallow Confined Aquifer." Within the Study Area, all three WBZs are in hydraulic connection with no laterally extensive aquitards inhibiting hydraulic communication.

3.4 Hydrogeologic Properties

The physics of groundwater occurrence, storage, and movement are controlled by hydrogologic properties that include hydraulic conductivity, porosity, and storage coefficients.

3.4.1 Hydraulic Conductivity

Hydraulic conductivity is the proportionality constant relating groundwater flux to the hydraulic gradient. Table 3-3 provides estimates of horizontal hydraulic conductivity from tests conducted

throughout the Study Area, including estimates from slug tests conducted under the CZE Work Plan (Northgate, 2010d). Appendix C contains slug test data and analysis for five new wells screened within the UMCf to improve estimates of hydraulic conductivity within the Middle WBZ (Northgate, 2010d). Table 3-3 groups hydraulic conductivities from well and tracer tests by the lithology reported for each well.

Hydraulic conductivity estimates for the Qal deposits have a geometric mean of 22.7 ft/day and range between 0.1 and 846 ft/day. The three orders of magnitude range in hydraulic conductivity of the alluvium reflect the presence of paleochannels with higher conductivity (e.g. above 100 ft/day where they are noted). The tested combined alluvium/Muddy Creek Formation (Qal/UMCf) and transitional Muddy Creek Formation (xMCf or Qal/xMCf/UMCf) have a geometric mean hydraulic conductivity of 1.7 ft/day and range between 0.04 and 102 ft/day. Tests of the UMCf have a geometric mean of 0.08 ft/day and range between 0.001 and 5 ft/day. Three tests of Las Vegas Wash deposits indicate hydraulic conducitivies around 475 ft/day.

Table 3-4 summarizes the results from laboratory tests conducted on soil samples collected from boreholes within the Site area, including samples collected under the CZE Work Plan (Northgate, 2010d). Laboratory tests are used to provide estimates of vertical hydraulic conductivity on soil samples collected typically as cores from a boring. Within the Qal, tested samples have a geometric mean vertical hydraulic conductivity of 0.31 ft/day. Tests of the UCMf samples have a geometric mean of 0.0022 ft/day.

3.4.2 Porosity

Porosity is a measure of the water bearing capacity of the deposits. Total porosity is a measure of the total volume of voids as a percent of the total volume of soil; it is usually expessed as a percentage. Table 3-4 presents laboratory porosity measurements on soil samples from the Qal and UMCf. An average total porosity of 40% is indicated for the Qal and 56% for the UMCf. Because not all voids are interconnected to allow the passage of fluids, the effective porosity is sometimes used to estimate groundwater velocity or travel times. An effective porosity of 10% is estimated for Qal deposits near the SWF (Errol L. Montgomery & Associates, 2001) and an effective porosity of 20% is estimated for the UMCf (UNLV, 2003).

3.4.3 Storage Coefficients

Storage coefficient is the volume of water released from an aquifer per unit surface area, per unit decline in head (a dimensionless ratio). Under fully confined conditions, this is entirely a function of the compressibility of water and the aquifer matrix. The compressibility of water alone is responsible for a storativity of approximately 1×10^{-7} per vertical foot of aquifer. Thus, a

100-ft thick confined aquifer has a storativity of at least 1×10^{-5}. Under semi-confined conditions, the effective storage coefficient is influenced by aquitard leakage and typically ranges between 0.001 and 0.01.

Specific yield is the storage coefficient under water-table conditions. It represents the volume of water that drains from a unit volume of saturated, unconfined aquifer as a result of gravity. Values typically range from 0.01 to 0.25 (i.e., 1 to 25 percent), somewhat less than aquifer porosity.

For a given rate and duration of pumping, a well's depression of the piezometric surface (i.e., drawdown cone) is determined primarily by aquifer transmissivity and storage coefficient. In the case of a confined or leaky aquifer, the cone of depression remains above the top of the aquifer, representing a change in groundwater pressure but not saturated aquifer volume. In the case of an unconfined aquifer, the water table is drawn down, diminishing the volume of saturated aquifer. Other factors being equal, the diameter and depth of a pumping well's drawdown cone are influenced by the relative magnitude of aquifer transmissivity and storage coefficient as follows:

Aquifer Condition	**Storage Coefficient**	**Trans-missivity**	**Drawdown Cone**	
			Diameter	**Depth**
Confined	Small	Low	Large	Deepest
		High		Moderately Shallow
Un-confined	Large	Low	Small	Moderately Deep
		High		Shallowest
Leaky	Moderate	Low	Moderately Small	Deep
		High		Shallow

For a given set of aquifer properties, the diameter and depth of the drawdown cone increases with increasing pumping rate or duration, except that the drawdown cone of a leaky aquifer stabilizes after a relatively short period of time.

Storage coefficients estimated from four different pumpng tests conducted within the Study Area range from 0.004 to 0.11. Measured values for the Qal (0.02 to 0.11) and the transitional UMCf (0.004-0.089) reflect unconfined to leaky aquifer conditions (Table 3-3) Transmisssivity, in the above table, equals the effective horizontal hydraulic conductivity of an aquifer multiplied by it's saturated thickness. Assuming an average saturated thickness at the extraction wells within the shallow WBZ near the IWF of 15 feet, near the AWF of 18 feet, and the SWF of 63 feet, transmissivities range between 340 ft^2/day at the IWF to 1,430 ft^2/day at the SWF. These transmissivities are relatively high, but may be limited by available drawdown, and pumping

drawdown cones are expected to be small to moderately small in diameter and shallow in depth when compared to confined aquifer systems.

3.5 Groundwater Occurrence and Movement

The groundwater zones of interest within the Study Area occur within two distinct sedimentary formations, the alluvial sediment fan deposits and the upper porttion of the underlying Muddy Creek Formation. The results of monitoring nearly 1,100 piezometers and wells during the past approximately 30 years indicate the occurrence of groundwater within these formations. The vast majority of the monitoring wells are screened over 0.5 to 30 foot intervals, providing depth-specific data. Approximately 25 Deep (300- 425 ft bgs), 120 Middle (90-300 ft bgs), and 950 Shallow (up to 90 ft deep) wells and piezometers have been installed and monitored within the Study Area (Figure 3-3).

For regulatory purposes, and consistency between the companies within the BMI Complex, the Shallow WBZ is defined to occur within the unconsolidated deposits (e.g. Qal and UMCf) to a depth of 90 ft bgs, the Middle WBZ to occur within unconsolidated deposits (UMCf) to a depth of 300 ft bgs, and the Deep WBZ to occur within unconsolidated UMCf deposits greater than 300 ft bgs (NDEP, 2009).

3.5.1 Aquifer Thickness

The cross-sections presented in the Annual Remedial Performance Report (Northgate, 2010) and data in Table 3-2 indicate the alluvium varies in thickness from approximately 18 feet to 57 feet beneath the Site. The west-east cross-sections show notable variation in elevation along the interface of the Qal and UMCf, on the order of 15 feet at the IWF, up to 25 feet at the AWF, and up to 10 feet at the SWF. This variation is due to paleochannels that are incised into the top of the UMCf and trend northeastward parallel to the direction of groundwater flow. Where the channel deposits are thickest, the paleochannels provide higher conductivity zones for groundwater flow (Figure 3-7).

The saturated Qal thickness generally increases from south to north, averaging 10 feet at the IWF (Figure 3-4), from 0-28 feet near the AWF (Figure 3-5), and 30-45 feet near the SWF (Figure 3-6). The underlying UMCf is in hydraulic connection with the Qal and occurs to depths of over 400 ft bgs within the Study Area (Table 3-2). The combined Qal/UCMf constitute the near surface aquifer (Kaufmann, 1977) in the Study Area. The near surface aquifer is subdivided into the Shallow, Middle, and Deep WBZ as noted above.

3.5.2 Hydraulic Gradients and Flow Direction

Figure 3-8 presents a potentiometric surface map of the third quarter 2010 Shallow WBZ at the Site. The groundwater elevation contours define the general horizontal groundwater flow direction and the hydraulic gradient. Within the Shallow WBZ, groundwater elevations range from 1,800 feet mean sea level (msl) in the south of the Study Area to 1,535 feet msl in the north at the Las Vegas Wash. Groundwater moves from higher to lower elevations in a direction perpendicular to the contours. The map shows groundwater moving in a north to northeast direction across the Site. The gradient, defined by the drop in groundwater hydraulic head (or elevation) divided by the distance over which the drop occurs is approximately 0.0142 ft/ft across the Site. The shallow groundwater generally mimics the topography, and south of the AWF the gradient is steeper (~ 0.0163 ft/ft) compared to north of the AWF (~ 0.0092 ft/ft). The generally uniform flow pattern is influenced by the presence of higher permeability paleochannels, acting as preferential conduits to flow, and inflecting contours in an upgradient direction (Figure 3-7). Other, localized influences on shallow WBZ groundwater flow include groundwater recovery well fields, the AMPAC reinjection system, the City of Henderson Bird Preserve ponds, a constructed Barrier Wall, and recharge trenches noted in Figure 1-1.

The groundwater gradients may also be affected by water density given that the local groundwater is variably saline. Groundwater elevations calculated from field measurements are corrected for density and expressed as equivalent freshwater heads (or elevations) when estimating vertical gradients between closely spaced wells screened over different depth intervals. Groundwater elevations that are used to map the potentiometric surface within the Shallow WBZ are not corrected for density for several reasons: 1) density corrections use the length of the water column to apply the density factor, and for wells screened within the Shallow WBZ the correction does not significantly change the Shallow WBZ elevations, 2) total dissolved solids data is not available to make corrections for all wells, and 3) at a regional scale, the density corrections would not make a difference in flow direction or gradient..

Vertical groundwater movement is generally upward from the deep to middle to shallow WBZs. Table 3-5 lists wells clusters, well construction information, and density corrected water levels used to estimate vertical gradients in select Site wells that are spaced closely and screened within different WBZs. The spatial distribution of wells used to evaluate the vertical groundwater gradients are shown in Figure 3-9. Data in Table 3-5 show upward (negative) gradients from the Middle to Shallow WBZ on the order of 0.017 to 0.26 ft/ft within the Tronox Site. Data from one well in the cluster M-44, M-152, and M-156 show a slight downward gradient (0.028) between well M-44 and M-152, but the deepr Middle WBZ well, M-156, shows an upward gradient of 0.106. Data from one well pair (TR-7 and TR-8) located near the southern Tronox property

boundary indicate an upward gradient of 0.18 ft/ft from the Deep to the Middle WBZ. It is expected that downward gradients have existed locally and transiently within the Shallow WBZ where recharge occurs via applied water, such as the Tronox infiltration trenches and the County of Henderson Bird Preserve unlined ponds. Vertical gradients are discussed further in Section 5, including gradients between wells screened at different elevations within a given WBZ (e.g., Shallow and Middle).

3.5.3 Influencing Factors on Flow

3.5.3.1 Geologic Influences

Geologic influences on the occurrence and movement of groundwater include lower permeability boundaries presented by finer grained sedimentary deposits of the UMCf and enhanced permeability features associated with paleo-channels. Hydraulic conductivity measured from wells inferred to be completed in or near paleochannel deposits are from two to five orders of magnitude higher than that measured from wells completed within the UMCf (Table 3-3). The locations of paleochannels have been inferred from multiple lines of evidence including the topography of the Qal-UMCf contact (Figure 3-7), the hydrogeologic interpretation of the potentiometric surface of the Shallow WBZ (Figure 3-8), previous interpretations of the locations of paleo-channels conducted by Tronox and the other Companies of the BMI Complex, and consistency with the observed spatial distribution of perchlorate movement within the Qal sediments (see Section 3.7).

3.5.3.2 Pumping Influences

Groundwater extraction for mostly remedial purposes began in 1986 within the Study Area. Tronox remedial wells are generally less than 60 feet deep and are screened over much of their length within the saturated Qal. Table 1-1 summarizes the record of average third quarter 2010 groundwater extractions at the Tronox well fields. AMPAC and POSSM, two other Company groups within the BMI Complex, also currently operate groundwater extraction systems (Figure 1-1). Pumping records and the well screen intervals for each of the pumping wells were used in developing the numerical groundwater model (Appendix E). A previous inventory for possible residential or agricultural water supply wells did not identify any wells within four miles of the Tronox Site that extract water from the Shallow, Middle, or Deep Zones (ENSR, 2005).

3.5.3.3 Recharge Influences

Groundwater recharge is water that enters the subsurface from above ground and reaches the saturated zone. Sources of recharge within the Study Area include precipitation, applied water (e.g., irrigation and leaks), and various forms of wastewater discharge (infiltration facilities and

ponds). Recharge is the net amount from such sources that is not lost to evapotranspiration and site runoff. Factors that influence the spatial and temporal availability of recharge across the Study Area include:

- Seasonal and climatic precipitation patterns and availability
- Influences of topographic elevation and aspect on precipitation
- Man-made and geomorphic controls on runoff and ponding
- Soil, geologic, and ambient moisture controls on infiltration capacity
- Type and extent of vegetative cover, and
- The location, nature, and variability of applied water and wastewater practices

Average annual precipitation measured in Las Vegas from 1971 to 2000 is 4.49 inches (Kleinfelder, 1993). Recharge from precipitation occurs primarily during high intensity, short duration, summer thunderstorms, and stormwater runoff is largely channeled into storm drains (developed areas) and other conveyance structures (industrial areas), resulting in very little recharge. On the Tronox property, stormwater is mostly contained by a berm constructed along the northern (downslope) property boundary and conveyed to an unlined ditch (called the Beta Ditch). The Beta Ditch is currently plugged near the eastern property boundary, and stormflow that enters it can infiltrate. As shown on the aerial photo basemap south of the IWF barrier wall in Figure 1-2, vegetation growing along the Beta Ditch forms a localized area of recharge.

A significant majority of recharge to the Shallow WBZ within the Study Area occurs via applied water (irrigation of residential and golf course areas and leaks from industrial areas), wastewater discharges (the County of Henderson Birding Preserve unlined ponds and Tronox lined ponds), and reinjection of Lake Mead water at the Tronox infiltration trenches, and the AMPAC reinjection system. Estimates of these recharge components are listed in Table 3-6. Figure 3-10 illustrates monthly precipitation, monthly applied water at the Tronox infiltration trenches, and Shallow WBZ hydrographs of wells located near the infiltration trenches. Hydrographs for wells M-84 and M-85, located approximately 50 feet downgradient of the trenches, show a direct correlation with the amount of applied water at the trenches for the period September 2003 to June 2010. Wells M-87 and M-88, located approximately 200 to 400 feet east and slightly downgradient of the trenches, and wells M-101 and M-102, about 600 feet downgradient of the trenches, show a similar but muted correlation. Total monthly precipitation data for the area do not appear to significantly affect groundwater levels, as particularly noted in the period between September 1997 and January 2003. The data indicate that anthropogenic sources of recharge are predominant within the Study Area. Historically, other water disposal facilities, including the Trade Effluent Ponds, BMI northern and southern rapid infiltration basins, the Timet Ponds, and

the County of Henderson wastewater treatment plant have been significant sources of recharge to the Shallow WBZ.

3.5.3.4 Estimated Groundwater Velocities

Based upon the hydrogeologic properties of the Qal and UMCf discussed in Section 3.4, relatively high groundwater velocities are expected in the paleo-channel deposits within the Qal compared to significantly lower velocities within the UMCf. An approximate rate of groundwater flow velocities may be expressed as follows:

	Gradient (ft/ft)	**Hydraulic Conductivity (ft/day)**	**Effective Porosity (%)**	**Velocity (ft/day)**
Groundwater flow within Qal across the Study Area	0.0142	23	10	3.3
Groundwater flow within Paleo-Channels across the Study Area	0.0142	150	10	21.3
Groundwater flow within UMCf across the Study Area	0.0142	0.08	20	0.006

Although gradients vary locally, the data illustrate that groundwater flux within the Qal and paleo-channels dominate. Advective transport of contaminants within the underlying UMCf will account for a significantly lower mass flux across a given Study Area transect when compared to mass flux within the overlying Qal.

3.6 Conceptual Water Budget

Recharge to and discharge from the groundwater system drives groundwater flow within the Study Area. As noted in Section 3.5, applied water currently and historically plays a large role in groundwater flow within the Shallow WBZ. Estimates of recharge are noted in Table 3-6. Discharges from the groundwater sytem include extraction from remedial well fields, flow to phreatophytes near the Las Vegas Wash, flow to seeps at the Las Vegas Wash, and flow across hydrogeologic boundaries established for the Study Area. Estimates of groundwater discharge to phreatophytes, or evapotranspiration, is based upon modeled values from the calibrated BMI Upper and Lower Pond Area Model (Northgate, 2010j). Estimates of groundwater pumping used in the numerical model are based upon pumping records available from Tronox, AMPAC, and POSSM. Estimates of groundwater flux into or out of the WBZs is based upon an evaluation of vertical gradient data for areas within the model domain. Flow from the deeper WBZs was

vertically upwards throughout most of the Study Area, except for the northeast region where downward vertical gradients were observed (Northgate, 2010j).

3.7 Nature and Extent of Perchlorate and Chromium Contamination

In general, perchlorate and chromium concentrations in groundwater are highest within the Tronox property and decrease with distance downgradient towards the Las Vegas Wash. However, groundwater remediation at the IWF has resulted in a relatively less-contaminated area immediately downgradient of this system. Overall, the higher concentration plumes of both perchlorate and chromium plumes are narrow relative to their length, due to preferential flow and transport within the higher permeability paleochannels. The perchlorate plume has two areas of high concentration (> 1,000 mg/L) upgradient of the IWF, reflecting two general source areas, while the chromium plume is associated only with the more eastern of these source areas.

Figure 3-11 shows the Shallow WBZ contoured perchlorate plume within the Tronox Site based on data collected in May and June 2010, as presented in the 2010 annual performance report (Northgate, 2010h). This dataset shows the highest perchlorate concentration south of the IWF occurred in well I-A-R (2400 mg/L) whereas north of the recharge trenches the highest perchlorate concentration found was 630 mg/L in well M-44 along the northern Tronox property boundary. As described in the 2010 annual performance report (Northgate, 2010h), significant changes in the perchlorate plume have occurred over eight years. In 2002, the highest perchlorate concentration (M-37, adjacent to I-A-R) contained 5,300 mg/L, whereas in 2010 the same well contains only 2,400 mg/L (Figure 3-11). In 2002, a large area downgradient of the barrier wall contained perchlorate in excess of 1,000 mg/L, and concentrations at the downgradient edge of the plume were as high as 160 mg/L where it intersects the Las Vegas Wash. In 2010, the highest concentration measured downgradient of the recharge trenches was 630 mg/L, and the highest concentration measured in the SWF was 13 mg/L.

Figure 3-12 presents the 2010 annual performance report (Northgate, 2010h) isoconcentration map of the Shallow WBZ chromium plume within the Tronox Site area. The main portion of the chromium plume and highest concentrations occur south of the barrier wall and are cut off by the IWF. South of the IWF, the highest total chromium concentration reported for the 2010 annual sampling event was 39 mg/L in well M-50. North of the recharge trenches the highest total chromium concentration found was 2.9 mg/L in well M-87, located south of Warm Springs Road. Concentrations in well M-12A (25 mg/L in May 2002), located on the trailing edge of the main plume, have declined steadily over time and have been below 10 mg/L since the November 2009 monitoring event. Total chromium concentrations downgradient of the barrier wall and recharge trenches also continue to decline, indicating that the groundwater recovery / barrier

system is functioning as an effective barrier to migration of the main portion of the chromium plume.

Contaminant concentrations generally attenutate with depth from the Shallow to Middle WBZs and within the Middle WBZ at a given location. On Site, both pechlorate and chromium appear to extend deepest into the Middle WBZ upgradient of the IWF in the original source areas, and both plumes appear to become shallower with distance downgradient towards the Las Vegas Wash. Available data indicate that hexavalent chromium in Site groundwater does not extend into the Middle WBZ at concentrations above its NDEP risk-based groundwater concentration (RBGC) of 0.1 millligram per liter (mg/L), and perchlorate attenuates markedly with increased depth to below 1 mg/L by approximately 150 feet below ground surface within the Middle WBZ in the area upgradient of the IWF and at shallower depths farther downgradient. The vertical extent of perchlorate and chromium in groundwater is described further in Section 4.3.

3.8 Fate and Transport of Chromium and Perchlorate

Chromium exists predominately in two oxidation states: Cr(VI) and Cr(III). Cr(VI) is mobile in groundwater, acutely toxic, and carcinogenic, while Cr(III) is relatively immobile under most groundwater conditions and is characterized with low toxicity. At concentrations present in Site groundwater, Cr(VI) exists primarily as monomeric chromate ($HCrO_4^-$,CrO_4^{2-}) anions. At higher concentrations, such as those that exist in the sodium chlorate process liquor, Cr(VI) exists as dimeric bichromate ($Cr_2O_7^{2-}$) anions. At the slightly alkaline pH conditions encountered at the Site, Cr(III) readily precipitates to an insoluble chromium hydroxide ($Cr(OH)_3$).

Cr(VI) anions are mobile in groundwater, but have been demonstrated to sorb onto surface sites on iron oxyhydroxides (Leckie et al., 1984). The strength of adsorption of Cr(VI) anions is intermediate between those of strongly binding anions, such as phosphate and arsenate, and weakly binding anions like sulfate (Davis et al., 2000). It has been demonstrated that high concentrations of sulfate can reduce chromate adsorption, but this typically occurs under acidic conditions that are not typically observed at the Site (Leckie et al., 1984). Other naturally occurring anions such as bicarbonate and dissolved silica can also compete for adsorption sites and enhance the mobility of Cr(VI) anions in groundwater (van Geen et al., 1994; Zachara et al., 1987).

Cr(VI) remaining in vadose zone soil is not expected to significantly impact groundwater (Northgate, 2010c). Concentrations of Cr(VI) in Site groundwater are expected to decrease over time due to the ongoing extraction and treatment of contaminated groundwater. Natural

attenuation via sorption onto mineral surfaces and via reduction into insoluble Cr(III) hydroxides from reactions with organic carbon may also play a role in reduction of Cr(VI) levels over time.

Perchlorate is a large anion with a relatively low diffuse charge. It is highly soluble and sorbs poorly, if at all, to most mineral surfaces. The partition coefficients for perchlorate sorption to geologic media are essentially zero. It does not form aqueous complexes or react with cations to form insoluble phases. Because perchlorate sorbs so poorly to most geologic materials, in the absence of biodegradation, perchlorate plumes do not attenuate and should move at practically the same velocity as groundwater.

Significant levels perchlorate remain in Site vadose zone soil, and has been identified as presenting an ongoing threat through the leaching to groundwater pathway (Northgate, 2010i; *Tronox/NDEP meeting minutes for February 5 and February 12, 2010*). Soil flushing and other remedial options are currently being considered to address this concern (Northgate, 2010h). Provided that this potential leaching concern is adequately addressed, perchlorate concentrations may increase locally, but would be expected to decline eventually in Shallow WBZ due to ongoing groundwater extraction and injection of Lake Mead water.

3.9 Potential Exposure Routes and Receptors

The identification of potentially exposed populations and exposure pathways related to contaminants in groundwater is important and must be incorporated in the CSM. For a complete exposure pathway to exist, each of the following elements must be present (USEPA, 1989):

- A source and mechanism for chemical release (discussed in Section 3.2 above);
- An environmental transport medium (e.g., air, soil, water);
- A point of potential human or ecological contact with the medium; and
- A route of exposure (e.g., inhalation, ingestion, dermal contact).

Potential contaminant migration pathways at or near the Site exist through air, soil, surface water, and groundwater. Contaminant transport can occur through the air pathway when contaminated soils are present at or near the surface and particulates are mobilized and carried by winds. Contaminants capable of volatizing or releasing gases can move via air through soil as soil gas. Contaminants in surface water and groundwater can also volatize. Contaminants can be transported on- or offsite through surface water movement when flowing across the Site due to rain or other runoff, or in bermed water control features such as in the Beta Ditch. In addition, soluble contaminants can be dissolved and transported across the surface and/or infiltrate into the subsurface, contaminating the vadose zone and possibly continuing into the groundwater. Where

contaminated groundwater surfaces, surface water, such as the Las Vegas Wash, may be impacted (ENSR, 2005). Humans may also be exposed to contaminated groundwater through water supply wells.

As discussed above, the Site is currently an active industrial facility. In the future, the Site is expected to continue to be used for industrial and/or commercial purposes. Additionally, consistent with the HRA Work Plan (Northgate 2010a), because the area will remain as part of an active commercial/industrial facility in the future, ecological habitat is not currently sufficient to warrant an ecological risk assessment, nor is it expected to be in the future. Accordingly, the current and future on-site receptors include long-term indoor workers, long-term outdoor workers and short-term construction workers.

3.9.1 Previous Site Risk Assessments

Previous health risk assessments (HRAs) for the Site including RZ-A and the Parcels (e.g., Northgate, 2010g) have focused on near-surface (ten feet below ground surface or less) contaminated soil for future onsite indoor and outdoor commercial workers and future construction workers via direct contact with soil (e.g., incidental ingestion, dermal contact and inhalation of dust). Removing soil that potentially presents an unacceptable risk for these pathways has been the focus of remediation activities at the Site during 2010. Residual contaminants in the soil can be leached through the pore space and into groundwater via water infiltration, and this is also under evaluation for the Site (Northgate, 2010k). Additionally, a Site-Wide Soil Gas HRA has been prepared to evaluate the potential for adverse health impacts that may occur as a result of exposure to chemicals in soil gas via inhalation of indoor or outdoor air (Northgate 2010k). While these VOCs (primarily chloroform) may originate in groundwater, that potential exposure pathway is not the focus of the CZE, but may be considered in future evaluations.

3.9.2 Potential Groundwater Exposure Pathways

In addition to exposure to VOCs volatilizing from groundwater, potential exposure pathways for contaminants in Site groundwater involve its potential use as water supply. The Site groundwater is not a current drinking water source, nor is it likely to be in the future due to its naturally poor quality (see Section 3.2). As discussed in the approved HRA Workplan, ingestion, dermal contact and domestic use (e.g. showering) with groundwater are not considered complete pathways due to the fact that the groundwater is not used as water supply. There are no water supply wells reported within four miles of the Site that extract water from the Shallow, Middle, or Deep Zones (ENSR, 2005). However, shallow Site groundwater does migrate to and discharge into the Las Vegas Wash and then flows into Lake Mead, which is a drinking water source. In

addition, groundwater extracted from the Site and treated for hexavalent chromium and perchlorate is discharged to the Las Vegas Wash under a NPDES permit. The migration of perchlorate into the Las Vegas Wash is the primary exposure pathway of concern for Site groundwater, and is the focus of this CZE.

4 TARGET CAPTURE ZONE DEVELOPMENT

4.1 Groundwater Extraction System Goals

A target capture zone is the three-dimensional zone of groundwater that must be captured by the site extraction wells for the GWETS system to be considered successful (USEPA, 2008). Although target capture zones for the Tronox well fields have been discussed amongst representatives of Tronox and NDEP, to date none have been firmly established. Based on recent input from NDEP including discussions between Tronox and NDEP at an April 16, 2010, project meeting, Tronox considered the following in developing the target capture zones proposed herein:

- An overall goal is to minimize to the extent feasible the mass of perchlorate migrating to the Las Vegas Wash and thereby into Lake Mead.
- Specifically at IWF and AWF, a 95 percent perchlorate mass flux capture is the initial goal.
- The incremental percentage of additional mass that could be captured by targeting a series of decreasing isoconcentration contours should be considered at IWF.
- A goal for SWF will be established in the future based upon IWF and AWF capture estimates and possible alternative remedial approaches (e.g., *in-situ* reductive bioremediation) being considered for this area of the plume.

Based on these considerations and other NDEP input (NDEP, 2010b), Tronox developed a three dimensional depiction of perchlorate and chromium concentrations (or three dimensional plume) from recent groundwater quality data. As described below, these three dimensional plumes were used to calculate the percentage of perchlorate plume mass contained with various isoconcentration contours, and these percentages were considered in defining an appropriate plume boundary targeted for capture. As described in Section 6, the three dimensional plume depictions and selected plume boundaries were used to evaluate the percent contaminant mass currently captured by the extraction systems. The chemical data sets, modeling method, and the resulting three dimensional plume figures are discussed below.

4.2 3-Dimensional Plume Definition Dataset and Modeling Method

The concentration and well location data used in the generation of the perchlorate and chromium 3D groundwater plume models were constructed in the following manner. Concentration data for perchlorate, chromium, and hexavalent chromium in groundwater were queried from the BMI Complex, Common Areas, and Vicinity Database (BMIdbase) on November 4, 2010 and copied

into a spreadsheet. As the BMIdbase only includes data up to 2009-Q4, the spreadsheet was augmented with more recent data obtained from 2010 groundwater monitoring reports.

At this point, well name conflicts were resolved using well locations as a QA/QC check and merged. The most recent data for each well was selected for inclusion into the concentration datasets. In the case of chromium, both total chromium and hexavalent chromium data were combined. Concentrations were analyzed to determine if the most recent sampling data fell within the range of historical values for that well location. In a few cases where the most recent data did not appear representative, that data was disqualified and earlier data was selected. Only data sampled after January 1, 2008 was considered eligible for inclusion.

Samples with elevated sample quantitation limits (SQLs) were also eliminated from inclusion into the dataset. These high SQLs typically resulted from high dilution levels and led to unreasonably large non-detect (ND) values. For perchlorate, an elevated SQL was defined as greater than one half the mean of the detected values. For chromium, an elevated SQL was defined as greater than 50 ppb.

Average well screen depths and surface elevations for each well were obtained from the "All Wells Database" dated December 22, 2009 and added to the spreadsheet. Wells without screen depth or elevation data were removed from consideration. The final step in developing the perchlorate and chromium datasets was to manually remove wells and to add control points to the west and east of the Site to honor the conceptual model for the Site and AMPAC perchlorate plumes. Further description and the perchlorate and chromium datasets used for the three-dimensional plume modeling are presented in Appendix F.

The three-dimensional perchlorate and chromium groundwater plumes were generated using Environmental Visualization Systems (EVS) by CTECH Development Corporation. Groundwater concentration data was combined with the wells' horizontal locations, surface elevations, and the center of the groundwater screen. EVS uses kriging to interpolate the concentration data in three dimensions. Kriging is a mathematical process that is commonly used the for interpolation of measured data. The concentration data is initially log processed before the interpolation is performed, changing all concentrations into the log of the concentration. EVS provides an expert system to drive the Kriging modules, making it unnecessary for the user to determine the optimal semivariogram parameters, but the settings were customized so the interpolation reflected the ground conditions more accurately. The following parameters were changed for the interpolation:

- The number of nodes in the horizontal direction for the model were increased from 41 to 75, making the model grid finer and the plume smoother.
- The anisotropy was increased from 10 to 25. The higher the number, the less influence the vertical direction has on the interpolation.

The model was limited to a 400 foot thickness, using the groundwater table elevation provided by the groundwater model for the top, and an elevation that was 400 feet below groundwater for the bottom. Without limiting the vertical boundaries, EVS would interpolate the model as a cube and not take into account the elevation variations over the plume area. EVS was then used to generate cross-sections at various locations, as well as calculate the volume and mass of the groundwater plume.

4.3 3-Dimensional Plume Maps

Figures 4-1and 4-2 depict the perchlorate groundwater plume in plan, cross-sectional and oblique views. Although 0.018 mg/L is NDEP's RBGC for perchlorate, 1 mg/L was selected for the lowest contour because below this level there is inherent variability with low concentration measurements and, as shown on Table 4-1, below 1 mg/L the mass of perchlorate represents less than 1% of the total mass. As Figure 4-1 illustrates, even at this concentration there are off-Site perchlorate sources contributing to the Tronox plume downgradient of the IWF. These include one or more apparent sources to the east, which may be related to past wastewater discharge to the former BMI ditches and ponds by Tronox and possibly others. Not shown on Figures 4-1 and 4-2 is the AMPAC perchlorate plume located west of the Tronox perchlorate plume. This plume may also commingle with the Tronox plume at low concentrations near the Las Vegas Wash.

As shown on Figures 4-1 and 4-2, the area of highest groundwater perchlorate concentration (1,000 to 2,400 mg/L) is limited upgradient of the IWF. Moderately high (between 100 and 500 mg/L) concentrations extend as far downgradient as several hundred feet north of the AWF. Lower concentrations (25 mg/L and less) are more broadly distributed and reflect apparent off-Site sources. As indicated in the plume-axis cross section on Figure 4-2, perchlorate concentrations above 1 mg/L do not appear to extend deeper than approximately 150 ft bgs. With the installation of a number of new UMCf wells upgradient and in the immediate vicinity of the IWF (see Appendix B), the depth distribution of perchlorate is now well-constrained in this area. The vertical perchlorate distribution is less well defined between the IWF area and the AWF. For this area, the anisotropy used in the plume model (see Section 4.2 above) has a considerable effect on how the vertical concentration distribution is depicted. Based on the perchlorate concentrations in deeper wells located downgradient of the IWF, the vertical extent of perchlorate between these wells and the AWF may be overestimated.

To provide a frame of reference for the mass flux capture evaluation discussed in Section 6 and as requested by NDEP (NDEP, 2010c), the EVS software was also used to calculate the groundwater perchlorate plume mass within various contours and portions of the plume, and the results of these calculations are presented in Table 4-1. These calculations are based on an assumed average total porosity of 0.5 for both the Qal and UMCf. Due to actual porosity variability and uncertainties in the actual concentration distribution, particularly in the vertical direction as described above, these perchlorate mass calculations are considered rough estimates for providing information on relative mass in different portions of the plume. As shown on Table 4-1, these calculations indicate that approximately 40% of the total plume mass is located upgradient of the IWF. As shown on Table 4-1, 94% of this plume mass upgradient of the IWF is contained within the 25 mg/L contour, an additional 3% falls between the 10 and 25 mg/L contours, 1% falls between the 5 and 10 mg/L contours, 1% falls between the 1 and 5 mg/L contours, and the remaining 1% falls below the 1 mg/L contour.

Figures 4-3 and 4-4 depict the chromium plume using the same views as those used for the perchlorate plume. The 0.1 mg/L RBGC was used as the lowest contour for the chromium plume. As shown on these figures, the chromium groundwater plume extent above 0.1 mg/L is similar to that for perchlorate above 1 mg/L, except that it is not as extensive laterally and vertically and does not indicate as much input from apparent sources east of the Tronox Site as the perchlorate plumes does. Also similar to the perchlorate distribution, the highest chromium concentrations (10 to 39 mg/L) are constrained to the area upgradient of the IWF (Figure 4-3). Groundwater containing moderate chromium levels (0.1 to 1 mg/L) extends downgradient of the IWF, and appears as far downgradient as the AWF in the eastern portion of the plume (i.e., within the more eastern of the two alluvial channels intercepted by this well field).

5 WATER LEVEL INTERPRETATION

The extent of horizontal or vertical capture can be estimated based upon water level contour maps, depicting groundwater flow on a two dimensional plane. Horizontal capture at the well fields can be estimated from a potentiometric map of water levels measured in the Shallow WBZ. Vertical capture can be estimated from a map showing the difference in heads (or water levels) between wells completed in different hydrostratigraphic units (e.g. Shallow, Middle, and Deep WBZs). For the Tronox Site, groundwater flow patterns have been analyzed in three dimensions, using a numerical groundwater flow model, that accounts for anisotropy and three dimensional head distributions. The model is discussed in Section 6.

This section presents a horizontal capture analysis of the Shallow WBZ by interpreting flow lines perpendicular to the water level contours as bounding the flow lines that would reach the IWF and AWF. Capture indicated through an idealized groundwater flow net interpretation is compared to that indicated by the numerical model in Section 8. Vertical gradients between the Shallow and Middle WBZs have also been calculated for specific well clusters at the Tronox Site (see Section 3) and indicate generally upward gradients from the Middle to the Shallow WBZ. The total number and spacing of wells screened within the Middle WBZ (Table 3-2) are not sufficient to create a potentiometric surface map for this unit, and thus a map showing the difference in heads between the Shallow and Middle WBZs could not be constructed. The following subsections describe the data and methods used to interpret water levels and the analysis of horizontal and vertical capture for the IWF and the AWF.

5.1 Data Selection

Water levels measured in existing wells and new wells installed as part of the *Capture Zone Evaluation Work Plan* (Northgate, 2010d) were used to analyze ground water flow patterns and inferred horizontal capture within the Shallow WBZ at the IWF and AWF. Approximately 240 existing wells are monitored routinely to assess groundwater elevations and contaminant concentrations. Wells are monitored monthly, quarterly, or annually to assess seasonal fluctuations and gradient trends. Forty-one new wells installed per the CZE Work Plan provide additional water level data in the vicinity of the IWF and AWF including:

- IWF: 11 piezometers adjacent to select recovery wells to provide accurate measure of drawdown in these areas; 12 new wells screened at varying depths in UMCf to provide additional information on vertical head differences, evaluate potential flow under the barrier wall,; and monitor the lateral and vertical influence of the recovery wells; and four new monitoring wells to restore missing/damaged water level measuring points.

- AWF: eight new monitoring wells in and around the recovery well field; two new monitoring wells screened in the "UMCf high;" one new recovery well, and four new monitoring wells to restore missing/damaged water level measuring points.

Table B-1 in Appendix B lists construction information for each of the new wells, replacement wells, and repaired wells, along with the primary rationale and/or data objective for each well within the CZE Work Plan. Hydrographs for select Site monitoring wells in the vicinity of the IWF and AWF are presented in Figure 5-1. Groundwater levels generally fluctuate in tandem and there are no significant differences (i.e., differences are less than 10 feet) in groundwater levels measured over the past 8 years. Groundwater elevations measured in the third quarter of 2010 were used for this analysis. If third quarter data were not available, data from second quarter 2010 were used. Groundwater levels measured at well PC-98R were excluded from the data set because they appeared anomalous compared to neighboring wells. Water level data collected in 2010 and the values used to prepare the water level contour maps are noted in Table 5-1. Well construction and water chemistry data used for calculating vertical gradients are provided in Table 5-2.

5.2 Methodology

5.2.1 Potentiometric Surface and Horizontal Gradients

Potentiometric surface maps for the Shallow WBZ at the IWF and AWF are presented as Figures 5-2 and 5-3, respectively. A Shallow WBZ potentiometric map for the Tronox Site is presented in Figure 3-8. Potentiometric maps were prepared using KT3D_H2O geostatistical software. The capture zones were estimated using a graphic flow-net analysis based on measured groundwater elevations.

KT3D_H2O is a software program developed by S.S. Papadopulos and Associates that combines several geostatistical programs that allow the user to generate gridded maps of water level elevations while taking into account elements such as point sinks or sources (e.g., extraction or injection wells) and horizontal line sinks or sources (i.e., interception trenches or infiltration galleries; Karanovic et al., 2009). Three Site factors affecting local groundwater flow are: (1) pumping from extraction wells, (2) injection at recharge trenches in the IWF area, and (3) the groundwater barrier wall in the IWF area. The water levels were interpolated in KT3D_H2O using pumping and injection rates from individual extraction wells and the recharge trenches as point sinks and sources (Table 1-1). The injection rate and location was approximated by dividing the combined recharge trench injection rate into four equal fractions and uniformly distributing four sources along the lateral length of the trench.

Groundwater elevation contours were generated in KT3D_H2O using ordinary kriging with an isotropic spherical variogram. Kriging is a geostatistical technique that interpolates the value of a random field (e.g., the groundwater elevation) at unobserved locations using measurements from nearby locations. KT3D_H2O is limited in its ability to account for low or no flow conditions, such as the groundwater barrier wall. Hence the resulting potentiometric surface generated out of KT3D_H2O was further interpolated in ArcGIS using Spatial Analyst, adjusting contour lines as appropriate at the IWF barrier wall and locations where features, such as the "UMCf high" at the AWF affect groundwater flow.

5.2.2 Vertical Gradients

Head differences and vertical gradients were calculated for well pairs screened in the Qal and at various depths in the UMCf. Head differences are simply the difference in the measured groundwater elevation between nearby wells screened in different hydrostratigraphic units. Vertical gradients are the difference in the measured groundwater elevation between wells divided by the vertical distance between the two monitoring points. In both of these calculations, groundwater elevation measurements were first corrected for density differences to account for the variably high TDS content in Site groundwater (Post et al., 2007). For the vertical gradient calculation, the elevation of the midpoint of the well screen was used to calculate the difference in vertical distance. Data used for the vertical gradient analysis are shown in Table 5-2, and well pair locations are displayed on Figure 3-9.

5.3 Analysis

The contoured groundwater elevation data (Figure 3-8) indicate that Shallow WBZ groundwater flows north or northeast beneath the Site, with minor perturbations near the recovery well fields. This map is consistent with a previous map prepared for the Annual Remedial Performance Report (e.g., Northgate; 2010g). Vertical gradients are generally upward, as shown by a comparison of water level data from Deep to Middle, Middle to Shallow, and deeper to shallower Shallow zone wells. Groundwater gradients are locally altered in the vicinity of the IWF (including the barrier wall and reinjection trenches) and AWF. Further interpretation of water level data in the area of the two well fields is provided below.

5.3.1 Interceptor Well Field

Figure 5-2 is a water level elevation map of the Shallow WBZ in the vicinity of the IWF. The groundwater level contours were interpolated using a graphic flow net analysis and adjusted by hand to account for influences affecting flow. The estimated zone of capture is noted as the flow

line (perpendicular to groundwater contours) that encompasses the area where horizontal flow within the upper 60 feet is captured by extraction wells located south of the barrier wall.

Well pairs used to estimate vertical gradients in the vicinity of the IWF are shown on Figure 3-9, and presented in Table 5-3. Vertical gradients are generally upward in most well pairs. There is a local downward gradient near well pair M-159/M-160, west of the IWF barrier wall, although both of these wells are completed within the Shallow WBZ. The vertical gradient is downward within two wells screened within the Middle WBZ (well pair M-187/M-188) located upgradient of the barrier wall, northeast of the Chemstar facility. One well pair (TR-7/TR-8) near the southwest property boundary indicate an upward vertical gradient from the Deep to the Middle WBZ.

5.3.2 Athens Road Well Field

Figure 5-3 is a water level elevation map of the Shallow WBZ in the vicinity of the AWF. The groundwater level contours were interpolated and zones of capture estimated as described above in Section 5.3.1. Two new wells (PC-149 and PC-148) were installed within the UMCf high to define groundwater levels in the area between the eastern and western extraction well fields. Groundwater elevation contours show a deflection at the UMCf high, suggesting lower permeability deposits within this area. Currently there are no pumping wells in this area, so capture is not indicated in the area between the AWF sets of extraction wells. Although flow is not captured in this area, it is expected that the mass flux of contaminants would be less than in the adjacent areas where alluvial channels are indicated on cross section (Figure 3-5). Downgradient from the pumping wells the gradient appears to flatten more on the west than the east, due to higher pumping volumes from the western set of recovery wells (Table 1-1).

Well pairs used to estimate vertical gradient in the vicinity of the AWF are shown on Figure 3-9, and presented in Table 5-3. These two well pairs are located just north and west of the western AWF. A measured vertical gradient is upward within two wells screened within the Shallow WBZ (well pair PC-134A/PC-135A). Within 400 feet west of this well pair, there is a very slight (0.006 foot/foot) downward gradient within two wells screened within the Shallow WBZ (well pair PC-141/PC-142). As noted in Section 3.5, vertical gradients within a WBZ could be variable, depending upon the lithology and on how the monitoring wells areconstructed.

6 GROUNDWATER FLOW MODEL AND RELATED CALCULATIONS

Calculations are used to provide additional lines of evidence regarding the extent of capture (EPA, 2008). Simple horizontal analyses related to capture, such as estimated flow rate calculations and capture zone width calculations, can be made quickly and compared to actual well field pumping rates and the estimated contaminant plume width. The simplicity of these analyses require assignation of single values of aquifer thickness, hydraulic conductivity, and hydraulic gradient. As the SCM in Section 3 demonstrates, there are significant variations in these parameters at the Site and at each well field. Therefore a groundwater model was developed to account for these variations both in space and time. This section first presents simple analytical calculations and then summarizes the numerical groundwater flow model used to quantitatively estimate capture of the three-dimensional plume and capture efficiency at each of the well fields.

6.1 Estimated Flow Rate and Capture Zone Width Calculations

Flow rate calculations estimate the pumping rate required to capture the groundwater flux through the estimated extent of the plume (or capture zone). This simple horizontal capture analysis includes assumptions of a homogenous, isotropic, confined aquifer of uniform thickness and fully penetrating extraction wells. None of these assumptions can be strictly applied for this site, however this analysis is included as part of EPA recommendations (EPA, 2008). The flow rate (Q) is expressed as:

$$Q = K * (b * w) * i * factor$$

Where:
K = hydraulic conductivity (ft/day)
b = saturated thickness (ft)
w = plume width (ft)
i = regional gradient (ft/ft- unitless)
factor = “rule of thumb” is 1.5 to 2.0, intended to account for other contributions to the pumping well such as flux from an injection system or induced vertical flow from another unit, such as the UMCf

The selection of input values are included in Table 6-1. The calculated flow rates are compared to the combined extraction rates at each well field. As shown by the calculated values, the combined average pumping rate of the IWF (73 gpm) exceeds the calculated flow rate for the entire 3.420-foot width of the 1 mg/L perchlorate plume under both the medium (7.9 gpm) and high (30 gpm) hydraulic conductivity scenarios. Similarly, the combined average pumping rate

of the AWF (approximately 281 gpm) exceeds the calculated flow rate for the entire 1,300-foot width of the "local" perchlorate plume (see Section 6.2.8 for definition) under the medium hydraulic conductivity scenario (170 gpm). Under the AWF high hydraulic conductivity scenario, (which assumes flow occurs entirely within paleochannels), the calculated flow rate (972 gpm) exceeds the the combined average third quarter pumping rate of 281 gpm. Using these simplifying assumptions, pumping rates at the AWF may not be sufficient to capture the width of the perchlorate plume under assumptions of a high hydraulic conductivity scenario.

The capture zone stagnation point and width calculation is an estimate of the geometry of the zone of capture around a single pumping well. These calculations assume a single pumping well pumps the toal volume of flow (Q) at the center of the well field. The stagnation point is measured in the downgradient direction from the pumping well parallel to the plume axis in the direction of groundwater flow. Y_{well} (the width of the capture zone from a pumping well located at the center of the plume) and Y_{max} (the maximum width of the capture zone) are measured symmetrically from the pumping well perpendicular to the plume axis. The capture zone widths for the IWF and AWF were estimated by assigning the respective total pumping rate at one centrally-located "equivalent well" per well field. For the IWF, the estimated stagnation point is 2,604 feet downgradient of hypothetical "equivalent well"and Y_{well} is a minimum of 4,090 feet (estimated in the high hydraulic conductivity scenario). However, pumping the total flow volume from a single well is not possible as transmissivity is limited by the saturated thickness. For the AWF, the estimated stagnation point is 119 feet downgradient of hypothetical "equivalent well" and Y_{well} is a minimum of 1,271 feet (estimated in the high hydraulic conductivity scenario). Calculated capture zone widths are similar to or larger than the capture zones estimated from the potentiometric surface maps for both the IWF and AWF. Modeled interpretations of groundwater capture in a 3-dimensional field provide more accurate lines of evidence for capture, as discussed in the remaining subsections.

6.2 Capture Zone Analysis Using Flow Model

Tronox developed a three dimensional flow model, the Tronox model, to assist in this quantitative capture zone evaluation and for ongoing optimization and evaluation of Site remediation. The model development in its entirety is described in Appendix E. A summary of the model development and results of the capture evaluation using the model are described below.

6.2.1 Model Domain

A three dimensional, numerical groundwater flow model was developed using the USGS MODFLOW code (McDonald and Harbaugh 1988; Harbaugh et al. 2000) for an area covering the entire the Tronox Site and including its immediately neighboring industrial facilities. The pre- and post-processing was carried out using the Groundwater Vista® software package. The model domain is shown in Figure 6-1. The active area of the model domain is wedge-shaped, narrowing from south to north toward the Las Vegas Wash. From south to north, the proposed model domain extends from south of Lake Mead Parkway to the Las Vegas Wash, approximately 20,000 feet (about 4 miles) in total length. Laterally (perpendicular to the regional groundwater flow direction), the model extends east and west of the Tronox Site to include the existing groundwater treatment systems of AMPAC and POSSM to the west and the proposed groundwater barrier wall and capture wells at the TIMET site to the east. The large extent of the model domain assures reflection of the hydraulic features which may impact the evaluation of groundwater capture zones and future plume evolution, and avoids having the lateral boundaries of the active domain intersect active sources and sinks.

6.2.2 Model Discretization

Horizontal cell size of the model grid varies from 50 ft to 243.75 ft. For the most part, the model grid blocks are uniform and are 200 ft by 200 ft. Near the well fields, the grid is refined by reducing grid size down to 50 ft. Vertically, the model extends downward from the ground surface, through the shallow Quaternary alluvium (Qal) and several hundred feet into the Upper Muddy Creek formation (UMCf). Within the model domain the saturated Qal unit varies in thickness from nearly 0 ft in the south to about 50 ft in the north. The UMCf is a massive unit extending more than 1,000 ft deep. The modeled UMCf terminates at a depth of about 300 ft below ground surface. The Qal and UMCf units were each represented by two and four model layers, respectively. The layer thicknesses were chosen such that most of the extraction wells are screened in Layers 2 and/or Layer 3. Large portions of the top alluvium layer are dry in the southern portion of the model domain.

6.2.3 Model Boundary Conditions

The eastern and the western boundaries were chosen to be roughly coincident with streamlines interpreted from regional groundwater elevation data. These two lateral boundaries were assigned “no-flow” condition. A series of wells were placed in the southern boundary to inject a volume of water known to enter the model domain from the south. The northern boundary

terminating into the Las Vegas Wash was assigned constant head values based on river stage measurements. Years of water level measurements in the UMCf indicate that a significant input to the modeled domain comes from upward artesian flow from deeper portions of the UMCf unit. The bottom boundary was simulated as MODFLOW's general head boundary condition (GHB) to simulate that upward flow through the model bottom.

6.2.4 Hydraulic Parameters and Model Calibration

A significant body of information is available for hydraulic conductivity of the Qal alluvium from pump tests and slug tests (Table 3-3). Relatively lesser but adequate information is also available for the UMCf unit. Hydraulic conductivity information was reviewed and screened for inclusion. Where descrepancies existed with well construction or well completion lithology recorded in the All_Wells database or where multiple tests indicated outlier values, data were not used for statistical estimates. Based on these information, horizontal hydraulic conductivities for the Qal alluvium have an arithmetic mean of 35 ft/day and a harmonic mean of 4 ft/day. For the UMCf available information indicates an arithmetic mean hydraulic conductivity of about 2 ft/day and a harmonic mean of about 0.013 ft/day. The harmonic and arithmetic means were used to set the lower and upper bounds during the calibration stage. Final values of all the parameters were chosen based on an exhaustive calibration using head data from 263 measured water level elevations over a nearly steady period from 8/2008 to 3/2009. The comparison of simulated head values at these 263 locations to measured values indicates an adequate agreement given the rather large range of measured values of about 285.8 ft (Figure 6-1). The calibration indicated that the model predicted heads have a residual mean of 1.26 ft with a Root Mean Squared (RMS) error of about 6.2 ft. The agreement is relatively better in the Qal alluvium than that in the UMCf Muddy Creek. Further details of the model, parameter values and calibration results are provided in Appendix E .

6.2.5 Use of Plume Model in Capture Zone Evaluation

As described in Section 1, three remedial extraction systems are in operation at the Tronox site – the IWF, AWF and the SWF. The primary objective of the development of the Tronox model was to evaluate how efficiently the IWF and AWF extraction systems are capturing the monitored perchlorate plume. As described in Section 4, a three dimensional perchlorate plume envelope was developed based on the available data (see Figures 4-1 and 4-2). For the purpose of capture zone evaluation using the Tronox model, the 1 mg/L perchlorate plume contour was estimated at the mid-height of each of the six model layers. As described in the next subsection, the resultant plume contours were used to define starting points for the endpoint analysis.

6.2.6 Capture Zone Evaluation by Endpoint Analyses

The calibrated Tronox model was used to carry out endpoint analyses for particles released at the mid-height of each model layer. The endpoint analyses were performed using the MODPATH code (Pollock, 1994) which is a particle tracking companion code to MODFLOW. On the basis of head values from a MODFLOW analyses, the MODPATH code can track the movement of particles along streamlines. In particular, the endpoint analyses can determine which of the released particles are discharged at a boundary of interest marked by a reach number. In the present case the endpoint analyses determined which of the particles released at each layer were discharged (i.e. captured) at the extraction wells. The Tronox model was used to perform the endpoint analyses. At each layer, particles were released at a uniform density of one particle every 50 ft in X and Y directions. Figures 6-2 through 6-6 display the results of the endpoint analyses. Dots indicate the locations of particle release points that are captured by a well field. To distinguish capture by IWF, AWF and SWF, the dots are color coded dark green, yellow and blue respectively. Two other company well fields, AMPAC and POSSM, also capture particles, as indicated by dots color coded turquoise and pink, respectively. This analysis however, focuses on Tronox well fields. The perchlorate plume boundary is shown on each layer by a red contour, and the chromium plume boundary is shown in pink. Empty areas (i.e., no colored dots) within the perchlorate plume boundary indicate locations from which released particles bypass the three well fields Capture from each layer is discussed below:

1. Figure 6-2 shows the endpoint analysis for Layer 1 particles. Except for small area between the POSSM well field and AWF and some “islands,” virtually the entire layer is dry (unsaturated). However, particles from the plume in the small saturated zones are being captured by AWF (yellow) and SWF (blue).
2. Figure 6-3 shows the endpoint analysis for Layer 2 particles. Layer 2 is mostly saturated except for:
    a. an area next to the eastern boundary and outside the plume,
    b. upgradient of the IWF and a few disjointed areas next to the southern boundary and outside the plume.

    Perchlorate from Layer 2 is captured primarily by AWF (yellow particles) and SWF (blue). A narrow area on the north east section of the plume and east of Pabco Road is not captured by any of the extraction fields.
3. Figure 6-4 shows the endpoint analysis for Layer 3 particles. Layer 3 is mostly saturated except for an area adjacent to the eastern boundary of the model domain. For Layers 1 and 2 the perchlorate plume did not extend south of the IWF because these layers are

unsaturated in this area. In Layer 3, the perchlorate plume does extend to the south of IWF, a large part of that portion is captured by the IWF (green). Except for a portion of the plume east of the PabcoRoad, the remaining part of the plume in Layer 3 is captured by AWF (yellow) and SWF (blue).

4. Figure 6-5 shows the endpoint analysis for Layer 4 particles. Layer 4 is fully saturated. The perchlorate plume in Layer 4 is not continuous and is broken into a northern and a southern segment. The south central part, covering most of the Tronox site, terminates at AWF and is virtually fully captured by IWF (dark green), AWF (yellow) and SWF (blue). The northern segment of the plume lies mostly east of Pabco Road. A good portion of the northern segment lying west of Pabco Road is captured by SWF.
5. Figure 6-6 shows the endpoint analysis for Layer 5 particles. Very little of the perchlorate plume extends down to Layer 5. The perchlorate plume in Layer 5 is composed of four disjointed "islands" which represent the tips of the plume bottom. The two southern "islands" on or next to the Tronox property are captured by the IWF (green), AWF (yellow) and the SWF (blue). The northern two "islands" are not captured.
6. Since the perchlorate plume does not extend into Layer 6, no endpoint analysis is needed for this layer.

One of the modeling objectives is to estimate perchlorate travel times and future daylighting of perhclorate from the UMCf to the Qal. Since perchlorate undergoes very little or no retardation, its travel times were calculated based on the time for advective transport along a streamline from bottom of the plume, located in model Layer 5. This is the only layer from which released particles daylight into the Qal beyond the IWF. The travel time from the release point to the Qal/UMCf contact is on the order of 230 years, with an additional 10 years for the same particles to be captured further downgradient at the AWF. The perchlorate daylighting travel times from the bottom of the plume are longer than the orginal time it took to travel down from the source areas (on the order of several decades) for two reasons; first, the total daylighting travel distance is much longer than shorter vertical distance from the source area, and second, strong downward vertical gradients previously existed that accelerated downward migration.

Chromium capture was also evaluated through this endpoint analysis. Chromium is present in groundwater above its 0.1 mg/L RBGC in model layers 2 through 4. As shown on Figures 6-3 through 6-5, the chromium groundwater plume above this concentration generally falls within the 1 mg/L perchlorate plume boundary, demonstrating that the perchlorate capture zones are also effectively capturing chromium. As presented on Figure 6-4 and 6-5, layers 3 and 4 (first two UMCf layers) show some areas of chromium concentration above 0.1 mg/L extending beyond the 1 mg/L perchlorate contour on the eastern fringes of the main Tronox plume.

Although the EVS contours indicate connection with the Tronox plume, this interpretation is based on limited data in these areas, and the data influencing these contours may be associated with potential sources to the east of the Site rather than the Site plume. This will be further evaluated as part of ongoing CZE work.

6.2.7 Three Dimensional Visualization of the Capture Zone

Figure 6-2 through 6-6 along with the discussions above describe capture of the perchlorate plume layer by layer in a two dimensional platform. However, the capture zone is really a three dimensional ("3D") envelope. It is helpful to get a sense of the 3D capture zone. Figures 6-7 and 6-8 were developed in order provide a 3D visualization for the IWF and AWF respectively. To develop these figures Tronox developed two sub-models using Groundwater Vista's® Telescopic Mesh Refinement ("TMR") scheme. Figures 6-7 and 6-8 were developed employing MODAPATH's reverse particle tracking on each of the sub-models. On both the figures reverse particle traces are shown starting from the respective extraction wells. In order to have an uncluttered view only 50 particles were released at each of the extraction wells and their path traced opposite to the direction of travel. The left panels of Figures 6-7 and 6-8 show the extraction wells in short red vertical lines and particle traces in blue changing to aqua marine with increasing distance away from the wells. The left panels of Figures 6-7 and 6-8 also show the equipotential surfaces in green. The particle traces cross the equipotential surfaces orthogonally, however the orthogonality is distorted because of the 10x vertical exaggeration used to facilitate an uncluttered view. The equipotential surfaces and the intersecting particle traces in the lower layers show a vertically upward component as has been understood from numerous monitoring records. The right panels of Figures 6-7 and 6-8 show the same particle traces but instead of the equipotential lines, the contact surface between the Qal and the UMCf is shown.

6.2.8 Capture Efficiencies of the Well Fields

In order to quantitatively evaluate the capture efficiency of the extraction well fields, Tronox developed a mass transport model using the MT3D code (Zheng, 1993). Perchlorate is a conservative tracer that does not suffer any degradation and adsorption. The details of the transport model are presented in Appendix E.

The captured and bypassed perchlorate mass flux for the IWF and the AWF are calculated by defining a thin zone along the plane of the extraction wells and extending the plane to (1) a local boundary and (2) the wider 1 ppm perchlorate plume boundary. At the IWF, the width of the

local boundary is defined to extend to the Tronox property line on the eastern side and to the 1 ppm plume on the western side. At the AWF, the local boundary is defined as the width of the capture zone obtained from the endpoint analysis. A narrow zone of grid blocks along that plane is defined for the purpose of perchlorate mass budget. The fraction of mass of perchlorate crossing the plane and captured by the well fields per day is defined as the capture efficiency. Examples of the mass budget zones for Layer 3 at the IWF and the AWF are shown on Figure 6-9. The total mass fluxes and the perchlorate mass budget captured by the field as a fraction of the mass crossing the plane is presented on Table 6-1 below. The increase in the capture efficiency using the local boundary versus the wider 1 ppm plume boundary is around 1% in both well fields, indicating that the contribution of the plume further away from the well fields to the bypassed mass flux is minimal.

Table 6-2

Capture Efficiency of Well Fields

Region	Extent for Estimating Mass Flux	Mass Flux (lbs/day)		% Captured
		Captured	Bypassed	
Interceptor Well Field	1 ppm boundary	353	11	97
Interceptor Well Field	Local boundary	353	8	98
Athens Road Well Field	1 ppm boundary	423	75	85
Athens Road Well Field	Local boundary	423	67	86
Seep Well Field	Not calculated	40	Not calculated	--
All well fields (IWF, AWF, Seep)		816		
Mass flux entering Las Vegas Wash	--	14	--	--

In summary, this evaluation indicates that the IWF attains a capture efficiency of 97 % and the AWF attains a capture efficiency of 85 %. In addition, the SWF captures 40 lbs per day, while 14 lbs/day bypasses the SWF and discharges at the Wash.

The captured mass fluxes using this method were compared with mass removal rates reported for the extraction systems (Northgate, 2010e). The model underestimates the flux at the IWF (353 lbs/day versus a range of 744 – 1001 lbs/day between June 2008 and June 2010), while for the AWF the modeled flux is close to the lower range of measured rates (423 lbs/day versus a range

of 571-758 lbs/day). The modeled mass flux at the SWF is in general agreement with the measured fluxes (40 lbs/day versus a range of 32 to 59 lbs/day). The primary reason for this discrepancy at the IWF appears to be related to the interpolation method used for three-dimensional plume model developed in EVS. The plume model likely is underestimating the perchlorate concentrations in the areas close to the IWF and AWF extraction systems. Plume concentrations were calculated by EVS using measured well concentrations assigned to the screened interval mid-point, with the result that concentrations were not considered for some wells that are significantly de-watered. Adjustments to the plume modeling method may be made in the future to improve the interpolation near the well fields, however, the current interpretation is adequate for relative capture evaluation. The current analysis likely underestimates perchlorate concentrations within the area captured, and thus provides a conservative assessment of percent mass flux captured. The actual percentages captured are likely higher than what is presented in the table above.

7 CONCENTRATION TREND EVALUATION

Step 5 of the CZE guidance (USEPA, 2008) recommends evaluating contaminant concentration trends over time in two types of wells:

1. Sentinel wells, located downgradient of the Target Capture Zone and not currently impacted above background concentrations. If capture is successful, contaminant concentrations in these wells should remain at background levels over time.
2. Downgradient performance monitoring wells, located downgradient of the Target Capture Zone and currently impacted above background concentrations. If capture is successful, contaminant concentrations should decline over time, eventually reaching cleanup levels (or background).

As measurable concentrations of both perchlorate and hexavalent chromium appear to extend to the Las Vegas Wash, no available downgradient wells can be defined as sentinel wells (assuming that background concentrations are non-detect). Therefore, the focus of this evaluation was perchlorate and hexavalent chromium concentration trends over time for a number of wells selected as downgradient performance monitoring wells for each well field. Previous concentration trend evaluations performed, and their relevance to this CZE, include:

- Annual Remedial Performance Reports for Chromium and Perchlorate (e.g., Northgate, 2010h): Graphs of perchlorate concentration over time are presented and discussed for the wells in each of the three extraction well fields, as well as for several monitoring well transects between the AWF and SWF (i.e., the Athens Road Piezometer [ARP] transect wells, the City of Henderson Water Reclamation Facility [COH WRF] transect wells, and the Lower Ponds wells). The extraction well concentration trends are not appropriate for CZE; however, the monitoring well transects between the AWF and SWF are all appropriate as downgradient performance monitoring wells for the AWF, and these graphs are therefore included in the evaluation. For hexavalent chromium, the wells evaluated for concentration over time include those in the IWF and AWF well field areas, which are not appropriate for CZE, and the five wells specified for monitoring in the Appendix J of the 1986 Consent Order for removal of chromium from groundwater. Three of these five wells are upgradient of the IWF and are therefore not appropriate for CZE. The well M-72 is located in the “dead zone” between the barrier wall and the downgradient infiltration trenches and concentration trends in this well will be discussed in the future barrier wall evaluation memorandum. Therefore, only well M-86 which is downgradient of the IWF and barrier wall is included in this evaluation.

- Interim Capture Zone Evaluation (Northgate, 2010c): In addition to referencing the concentration over time graphs from the annual remedial performance report, this evaluation included three selected downgradient performance monitoring wells at increasing distances downgradient of the IWF (i.e., wells M-100, M-23 and M-96). These wells are included in this evaluation, along with additional wells (M-101, M-102, M-87, M-88, M-99 and PC-54) selected as IWF downgradient performance monitoring wells.

Table 7-1 and Figure 3-3 indicate the wells selected as downgradient performance monitoring wells. Figure 7-1 through 7-7 present concentration-time plots for the selected wells using all the available chemical data for perchlorate and total chromium. If a primary and duplicate sample were collected during a sampling event, the higher of the two results is used in the plots. Non-detect results are plotted using the laboratory sample quantitation limits. Outliers and anomalous data were screened out based upon professional judgment and studying historical concentration trends, and the specific data points removed are identified in a footnote for each affected plot. Several of the wells used in the evaluation are replacements for earlier monitoring wells that were destroyed or rendered unusable due to burial, damage, or construction activity. In these cases, results from both the original and replacement wells are used in the plots to provide the most complete data set.

7.1 Concentration Trends Downgradient of the Interceptor Well Field

Concentration trends at downgradient monitoring wells M-100, M-101, M-102, M-23, M-86, M-87, M-88, M-96, M-99 and PC-54 (see Figure 3-3) were evaluated to assess capture at the IWF (Figures 7-1 through 7-3).

Wells M-86, M-87 and M-88 are located just downgradient of the infiltration trenches at the Interceptor well field. As shown on Figure 7-1, M-86 and M-87 both exhibited a sharp decline in perchlorate and chromium concentrations following installation of the barrier wall in October 2001and introduction of clean Lake Mead water into the infiltration trenches beginning in 1998. Total chromium and/or perchlorate concentrations in both wells rebounded beginning in late-2005 and have been steady in recent years, though remaining well below the previous highs. This rebound may be attributed to a reduction of infiltration water due to fouling of the recharge trenches with a concomitant dispersal of “dead zone” groundwater (perchlorate and chromium-impacted water trapped between the barrier wall and infiltration trenches) and/or recharge of contaminated water from the underlying Muddy Creek formation. However, perchlorate and chromium concentrations appear to be holding steady since the refurbishment of the trenches in July 2009. Concentrations of total chromium in well M-88 have historically been low and remain steady at less than 1 mg/l. Perchlorate concentrations in M-88 climbed between 1998 and 2001

when the barrier wall was installed, and have remained in the range of 40 to 60 mg/l since 2001. M-86 was inactive from mid-2007 through 2010 during refurbishment of the infiltration trenches, and all three wells were recently plugged and abandoned due to conflicts with soil remediation and excavation activities. Following completion of soil remediation activities, replacement wells will be installed along the transect monitored by these wells at locations approved by NDEP. Extraction wells are currently operating downgradient of the barrier wall to remove and treat "dead zone" groundwater and these replacement wells will be monitored in the future to observe the effect of the removal of "dead zone" groundwater on downgradient contaminant concentrations..

Wells M-99, M-100, M-101 and M-102 are located approximately 1000 feet north of the IWF. As shown on Figure 7-2, all of these wells have shown declining perchlorate and chromium concentrations over time, though perchlorate trends in M-99 have exhibited an inconsistent trend with a broad concentration spike between 2003 and 2006 and a recent increase back to similar levels. M-99 is located downgradient of the western edge of the barrier wall. Concentrations of both perchlorate and chromium in M-102 spiked sharply upwards between 2002 and 2003 as a slug of perchlorate and chromium-impacted groundwater moved through the well, possibly due to changing flow paths brought about by the installation of the barrier wall, then sharply declined. Concentration trends in M-100 and M-101, downgradient of the center of the barrier wall, were relatively steady from 1999 through 2001 then declined sharply beginning in 2001 and now appear asymptotic though they do not approach zero in either well. The residual baseline concentrations in these wells may be due to dispersion of "dead zone" groundwater and/or upward migration of contaminants from the underlying Muddy Creek formation. There are no data for either M-101 or M-102 after mid-2006 and mid-2007, respectively, due to a lowering of the water table and insufficient water for sampling. Overall, the concentration plots indicate that the barrier wall has been effective in significantly reducing downgradient perchlorate and chromium concentrations, although the perchlorate concentrations measured in well M-99 suggest that some perchlorate flowing past the western edge of the wall may be impacting this well. Tronox has been aware that some perchlorate from a high-concentration plume bypasses the Interceptor well field and barrier wall through along the western edge, and has installed additional extraction wells (I-AA and I-AB) to improve capture in this area. These wells are currently being plumbed and connected to the groundwater treatment system, the impact of the additional wells on capture at the IWF has been modeled (Section 8), and will be further evaluated in a future CZE report.

Wells M-23, M-96 and PC-54 are located further downgradient of the IWF near Warm Springs Road (Figure 3-3). As shown in Figure 7-3, these wells have also shown consistent declining

perchlorate and chromium concentration trends over time, beginning around 2001 in M-23 and 2003/2004 in M-96 and PC-54. PC-54, located downgradient of well M-102, shows a similar pattern of concentration trends. Although concentrations in these wells do not currently appear to be approaching background (non-detect), concentration trends appear to be flattening and recent concentrations may be due to recharge from the underlying Muddy Creek formation.

7.2 Concentration Trends Downgradient of the Athens Road Well Field

Concentration trends at the Athens Road piezometer wells (ARP-1, ARP-2, ARP-3, ARP-4A, ARP-5A, ARP-6B ARP-7, and MW-K4), the COH WRF wells (MW-K5, PC-53, PC-98R and PC-103) and the Lower Pond wells (PC-56, PC-58, PC-59, PC-60, PC-62 and PC-68) were evaluated to assess capture at the AWF (Figures 7-4 through 7-6). The AWF began full-time operation in October 2002. ART-9 replaced ART-6A as an extraction well in the eastern subchannel in late 2006.

The Athens Road piezometer well line is located approximately 250 feet north of the AWF. No data have been available from wells ARP-2 and -3 since June 2008 because these wells were buried during City of Henderson construction activities. Replacement wells ARP-2A and ARP-3A were installed during the second quarter of 2010 and will be sampled on a quarterly basis starting August 2010. In December 2007, ARP-4A, -5A and -6B replaced ARP-4, -5 and -6A respectively, which were plugged and abandoned to make way for COH area development and drainage ditch construction.

As shown in Figure 7-4, perchlorate concentrations on the western side of the well line in wells ARP-1, -2, and -3 declined rapidly at the start of operation of the AWF, and have remained very low despite a small uptick in recent perchlorate results at ARP-1. In the center of the well line, perchlorate concentrations in ARP-4A have steadily declined since about 2002, and perchlorate and chromium concentrations in ARP-5A declined rapidly after the installation of extraction well ART-9 in 2006 and have remained low. Concentrations in well MW-K4, east of ARP-3A, initially declined with the operation of the AWF and dropped further when ART-9 began pumping, but both chromium and perchlorate concentrations have been trending upwards since mid-2008. On the eastern side of the well line, ARP-6 and -7 also initially declined rapidly, but perchlorate and chromium concentration trends have since been erratic at ARP-6B (recently trending upwards) and perchlorate concentrations, although low, have been trending upwards since 2004 in ARP-7. Overall, the plots indicate that the AWF has been successful at capturing the perchlorate and chromium plumes on the west and central portions of the plume. However, concentration trends at ARP-6B and ARP-7 that, although low, are increasing suggest that some portion of the plume may be evading capture in the eastern subchannel. Increasing trends in well

MW-K4, along with monitoring results from additional wells installed for the CZE in the area, suggest that impacted groundwater may be passing between extraction well pair ART-4/4A and the Muddy Creek high and evading capture.

Intermediate between the Athens Road area and the Seep area are the COH WRF and the Lower Ponds monitor well lines. The COH WRF wells, MW-K5 and PC-53, -98R, and -103 are shown on Figure 7-5. Chromium concentrations in all four wells have been below the laboratory sample quantitation reporting limit for the monitoring period. The two wells in the center of the plume with the highest initial perchlorate concentrations, MW-K5 and PC-98R, have exhibited strong downward trends since the AWF came online, although concentrations in PC-98R have lately stabilized around 20 ppm with occasional sharp downward spikes. Concentrations are erratic but low (less than 5 mg/l) in PC-53, on the east side of the well line. Perchlorate concentrations in well PC-103 to the west have been increasing since early 2005. The reason for the increasing perchlorate concentration trend, which does not reflect trends in the upgradient western ARP wells, is not clear. Water levels in PC-103 have historically averaged several feet higher than adjacent well PC-98R to the east, and groundwater flow in this area may have an easterly component. However, water level interpretation is complicated by a lack of nearby monitoring points west of PC-103 and intermittent infiltration from City of Henderson Water Reclamation Facility ponds. Tronox will continue to monitor concentration trends in PC-103 and evaluate impacts from planned improvements to the AWF in the next CZE.

The Lower Ponds well line is 2,200 feet north of the COH well line. As shown in Figure 7-6, with the exception of well PC-58, perchlorate concentrations declined sharply between 1999 and 2004,and have remained steady or continued a slow decline since about February 2004. Concentrations in well PC-58 have been erratic, generally fluctuating in the range of 4 to 12 mg/l, and remain at levels similar to or slightly lower than those measured in 1999.

7.3 Concentration Trends Downgradient of the Seep Well Field

Concentration trends at downgradient wells PC-96 and PC-97 were evaluated to assess capture at the SWF. As shown in Figure 7-7, perchlorate concentrations in the Seep wells initially declined between 2001 and 2004 to concentrations approaching zero, following the operation of groundwater extraction wells at the SWF. Recently, concentrations have increased slightly since 2008, possibly due to fluctuations in pumping rates in well PC-121 and changes in infiltration patterns from COH WRF ponds.

8 CAPTURE ZONE EVALUATION RESULTS SUMMARY

8.1 Evaluation of Capture with Current Operation

Table 8-1 below summarizes the findings for the various evaluations conducted for this CZE following US EPA guidance (US EPA, 2008). In summary, sufficient data have been collected to develop an adequate conceptual model for CZE at the Site (Step 1 of guidance). Based on previous NDEP input, 95% mass flux capture has been used to define interim target capture for the IWF and AWF (Step 2). The water level interpretations (Step 3), ancillary calculations (part of Step 4), and concentration trends over time (Step 5) corroborate the flow model findings (Step 4), and indicate that the flow model is an effective and accurate tool for evaluating current and predicting future groundwater capture.

As discussed in Section 4, the 1 mg/L perchlorate contour was used to define the plumes because 99% of the groundwater mass at the Site falls within that contour, and even at 1 mg/L there is commingling with other sources to the west and east of the Site. The mass flux evaluation using the model indicates that the capture goal of “95% mass flux” is currently being met at the IWF. At the AWF, at least 86% of the mass flux is calculated to be currently captured, and there is an area west of the UMCf high where capture can and will be improved to achieve 95% (see Section 8.2 below). As discussed in Section 7, capture at the AWF may have been better in this specific area prior to 2008.

Although no specific goal has been set for SWF capture, this evaluation indicates the SWF is significantly capturing the perchlorate mass that migrates past the AWF, and that the flux potentially associated with the Tronox facility represents less than a third of the total 65 lbs/day flux to the Las Vegas Wash measured at the Northshore Road monitoring station. The mass flux analysis (Section 6) indicates that the combined AWF and SWF systems remove between 94% and 97% of the total perchlorate flux calculated at the AWF transect.

Table 8-1
Lines of Evidence for Groundwater Capture

Method	Results – Current Operation
Interceptor Well Field	
Water Level Interpretation using KT3D	Indicates horizontal capture zone very similar to that indicated by the flow model.
Particle Tracking with Groundwater Flow Model	Mass flux calculation indicates that 97% of perchlorate is captured based on the entire plume, including that portion to the east of the Site boundary, and that 98% of perchlorate flux is being captured based on the eastern Site boundary. Plume mass calculations also indicate that significantly more than 95% of the perchlorate plume upgradient of the IWF is within the capture envelope. Greater than 95% of chromium is also captured.
Flow Rate and Capture Width Calculations	Calculations indicate the combined pumping rate at the IWF is sufficient to capture the width of the full 1 mg/L plume..
Downgradient Concentration Trends	Overall concentration trends support the flow model capture results. However, well M-99 trend suggests some incomplete capture of higher concentration groundwater at west end of IWF. Trends in wells near barrier wall are complicated by varying trench recharge rates and high concentration groundwater trapped in “dead zone”.
Athens Road Well Field	
Water Level Interpretation using KT3D	Indicates horizontal capture zone very similar to that indicated by the flow model (i.e., small area not captured within and west of UMCf high). Narrower capture zone for the eastern channel than indicated by the flow model is the result of the data set used (i.e.,used Tronox data only, while the flow model used regional data for improved definition of the potentiometric surface to the east).
Particle Tracking with Groundwater Flow Model	Mass flux calculation indicates at least 86% of perchlorate is captured at the well field. Actual capture is likely higher because the flow model shows slightly more saturated alluvium than is actually present and plume model may underestimate plume concentrations in drawdown areas.
Flow Rate and Capture Width Calculations	Calculations indicate that the combined pumping rate at the AWF may not be sufficient to capture the width of the local boundary plume under higher hydraulic conductivity conditions.
Downgradient Concentration Trends	Overall concentration trends support flow model capture results. Recent concentration increase in well MW-K4 is consistent with area of non-capture shown by flow model and water level interpretation.
Seep Well Field	
Particle Tracking with Groundwater Flow Model	Mass flux calculation indicates nearly complete capture of Tronox plume mass passing through SWF area.

Downgradient Concentration Trends	Overall concentration trends support flow model capture results.

8.2 Capture Enhancements

As described in Section 1, planned enhancements discussed in the CZE Work Plan (Northgate, 2010c) included the addition of seven new extraction wells at the IWF and deepening well ART-7B at the AWF. Because of the potential breach in capture identified by the flow model immediately to the west of and within the UMCf high at the AWF, the following additional enhancements were identified: 1) increase pumping from ART-3 to the extent possible; 2) switch pumping back from ART-4A to ART-4, because ART-4 appears to be a more efficient and effective well; 3) plumb new well PC-150 as an extraction well and pump to maximum capacity; and, 4) if the interpretation of water levels measured after implementation of these improvements indicate that it is needed to exceed 95% mass flux capture, plumb new UMCf high well PC-149 into system and pump to maximum capacity.

To evaluate the effects of these improvements, Tronox used the calibrated flow model and particle tracking endpoint analysis to simulate flow under these new conditions. Results are presented on Figures 8-1 and 8-2. As discussed above, at least 95% of the perchlorate and chromium flux is already being captured by the IWF and the new wells are not necessary to meet the capture goal. As shown on Figures 8-1 and 8-2, the new wells will enhance the already effective capture provided by the IWF system and barrier wall by improving capture at the east end of the barrier wall (new wells I-AC and I-AD). As shown on Figures 8-1 and 8-2 the improvements discussed above for the AWF would greatly reduce the gap in current capture and based on mass flux calculations would increase capture to at least 95%.

In conclusion, capture goals are met at IWF. Even though the 95% capture goal is being met, recovery enhancement will continue by plumbing in seven new IWF wells. The work is underway and these wells will be pumping by early 2011. At the AWF, pumping from ART-3 has recently been increased to the extent possible and ART-4A pumping has been replaced by pumping from ART-4. Plumbing well PC-150 into the extraction system is currently underway. The effects of these improvements at the AWF will be evaluated one month after PC-150 start-up by measuring water levels and evaluating capture using the KT3D software method described in Section 5. If these improvements are not sufficient to achieve the 95% mass flux goal, well PC-149 will be added to the extraction system.

8.3 Ongoing Capture Zone Evaluations

Capture zone evaluation is an ongoing process, and the following specific CZE activities are planned for the Tronox site:

- Complete refinements to the 3-D plume model to achieve better agreement between the modeled mass flux capture and the well field operational records for mass removal (as discussed in Section 6), so that the mass flux evaluation can be completed and the 3-D plume models validated for potential future use. The expected completion date for this activity is December 2010.
- Evaluate the actual capture improvement achieved by the enhancements described in Section 8.2 through water level measurements and interpretation. This evaluation will be used both to assess percent mass capture at the AWF (see Section 8.2) and to further validate the ability of the flow model to accurately predict the effects of system changes. The expected completion date for this activity is first quarter 2011, and the results of this evaluation will be included in the Annual Remedial Performance Report to be submitted in August.
- Establish with NDEP approval target capture zones that are clear and easy to evaluate for use in future CZE. Target capture zones based on percent perchlorate mass and/or mass flux are subject to significant uncertainty and latitude in interpretation, can be cumbersome to calculate, and may change continuously over time with changing plume conditions. Therefore, Northgate recommends that alternative capture targets be developed in the future that are spatially based or are based on groundwater flow rather than being based on mass or mass flux. These would be interim targets for use in future CZEs conducted until final groundwater remedial objectives are established.
- Conduct routine CZE on a periodic basis. These CZEs will be conducted based on the latest U.S. EPA guidance and the results will be included in annual remedial performance reports.
- Conduct additional CZE as needed for any planned or unplanned changes to groundwater flow (e.g., new or modified groundwater extraction or re-injection systems at neighboring sites, future soil flushing at the Tronox site).

9 REFERENCES

Davis, J.A., Kent, D.B., Coston, J.A., Hess, K.M., and Joye, J.L., 2000. *Multispecies Reactive Tracer Test in an Aquifer with Spacially Variable Chemical Condition: Experimental Design and Observed Tracer Movement*, Water Resources Research, v. 36, p. 119-134.

DBSA, 2008. *Groundwater Flow Model Calibration: BMI Upper and Lower Ponds Area*. Prepared for Basic Remediation Company, Henderson, Nevada, November 2008.

DBSA, 2009. *Summary report for updated groundwater flow model calibration, BMI upper and lower ponds area*, 2009.

ENSR Corporation (ENSR), 2001. *Supplemental Phase II Environmental Conditions Assessment*, April.

ENSR, 2005. *Conceptual Site Model Kerr-McGee Facility, Henderson, Nevada*, Prepared for Kerr-McGee Chemical LLC, Henderson, Nevada, February.

ENSR, 2007a. *Draft Work Plan to Evaluate Effective Groundwater Capture at Tronox Extraction Systems*, Tronox, LLC, Henderson, Nevada: ENSR, Camarillo, California, 4020-023-160, May 30.

ENSR, 2007b. *Revised Work Plan to Evaluate Effective Groundwater Capture at Tronox Extraction Systems, Tronox LLC, Henderson, Nevada*: ENSR, Camarillo, California, 4020-023-110, August 29.

ENSR, 2008. *Annual Performance Report for Chromium and Perchlorate, July 2007-June 2008, Submitted in Accordance with Chromium Mitigation Program and Perchlorate Performance Consent Orders*: ENSR, Camarillo, California, 4020-023-110, August 28.

Errol Montgomery & Associates, 2000. *Analysis of Rate of Groundwater Movement Based on Results of Tracer and Hydraulic Tests Conducted Between Pittman Lateral and Seep Area.*

Geraghty & Miller, Inc., 1993. *Phase I Environmental Conditions Assessment for The Basic Management, Inc. Industrial Complex, Clark County, Nevada*, April 14.

H+A, 2010. *Work Plan to Conduct an Additional Middle Zone DNAPL Investigation, Henderson, Nevada*, Revision 2.0, May 19.

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000,*MODFLOW-2000, the U.S. Geological Survey modular ground-water model User guide to modularization concepts and the Ground-Water Flow Process*: U.S. Geological Survey Open-File Report 00-92, 121 p.

Karanovic, M., Tonkin, M., and Wilson, D. 2009. *KT3D_H2O: A Program for Kriging Water Level Data Using Hydrologic Drift Terms*. Ground Water, Vol. 47, N0. 4:580-586.

Kaufmann, R.F., 1977. *Land and Water Use Impacts on Ground-Water Quality in Las Vegas Valley*, Ground Water, v. 15, no. 1, p. 81-89

Kleinfelder, 1993. *Environmental Conditions Assessment, Kerr-McGee Chemical Corporation, Henderson, Nevada*, April.

LAW Engineering, 1993. *Final Report of Phase I Environmental Conditions Assessment, Volume 1: Text, Titanium Metals Corporation (TIMET), Henderson, Nevada*, April 15.

Leckie, J.O., Appleton, A.R., Ball, N.B., Hayes, K.F., and Honeyman, B.D., 1984. *Adsorptive Removal of Trace Elements from Fly-Ash Pond Effluents onto Iron Oxyhydroxide:* Electric Power Research Institute Report, EPRI-RP-910-1, Palo Alto, California.

McDonald, M. G. and Arlen W. Harbaugh, 1988. *A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model*: USGS Geological Survey Open-File Report , Reston, Virginia.

McGinley, 2007. *Athens Road Well Field Modeling Report – Near BMI Industrial Complex, Henderson, Nevada*: McGinley and Associates, Reno, Nevada, June 30.

Nevada Division of Environmental Protection (NDEP), 2007a. *Comments on the Tronox Semi-Annual Performance Report for Chromium and Perchlorate, dated February 26, 2007*: Las Vegas, Nevada, March 29.

NDEP, 2007b. *Response to NDEP Comments on the Tronox Semi-Annual Performance Report Dated February 28, 2007 and the Required Work Plan to Evaluate Effective Groundwater Capture at Tronox Extraction Systems, Henderson, Nevada, Dated May 30, 2007*: Las Vegas, Nevada, June 26.

NDEP, 2007c. *Response to NDEP Comments on the Revised Work Plan to Evaluate Effective Groundwater Capture at Tronox Extraction Systems, Tronox LLC, Henderson, Nevada, dated August 29, 2007*: Las Vegas, Nevada, October 3.

NDEP, 2007d. *Response to NDEP Comments on the Revised Work Plan to Evaluate Effective Groundwater Capture at Tronox Extraction Systems, Tronox LLC, Henderson, Nevada, dated November 28, 2007*: Las Vegas, Nevada, December 11.

NDEP, 2008. *Response to Annual Remedial Performance Report for Chromium and Perchlorate, dated August 25 2008*: Las Vegas, Nevada, October 6.

NDEP, 2009. BMI Plant Sites and Common Areas Project, Henderson, Nevada*: Hydrogeologic and Lithologic Nomenclature Unification*, January 6.

NDEP, 2010a. *Comments on the Interim Groundwater Capture Evaluation and Vertical Delineation Report*, dated December 23, 2009: Las Vegas, Nevada, January 26.

NDEP, 2010b. Meeting Minutes - WebEx Meeting to Discuss NDEP's April 1, 2010 comments to TRX's March 25, 2010 *Capture Zone Evaluation Work Plan*, April 16.

NDEP, 2010c. *Comments on the Interim Groundwater Capture Evaluation and Vertical Delineation Report*, dated March 23, 2010: Las Vegas, Nevada, April 30.

NDEP, 2010d. *NDEP Response to TRX Letter regarding Seep Access Issues with BMI, dated February 12, 2010*: Las Vegas, Nevada, June 28.

Northgate Environmental Management, Inc. (Northgate), 2007. *Revised Work Plan to Evaluate Effective Groundwater Capture at Tronox Extraction Systems, Tronox LLC, Henderson, Nevada*: Oakland, California, August 27.

Northgate, 2009, *Annual Remedial Performance Report for Chromium and Perchlorate, Tronox LLC, Henderson, Nevada*: Oakland, California, August 21.

Northgate, 2010a. *Health Risk Assessment Work Plan, Tronox LLC Facility, Henderson, Nevada*: Oakland, California, March 9.

Northgate, 2010b, *Response to NDEP's January 26, 2010 Comments Regarding Interim Groundwater Capture Evaluation and Vertical Delineation Report* , dated December 23, 2009: Oakland, California, March 23.

Northgate, 2010c, *Interim Groundwater Capture Evaluation and Vertical Delineation Report, Tronox LLC, Henderson, Nevada*: Oakland, California, March 23.

Northgate, 2010d, *Capture Zone Evaluation Work Plan, Tronox LLC, Henderson, Nevada*: Oakland, California, May 13.

Northgate, 2010e, *Revised Hydrogeologic Modeling Work Plan, Tronox LLC, Henderson, Nevada*: Oakland, California, June 7.

Northgate, 2010f, *Responses to May 26, 2010, NDEP Comments on the Capture Zone Evaluation Work Plan*, dated May 13, 2010: Oakland, California, July 7.

Northgate, 2010g, *Revised Human Health Risk Assessment for Remediation Zone A, Tronox LLC, Henderson, Nevada*: Oakland, California, July 23.

Northgate, 2010h, *Annual Remedial Performance Report for Chromium and Perchlorate, Tronox LLC, Henderson, Nevada*: Oakland, California, August 27.

Northgate, 2010i. *Revised Technical Memorandum: Calculation of Leaching-Based Site-Specific Levels for the Soil-to-Groundwater Pathway Using NDEP Guidance, Tronox LLC, Henderson, Nevada:* Oakland, California, September 9.

Northgate, 2010j. *Technical Memorandum: Hydrogeologic Groundwater Model Inputs, Tronox LLC, Henderson, Nevada:* Oakland, California, October 29.

Northgate, 2010k. *Revised Technical Memorandum: Calculation of Leaching-Based, Site-Specific Levels (LSSLs) for the Soil-to-Groundwater Pathway Using NDEP Guidance, Tronox LLC, Henderson, Nevada:* Oakland, California, November 18.

Northgate, 2010l. *Site-Wide Soil Gas Human Health Risk Assessment, Tronox LLC, Henderson, Nevada*: Oakland, California, November 22.

Pollock, D.W., 1994. *User's Guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking post-processing package for MODFLOW, the U.S. Geological Survey finite-difference ground-water flow model*: U.S. Geological Survey Open-File Report 94-464, 6 ch.

Post, V., Kooi, H., & Simmons, C.T., 2007. *Using Hydraulic Head Measurements in Variable-Density Ground Water Flow Analyses,* Ground Water, 45(6), 664-671.

TRONOX, 2007. *Response to Nevada Division of Environmental Protection (NDEP) Comments to the Revised Work Plan to Evaluate Effective Groundwater Capture at Tronox LLC, Henderson, Nevada*: Henderson, Nevada, November 28.

University of Nevada at Las Vegas (UNLV), 2003. *Final Report, The Fate and Transport of Perchlorate in a Contaminated Site in the Las Vegas Valley*, Prepared for USEPA, March.

USEPA, 1989. *Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual (Part A),* Interim Final: United States Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC, EPA/540/1-89/002, December.

USEPA 2002. *Elements for Effective Management of Operating Pump and Treat Systems*, EPA 542-R-02-009: United States Environmental Protection Agency, Washington, D.C., December.

USEPA, 2005. *Capture Zone Analysis for Pump-and-Treat Systems*, EPA NARPM Conference: United States Environmental Protection Agency, Washington, D.C., May 24.

USEPA, 2008. *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems*: U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/003.

van Geen, A.. Robertson, A.P., and Leckie, J.O., 1994. *Complexation of Carbonate Species at the Goethite Surface: Implications for Adsorption of Metal Ions in Natural Waters, Geochimica et Cosmochimica Acta*, v. 58, p. 2073-2086.

Zachara, J.M., Girvin, D.C., Schmidt, R.L., and Resch, C.T., 1987. *Chromate Adsorption on Amorphous Iron Oxyhydroxides in the Presence of Major Groundwater Ions, Environmental Science and Technology*, v. 21, p. 589-594.

Zheng, C. 1990. *MT3D: A modular three dimensional transport model for simulation of advection, dispersion and chemical reactions of contaminants in ground-water systems,* U.S. Environmental Protection Agency and R.S. Kerr Environmental Research Laboratory, Ada, Oklahoma.

TABLES

TABLE 7-1
Performance Monitoring Well Information

Well ID	Screen Top	Screen Bottom	Water-Bearing Zone	Lithology	Concentration Trend Summary
Wells Downgradient of the Interceptor Well Field (IWF)					
Wells located immediately downgradient of the infiltration trenches:					
M-86/M-86A	11.3	40.9	Shallow	UMCf	M-86 and M-87 both exhibited a sharp decline in perchlorate and chromium concentrations following installation of the barrier wall in October 2001and introduction of clean Lake Mead water into the infiltration trenches. Total chromium and/or perchlorate concentrations in both wells rebounded beginning in late-2005 and have been steady in recent years, though remaining well below the previous highs. This rebound may be attributed to a reduction of infiltration water due to fouling of the recharge trenches with a concomitant dispersion of "dead zone" groundwater (perchlorate and chromium-impacted water trapped between the barrier wall and infiltration trenchs) and/or recharge of contaminated water from the underlying Muddy Creek formation. However, perchlorate and chromium concentrations appear to be holding steady since the refurbishment of the trenches.
M-87	9.3	38.8	Shallow	UMCf	
M-88	7.3	36.8	Shallow	Qal/xMCf/UMCf	Concentrations of total Chromium in well M-88 have historically been low and remain steady at less than 1 mg/l. Perchlorate concentrations in M-88 climbed between 1998 and 2001 when the barrier wall was installed, and have remained in the range of 40 to 60 mg/l since 2001.
Wells located approximately 1000 feet north of IWF:					
M-99	16	31	Shallow	Qal	Perchlorate trends in M-99 have been inconsistent with a broad concentration spike between 2003 and 2006 and a recent increase back to similar levels. Perchlorate concentrations measured in well M-99 suggest that some perchlorate flowing past the western edge of the wall may be impacting this well.
M-100	19	29	Shallow	Qal	Concentration trends in M-100 and M-101 are relatively steady from 1999 through 2001 then decline sharply beginning in 2001 and appear asymptotic though they do not approach zero in either well. The residual baseline concentrations in these wells may be due to dispersion of "dead zone" groundwater and/or upward migration of contaminants from the underlying Muddy Creek formation.
M-101	17	27	Shallow	Qal	
M-102	19.4	39.4	Shallow	Qal	Concentrations of both perchlorate and chromium in M-102 spiked sharply upwards between 2002 and 2003, possibly due to changing flow patterns brought about by the installation of the barrier wall, then sharply declined.
Wells located downgradient of the IWF at Warm Springs Road:					
M-23	9.4	37.4	Shallow	Qal	All three wells have shown consistent declining perchlorate and chromium concentration trends over time, beginning around 2001 in M-23 and 2003/2004 in M-96 and PC-54. Although concentrations in these wells do not currently appear to be approaching background (zero), concentration trends appear to be asymptotic and baseline concentrations may be due to recharge from the underlying Muddy Creek formation.
PC-54	9.5	34.5	Shallow	Qal	
M-96	10.5	20.5	Shallow	Qal	
Wells Downgradient of the Athens Road Well Field					
Athens Road Piezometer Wells:					
ARP-1	14	44	Shallow	Qal	Perchlorate concentrations on the western side of the well line in wells ARP-1, -2, and -3 declined rapidly at the start of operation of the Athens Road Well Field (ARWF), and have remained very low despite a small uptick in recent perchlorate results at ARP-1.
ARP-2/ARP-2A	16	51	Shallow	Qal	
ARP-3/ARP-3A	14	44	Shallow	Qal	
MW-K4	9.5	50	Shallow	xMCf	Concentrations in well MW-K4 initially declined with the operation of the ARWF and dropped further when ART-9 began pumping, but both chromium and perchlorate concentrations have been trending upwards since mid-2008. Increasing trends in well MW-K4, along with monitoring results from additional wells installed for the CZE in the area, suggest that impacted groundwater may be passing between extraction well pair ART-4/4A and the Muddy Creek high and evading capture.
ARP-4/ARP-4A	17.7	32.7	Shallow	Qal	Perchlorate concentrations in ARP-4A have steadily declined since about 2002
ARP-5/ARP-5A	12.7	37.7	Shallow	Qal	Perchlorate and chromium concentrations in ARP-5A declined rapidly after the installation of extraction well ART-9 in 2006 and have remained low
ARP-6/ARP-6A/ARP-6B	27.7	42.7	Shallow	Qal	On the eastern side of the well line, ARP-6 and -7 also initially declined rapidly, but perchlorate and chromium concentration trends have since been erratic at ARP-6B (recently trending upwards) and perchlorate concentrations, although low, have been trending upwards since 2004 in ARP-7. Concentration trends at ARP-6B and ARP-7 that, although low, are increasing suggest that some portion of the plume may be evading capture in the eastern subchannel.
ARP-7	14	39	Shallow	Qal	
City of Henderson Wells:					
PC-103	9	29	Shallow	Qal	Perchlorate concentrations in well PC-103 to the west have been increasing since early 2005.
PC-98R	20	35	Shallow	Qal	MW-K5 and PC-98R have exhibited strong downward trends since the ARWF came online, although concentrations in PC-98R have lately stabilized around 20 ppm with occasional sharp downward spikes.
MW-K5	28.5	44	Shallow	xMCf/UMCf	
PC-53	13	32.5	Shallow	Qal	Concentrations are erratic but low (less than 5 mg/l) in PC-53, on the east side of the well line.
Lower Pond Wells:					
PC-68	9.9	54.9	Shallow	Qal/xMCf/UMCf	Perchlorate concentrations declined sharply between 1999 and 2004,and have remained steady or continued a slow decline since about February 2004.
PC-62	7.6	37.6	Shallow	Qal/xMCf/UMCf	
PC-59	4.8	34.8	Shallow	Qal/xMCf/UMCf	
PC-60	4.5	39.5	Shallow	Qal	
PC-56	4.8	54.8	Shallow	Qal/xMCf/UMCf	
PC-58	7.8	32.8	Shallow	Qal	Concentrations in well PC-58 have been erratic, generally fluctuating in the range of 4 to 12 mg/l, and remain at levels similar to or slightly lower than those measured in 1999.
Wells Downgradient of the Seep Well Field					
PC-96	29	39	Shallow	Qal	Perchlorate concentrations in the Seep wells initially declined between 2001 and 2004 to concentrations approaching zero, following the operation of groundwater extraction wells at the SWF. Recently, concentrations have increased slightly since 2008, possibly due to fluctuations in pumping rates in well PC-121 and changes in infiltration patterns from COH WRF ponds.
PC-97	23	33	Shallow	Qal	

TABLE 6-1
Flow Rate and Capture Zone Width Calculations

		WELL FIELD					
		IWF			AWF		
		low[1]	med[2]	high[3]	low[4]	med[5]	high[6]
b	feet	15	15	15	18	18	18
i	feet/foot	0.018	0.018	0.018	0.020	0.020	0.020
K	feet/day	0.016	0.82	3.2	5.4	35	200
T	$feet^2$/day	0.24	12.3	47	97	630	3,600
w	feet	3,420	3,420	3,420	1,300	1,300	1,300
3Q 2010 Average Pumping Rate	gpm	73	73	73	281	281	281
Calculated Flow Rate (Q) [factor of 2]	gpm	0.15	7.9	30	26	170	972
stagnation point	feet	(519,973)	(10,051)	(2,604)	(4,427)	(682)	(119)
capture zone width (at extraction well)	feet	816,774	15,788	4,090	1,633,547	6,955	1,271
capture zone width (maximum)	feet	1,633,547	31,575	8,179	13,909	2,143	375

LINE OF EVIDENCE	IS CAPTURE SUFFICIENT?	COMMENTS
flow rates *capture zone widths*	*Yes for IWF; Maybe for AWF*	*Using full range of K values, current pumping rates are sufficient to capture 1 mg/L plume at IWF. Using medium to low range K values, current pumping rates are sufficient to capture the plume in main channels at AWF.*

Notes and Abbreviations:
1 = harmonic mean of measured horizontal K in wells screened in UMCf at project Site and adjacent properties
2 = calibrated horizontal K in UMCf from groundwater flow model (Appendix # of this report)
3 = arithmetic mean of measured horizontal K in wells screened in UMCf at project Site and adjacent properties
4 = harmonic mean of measured horizontal K in wells screened in Qal at project Site and adjacent properties
5 = calibrated horizontal K in Qal from groundwater flow model (Appendix E)
6 = calibrated horizontal K in paleochannels from groundwater flow model (Appendix E)

b = aquifer or saturated thickness
factor = accounts for other flow contributions to the extraction well (a factor of 2 was selected)
gpm = gallons per minute
i = regional hydraulic gradient
IWF = Interceptor Well Field; AWF = Athens Road Well Field
K = hydraulic conductivity
Q = extraction flow rate at the well field
T = transmissivity (aquifer thickness * hydraulic conductivity)
w = defined plume width upgradient of extraction well field (full 1 mg/L plume at IWF; main channels plume at AWF)
X_0 = downgradient stagnation point
Y_{max} = maximum capture zone width
Y_{well} = capture zone width in-line with extraction well field

Formulas:

flow rate	$Q = K \times (b \times w) \times i \times factor$
stagnation point	$X_0 = -Q / 2\pi Ti$
capture zone width (at extraction well)	$Y_{well} = \pm Q / 4Ti$
capture zone width (maximum)	$Y_{max} = \pm Q / 2Ti$

Assumptions:
- homogeneous, isotropic, confined aquifer of infinite extent
- uniform regional horizontal hydraulic gradient
- net recharge is accounted for in regional hydraulic gradient
- no other sources of water introduced into aquifer
- uniform aquifer thickness
- fully penetrating extraction well
- steady-state flow
- negligible vertical gradient

TABLE 5-3
Head Difference and Vertical Gradient Results

Well ID downgradient/ deeper (depth in ft)	Date	Fresh Water Head feet amsl	Well ID upgradient/ shallower (depth in ft)	Date	Fresh Water Head feet amsl	Head Difference[1] feet	Vertical Gradient[2] feet/feet	Gradient Direction	Comments
INTERCEPTOR WELL FIELD (IWF)									
M-133 Shallow (70)	5/13/2010	1716.21	**M-74** Shallow (39)	5/5/2010	1715.79	0.41	-0.010	**upward**	east and downgradient of IWF barrier wall
M-132 Middle (90)	5/13/2010	1717.53	**M-133** Shallow (70)	5/13/2010	1716.21	1.3	-0.068	**upward**	east and downgradient of IWF barrier wall
M-134 Shallow (70)	5/12/2010	1721.66	**M-135** Shallow (39)	5/4/2010	1721.52	0.14	-0.0047	**upward**	cross/downgradient of IWF barrier wall western side of wall
M-136 Middle (90)	5/12/2010	1723.71	**M-134** Shallow (70)	5/12/2010	1721.66	2.1	-0.10	**upward**	cross/downgradient of IWF barrier wall western side of wall
M-161 Middle (110)	9/2/2010	1729.43	**M-135** Shallow (39)	8/3/2010	1721.52	7.9	-0.11	**upward**	cross/downgradient of IWF barrier wall western side of wall
M-159 Shallow (75)	9/2/2010	1723.12	**M-160** Shallow (50)	9/2/2010	1723.23	-0.11	0.0045	**downward**	west of IWF
M-164 Shallow (70)	9/2/2010	1719.50	**M-71** Shallow (42)	8/6/2010	1719.16	0.34	-0.010	**upward**	downgradient of IWF barrier wall
M-163 Shallow (90)	9/2/2010	1723.80	**M-164** Shallow (70)	9/2/2010	1719.50	4.3	-0.22	**upward**	downgradient of IWF barrier wall
M-162 Middle (110)	9/2/2010	1726.51	**M-163** Shallow (90)	9/2/2010	1723.80	2.7	-0.13	**upward**	downgradient of IWF barrier wall
M-181 Middle (115)	9/2/2010	1733.38	**M-182** Shallow (90)	9/2/2010	1729.71	3.67	-0.15	**upward**	south of IWF barrier wall and Beta Ditch near eastern Site boundary
M-186 Middle (115)	9/2/2010	1755.36	**M-148A** Shallow (50)	9/2/2010	1753.95	1.4	-0.02	**upward**	upgradient of IWF barrier wall
M-187 Middle (170)	9/2/2010	1754.67	**M-188** Middle (120)	9/2/2010	1761.90	-7.2	0.14	**downward**	upgradient of IWF barrier wall northeast of Chemstar facility
ATHENS ROAD WELL FIELD (AWF)									
PC-134A Shallow (70)	9/2/2010	1588.81	**PC-135A** Shallow (51)	9/2/2010	1588.57	0.24	-0.0078	**upward**	AWF, west subchannel
PC-141 Shallow (55)	9/2/2010	1591.26	**PC-142** Shallow (32)	9/2/2010	1591.40	-0.14	0.0063	**downward**	AWF
OTHER VERTICAL DELINEATION WELLS									
M-149 Middle (120)	6/8/2010	1752.70	**M-31A** Shallow (55)	6/22/2010	1751.60	1.1	-0.017	**upward**	central portion of Site, upgradient of IWF ~850 feet north of Unit 5
M-153 Deep (170)	6/8/2010	1765.71	**M-149** Middle (120)	6/8/2010	1752.70	13	-0.26	**upward**	central portion of Site, upgradient of IWF ~850 feet north of Unit 5
M-150 Middle (145)	6/8/2010	1733.63	**M-36** Shallow (35)	6/22/2010	1727.91	5.7	-0.053	**upward**	upgradient of IWF barrier wall ~2,200 feet north of Unit 5
M-154 Deep (195)	6/8/2010	1745.70	**M-150** Middle (145)	6/8/2010	1733.63	12	-0.24	**upward**	upgradient of IWF barrier wall ~2,200 feet north of Unit 5

TABLE 5-3
Head Difference and Vertical Gradient Results

Well ID downgradient/ deeper (depth in ft)	Date	Fresh Water Head feet amsl	Well ID upgradient/ shallower (depth in ft)	Date	Fresh Water Head feet amsl	Head Difference[1] feet	Vertical Gradient[2] feet/feet	Gradient Direction	Comments
M-151 Middle (145)	6/8/2010	1712.58	**M-100** Shallow (29)	6/22/2010	1703.70	8.9	-0.080	**upward**	northern portion of Site, downgradient of IWF ~3,300 feet north of Unit 5
M-155 Deep (220)	6/8/2010	1730.20	**M-151** Middle (145)	6/8/2010	1712.58	18	-0.24	**upward**	northern portion of Site, downgradient of IWF ~3,300 feet north of Unit 5
M-152 Middle (145)	6/8/2010	1674.78	**M-44** Shallow (35)	6/17/2010	1677.97	-3.2	0.028	**downward**	northern Site boundary ~5,300 feet north of Unit 5
M-156 Deep (195)	6/8/2010	1680.08	**M-152** Middle (145)	6/8/2010	1674.78	5.3	-0.11	**upward**	northern Site boundary ~5,300 feet north of Unit 5
TR-2 Middle (175)	6/10/2010	1726.81	**M-5A** Shallow (50)	5/4/2010	1713.87	13	-0.11	**upward**	western Site boundary
TR-7 Deep (290)	6/10/2010	1814.05	**TR-8** Middle (93)	6/10/2010	1778.31	36	-0.18	**upward**	south/western Site boundary

Notes and Abbreviations:
1 = Positive value denotes an upward gradient (from deeper to shallower).
2 = Vertical gradient estimated as the difference between the fresh water head divided by the distance between the mid-point elevations of their screen intervals. A negative value denotes an upward gradient (from deeper to shallower).

Blue = Upward Vertical Gradient
Red = Downward Vertical Gradient

TABLE 5-2
Data for Vertical Gradient Calculations

Well ID	General Well Location	Screened Lithology	Water-Bearing Zone	Total Well Depth	Mid-Point of Well Screen Elevation	Sample Date	Total Dissolved Solids	Temperature	Water Density [1]	Groundwater Elevation	Fresh Water Head [2]
				feet bgs	feet amsl		mg/L	°C	kg/m³	feet amsl	feet amsl
Interceptor Well Field											
M-74	East Barrier	Qal	Shallow	39.0	1720.38	5/5/10	6,000	24.9	1001.61	1715.80	1715.79
M-133		UMCf	Shallow	70.0	1678.62	5/13/10	4,900	23.2	1001.22	1716.16	1716.21
M-132		UMCf	Middle	90.0	1659.27	5/13/10	1,200	22.6	998.57	1717.61	1717.53
M-135	West Barrier	UMCf	Shallow	39.0	1717.85	5/4/10	3,400	24.0	999.89	1721.52	1721.52
M-134		UMCf	Shallow	70.0	1687.14	5/12/10	2,700	22.2	999.80	1721.67	1721.66
M-136		UMCf	Middle	90.0	1666.87	5/12/10	1,400	22.8	998.68	1723.79	1723.71
M-135		UMCf	Shallow	39.0	1718.15	8/3/10	3,600	---	999.78	1721.52	1721.52
M-161		UMCf	Middle	110.0	1647.40	9/2/10	630	27.6	996.85	1729.69	1729.43
M-160	West Barrier		Shallow	50.0	1709.73	9/2/10	2,900	26.4	998.89	1723.25	1723.23
M-159			Shallow	75.0	1684.88	9/2/10	2,200	28.0	997.91	1723.20	1723.12
M-71	Downgradient of Barrier wall	Qal/xMCf/UMCf	Shallow	42.2	1717.29	8/6/10	5,400	24.9	1001.16	1719.16	1719.16
M-164		UMCf	Shallow	70.0	1682.61	9/2/10	2,200	32.3	996.61	1719.63	1719.50
M-163		UMCf	Shallow/Middle	90.0	1662.95	9/2/10	590	30.7	995.89	1724.05	1723.80
M-162		UMCf	Middle	110.0	1642.82	9/2/10	0	26.6	996.66	1726.79	1726.51
M-181	South Barrier and Beta Ditch	UMCf	Middle	115.0	1652.06	9/2/10	510	25.9	997.22	1733.61	1733.38
M-182		UMCf	Shallow	90.0	1677.13	9/2/10	13,000	29.8	1005.41	1729.43	1729.71
M-148A	Upgradient of Interceptor Well Field	Qal/UMCf	Shallow	50.0	1755.04	9/2/10	5,500	24.4	1001.36	1753.95	1753.95
M-186		UMCf	Middle	115.0	1690.60	9/2/10	6,400	28.9	1000.79	1755.30	1755.36
M-187	Upgradient of Barrier	UMCf	Middle	170.0	1635.07	9/2/10	880	35.0	994.70	1755.30	1754.67
M-188		UMCf	Middle	120.0	1685.07	9/2/10	880	26.6	997.32	1762.11	1761.90
Athens Road Well Field											
PC-135A	Athens Road West Subchannel	Qal	Shallow	50.0	1582.55	9/2/10	8,300	---	1003.30	1588.55	1588.57
PC-134A		UMCf	Shallow	70.0	1552.31	9/2/10	1,800	---	998.43	1588.87	1588.81
PC-142	Athens Road Well Field	Qal	Shallow	32.0	1592.94	9/2/10	5,900	---	1001.51	1591.41	1591.40
PC-141		Qal	Shallow	55.0	1569.83	9/2/10	4,300	---	1000.31	1591.25	1591.26
Other Vertical Delineation Wells											
M-31A	850 feet north of Unit 5	UMCf	Shallow	55.0	1751.87	6/22/10	9,000	27.0	1003.27	1751.60	1751.60
M-149		UMCf	Middle	120.0	1686.81	6/8/10	2,600	26.7	998.58	1752.79	1752.70
M-153		UMCf	Middle	170.0	1636.69	6/8/10	610	28.4	996.61	1766.15	1765.71
M-36	2200 feet north of Unit 5	UMCf	Shallow	35.0	1732.32	6/22/10	15,000	26.1	1008.02	1727.95	1727.91
M-150		UMCf	Middle	145.0	1623.86	6/8/10	820	24.1	997.92	1733.86	1733.63
M-154		UMCf	Middle	195.0	1573.78	6/8/10	530	25.0	997.47	1746.14	1745.70
M-100	3300 feet north of Unit 5	Qal/UMCf	Shallow	30.0	1706.93	6/22/10	1,500	23.4	998.61	1703.70	1703.70
M-151		UMCf	Middle	145.0	1595.64	6/8/10	520	22.3	998.12	1712.80	1712.58
M-155		UMCf	Middle	220.0	1520.69	6/8/10	530	22.8	998.03	1730.61	1730.20

TABLE 5-2
Data for Vertical Gradient Calculations

Well ID	General Well Location	Screened Lithology	Water-Bearing Zone	Total Well Depth	Mid-Point of Well Screen Elevation	Sample Date	Total Dissolved Solids	Temperature	Water Density [1]	Groundwater Elevation	Fresh Water Head [2]
				feet bgs	feet amsl		mg/L	°C	kg/m³	feet amsl	feet amsl
M-44	5300 feet north of Unit 5	Qal	Shallow	35.0	1678.31	6/17/10	7,300	---	1002.55	1677.97	1677.97
M-152		UMCf	Middle	145.0	1563.50	6/8/10	730	24.8	997.68	1675.04	1674.78
M-156		UMCf	Middle	195.0	1513.38	6/8/10	560	30.2	996.04	1680.74	1680.08
M-5A	Western Site Boundary	UMCf	Shallow	50.0	1706.80	5/4/10	12,000	28.7	1005.01	1713.83	1713.87
TR-2		UMCf	Middle	175.0	1592.29	6/10/10	550	26.3	997.15	1727.19	1726.81
TR-8	Southwestern Site Boundary	UMCf	Middle	93.5	1751.08	6/10/10	1,100	26.7	997.45	1778.38	1778.31
TR-7		UMCf	Deep	290.5	1554.03	6/10/10	760	24.1	997.88	1814.60	1814.05

Notes and Abbreviations:

1 = Water density estimated using calculation presented at http://www.earthwardconsulting.com/density, and using the water temperature and total dissolved solids concentration reported during sampling.
If temperature was not reported an average value of 25.3 °C was used.

2 = Fresh water head after Post, V., Looi, H., and Simmons, C., "Using Hydraulic Head Measurments in Variable-Density Ground Water Flow Analyses", Groundwater Volume 45, No. 6, November-December 2007.

$h_{fi} = (\rho_i/\rho_f)h_i - [(\rho_i-\rho_f)/(\rho_f)]z_i$

h_{fi} = fresh water head (feet)

ρ_i = density at point of measurement (kg/m^3)

ρ_f = fresh water density (kg/m^3)

h_i = hydraulic head, water level measurement (feet)

z_i = elevation head, screen depth (feet)

amsl = above mean sea level

bgs = below ground surface

kg/m^3 = kilograms per cubic meter

mg/L = milligrams per liter

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
ARP-1	1/12/2010	1613.32	24.30	1589.02	mon	26728365.51	828593.16	14.0	44.0	30.0	44.2	Shallow	Qal
	2/9/2010	1613.32	24.05	1589.27									
	3/9/2010	1613.32	23.26	1590.06									
	4/13/2010	1613.32	24.14	1589.18									
	5/19/2010	1613.32	24.50	1588.82									
	6/15/2010	1613.32	24.57	1588.75									
	7/13/2010	1613.32	24.55	1588.77									
	8/10/2010	1613.32	24.66	1588.66									
	9/15/2010	1613.32	24.68	1588.64									
	10/13/2010	1613.32	24.31	1589.01									
ARP-2A	7/14/2010	1614.18	26.09	1588.09	mon	26728402.86	828856.20	23.7	53.7	30.0	54.0	Shallow	Qal
	8/11/2010	1614.18	26.17	1588.01									
	9/16/2010	1614.18	26.22	1587.96									
	10/20/2010	1614.18	25.71	1588.47									
ARP-3A	7/14/2010	1614.67	27.52	1587.15	mon	26728404.34	828722.80	20.7	40.7	20.0	41.0	Shallow	Qal
	8/11/2010	1614.67	27.62	1587.05									
	9/16/2010	1614.67	27.54	1587.13									
	10/20/2010	1614.67	27.11	1587.56									
ARP-4A	1/13/2010	1615.47	29.30	1586.17	mon	26728411.81	829167.89	17.7	32.7	15.0	33.0	Shallow	Qal
	2/10/2010	1615.47	28.93	1586.54									
	3/10/2010	1615.47	28.74	1586.73									
	4/14/2010	1615.47	28.97	1586.50									
	5/19/2010	1615.47	29.34	1586.13									
	6/16/2010	1615.47	29.39	1586.08									
	7/14/2010	1615.47	29.51	1585.96									
	8/11/2010	1615.47	29.52	1585.95									
	9/16/2010	1615.47	30.72	1584.75									
	10/20/2010	1615.47	29.09	1586.38									
ARP-5A	1/13/2010	1616.10	32.90	1583.20	mon	26728458.43	829375.01	12.7	37.7	25.0	38.0	Shallow	Qal
	2/10/2010	1616.10	32.80	1583.30									
	3/10/2010	1616.10	32.67	1583.43									
	4/14/2010	1616.10	32.58	1583.52									
	5/19/2010	1616.10	32.71	1583.39									
	6/16/2010	1616.10	32.83	1583.27									
	7/14/2010	1616.10	32.87	1583.23									
	8/11/2010	1616.10	32.96	1583.14									
	9/16/2010	1616.10	32.96	1583.14									
	10/20/2010	1616.10	32.22	1583.88									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
ARP-6B	1/13/2010	1615.56	32.42	1583.14	mon	26728499.92	829520.52	27.7	42.7	15.0	43.0	Shallow	Qal
	2/10/2010	1615.56	32.33	1583.23									
	3/10/2010	1615.56	32.14	1583.42									
	4/14/2010	1615.56	32.11	1583.45									
	5/19/2010	1615.56	32.21	1583.35									
	6/16/2010	1615.56	32.32	1583.24									
	7/14/2010	1615.56	32.36	1583.20									
	8/11/2010	1615.56	32.46	1583.10									
	9/16/2010	1615.56	33.43	1582.13									
	10/20/2010	1615.56	31.65	1583.91									
ARP-7	1/13/2010	1613.20	30.37	1582.83	mon	26728501.08	829668.22	14.0	39.0	25.0	39.2	Shallow	Qal
	2/10/2010	1613.20	30.30	1582.90									
	3/10/2010	1613.20	30.14	1583.06									
	4/14/2010	1613.20	30.09	1583.11									
	5/19/2010	1613.20	30.16	1583.04									
	6/16/2010	1613.20	30.26	1582.94									
	8/11/2010	1613.20	30.47	1582.73									
	9/16/2010	1613.20	30.21	1582.99									
	10/20/2010	1613.20	29.59	1583.61									
ART-1	1/25/2010	1614.47	24.01	1590.46	extr	26728122.71	828543.96	14.0	54.0	40.0	56.0	Shallow	Qal
	2/15/2010	1614.47	23.53	1590.94									
	3/15/2010	1614.47	23.61	1590.86									
	4/14/2010	1614.47	25.91	1588.56									
	5/24/2010	1614.47	25.87	1588.60									
	6/15/2010	1614.47	26.11	1588.36									
	7/13/2010	1614.47	25.73	1588.74									
	8/12/2010	1614.47	27.13	1587.34									
	9/27/2010	1614.47	24.05	1590.42									
	10/25/2010	1614.47	25.71	1588.76									
ART-1A	1/25/2010	1614.40	23.96	1590.44	mon	26728122.21	828536.78	19.0	54.0	35.0	56.0	Shallow	Qal
	2/15/2010	1614.40	23.65	1590.75									
	3/15/2010	1614.40	23.15	1591.25									
	4/14/2010	1614.40	24.02	1590.38									
	5/24/2010	1614.40	24.44	1589.96									
	6/15/2010	1614.40	24.52	1589.88									
	7/13/2010	1614.40	24.47	1589.93									
	8/12/2010	1614.40	25.56	1588.84									
	9/27/2010	1614.40	23.96	1590.44									
	10/25/2010	1614.40	24.15	1590.25									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
ART-2	1/25/2010	1617.10	27.99	1589.11	extr	26728084.71	828625.03	19.0	54.0	35.0	56.0	Shallow	Qal
	2/15/2010	1617.10	27.69	1589.41									
	3/15/2010	1617.10	27.43	1589.67									
	4/14/2010	1617.10	27.99	1589.11									
	5/24/2010	1617.10	28.23	1588.87									
	6/15/2010	1617.10	28.37	1588.73									
	7/13/2010	1617.10	28.39	1588.71									
	8/12/2010	1617.10	28.45	1588.65									
	9/27/2010	1617.10	28.10	1589.00									
	10/25/2010	1617.10	28.07	1589.03									
ART-2A	1/25/2010	1616.81	27.13	1589.68	mon	26728085.56	828618.82	21.0	56.0	35.0	58.0	Shallow	Qal
	2/15/2010	1616.81	26.51	1590.30									
	3/15/2010	1616.81	26.81	1590.00									
	4/14/2010	1616.81	26.88	1589.93									
	5/24/2010	1616.81	27.15	1589.66									
	6/15/2010	1616.81	27.29	1589.52									
	7/13/2010	1616.81	27.26	1589.55									
	8/12/2010	1616.81	27.45	1589.36									
	9/27/2010	1616.81	26.91	1589.90									
	10/25/2010	1616.81	27.06	1589.75									
ART-3	1/25/2010	1617.94	30.70	1587.24	mon	26728085.17	828775.42	15.0	45.0	30.0	47.0	Shallow	Qal
	2/15/2010	1617.94	30.77	1587.17									
	3/15/2010	1617.94	30.40	1587.54									
	4/14/2010	1617.94	31.09	1586.85									
	5/24/2010	1617.94	31.22	1586.72									
	6/15/2010	1617.94	31.33	1586.61									
	7/13/2010	1617.94	31.28	1586.66									
	8/12/2010	1617.94	31.28	1586.66									
	9/27/2010	1617.94	31.16	1586.78									
	10/25/2010	1617.94	31.03	1586.91									
ART-3A	1/25/2010	1617.60	38.41	1579.19	extr	26728084.70	828768.70	18.0	53.0	35.0	55.0	Shallow	Qal
	2/15/2010	1617.60	35.82	1581.78									
	3/15/2010	1617.60	37.19	1580.41									
	4/14/2010	1617.60	38.11	1579.49									
	5/24/2010	1617.60	38.56	1579.04									
	6/15/2010	1617.60	38.63	1578.97									
	7/13/2010	1617.60	36.37	1581.23									
	8/12/2010	1617.60	36.19	1581.41									
	9/27/2010	1617.60	36.76	1580.84									
	10/25/2010	1617.60	36.71	1580.89									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
ART-4	1/25/2010	1617.46	28.74	1588.72	mon	26728085.26	828850.69	19.0	44.0	25.0	46.0	Shallow	Qal
	2/15/2010	1617.46	28.92	1588.54									
	3/15/2010	1617.46	28.26	1589.20									
	4/14/2010	1617.46	28.93	1588.53									
	5/24/2010	1617.46	29.21	1588.25									
	6/15/2010	1617.46	29.59	1587.87									
	7/13/2010	1617.46	29.32	1588.14									
	8/12/2010	1617.46	29.44	1588.02									
	9/27/2010	1617.46	29.13	1588.33									
	10/25/2010	1617.46	29.00	1588.46									
ART-4A	1/25/2010	1617.46	42.49	1574.97	extr	26728084.58	828844.49	19.0	44.0	25.0	46.0	Shallow	Qal
	2/15/2010	1617.46	43.05	1574.41									
	3/15/2010	1617.46	41.98	1575.48									
	4/14/2010	1617.46	42.85	1574.61									
	5/24/2010	1617.46	42.93	1574.53									
	6/15/2010	1617.46	43.13	1574.33									
	7/13/2010	1617.46	43.08	1574.38									
	8/12/2010	1617.46	43.18	1574.28									
	9/27/2010	1617.46	43.14	1574.32									
	10/25/2010	1617.46	42.00	1575.46									
ART-6	1/25/2010	1615.31	31.29	1584.02	mon	26728140.60	829472.91	14.0	34.0	20.0	36.0	Shallow	Qal
	2/15/2010	1615.31	31.41	1583.90									
	3/15/2010	1615.31	31.24	1584.07									
	4/14/2010	1615.31	30.18	1585.13									
	5/24/2010	1615.31	31.27	1584.04									
	6/15/2010	1615.31	31.33	1583.98									
	7/13/2010	1615.31	30.02	1585.29									
	8/12/2010	1615.31	30.01	1585.30									
	9/27/2010	1615.31	29.90	1585.41									
	10/25/2010	1615.31	29.60	1585.71									
ART-7	1/25/2010	1615.38	32.97	1582.41	mon	26728145.71	829576.52	16.9	36.9	20.0	38.9	Shallow	Qal
	2/15/2010	1615.38	29.73	1585.65									
	3/15/2010	1615.38	30.81	1584.57									
	4/14/2010	1615.38	30.02	1585.36									
	5/24/2010	1615.38	30.76	1584.62									
	6/15/2010	1615.38	31.01	1584.37									
	7/14/2010	1615.38	34.13	1581.25									
	8/12/2010	1615.38	33.25	1582.13									
	9/27/2010	1615.38	33.08	1582.30									
	10/25/2010	1615.38	30.61	1584.77									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
ART-7A	1/25/2010	1614.78	30.08	1584.70	extr	26728143.19	829582.79	18.0	38.0	20.0	41.0	Shallow	Qal
	2/15/2010	1614.78	32.07	1582.71									
	3/15/2010	1614.78	31.88	1582.90									
	4/14/2010	1614.78	31.98	1582.80									
	5/24/2010	1614.78	31.97	1582.81									
	6/15/2010	1614.78	32.23	1582.55									
	7/14/2010	1614.78	36.67	1578.11									
	8/12/2010	1614.78	30.42	1584.36									
	9/27/2010	1614.78	33.40	1581.38									
	10/25/2010	1614.78	31.72	1583.06									
ART-7B	7/14/2010	1619.62	35.43	1584.19	mon	26728151.94	829576.25	29.5	44.5	15.0	50.0	Shallow	Qal
	8/12/2010	1619.62	35.48	1584.14									
	9/27/2010	1619.62	35.12	1584.50									
	10/25/2010	1619.62	34.81	1584.81									
ART-8	1/25/2010	1617.69	33.08	1584.61	extr	26728084.10	828697.72	18.0	48.0	30.0	50.5	Shallow	Qal
	2/15/2010	1617.69	32.61	1585.08									
	3/15/2010	1617.69	32.63	1585.06									
	4/14/2010	1617.69	33.07	1584.62									
	5/24/2010	1617.69	34.10	1583.59									
	6/15/2010	1617.69	33.84	1583.85									
	7/13/2010	1617.69	33.97	1583.72									
	8/12/2010	1617.69	34.02	1583.67									
	9/27/2010	1617.69	33.54	1584.15									
	10/25/2010	1617.69	33.56	1584.13									
ART-8A	1/25/2010	1617.10	27.94	1589.16	mon	26728083.31	828691.89	22.0	52.0	30.0	54.0	Shallow	Qal
	2/15/2010	1617.10	27.59	1589.51									
	3/15/2010	1617.10	27.62	1589.48									
	4/14/2010	1617.10	27.95	1589.15									
	5/24/2010	1617.10	28.25	1588.85									
	6/15/2010	1617.10	28.34	1588.76									
	7/13/2010	1617.10	28.33	1588.77									
	8/12/2010	1617.10	28.38	1588.72									
	9/27/2010	1617.10	28.06	1589.04									
	10/25/2010	1617.10	27.97	1589.13									
ART-9	1/25/2010	1615.06	41.01	1574.05	extr	26728143.32	829525.57	20.5	40.5	20.0	43.0	Shallow	Qal
	2/15/2010	1615.06	34.50	1580.56									
	3/15/2010	1615.06	35.54	1579.52									
	4/14/2010	1615.06	35.73	1579.33									
	5/24/2010	1615.06	38.78	1576.28									
	6/15/2010	1615.06	34.41	1580.65									
	7/14/2010	1615.06	36.49	1578.57									
	8/12/2010	1615.06	34.83	1580.23									
	9/27/2010	1615.06	34.76	1580.30									
	10/25/2010	1615.06	33.84	1581.22									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
H-28A	8/6/2010	1731.75	39.28	1692.47	mon	26721023.60	825864.67	37.4	50.5	13.1	51.7	Shallow	Qal
I-AA	8/2/2010	1753.93	31.37	1722.56	extr	26719770.85	827174.40	23.7	43.7	20.0	46.0	Shallow	UMCf
I-AB	8/2/2010	1754.03	31.19	1722.84	extr	26719790.40	827225.04	25.0	45.0	20.0	51.0	Shallow	Qal/UMCf
I-AC	8/4/2010	1752.76	29.22	1723.54	extr	26719889.66	828792.61	24.5	44.5	20.0	50.0	Shallow	Qal/UMCf
I-AD	8/4/2010	1755.39	29.35	1726.04	extr	26719794.82	828806.68	24.5	44.5	20.0	50.0	Shallow	Qal/UMCf
I-AR	1/25/2010	1758.35	43.17	1715.18	extr	26719429.52	827414.35	25.0	45.0	20.0	45.0	Shallow	UMCf
	2/2/2010	1758.35	43.98	1714.37									
	3/8/2010	1758.35	43.16	1715.19									
	4/20/2010	1758.35	41.12	1717.23									
	5/3/2010	1758.35	36.52	1721.83									
	6/17/2010	1758.35	37.66	1720.69									
	7/20/2010	1758.35	37.43	1720.92									
	8/2/2010	1758.35	36.38	1721.97									
	9/21/2010	1758.35	36.14	1722.21									
	10/19/2010	1758.35	34.94	1723.41									
I-B	1/25/2010	1752.70	39.41	1713.29	extr	26719808.09	827282.89	17.8	42.5	24.7	43.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1752.70	34.91	1717.79									
	3/8/2010	1752.70	34.78	1717.92									
	4/20/2010	1752.70	32.48	1720.22									
	5/3/2010	1752.70	36.14	1716.56									
	6/17/2010	1752.70	34.58	1718.12									
	7/20/2010	1752.70	35.29	1717.41									
	8/2/2010	1752.70	35.09	1717.61									
	9/21/2010	1752.70	35.89	1716.81									
	10/19/2010	1752.70	35.56	1717.14									
I-C	1/25/2010	1752.80	44.68	1708.12	extr	26719791.90	827486.47	13.2	42.5	29.3	43.0	Shallow	UMCf
	2/2/2010	1752.80	43.69	1709.11									
	3/8/2010	1752.80	33.18	1719.62									
	4/20/2010	1752.80	31.56	1721.24									
	5/3/2010	1752.80	31.28	1721.52									
	6/17/2010	1752.80	32.65	1720.15									
	7/20/2010	1752.80	33.18	1719.62									
	8/2/2010	1752.80	32.69	1720.11									
	9/21/2010	1752.80	32.71	1720.09									
	10/19/2010	1752.80	31.95	1720.85									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
I-D	1/25/2010	1752.70	46.99	1705.71	extr	26719805.21	827582.21	16.0	44.5	28.5	45.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1752.70	46.75	1705.95									
	3/8/2010	1752.70	45.67	1707.03									
	4/20/2010	1752.70	41.21	1711.49									
	5/3/2010	1752.70	46.65	1706.05									
	6/17/2010	1752.70	46.43	1706.27									
	7/20/2010	1752.70	46.49	1706.21									
	8/2/2010	1752.70	46.58	1706.12									
	9/21/2010	1752.70	42.09	1710.61									
	10/19/2010	1752.70	46.82	1705.88									
I-E	1/25/2010	1752.40	44.28	1708.12	extr	26719825.39	827733.37	21.5	43.5	22.0	44.0	Shallow	UMCf
	2/2/2010	1752.40	44.76	1707.64									
	3/8/2010	1752.40	44.45	1707.95									
	4/20/2010	1752.40	44.13	1708.27									
	5/3/2010	1752.40	44.53	1707.87									
	6/17/2010	1752.40	44.52	1707.88									
	7/20/2010	1752.40	44.48	1707.92									
	8/2/2010	1752.40	44.28	1708.12									
	9/21/2010	1752.40	44.53	1707.87									
	10/19/2010	1752.40	30.20	1722.20									
I-F	1/25/2010	1749.70	36.71	1712.99	extr	26719845.58	827879.70	11.8	43.3	31.5	43.8	Shallow	Qal/xMCf/UMCf
	2/2/2010	1749.70	35.94	1713.76									
	3/8/2010	1749.70	36.67	1713.03									
	4/20/2010	1749.70	27.49	1722.21									
	5/3/2010	1749.70	28.12	1721.58									
	6/17/2010	1749.70	28.26	1721.44									
	7/20/2010	1749.70	28.42	1721.28									
	8/2/2010	1749.70	28.47	1721.23									
	9/21/2010	1749.70	28.37	1721.33									
	10/19/2010	1749.70	28.56	1721.14									
I-G	1/25/2010	1752.50	33.01	1719.49	extr	26719866.33	828030.70	9.5	38.8	29.3	39.3	Shallow	Qal/xMCf/UMCf
	2/2/2010	1752.50	31.71	1720.79									
	3/8/2010	1752.50	28.61	1723.89									
	4/20/2010	1752.50	34.78	1717.72									
	5/3/2010	1752.50	38.71	1713.79									
	6/17/2010	1752.50	40.61	1711.89									
	7/20/2010	1752.50	41.19	1711.31									
	8/2/2010	1752.50	38.06	1714.44									
	9/21/2010	1752.50	41.61	1710.89									
	10/19/2010	1752.50	41.66	1710.84									
I-H	1/25/2010	1753.20	43.87	1709.33	extr	26719887.13	828177.55	13.6	43.1	29.5	43.6	Shallow	UMCf
	2/2/2010	1753.20	44.51	1708.69									
	3/8/2010	1753.20	33.33	1719.87									
	4/20/2010	1753.20	40.04	1713.16									
	5/3/2010	1753.20	30.21	1722.99									
	6/17/2010	1753.20	31.82	1721.38									
	7/20/2010	1753.20	32.58	1720.62									
	8/2/2010	1753.20	39.74	1713.46									
	9/21/2010	1753.20	31.48	1721.72									
	10/19/2010	1753.20	33.38	1719.82									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
I-I	1/25/2010	1745.50	24.11	1721.39	extr	26719914.40	828375.04	11.3	40.5	29.2	41.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1745.50	23.71	1721.79									
	3/11/2010	1745.50	23.59	1721.91									
	4/15/2010	1745.50	23.71	1721.79									
	5/5/2010	1745.50	22.99	1722.51									
	6/22/2010	1745.50	23.97	1721.53									
	7/19/2010	1745.50	24.08	1721.42									
	8/4/2010	1745.50	23.97	1721.53									
	9/30/2010	1745.50	25.02	1720.48									
	10/25/2010	1745.50	23.70	1721.80									
I-J	1/25/2010	1750.10	36.07	1714.03	extr	26719940.33	828573.94	11.2	40.5	29.3	41.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1750.10	34.82	1715.28									
	3/11/2010	1750.10	34.71	1715.39									
	4/15/2010	1750.10	35.35	1714.75									
	5/5/2010	1750.10	35.84	1714.26									
	6/22/2010	1750.10	38.27	1711.83									
	7/19/2010	1750.10	39.13	1710.97									
	8/4/2010	1750.10	37.24	1712.86									
	9/30/2010	1750.10	35.73	1714.37									
	10/25/2010	1750.10	30.93	1719.17									
I-K	1/25/2010	1746.00	33.19	1712.81	extr	26719962.87	828738.09	7.0	35.2	28.2	35.8	Shallow	UMCf
	2/3/2010	1746.00	37.68	1708.32									
	3/11/2010	1746.00	30.89	1715.11									
	4/15/2010	1746.00	31.83	1714.17									
	5/5/2010	1746.00	29.47	1716.53									
	6/22/2010	1746.00	34.96	1711.04									
	7/19/2010	1746.00	34.42	1711.58									
	8/4/2010	1746.00	29.91	1716.09									
	9/30/2010	1746.00	34.42	1711.58									
	10/25/2010	1746.00	34.36	1711.64									
I-L	1/25/2010	1751.70	30.84	1720.86	extr	26719803.23	827352.86	9.0	39.0	30.0	40.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1751.70	30.81	1720.89									
	3/11/2010	1751.70	29.12	1722.58									
	4/20/2010	1751.70	28.22	1723.48									
	5/3/2010	1751.70	28.25	1723.45									
	6/17/2010	1751.70	29.79	1721.91									
	7/20/2010	1751.70	29.87	1721.83									
	8/2/2010	1751.70	28.65	1723.05									
	9/21/2010	1751.70	31.31	1720.39									
	10/19/2010	1751.70	29.14	1722.56									
I-M	1/25/2010	1752.90	40.97	1711.93	extr	26719817.42	827669.83	9.0	39.0	30.0	40.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1752.90	41.77	1711.13									
	3/11/2010	1752.90	38.23	1714.67									
	4/20/2010	1752.90	36.76	1716.14									
	5/3/2010	1752.90	36.46	1716.44									
	6/17/2010	1752.90	36.73	1716.17									
	7/20/2010	1752.90	36.83	1716.07									
	8/2/2010	1752.90	36.86	1716.04									
	9/21/2010	1752.90	33.34	1719.56									
	10/19/2010	1752.90	32.94	1719.96									
I-N	1/25/2010	1751.40	36.41	1714.99	extr	26719837.85	827802.25	7.0	37.0	30.0	38.0	Shallow	Qal/xMCf/UMCf

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
	2/2/2010	1751.40	35.51	1715.89									
	3/8/2010	1751.40	33.58	1717.82									
	4/20/2010	1751.40	30.27	1721.13									
	5/3/2010	1751.40	30.38	1721.02									
	6/17/2010	1751.40	30.51	1720.89									
	7/20/2010	1751.40	30.63	1720.77									
	8/2/2010	1751.40	30.84	1720.56									
	9/21/2010	1751.40	30.84	1720.56									
	10/19/2010	1751.40	30.81	1720.59									
I-O	1/25/2010	1752.80	37.94	1714.86	extr	26719898.00	828263.13	9.0	39.0	30.0	40.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1752.80	32.51	1720.29									
	3/8/2010	1752.80	33.48	1719.32									
	4/20/2010	1752.80	36.84	1715.96									
	5/3/2010	1752.80	33.11	1719.69									
	6/17/2010	1752.80	38.06	1714.74									
	7/20/2010	1752.80	37.31	1715.49									
	8/2/2010	1752.80	37.92	1714.88									
	9/21/2010	1752.80	33.81	1718.99									
	10/19/2010	1752.80	33.43	1719.37									
I-P	1/25/2010	1751.70	41.68	1710.02	extr	26719892.08	828221.66	14.0	44.0	30.0	44.5	Shallow	Qal/xMCf/UMCf
	2/2/2010	1751.70	42.89	1708.81									
	3/8/2010	1751.70	32.93	1718.77									
	4/20/2010	1751.70	33.82	1717.88									
	5/3/2010	1751.70	35.11	1716.59									
	6/17/2010	1751.70	38.92	1712.78									
	7/20/2010	1751.70	36.93	1714.77									
	8/2/2010	1751.70	42.14	1709.56									
	9/21/2010	1751.70	33.35	1718.35									
	10/19/2010	1751.70	41.31	1710.39									
I-Q	1/25/2010	1753.10	31.99	1721.11	extr	26719855.17	827952.15	9.6	39.6	30.0	40.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1753.10	39.46	1713.64									
	3/8/2010	1753.10	31.91	1721.19									
	4/20/2010	1753.10	39.47	1713.63									
	5/3/2010	1753.10	31.90	1721.20									
	6/17/2010	1753.10	30.12	1722.98									
	7/20/2010	1753.10	40.11	1712.99									
	8/2/2010	1753.10	39.59	1713.51									
	9/21/2010	1753.10	40.47	1712.63									
	10/19/2010	1753.10	40.45	1712.65									
I-R	1/25/2010	1751.35	31.64	1719.71	extr	26719801.85	827316.06	9.8	39.8	30.0	43.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1751.35	31.28	1720.07									
	3/8/2010	1751.35	30.22	1721.13									
	4/20/2010	1751.35	29.33	1722.02									
	5/3/2010	1751.35	29.31	1722.04									
	6/17/2010	1751.35	30.49	1720.86									
	7/20/2010	1751.35	30.41	1720.94									
	8/2/2010	1751.35	30.52	1720.83									
	9/21/2010	1751.35	31.97	1719.38									
	10/19/2010	1751.35	30.44	1720.91									
I-S	1/25/2010	1750.03	44.67	1705.36	extr	26719799.87	827404.20	12.0	42.0	30.0	45.2	Shallow	Qal/xMCf/UMCf
	2/2/2010	1750.03	42.36	1707.67									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
	3/8/2010	1750.03	27.42	1722.61									
	4/20/2010	1750.03	26.47	1723.56									
	5/3/2010	1750.03	26.43	1723.60									
	6/17/2010	1750.03	44.39	1705.64									
	7/20/2010	1750.03	43.58	1706.45									
	8/2/2010	1750.03	44.38	1705.65									
	9/21/2010	1750.03	43.88	1706.15									
	10/19/2010	1750.03	27.42	1722.61									
I-T	1/25/2010	1751.66	42.15	1709.51	extr	26719873.66	828073.50	12.0	42.0	30.0	45.2	Shallow	Qal/xMCf/UMCf
	2/2/2010	1751.66	43.58	1708.08									
	3/8/2010	1751.66	43.57	1708.09									
	4/20/2010	1751.66	43.52	1708.14									
	5/3/2010	1751.66	43.61	1708.05									
	6/17/2010	1751.66	33.06	1718.60									
	7/20/2010	1751.66	34.17	1717.49									
	8/2/2010	1751.66	34.53	1717.13									
	9/21/2010	1751.66	32.96	1718.70									
	10/19/2010	1751.66	36.56	1715.10									
I-U	1/25/2010	1752.17	40.81	1711.36	extr	26719879.67	828118.60	12.0	42.0	30.0	45.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1752.17	39.92	1712.25									
	3/8/2010	1752.17	39.74	1712.43									
	4/20/2010	1752.17	39.57	1712.60									
	5/3/2010	1752.17	41.76	1710.41									
	6/17/2010	1752.17	44.88	1707.29									
	7/20/2010	1752.17	44.27	1707.90									
	8/2/2010	1752.17	43.29	1708.88									
	9/21/2010	1752.17	39.61	1712.56									
	10/19/2010	1752.17	36.81	1715.36									
I-V	1/25/2010	1752.13	31.24	1720.89	extr	26719894.97	828326.28	12.0	42.0	30.0	45.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1752.13	31.61	1720.52									
	3/11/2010	1752.13	31.52	1720.61									
	4/15/2010	1752.13	31.63	1720.50									
	5/5/2010	1752.13	31.63	1720.50									
	6/22/2010	1752.13	31.89	1720.24									
	7/19/2010	1752.13	32.02	1720.11									
	8/4/2010	1752.13	31.94	1720.19									
	9/30/2010	1752.13	31.77	1720.36									
	10/25/2010	1752.13	31.74	1720.39									
I-W	1/25/2010	1751.50	30.48	1721.02	mon	26719895.87	828245.87	20.0	50.0	30.0	50.5	Shallow	Qal/xMCf/UMCf
	2/2/2010	1751.50	30.02	1721.48									
	3/8/2010	1751.50	29.79	1721.71									
	4/20/2010	1751.50	29.89	1721.61									
	5/3/2010	1751.50	29.91	1721.59									
	6/17/2010	1751.50	30.02	1721.48									
	7/20/2010	1751.50	30.19	1721.31									
	8/2/2010	1751.50	30.20	1721.30									
	9/21/2010	1751.50	29.85	1721.65									
	10/19/2010	1751.50	29.99	1721.51									
I-X	1/25/2010	1748.60	29.38	1719.22	mon	26719843.08	827840.23	20.0	50.0	30.0	50.5	Shallow	Qal/xMCf/UMCf
	2/2/2010	1748.60	30.08	1718.52									
	3/8/2010	1748.60	29.81	1718.79									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
	4/20/2010	1748.60	25.99	1722.61									
	5/3/2010	1748.60	26.36	1722.24									
	6/17/2010	1748.60	26.53	1722.07									
	7/20/2010	1748.60	26.73	1721.87									
	8/2/2010	1748.60	26.74	1721.86									
	9/21/2010	1748.60	26.74	1721.86									
	10/19/2010	1748.60	26.89	1721.71									
I-Y	1/25/2010	1751.40	29.13	1722.27	mon	26719800.78	827334.69	20.0	50.0	30.0	50.5	Shallow	Qal/xMCf/UMCf
	2/2/2010	1751.40	28.96	1722.44									
	3/8/2010	1751.40	27.89	1723.51									
	4/20/2010	1751.40	27.06	1724.34									
	5/3/2010	1751.40	27.11	1724.29									
	6/17/2010	1751.40	28.93	1722.47									
	7/20/2010	1751.40	28.52	1722.88									
	8/2/2010	1751.40	28.27	1723.13									
	9/21/2010	1751.40	28.57	1722.83									
	10/19/2010	1751.40	28.01	1723.39									
I-Z	1/25/2010	1743.78	30.76	1713.02	extr	26719923.37	828467.92	15.0	35.0	20.0	35.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1743.78	28.44	1715.34									
	3/11/2010	1743.78	29.31	1714.47									
	4/15/2010	1743.78	33.56	1710.22									
	5/5/2010	1743.78	30.39	1713.39									
	6/22/2010	1743.78	35.37	1708.41									
	7/19/2010	1743.78	32.18	1711.60									
	8/4/2010	1743.78	34.92	1708.86									
	9/30/2010	1743.78	29.09	1714.69									
	10/25/2010	1743.78	32.66	1711.12									
M-5A	8/5/2010	1751.80	37.93	1713.87	mon	26719961.12	826179.29	40.0	50.0	10.0	50.0	Shallow	UMCf
M-10	1/25/2010	1836.21	47.08	1789.13	mon	26716636.63	828536.18	43.0	63.0	20.0	67.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1836.21	48.21	1788.00									
	3/8/2010	1836.21	48.71	1787.50									
	4/20/2010	1836.21	49.11	1787.10									
	5/5/2010	1836.21	49.41	1786.80									
	6/22/2010	1836.21	49.99	1786.22									
	7/19/2010	1836.21	50.25	1785.96									
	8/6/2010	1836.21	50.39	1785.82									
	9/30/2010	1836.21	49.14	1787.07									
	10/25/2010	1836.21	48.75	1787.46									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-11	1/25/2010	1815.53	42.15	1773.38	mon	26717608.56	828617.03	33.3	53.0	19.7	58.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1815.53	42.25	1773.28									
	3/11/2010	1815.53	42.61	1772.92									
	4/15/2010	1815.53	42.84	1772.69									
	5/5/2010	1815.53	42.76	1772.77									
	6/22/2010	1815.53	43.35	1772.18									
	7/19/2010	1815.53	43.58	1771.95									
	8/6/2010	1815.53	43.42	1772.11									
	9/30/2010	1815.53	43.94	1771.59									
	10/25/2010	1815.53	43.87	1771.66									
M-12A	8/5/2010	1812.76	41.07	1771.69	mon	26717575.29	828178.52	40.0	50.0	10.0	50.0	Shallow	UMCf
M-14A	1/25/2010	1760.93	32.97	1727.96	mon	26719382.67	827045.36	20.0	40.0	20.0	40.2	Shallow	UMCf
	2/4/2010	1760.93	32.66	1728.27									
	3/11/2010	1760.93	31.96	1728.97									
	4/15/2010	1760.93	31.98	1728.95									
	5/5/2010	1760.93	32.08	1728.85									
	6/22/2010	1760.93	32.37	1728.56									
	7/19/2010	1760.93	32.49	1728.44									
	8/3/2010	1760.93	32.52	1728.41									
	9/30/2010	1760.93	32.27	1728.66									
	10/25/2010	1760.93	32.36	1728.57									
M-17A	1/25/2010	1768.99	32.35	1736.64	mon	26719053.74	828061.72	35.0	45.0	10.0	45.0	Shallow	UMCf
	2/4/2010	1768.99	22.43	1746.56									
	3/11/2010	1768.99	32.23	1736.76									
	4/15/2010	1768.99	32.29	1736.70									
	5/6/2010	1768.99	32.49	1736.50									
	6/22/2010	1768.99	32.52	1736.47									
	7/19/2010	1768.99	32.76	1736.23									
	8/3/2010	1768.99	32.66	1736.33									
	9/30/2010	1768.99	32.81	1736.18									
M-18	1/25/2010	1740.48	29.48	1711.00	mon	26720182.87	828665.45	14.0	24.0	10.0	28.0	Shallow	Qal
	2/3/2010	1740.48	29.19	1711.29									
	3/11/2010	1740.48	29.11	1711.37									
	4/15/2010	1740.48	28.96	1711.52									
	5/5/2010	1740.48	28.93	1711.55									
	6/22/2010	1740.48	29.14	1711.34									
	7/19/2010	1740.48	29.17	1711.31									
	8/12/2010	1740.48	29.15	1711.33									
	9/30/2010	1740.48	29.44	1711.04									
M-19	1/25/2010	1766.77	33.57	1733.20	mon	26719350.03	828846.19	14.5	34.5	20.0	40.0	Shallow	UMCf
	2/3/2010	1766.77	33.63	1733.14									
	3/11/2010	1766.77	33.68	1733.09									
	4/15/2010	1766.77	33.73	1733.04									
	5/5/2010	1766.77	33.86	1732.91									
	6/17/2010	1766.77	34.21	1732.56									
	7/19/2010	1766.77	34.51	1732.26									
	8/4/2010	1766.77	32.01	1734.76									
	9/30/2010	1766.77	32.38	1734.39									
	10/25/2010	1766.77	32.41	1734.36									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-22A	1/25/2010	1759.46	29.83	1729.63	mon	26719531.63	828270.11	16.0	36.0	20.0	36.4	Shallow	Qal/xMCf/UMCf
	2/4/2010	1759.46	29.56	1729.90									
	3/11/2010	1759.46	29.46	1730.00									
	4/15/2010	1759.46	29.62	1729.84									
	5/6/2010	1759.46	29.76	1729.70									
	6/22/2010	1759.46	29.96	1729.50									
	7/19/2010	1759.46	30.16	1729.30									
	8/6/2010	1759.46	30.00	1729.46									
	9/30/2010	1759.46	31.09	1728.37									
	10/25/2010	1759.46	29.71	1729.75									
M-23	1/25/2010	1720.35	29.15	1691.20	mon	26721391.25	827373.96	9.4	37.4	28.0	43.0	Shallow	Qal
	2/1/2010	1720.35	29.77	1690.58									
	3/11/2010	1720.35	28.38	1691.97									
	4/15/2010	1720.35	28.08	1692.27									
	5/3/2010	1720.35	27.86	1692.49									
	6/17/2010	1720.35	27.63	1692.72									
	7/19/2010	1720.35	27.43	1692.92									
	8/2/2010	1720.35	27.38	1692.97									
	9/21/2010	1720.35	27.11	1693.24									
	10/21/2010	1720.35	27.24	1693.11									
M-25	1/25/2010	1759.93	33.31	1726.62	mon	26719503.57	827677.80	24.0	39.0	15.0	39.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1759.93	33.28	1726.65									
	3/8/2010	1759.93	32.94	1726.99									
	4/20/2010	1759.93	32.48	1727.45									
	5/4/2010	1759.93	32.48	1727.45									
	6/17/2010	1759.93	32.91	1727.02									
	7/20/2010	1759.93	32.95	1726.98									
	8/3/2010	1759.93	32.93	1727.00									
	9/21/2010	1759.93	33.27	1726.66									
	10/19/2010	1759.93	33.13	1726.80									
M-31A	1/25/2010	1796.87	43.67	1753.20	mon	26718289.58	828368.37	35.0	55.0	20.0	55.0	Shallow	UMCf
	2/3/2010	1796.87	44.96	1751.91									
	3/11/2010	1796.87	43.96	1752.91									
	4/15/2010	1796.87	44.82	1752.05									
	5/5/2010	1796.87	45.09	1751.78									
	6/22/2010	1796.87	45.27	1751.60									
	7/19/2010	1796.87	45.59	1751.28									
	8/6/2010	1796.87	45.73	1751.14									
	9/30/2010	1796.87	46.01	1750.86									
	10/24/2010	1796.87	46.05	1750.82									
M-34	8/3/2010	1777.10	33.59	1743.51	mon	26718833.45	828318.25	25.0	40.0	15.0	40.0	Shallow	Qal/xMCf/UMCf

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-35	1/25/2010	1775.95	33.99	1741.96	mon	26718840.13	828509.37	25.0	40.0	15.0	40.0	Shallow	UMCf
	2/3/2010	1775.95	34.12	1741.83									
	3/11/2010	1775.95	34.17	1741.78									
	4/15/2010	1775.95	34.38	1741.57									
	5/5/2010	1775.95	34.56	1741.39									
	6/22/2010	1775.95	31.75	1744.20									
	7/19/2010	1775.95	31.96	1743.99									
	8/3/2010	1775.95	31.75	1744.20									
	9/30/2010	1775.95	31.67	1744.28									
	10/25/2010	1775.95	31.69	1744.26									
M-36	1/25/2010	1759.82	31.88	1727.94	mon	26719556.63	828069.09	20.0	35.0	15.0	35.0	Shallow	UMCf
	2/4/2010	1759.82	31.77	1728.05									
	3/11/2010	1759.82	31.59	1728.23									
	4/15/2010	1759.82	31.58	1728.24									
	5/6/2010	1759.82	31.64	1728.18									
	6/22/2010	1759.82	31.87	1727.95									
	7/19/2010	1759.82	31.99	1727.83									
	8/5/2010	1759.82	31.95	1727.87									
	9/30/2010	1759.82	33.16	1726.66									
	10/25/2010	1759.82	31.91	1727.91									
M-37	1/25/2010	1761.06	31.33	1729.73	mon	26719422.01	827414.22	20.0	35.0	15.0	35.0	Shallow	UMCf
	2/2/2010	1761.06	31.75	1729.31									
	3/8/2010	1761.06	31.21	1729.85									
	4/20/2010	1761.06	31.09	1729.97									
	5/4/2010	1761.06	31.13	1729.93									
	6/17/2010	1761.06	31.49	1729.57									
	7/20/2010	1761.06	31.54	1729.52									
	8/5/2010	1761.06	31.49	1729.57									
	9/21/2010	1761.06	31.61	1729.45									
	10/19/2010	1761.06	31.65	1729.41									
M-38	1/25/2010	1759.73	31.04	1728.69	mon	26719523.27	827877.66	20.0	35.0	15.0	35.0	Shallow	UMCf
	2/4/2010	1759.73	30.94	1728.79									
	3/11/2010	1759.73	30.84	1728.89									
	4/15/2010	1759.73	30.78	1728.95									
	5/6/2010	1759.73	30.92	1728.81									
	6/22/2010	1759.73	31.08	1728.65									
	7/19/2010	1759.73	31.07	1728.66									
	8/5/2010	1759.73	31.05	1728.68									
	9/30/2010	1759.73	31.16	1728.57									
	10/25/2010	1759.73	31.13	1728.60									
M-39	1/25/2010	1761.13	31.16	1729.97	mon	26719525.34	828548.82	24.9	39.9	15.0	40.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1761.13	30.92	1730.21									
	3/11/2010	1761.13	30.88	1730.25									
	4/15/2010	1761.13	31.04	1730.09									
	5/5/2010	1761.13	31.14	1729.99									
	6/22/2010	1761.13	31.47	1729.66									
	7/19/2010	1761.13	31.66	1729.47									
	8/4/2010	1761.13	31.29	1729.84									
	9/30/2010	1761.13	30.92	1730.21									
	10/25/2010	1761.13	30.86	1730.27									
M-44	1/25/2010	1698.31	21.18	1677.13	mon	26722699.15	827005.61	5.0	35.0	30.0	35.0	Shallow	Qal/xMCf/UMCf

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
	2/1/2010	1698.31	21.00	1677.31									
	3/11/2010	1698.31	20.57	1677.74									
	4/15/2010	1698.31	20.46	1677.85									
	5/3/2010	1698.31	20.34	1677.97									
	6/17/2010	1698.31	20.34	1677.97									
	7/19/2010	1698.31	20.25	1678.06									
	8/5/2010	1698.31	20.22	1678.09									
	9/21/2010	1698.31	20.21	1678.10									
	10/21/2010	1698.31	20.25	1678.06									
M-48A	6/17/2010	1718.36	24.97	1693.39	mon	26721339.07	828294.38	19.7	39.7	20.0	40.0	Shallow	Qal/UMCf
	7/19/2010	1718.36	24.84	1693.52									
	8/6/2010	1718.36	24.78	1693.58									
	9/30/2010	1718.36	24.68	1693.68									
	10/21/2010	1718.36	24.61	1693.75									
M-50	1/25/2010	1795.64	46.08	1749.56	mon	26718315.58	828083.47	39.6	59.6	20.0	60.0	Shallow	UMCf
	2/3/2010	1795.64	46.23	1749.41									
	3/11/2010	1795.64	46.17	1749.47									
	4/15/2010	1795.64	46.31	1749.33									
	5/5/2010	1795.64	46.41	1749.23									
	6/22/2010	1795.64	37.08	1758.56									
	7/19/2010	1795.64	46.63	1749.01									
	8/6/2010	1795.64	46.69	1748.95									
	9/30/2010	1795.64	46.71	1748.93									
M-55	1/25/2010	1750.88	29.77	1721.11	mon	26719819.36	827683.04	14.6	44.6	30.0	44.6	Shallow	Qal/xMCf/UMCf
	2/15/2010	1750.88	29.53	1721.35									
	3/8/2010	1750.88	29.29	1721.59									
	4/20/2010	1750.88	28.63	1722.25									
	5/24/2010	1750.88	29.25	1721.63									
	6/17/2010	1750.88	28.72	1722.16									
	7/20/2010	1750.88	28.82	1722.06									
	8/2/2010	1750.88	28.79	1722.09									
	9/21/2010	1750.88	28.69	1722.19									
	10/19/2010	1750.88	28.58	1722.30									
M-56	1/25/2010	1750.83	30.91	1719.92	mon	26719859.52	827980.36	15.0	40.0	25.0	40.0	Shallow	Qal/xMCf/UMCf
	2/15/2010	1750.83	30.83	1720.00									
	3/8/2010	1750.83	30.22	1720.61									
	4/20/2010	1750.83	29.44	1721.39									
	5/24/2010	1750.83	28.82	1722.01									
	6/17/2010	1750.83	28.93	1721.90									
	7/20/2010	1750.83	28.94	1721.89									
	8/2/2010	1750.83	31.21	1719.62									
	9/21/2010	1750.83	29.45	1721.38									
	10/19/2010	1750.83	29.65	1721.18									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-57A	1/25/2010	1753.44	29.71	1723.73	mon	26719716.74	826993.31	20.0	40.0	20.0	40.2	Shallow	UMCf
	2/2/2010	1753.44	29.01	1724.43									
	3/8/2010	1753.44	29.03	1724.41									
	4/20/2010	1753.44	28.82	1724.62									
	5/24/2010	1753.44	28.79	1724.65									
	6/17/2010	1753.44	28.96	1724.48									
	7/20/2010	1753.44	29.07	1724.37									
	8/2/2010	1753.44	29.02	1724.42									
	9/21/2010	1753.44	28.98	1724.46									
	10/19/2010	1753.44	29.27	1724.17									
M-58	1/25/2010	1751.25	29.94	1721.31	mon	26719900.55	828276.62	15.0	45.0	30.0	45.0	Shallow	Qal/xMCf/UMCf
	2/15/2010	1751.25	29.61	1721.64									
	3/8/2010	1751.25	29.55	1721.70									
	4/20/2010	1751.25	29.61	1721.64									
	5/24/2010	1751.25	29.62	1721.63									
	6/17/2010	1751.25	29.74	1721.51									
	7/20/2010	1751.25	29.92	1721.33									
	8/2/2010	1751.25	29.91	1721.34									
	9/21/2010	1751.25	30.79	1720.46									
	10/25/2010	1751.25	29.41	1721.84									
M-60	1/25/2010	1750.94	31.98	1718.96	mon	26719872.48	828079.11	17.8	42.8	25.0	43.0	Shallow	UMCf
	2/15/2010	1750.94	31.75	1719.19									
	3/8/2010	1750.94	31.58	1719.36									
	4/20/2010	1750.94	31.33	1719.61									
	5/24/2010	1750.94	31.19	1719.75									
	6/17/2010	1750.94	29.75	1721.19									
	7/20/2010	1750.94	30.22	1720.72									
	8/2/2010	1750.94	31.43	1719.51									
	9/21/2010	1750.94	29.22	1721.72									
	10/19/2010	1750.94	29.69	1721.25									
M-61	5/12/2010	1747.55	24.93	1722.62	mon	26719955.76	828673.67	9.3	38.8	29.5	39.0	Shallow	Qal/xMCf/UMCf
	6/22/2010	1747.55	24.81	1722.74									
	7/19/2010	1747.55	24.76	1722.79									
	8/4/2010	1747.55	24.55	1723.00									
	9/30/2010	1747.55	24.27	1723.28									
	10/25/2010	1747.55	23.90	1723.65									
M-64	1/25/2010	1749.76	29.35	1720.41	mon	26719748.40	827601.30	12.7	37.3	24.6	37.5	Shallow	Qal/xMCf/UMCf
	2/2/2010	1749.76	29.28	1720.48									
	3/8/2010	1749.76	28.81	1720.95									
	4/20/2010	1749.76	28.17	1721.59									
	5/12/2010	1749.76	28.17	1721.59									
	6/17/2010	1749.76	28.59	1721.17									
	7/20/2010	1749.76	28.34	1721.42									
	8/12/2010	1749.76	29.00	1720.76									
	9/21/2010	1749.76	28.69	1721.07									
	10/19/2010	1749.76	28.65	1721.11									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-65	1/25/2010	1753.91	32.63	1721.28	mon	26719746.36	827899.72	14.4	39.0	24.6	39.2	Shallow	Qal/xMCf/UMCf
	2/2/2010	1753.91	32.58	1721.33									
	3/8/2010	1753.91	32.34	1721.57									
	4/20/2010	1753.91	30.44	1723.47									
	5/12/2010	1753.91	29.54	1724.37									
	6/17/2010	1753.91	30.69	1723.22									
	7/20/2010	1753.91	30.93	1722.98									
	8/12/2010	1753.91	30.86	1723.05									
	9/21/2010	1753.91	32.19	1721.72									
	10/19/2010	1753.91	31.13	1722.78									
M-66	1/25/2010	1754.24	30.99	1723.25	mon	26719787.47	828183.64	17.5	42.3	24.8	42.5	Shallow	Qal/xMCf/UMCf
	2/2/2010	1754.24	30.78	1723.46									
	3/8/2010	1754.24	30.56	1723.68									
	4/20/2010	1754.24	30.62	1723.62									
	5/12/2010	1754.24	30.65	1723.59									
	6/17/2010	1754.24	30.85	1723.39									
	7/20/2010	1754.24	30.98	1723.26									
	8/12/2010	1754.24	30.87	1723.37									
	9/21/2010	1754.24	31.85	1722.39									
	10/19/2010	1754.24	30.38	1723.86									
M-67	1/25/2010	1745.91	21.68	1724.23	mon	26719829.72	828508.52	7.8	37.8	30.0	38.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1745.91	21.48	1724.43									
	3/11/2010	1745.91	21.22	1724.69									
	4/15/2010	1745.91	21.57	1724.34									
	5/12/2010	1745.91	21.63	1724.28									
	6/22/2010	1745.91	21.83	1724.08									
	7/19/2010	1745.91	21.97	1723.94									
	8/12/2010	1745.91	21.72	1724.19									
	9/30/2010	1745.91	22.87	1723.04									
	10/25/2010	1745.91	21.46	1724.45									
M-68	1/25/2010	1750.23	26.13	1724.10	mon	26719864.47	828751.00	11.2	39.8	28.6	41.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1750.23	25.82	1724.41									
	3/11/2010	1750.23	25.79	1724.44									
	4/15/2010	1750.23	25.95	1724.28									
	5/5/2010	1750.23	26.03	1724.20									
	6/22/2010	1750.23	26.36	1723.87									
	7/19/2010	1750.23	26.57	1723.66									
	8/4/2010	1750.23	26.14	1724.09									
	9/30/2010	1750.23	25.86	1724.37									
	10/25/2010	1750.23	25.55	1724.68									
M-69	1/25/2010	1749.75	29.64	1720.11	mon	26719885.28	827265.73	19.9	39.3	19.4	40.0	Shallow	Qal/xMCf/UMCf
	2/2/2010	1749.75	28.87	1720.88									
	3/8/2010	1749.75	28.39	1721.36									
	4/20/2010	1749.75	27.79	1721.96									
	5/4/2010	1749.75	27.64	1722.11									
	6/17/2010	1749.75	27.76	1721.99									
	7/20/2010	1749.75	27.73	1722.02									
	8/3/2010	1749.75	27.69	1722.06									
	9/21/2010	1749.75	28.28	1721.47									
	10/25/2010	1749.75	29.93	1719.82									
M-6A	8/6/2010	1733.19	38.93	1694.26	mon	26721013.69	825984.54	26.8	41.5	14.7	43.6	Shallow	Qal/xMCf/UMCf

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-70	1/25/2010	1748.25	25.01	1723.24	mon	26719904.69	827567.35	15.3	40.0	24.7	40.2	Shallow	Qal/xMCf/UMCf
	2/4/2010	1748.25	23.64	1724.61									
	3/11/2010	1748.25	23.35	1724.90									
	4/15/2010	1748.25	22.62	1725.63									
	5/6/2010	1748.25	22.54	1725.71									
	6/22/2010	1748.25	23.26	1724.99									
	7/19/2010	1748.25	22.79	1725.46									
	8/6/2010	1748.25	22.71	1725.54									
	9/30/2010	1748.25	35.98	1712.27									
	10/25/2010	1748.25	30.54	1717.71									
M-71	1/25/2010	1747.04	29.06	1717.98	mon	26719943.63	827859.71	17.5	42.0	24.5	42.2	Shallow	Qal/xMCf/UMCf
	2/4/2010	1747.04	28.64	1718.40									
	3/11/2010	1747.04	28.09	1718.95									
	4/15/2010	1747.04	27.83	1719.21									
	5/6/2010	1747.04	27.44	1719.60									
	6/22/2010	1747.04	27.89	1719.15									
	7/19/2010	1747.04	27.84	1719.20									
	8/6/2010	1747.04	27.88	1719.16									
	9/30/2010	1747.04	30.31	1716.73									
	10/25/2010	1747.04	32.86	1714.18									
M-72	1/25/2010	1746.49	31.03	1715.46	mon	26719977.14	828172.13	10.1	34.8	24.7	35.0	Shallow	Qal/xMCf/UMCf
	2/4/2010	1746.49	30.82	1715.67									
	3/11/2010	1746.49	30.73	1715.76									
	4/15/2010	1746.49	30.68	1715.81									
	5/6/2010	1746.49	30.43	1716.06									
	6/22/2010	1746.49	30.58	1715.91									
	7/19/2010	1746.49	30.58	1715.91									
	8/6/2010	1746.49	31.73	1714.76									
	9/30/2010	1746.49	30.63	1715.86									
	10/25/2010	1746.49	31.11	1715.38									
M-73	1/25/2010	1741.14	29.13	1712.01	mon	26720018.47	828427.82	11.0	35.8	24.8	36.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1741.14	22.88	1718.26									
	3/11/2010	1741.14	28.88	1712.26									
	4/15/2010	1741.14	28.79	1712.35									
	5/5/2010	1741.14	28.71	1712.43									
	6/22/2010	1741.14	28.84	1712.30									
	7/19/2010	1741.14	28.89	1712.25									
	8/4/2010	1741.14	28.93	1712.21									
	9/30/2010	1741.14	30.49	1710.65									
	10/25/2010	1741.14	28.86	1712.28									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-74	1/25/2010	1744.38	28.95	1715.43	mon	26720062.18	828713.65	9.2	38.8	29.6	39.0	Shallow	UMCf
	2/3/2010	1744.38	28.68	1715.70									
	3/11/2010	1744.38	28.51	1715.87									
	4/15/2010	1744.38	28.53	1715.85									
	5/5/2010	1744.38	28.57	1715.81									
	6/22/2010	1744.38	28.83	1715.55									
	7/19/2010	1744.38	28.94	1715.44									
	8/4/2010	1744.38	28.89	1715.49									
	9/30/2010	1744.38	28.67	1715.71									
	10/25/2010	1744.38	28.52	1715.86									
M-76	1/25/2010	1785.22	39.34	1745.88	mon	26718659.92	827550.73	34.6	49.3	14.7	51.4	Shallow	UMCf
	2/4/2010	1785.22	39.39	1745.83									
	3/11/2010	1785.22	39.08	1746.14									
	4/15/2010	1785.22	39.13	1746.09									
	5/6/2010	1785.22	39.24	1745.98									
	6/22/2010	1785.22	39.38	1745.84									
	7/19/2010	1785.22	39.46	1745.76									
	8/12/2010	1785.22	39.49	1745.73									
	9/30/2010	1785.22	39.45	1745.77									
	10/25/2010	1785.22	39.43	1745.79									
M-77	4/15/2010	1799.61	36.34	1763.27	mon	26718047.69	828933.94	29.0	43.8	14.8	45.9	Shallow	Qal/xMCf/UMCf
	5/5/2010	1799.61	36.51	1763.10									
	6/22/2010	1799.61	36.93	1762.68									
	7/19/2010	1799.61	37.17	1762.44									
	8/12/2010	1799.61	37.29	1762.32									
	9/30/2010	1799.61	37.49	1762.12									
	10/25/2010	1799.61	37.54	1762.07									
M-78	1/25/2010	1751.50	32.56	1718.94	mon	26719838.17	827777.45	21.5	41.5	20.0	43.6	Shallow	Qal/xMCf/UMCf
	2/15/2010	1751.50	32.09	1719.41									
	3/8/2010	1751.50	31.98	1719.52									
	4/20/2010	1751.50	29.22	1722.28									
	5/24/2010	1751.50	28.44	1723.06									
	6/17/2010	1751.50	29.48	1722.02									
	7/20/2010	1751.50	29.72	1721.78									
	8/12/2010	1751.50	29.54	1721.96									
	9/21/2010	1751.50	29.74	1721.76									
	10/19/2010	1751.50	29.54	1721.96									
M-79	1/25/2010	1742.53	24.27	1718.26	mon	26720048.92	827382.10	10.8	35.4	24.6	37.6	Shallow	Qal/xMCf/UMCf
	2/2/2010	1742.53	23.00	1719.53									
	3/8/2010	1742.53	22.42	1720.11									
	4/20/2010	1742.53	21.23	1721.30									
	5/4/2010	1742.53	21.78	1720.75									
	6/17/2010	1742.53	22.16	1720.37									
	7/20/2010	1742.53	21.89	1720.64									
	8/3/2010	1742.53	21.94	1720.59									
	9/21/2010	1742.53	23.67	1718.86									
	10/19/2010	1742.53	26.52	1716.01									
M-7B	8/5/2010	1732.83	36.02	1696.81	mon	26720979.66	826106.50	25.5	50.5	25.0	52.5	Shallow	Qal/xMCf/UMCf

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-80	1/25/2010	1746.04	26.37	1719.67	mon	26720112.87	827759.79	11.5	41.5	30.0	43.7	Shallow	Qal/xMCf/UMCf
	2/3/2010	1746.04	24.31	1721.73									
	3/11/2010	1746.04	24.06	1721.98									
	4/15/2010	1746.04	23.68	1722.36									
	5/6/2010	1746.04	23.28	1722.76									
	6/22/2010	1746.04	24.49	1721.55									
	7/19/2010	1746.04	23.89	1722.15									
	8/5/2010	1746.04	23.94	1722.10									
	9/30/2010	1746.04	28.99	1717.05									
	10/14/2010	1746.04	30.63	1715.41									
M-81A	1/25/2010	1744.16	32.39	1711.77	mon	26720176.85	828139.67	30.0	40.0	10.0	40.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1744.16	32.23	1711.93									
	3/11/2010	1744.16	30.95	1713.21									
	4/15/2010	1744.16	30.77	1713.39									
	5/6/2010	1744.16	30.15	1714.01									
	6/22/2010	1744.16	30.46	1713.70									
	7/19/2010	1744.16	30.44	1713.72									
	8/4/2010	1744.16	30.47	1713.69									
	9/30/2010	1744.16	32.26	1711.90									
	10/14/2010	1744.16	31.74	1712.42									
M-83	5/6/2010	1742.77	16.73	1726.04	mon	26720161.50	827586.44	10.8	40.3	29.5	42.5	Shallow	Qal/xMCf/UMCf
	6/16/2010	1742.77	17.32	1725.45									
	7/14/2010	1742.77	17.70	1725.07									
	8/5/2010	1742.77	16.72	1726.05									
	9/30/2010	1742.77	24.21	1718.56									
M-84	1/25/2010	1741.03	22.79	1718.24	mon	26720189.13	827766.70	11.8	34.1	22.3	36.6	Shallow	Qal/xMCf/UMCf
	2/3/2010	1741.03	20.88	1720.15									
	3/11/2010	1741.03	20.52	1720.51									
	4/15/2010	1741.03	20.12	1720.91									
	5/6/2010	1741.03	19.40	1721.63									
	6/22/2010	1741.03	20.62	1720.41									
	7/19/2010	1741.03	20.14	1720.89									
	8/5/2010	1741.03	20.23	1720.80									
	9/30/2010	1741.03	24.49	1716.54									
M-85A	6/22/2010	1741.80	25.45	1716.35	mon	26720228.81	827963.24	20.0	35.0	15.0	35.0	Shallow	Qal/UMCf
	7/19/2010	1741.80	25.34	1716.46									
	8/5/2010	1741.80	25.39	1716.41									
	9/30/2010	1741.80	27.26	1714.54									
M-86A	6/22/2010	1744.32	31.48	1712.84	mon	26720245.83	828141.69	25.0	45.0	20.0	45.0	Shallow	Qal/UMCf
	7/19/2010	1744.32	31.47	1712.85									
	8/5/2010	1744.32	31.47	1712.85									
	9/30/2010	1744.32	31.95	1712.37									
	10/14/2010	1744.32	32.61	1711.71									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-87	2/3/2010	1744.13	36.62	1707.51	mon	26720276.13	828358.13	9.3	38.8	29.5	41.0	Shallow	UMCf
	3/10/2010	1744.13	36.29	1707.84									
	4/14/2010	1744.13	36.21	1707.92									
	5/6/2010	1744.13	36.00	1708.13									
	6/16/2010	1744.13	35.92	1708.21									
	7/14/2010	1744.13	35.97	1708.16									
	8/6/2010	1744.13	36.02	1708.11									
	9/30/2010	1744.13	35.86	1708.27									
	10/14/2010	1744.13	36.36	1707.77									
M-88	1/25/2010	1739.35	32.08	1707.27	mon	26720313.96	828588.75	7.3	36.8	29.5	39.0	Shallow	Qal/xMCf/UMCf
	2/3/2010	1739.35	31.73	1707.62									
	3/11/2010	1739.35	31.71	1707.64									
	4/15/2010	1739.35	31.56	1707.79									
	5/5/2010	1739.35	31.42	1707.93									
	6/22/2010	1739.35	31.51	1707.84									
	7/19/2010	1739.35	31.57	1707.78									
	8/4/2010	1739.35	31.57	1707.78									
	9/30/2010	1739.35	32.76	1706.59									
M-89	1/25/2010	1766.19	32.99	1733.20	mon	26719294.84	827890.08	18.0	38.2	20.2	38.2	Shallow	Qal/xMCf/UMCf
	2/4/2010	1766.19	32.88	1733.31									
	3/11/2010	1766.19	32.67	1733.52									
	4/15/2010	1766.19	32.74	1733.45									
	5/6/2010	1766.19	32.91	1733.28									
	6/22/2010	1766.19	33.19	1733.00									
	7/19/2010	1766.19	33.21	1732.98									
	8/6/2010	1766.19	33.15	1733.04									
	9/30/2010	1766.19	33.41	1732.78									
M-92	1/25/2010	1800.76	36.64	1764.12	mon	26717531.94	827138.09	34.9	44.9	10.0	45.5	Shallow	UMCf
	2/4/2010	1800.76	36.72	1764.04									
	3/8/2010	1800.76	36.67	1764.09									
	4/15/2010	1800.76	36.65	1764.11									
	5/4/2010	1800.76	36.95	1763.81									
	6/17/2010	1800.76	36.83	1763.93									
	7/19/2010	1800.76	36.98	1763.78									
	8/3/2010	1800.76	37.05	1763.71									
	9/21/2010	1800.76	36.96	1763.80									
	10/25/2010	1800.76	36.98	1763.78									
M-93	1/25/2010	1797.54	35.74	1761.80	mon	26717685.92	827143.44	35.4	45.4	10.0	46.0	Shallow	UMCf
	2/3/2010	1797.54	35.82	1761.72									
	3/8/2010	1797.54	35.73	1761.81									
	4/15/2010	1797.54	35.69	1761.85									
	5/4/2010	1797.54	35.72	1761.82									
	6/17/2010	1797.54	35.93	1761.61									
	7/19/2010	1797.54	36.07	1761.47									
	8/3/2010	1797.54	36.09	1761.45									
	9/21/2010	1797.54	36.06	1761.48									
	10/25/2010	1797.54	36.02	1761.52									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-95	1/25/2010	1694.09	13.26	1680.83	mon	26722701.69	827426.74	12.0	22.0	10.0	22.0	Shallow	Qal
	2/1/2010	1694.09	12.91	1681.18									
	3/11/2010	1694.09	12.47	1681.62									
	4/20/2010	1694.09	12.22	1681.87									
	5/3/2010	1694.09	12.22	1681.87									
	6/17/2010	1694.09	12.25	1681.84									
	8/5/2010	1694.09	12.19	1681.90									
	9/21/2010	1694.09	12.12	1681.97									
	10/21/2010	1694.09	12.12	1681.97									
M-96	1/25/2010	1693.52	13.45	1680.07	mon	26722700.30	827626.08	10.5	20.5	10.0	20.5	Shallow	Qal
	2/1/2010	1693.52	12.99	1680.53									
	3/11/2010	1693.52	12.48	1681.04									
	4/20/2010	1693.52	12.31	1681.21									
	5/3/2010	1693.52	12.35	1681.17									
	6/17/2010	1693.52	12.38	1681.14									
	7/19/2010	1693.52	12.49	1681.03									
	8/1/2010	1693.52	12.41	1681.11									
	9/21/2010	1693.52	12.28	1681.24									
	10/21/2010	1693.52	12.36	1681.16									
M-97	1/25/2010	1800.85	39.99	1760.86	mon	26717795.18	827492.47	35.0	45.0	10.0	45.5	Shallow	UMCf
	2/4/2010	1800.85	40.09	1760.76									
	3/8/2010	1800.85	39.97	1760.88									
	4/15/2010	1800.85	37.94	1762.91									
	5/3/2010	1800.85	40.00	1760.85									
	6/17/2010	1800.85	40.19	1760.66									
	7/19/2010	1800.85	40.37	1760.48									
	8/3/2010	1800.85	40.37	1760.48									
	9/21/2010	1800.85	40.35	1760.50									
	10/25/2010	1800.85	40.32	1760.53									
M-99	1/25/2010	1730.74	31.42	1699.32	mon	26720851.72	827309.69	16.0	31.0	15.0	33.0	Shallow	Qal
	2/2/2010	1730.74	30.31	1700.43									
	3/8/2010	1730.74	30.01	1700.73									
	4/20/2010	1730.74	29.44	1701.30									
	5/4/2010	1730.74	29.34	1701.40									
	6/17/2010	1730.74	29.03	1701.71									
	7/20/2010	1730.74	28.75	1701.99									
	8/3/2010	1730.74	28.68	1702.06									
	9/21/2010	1730.74	28.53	1702.21									
	10/25/2010	1730.74	28.81	1701.93									
M-100	1/25/2010	1730.93	30.11	1700.82	mon	26720820.26	827659.99	19.0	29.0	10.0	30.5	Shallow	Qal
	2/3/2010	1730.93	29.21	1701.72									
	3/11/2010	1730.93	28.26	1702.67									
	4/15/2010	1730.93	27.86	1703.07									
	5/3/2010	1730.93	27.72	1703.21									
	6/22/2010	1730.93	27.23	1703.70									
	7/19/2010	1730.93	27.09	1703.84									
	8/5/2010	1730.93	26.93	1704.00									
	9/30/2010	1730.93	26.99	1703.94									
	10/25/2010	1730.93	27.64	1703.29									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-101	3/11/2010	1730.81	31.71	1699.10	mon	26720786.74	828060.83	17.0	27.0	10.0	29.0	Shallow	Qal
	4/15/2010	1730.81	31.68	1699.13									
	5/3/2010	1730.81	31.67	1699.14									
	6/22/2010	1730.81	31.49	1699.32									
	7/19/2010	1730.81	31.57	1699.24									
	8/4/2010	1730.81	31.41	1699.40									
	9/30/2010	1730.81	31.13	1699.68									
	10/25/2010	1730.81	31.17	1699.64									
M-102	1/25/2010	1740.24	43.53	1696.71	mon	26720705.96	828437.98	19.4	39.4	20.0	41.4	Shallow	Qal
	2/3/2010	1740.24	43.31	1696.93									
	3/11/2010	1740.24	42.23	1698.01									
	4/15/2010	1740.24	43.14	1697.10									
	5/3/2010	1740.24	43.12	1697.12									
	6/22/2010	1740.24	42.89	1697.35									
	7/19/2010	1740.24	42.81	1697.43									
	8/4/2010	1740.24	42.46	1697.78									
M-115	1/25/2010	1783.44	38.09	1745.35	mon	26718612.90	827243.65	35.0	45.0	10.0	45.2	Shallow	Qal/xMCf/UMCf
	2/4/2010	1783.44	38.07	1745.37									
	3/11/2010	1783.44	37.61	1745.83									
	4/15/2010	1783.44	37.74	1745.70									
	5/3/2010	1783.44	37.82	1745.62									
	6/22/2010	1783.44	37.99	1745.45									
	7/19/2010	1783.44	38.09	1745.35									
	8/3/2010	1783.44	38.14	1745.30									
	9/30/2010	1783.44	37.89	1745.55									
	10/25/2010	1783.44	38.00	1745.44									
M-117	6/9/2010	1880.31	74.02	1806.29	mon	26715198.29	828917.06	130.0	150.0	20.0	155.0	Middle	UMCf
M-118	6/9/2010	1876.91	70.70	1806.21	mon	26715068.01	828036.40	138.0	158.0	20.0	163.0	Middle	UMCf
M-120	6/9/2010	1878.58	79.60	1798.98	mon	26715162.90	828387.79	80.0	100.0	20.0	105.0	Middle	UMCf
M-121	6/9/2010	1875.63	77.19	1798.44	mon	26715011.24	827694.57	77.0	97.0	20.0	102.0	Middle	UMCf
M-131	8/3/2010	1754.13	31.22	1722.91	mon	26719770.57	827158.08	28.7	38.7	10.0	39.0	Shallow	UMCf
M-132	5/13/2010	1744.27	26.66	1717.61	mon	26720048.49	828714.609	79.7	89.7	10.0	90.0	Middle	UMCf
M-133	5/13/2010	1743.62	27.46	1716.16	mon	26720067.29	828698.608	59.7	69.7	10.0	70.0	Shallow	UMCf
M-134	5/12/2010	1752.14	30.47	1721.67	mon	26719889.14	827144.353	59.7	69.7	10.0	70.0	Shallow	UMCf
M-135	8/3/2010	1751.85	30.33	1721.52	mon	26719890.17	827154.48	28.7	38.7	10.0	39.0	Shallow	UMCf
M-136	5/12/2010	1751.87	28.08	1723.79	tue	26719889.77	827165.342	79.7	89.7	10.0	90.0	Shallow	UMCf
M-137	5/12/2010	1847.54	57.11	1790.43	mon	26716034.02	827666.01	52.0	72.0	20.0	75.0	Shallow	UMCf
M-138	5/12/2010	1846.35	56.00	1790.35	mon	26716058.31	827816.34	50.5	65.5	15.0	65.0	Shallow	UMCf
M-140	9/2/2010	1748.21	24.51	1723.70	extr	26719889.51	827428.84	23.0	43.0	20.0	43.0	Shallow	Qal/UMCf
M-148A	9/2/2010	1800.04	46.09	1753.95	mon	26718357.14	829030.35	40.0	50.0	10.0	50.0	Shallow	Qal/UMCf
M-149	6/8/2010	1796.806	44.02	1752.79	mon	26718285.78	828373.149	100.0	120.0	20.0	120.0	Middle	UMCf
M-150	6/8/2010	1758.86	25.00	1733.86	mon	26719569.83	828059.148	125.0	145.0	20.0	145.0	Middle	UMCf
M-151	6/8/2010	1730.64	17.84	1712.80	mon	26720826.75	827643.033	125.0	145.0	20.0	145.0	Middle	UMCf
M-152	6/8/2010	1698.50	23.46	1675.04	mon	26722690.63	826973.486	125.0	145.0	20.0	145.0	Middle	UMCf
M-153	6/8/2010	1796.69	30.54	1766.15	mon	26718287.91	828385.605	150.0	170.0	20.0	170.0	Middle	UMCf
M-154	6/8/2010	1758.78	12.65	1746.13	mon	26719568.61	828047.739	175.0	195.0	20.0	195.0	Middle	UMCf
M-155	6/8/2010	1730.69	0.08	1730.61	mon	26720827.4	827636.1	200.0	220.0	20.0	220.0	Middle	UMCf
M-156	6/8/2010	1698.38	17.64	1680.74	mon	26722690.74	826964.224	175.0	195.0	20.0	195.0	Middle	UMCf
M-159	9/2/2010	1754.88	31.68	1723.20	mon	26719824.06	826758.00	65.0	75.0	10.0	75.0	Shallow	UMCf
M-160	9/2/2010	1754.73	31.48	1723.25	mon	26719826.22	826769.05	40.0	50.0	10.0	50.0	Shallow	UMCf
M-161	9/2/2010	1752.40	22.71	1729.69	mon	26719889.85	827134.13	100.0	110.0	10.0	110.0	Middle	UMCf

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
M-162	9/2/2010	1747.82	21.03	1726.79	mon	26719946.02	827877.81	100.0	110.0	10.0	110.0	Middle	UMCf
M-163	9/2/2010	1747.95	23.90	1724.05	mon	26719939.04	827873.42	80.0	90.0	10.0	90.0	Shallow	UMCf
M-164	9/2/2010	1747.61	27.98	1719.63	mon	26719949.61	827870.17	60.0	70.0	10.0	70.0	Shallow	UMCf
M-165	9/2/2010	1743.84	23.07	1720.77	mon	26720053.24	828701.37	110.0	120.0	10.0	120.0	Middle	UMCf
M-166	8/2/2010	1751.09	28.00	1723.09	mon	26719779.41	827230.05	21.7	31.7	10.0	32.0	Shallow	Qal/UMCf
M-167	8/2/2010	1749.95	27.80	1722.15	mon	26719787.69	827337.72	19.7	29.7	10.0	30.0	Shallow	Qal/UMCf
M-168	8/2/2010	1748.46	25.72	1722.74	mon	26719788.50	827408.08	21.7	31.7	10.0	32.0	Shallow	Qal/UMCf
M-169	8/2/2010	1750.22	27.49	1722.73	mon	26719786.63	827469.30	24.7	34.7	10.0	35.0	Shallow	Qal/UMCf
M-170	8/2/2010	1750.66	28.92	1721.74	mon	26719796.38	827577.55	24.7	34.7	10.0	35.0	Shallow	Qal/UMCf
M-172	8/2/2010	1750.58	29.31	1721.27	mon	26719835.83	827894.87	26.7	36.7	10.0	37.0	Shallow	Qal/UMCf
M-173	8/2/2010	1749.88	28.54	1721.34	mon	26719875.60	828181.82	24.7	39.7	15.0	40.0	Shallow	Qal/UMCf
M-174	8/4/2010	1742.29	20.29	1722.00	mon	26719902.97	828379.00	17.7	27.7	10.0	28.0	Shallow	Qal/UMCf
M-175	8/4/2010	1742.74	21.13	1721.61	mon	26719911.14	828471.22	18.7	28.7	10.0	29.0	Shallow	Qal/UMCf
M-176	8/4/2010	1745.35	23.88	1721.47	mon	26719948.07	828586.42	19.7	29.7	10.0	30.0	Shallow	Qal/UMCf
M-177	8/4/2010	1743.23	21.63	1721.60	mon	26719965.79	828724.83	19.7	29.7	10.0	30.0	Shallow	Qal
M-178	9/2/2010	1749.65	32.23	1717.42	extr	26719955.96	828012.64	26.0	46.0	20.0	46.0	Shallow	Qal/UMCf
M-179	9/2/2010	1749.98	36.71	1713.27	extr	26720002.95	828317.19	33.0	53.0	20.0	53.0	Shallow	Qal/UMCf
M-180	9/2/2010	1755.79	29.39	1726.40	mon	26719785.94	828806.85	24.0	39.0	15.0	39.0	Shallow	Qal/UMCf
M-181	9/2/2010	1761.76	28.15	1733.61	mon	26719579.72	828816.30	105.0	115.0	10.0	115.0	Middle	Qal/UMCf
M-182	9/2/2010	1761.83	32.40	1729.43	mon	26719588.73	828815.50	80.0	90.0	10.0	90.0	Shallow	UMCf
M-186	9/2/2010	1800.60	45.30	1755.30	mon	26718356.19	829022.55	105.0	115.0	10.0	115.0	Middle	UMCf
M-187	9/2/2010	1799.77	37.66	1762.11	mon	26718180.84	827375.01	160.0	170.0	10.0	170.0	Middle	UMCf
M-188	9/2/2010	1799.77	47.55	1752.22	mon	26718171.32	827377.14	110.0	120.0	10.0	120.0	Middle	UMCf
MC-29	5/11/2010	1723.40	35.34	1688.06	mon	26721514.06	825566.30	37.5	50.0	12.5	50.0	Shallow	Qal/UMCf
MC-3	5/11/2010	1725.73	34.33	1691.40	mon	26721409.73	825209.85					Shallow	Qal
MC-45	5/11/2010	1710.98	27.81	1683.17	mon	26722229.62	825400.47	30.0	34.0	4.0	34.0	Shallow	Qal
MC-50	5/11/2010	1713.32	28.93	1684.39	mon	26722075.95	825534.89	26.0	49.0	23.0	49.0	Shallow	Qal
MC-53	5/11/2010	1715.27	30.82	1684.45	mon	26721919.63	825942.62	19.0	38.0	19.0	38.0	Shallow	Qal/UMCf
MC-6	5/11/2010	1712.17	27.76	1684.41	mon	26722160.07	825208.13					Shallow	Qal
MC-65	5/11/2010	1705.43	33.05	1672.38	mon	26722421.15	826119.34	20.0	41.0	21.0	41.0	Shallow	Qal/UMCf
MC-69	5/11/2010	1718.66	33.05	1685.61	mon	26721806.62	825235.62	29.0	44.0	15.0	44.0	Shallow	Qal/UMCf
MC-93	5/11/2010	1719.26	32.39	1686.87	mon	26721672.78	825948.84	32.0	42.0	10.0	42.0	Shallow	Qal/UMCf
MC-97	5/11/2010	1723.95	35.59	1688.36	mon	26721425.52	825838.55	31.0	41.0	10.0	41.0	Shallow	Qal/UMCf
MW-K4	1/12/2010	1615.70	28.11	1587.59	mon	26728410.00	828994.00	9.5	50.0	40.5	50.0	Shallow	xMCf
	2/10/2010	1615.70	27.77	1587.93									
	3/10/2010	1615.70	27.59	1588.11									
	4/14/2010	1615.70	27.82	1587.88									
	5/19/2010	1615.70	28.10	1587.60									
	6/16/2010	1615.70	28.23	1587.47									
	7/14/2010	1615.70	28.26	1587.44									
	8/11/2010	1615.70	28.34	1587.36									
	9/16/2010	1615.70	28.37	1587.33									
	10/20/2010	1615.70	27.87	1587.83									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
MW-K5	1/13/2010	1598.87	37.53	1561.34	mon	26730252.00	829617.00	28.5	44.0	15.5	44.0	Shallow	xMCf/UMCf
	2/10/2010	1598.87	28.61	1570.26									
	3/10/2010	1598.87	30.46	1568.41									
	4/14/2010	1598.87	31.34	1567.53									
	5/19/2010	1598.87	29.28	1569.59									
	6/16/2010	1598.87	30.32	1568.55									
	7/14/2010	1598.87	31.59	1567.28									
	8/11/2010	1598.87	32.33	1566.54									
	9/16/2010	1598.87	19.71	1579.16									
	10/20/2010	1598.87	26.87	1572.00									
PC-18	1/12/2010	1618.47	28.65	1589.82	mon	26728079.97	828636.25	11.5	51.5	40.0	52.0	Shallow	Qal
	2/9/2010	1618.47	28.37	1590.10									
	3/10/2010	1618.47	28.25	1590.22									
	4/13/2010	1618.47	28.54	1589.93									
	5/19/2010	1618.47	28.89	1589.58									
	6/15/2010	1618.47	28.92	1589.55									
	7/14/2010	1618.47	28.99	1589.48									
	8/10/2010	1618.47	28.99	1589.48									
	9/15/2010	1618.47	29.07	1589.40									
	10/13/2010	1618.47	28.69	1589.78									
PC-28	5/10/2010	1650.85	11.62	1639.23	mon	26725375.67	828530.65	10.0	19.5	9.5	20.0	Shallow	Qal
PC-31	5/10/2010	1657.86	10.33	1647.53	mon	26725195.83	826781.65	14.5	49.5	35.0	50.0	Shallow	Qal
PC-37	1/25/2010	1707.72	26.91	1680.81	mon	26722172.24	826612.10	16.8	41.8	25.0	42.0	Shallow	Qal
	2/1/2010	1707.72	27.09	1680.63									
	3/11/2010	1707.72	26.97	1680.75									
	4/15/2010	1707.72	26.73	1680.99									
	5/3/2010	1707.72	26.62	1681.10									
	6/17/2010	1707.72	26.49	1681.23									
	7/19/2010	1707.72	26.45	1681.27									
	8/2/2010	1707.72	26.41	1681.31									
	9/21/2010	1707.72	26.33	1681.39									
	10/21/2010	1707.72	31.65	1676.07									
PC-40	5/10/2010	1679.23	21.71	1657.52	mon	26723971.04	826476.78	15.0	55.0	40.0	55.2	Shallow	Qal
PC-53	1/13/2010	1595.03	29.47	1565.56	mon	26730225.29	829941.58	13.0	32.5	19.5	33.0	Shallow	Qal
	2/10/2010	1595.03	24.08	1570.95									
	3/10/2010	1595.03	27.09	1567.94									
	4/14/2010	1595.03	28.27	1566.76									
	5/19/2010	1595.03	25.48	1569.55									
	6/16/2010	1595.03	27.25	1567.78									
	7/14/2010	1595.03	28.59	1566.44									
	8/11/2010	1595.03	29.46	1565.57									
	9/16/2010	1595.03	14.92	1580.11									
	10/20/2010	1595.03	22.40	1572.63									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
PC-54	1/25/2010	1704.43	19.51	1684.92	mon	26722067.79	828296.34	9.5	34.5	25.0	35.0	Shallow	Qal
	2/1/2010	1704.43	19.35	1685.08									
	3/11/2010	1704.43	18.95	1685.48									
	4/20/2010	1704.43	18.58	1685.85									
	5/3/2010	1704.43	18.59	1685.84									
	6/17/2010	1704.43	18.44	1685.99									
	7/19/2010	1704.43	18.35	1686.08									
	8/2/2010	1704.43	18.33	1686.10									
	9/21/2010	1704.43	18.19	1686.24									
	10/20/2010	1704.43	18.21	1686.22									
PC-55	1/12/2010	1617.19	26.39	1590.80	mon	26728056.66	828530.49	4.0	54.0	50.0	54.9	Shallow	Qal/xMCf/UMCf
	2/9/2010	1617.19	26.08	1591.11									
	3/10/2010	1617.19	25.94	1591.25									
	4/14/2010	1617.19	26.31	1590.88									
	6/15/2010	1617.19	26.61	1590.58									
	7/13/2010	1617.19	27.91	1589.28									
	8/12/2010	1617.19	28.02	1589.17									
	9/15/2010	1617.19	28.01	1589.18									
	10/13/2010	1617.19	27.63	1589.56									
PC-56	1/12/2010	1568.25	15.31	1552.94	mon	26732289.43	830645.29	4.8	54.8	50.0	55.0	Shallow	Qal/xMCf/UMCf
	2/9/2010	1568.25	12.85	1555.40									
	3/9/2010	1568.25	13.03	1555.22									
	4/12/2010	1568.25	14.23	1554.02									
	5/18/2010	1568.25	13.82	1554.43									
	6/15/2010	1568.25	14.43	1553.82									
	7/13/2010	1568.25	14.96	1553.29									
	8/9/2010	1568.25	15.61	1552.64									
	9/13/2010	1568.25	17.06	1551.19									
	10/12/2010	1568.25	14.87	1553.38									
PC-58	1/12/2010	1568.01	15.49	1552.52	mon	26732118.20	831123.78	7.8	32.8	25.0	33.0	Shallow	Qal
	2/9/2010	1568.01	13.29	1554.72									
	3/9/2010	1568.01	13.24	1554.77									
	4/12/2010	1568.01	14.41	1553.60									
	5/18/2010	1568.01	14.19	1553.82									
	6/15/2010	1568.01	14.68	1553.33									
	7/13/2010	1568.01	15.16	1552.85									
	8/9/2010	1568.01	15.73	1552.28									
	9/13/2010	1568.01	17.21	1550.80									
	10/12/2010	1568.01	15.28	1552.73									
PC-59	1/12/2010	1567.92	14.30	1553.62	mon	26732452.69	830150.30	4.8	34.8	30.0	35.0	Shallow	Qal/xMCf/UMCf
	2/9/2010	1567.92	12.73	1555.19									
	3/9/2010	1567.92	12.67	1555.25									
	4/12/2010	1567.92	13.32	1554.60									
	5/18/2010	1567.92	13.29	1554.63									
	6/15/2010	1567.92	13.76	1554.16									
	7/13/2010	1567.92	14.19	1553.73									
	8/9/2010	1567.92	14.76	1553.16									
	9/14/2010	1567.92	16.09	1551.83									
	10/12/2010	1567.92	13.29	1554.63									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
PC-60	1/12/2010	1568.38	15.15	1553.23	mon	26732358.75	830405.14	4.5	39.5	35.0	40.0	Shallow	Qal
	2/9/2010	1568.38	12.76	1555.62									
	3/9/2010	1568.38	12.94	1555.44									
	4/12/2010	1568.38	14.08	1554.30									
	5/18/2010	1568.38	13.66	1554.72									
	6/15/2010	1568.38	14.28	1554.10									
	7/13/2010	1568.38	14.82	1553.56									
	8/9/2010	1568.38	15.48	1552.90									
	9/13/2010	1568.38	16.92	1551.46									
	10/12/2010	1568.38	14.63	1553.75									
PC-62	1/12/2010	1567.83	13.59	1554.24	mon	26732733.52	829764.28	7.6	37.6	30.0	38.0	Shallow	Qal/xMCf/UMCf
	2/9/2010	1567.83	12.26	1555.57									
	3/9/2010	1567.83	12.11	1555.72									
	4/12/2010	1567.83	12.71	1555.12									
	5/18/2010	1567.83	12.86	1554.97									
	6/15/2010	1567.83	13.31	1554.52									
	7/13/2010	1567.83	13.67	1554.16									
	8/9/2010	1567.83	14.14	1553.69									
	9/14/2010	1567.83	15.47	1552.36									
	10/12/2010	1567.83	12.96	1554.87									
PC-64	6/14/2010	1675.29	7.94	1667.35	mon	26723702.44	827916.52	4.0	19.0	15.0	19.5	Shallow	Qal
PC-65	5/10/2010	1675.21	7.47	1667.74	mon	26723682.74	828386.90	4.1	18.7	14.6	19.1	Shallow	Qal
PC-66	5/10/2010	1673.53	11.16	1662.37	mon	26723966.95	828779.40	6.9	26.9	20.0	27.3	Shallow	Qal/xMCf/UMCf
PC-67	5/10/2010	1673.82	11.71	1662.11	mon	26723846.87	829207.80	11.0	35.6	24.6	36.0	Shallow	Qal
PC-68	1/12/2010	1566.97	12.20	1554.77	mon	26732906.82	829616.96	9.9	54.9	45.0	55.3	Shallow	Qal/xMCf/UMCf
	2/9/2010	1566.97	10.82	1556.15									
	3/9/2010	1566.97	10.74	1556.23									
	4/12/2010	1566.97	11.38	1555.59									
	5/18/2010	1566.97	11.63	1555.34									
	6/15/2010	1566.97	12.03	1554.94									
	7/13/2010	1566.97	12.44	1554.53									
	8/9/2010	1566.97	12.88	1554.09									
	9/14/2010	1566.97	14.31	1552.66									
	10/12/2010	1566.97	11.76	1555.21									
PC-71	1/25/2010	1698.73	24.21	1674.52	mon	26722687.72	826805.90	13.4	28.4	15.0	30.4	Shallow	Qal/xMCf/UMCf
	2/1/2010	1698.73	24.61	1674.12									
	3/11/2010	1698.73	24.19	1674.54									
	4/15/2010	1698.73	23.89	1674.84									
	5/3/2010	1698.73	23.83	1674.90									
	6/17/2010	1698.73	23.73	1675.00									
	7/19/2010	1698.73	23.63	1675.10									
	8/2/2010	1698.73	23.63	1675.10									
	9/21/2010	1698.73	23.59	1675.14									
	10/21/2010	1698.73	32.86	1665.87									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
PC-72	1/25/2010	1699.43	28.15	1671.28	mon	26722688.82	826604.72	15.0	35.0	20.0	37.0	Shallow	Qal
	2/1/2010	1699.43	28.24	1671.19									
	3/11/2010	1699.43	28.08	1671.35									
	4/15/2010	1699.43	25.90	1673.53									
	5/3/2010	1699.43	27.89	1671.54									
	6/17/2010	1699.43	27.76	1671.67									
	7/19/2010	1699.43	27.77	1671.66									
	8/2/2010	1699.43	27.74	1671.69									
	9/21/2010	1699.43	27.78	1671.65									
	10/21/2010	1699.43	31.11	1668.32									
PC-73	1/25/2010	1699.50	30.19	1669.31	mon	26722694.93	826404.90	20.0	45.0	25.0	47.5	Shallow	Qal
	2/1/2010	1699.50	30.22	1669.28									
	3/11/2010	1699.50	30.09	1669.41									
	4/15/2010	1699.50	29.93	1669.57									
	5/3/2010	1699.50	29.88	1669.62									
	6/17/2010	1699.50	29.85	1669.65									
	7/19/2010	1699.50	29.84	1669.66									
	8/2/2010	1699.50	29.89	1669.61									
	9/21/2010	1699.50	29.91	1669.59									
	10/21/2010	1699.50	28.86	1670.64									
PC-86	1/12/2010	1553.85	6.88	1546.97	mon	26733185.76	830826.99	17.5	27.5	10.0	28.0	Shallow	Qal
	2/9/2010	1553.85	5.32	1548.53									
	3/9/2010	1553.85	5.34	1548.51									
	4/13/2010	1553.85	6.02	1547.83									
	5/18/2010	1553.85	6.29	1547.56									
	6/15/2010	1553.85	6.41	1547.44									
	7/13/2010	1553.85	6.79	1547.06									
	8/10/2010	1553.85	7.29	1546.56									
	9/15/2010	1553.85	6.13	1547.72									
	10/13/2010	1553.85	5.29	1548.56									
PC-90	2/9/2010	1550.46	6.60	1543.86	mon	26733192.63	831271.92	4.5	14.5	10.0	15.0	Shallow	Qal
	3/9/2010	1550.46	6.48	1543.98									
	4/13/2010	1550.46	6.94	1543.52									
	5/18/2010	1550.46	7.42	1543.04									
	6/15/2010	1550.46	7.29	1543.17									
	7/13/2010	1550.46	7.63	1542.83									
	8/10/2010	1550.46	8.26	1542.20									
	9/15/2010	1550.46	9.21	1541.25									
	10/13/2010	1550.46	6.08	1544.38									
PC-91	1/12/2010	1552.33	12.96	1539.37	mon	26733110.85	831729.99	26.5	36.5	10.0	37.0	Shallow	Qal
	2/9/2010	1552.33	10.88	1541.45									
	3/9/2010	1552.33	11.81	1540.52									
	4/13/2010	1552.33	12.23	1540.10									
	5/18/2010	1552.33	12.63	1539.70									
	6/15/2010	1552.33	12.72	1539.61									
	7/13/2010	1552.33	12.99	1539.34									
	8/10/2010	1552.33	13.47	1538.86									
	9/15/2010	1552.33	13.52	1538.81									
	10/13/2010	1552.33	12.77	1539.56									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
PC-92	8/10/2010	1552.05	13.09	1538.96	mon	26733109.85	831749.30	11.5	21.5	10.0	22.0	Shallow	Qal
PC-94	8/10/2010	1548.95	13.68	1535.27	mon	26733122.48	832189.05	9.5	19.5	10.0	20.0	Shallow	Qal
PC-97	1/12/2010	1548.53	6.50	1542.03	mon	26733441.54	831565.69	23.0	33.0	10.0	33.5	Shallow	Qal
	2/9/2010	1548.53	5.18	1543.35									
	3/9/2010	1548.53	5.12	1543.41									
	4/13/2010	1548.53	5.67	1542.86									
	5/18/2010	1548.53	5.99	1542.54									
	6/15/2010	1548.53	5.94	1542.59									
	7/13/2010	1548.53	6.21	1542.32									
	8/10/2010	1548.53	6.82	1541.71									
	9/15/2010	1548.53	6.62	1541.91									
	10/13/2010	1548.53	5.56	1542.97									
PC-98R	1/13/2010	1593.35	25.60	1567.75	mon	26730260.53	829522.58	20.0	35.0	15.0	40.5	Shallow	Qal
	2/10/2010	1593.35	22.20	1571.15									
	3/10/2010	1593.35	23.66	1569.69									
	4/13/2010	1593.35	24.27	1569.08									
	5/19/2010	1593.35	22.52	1570.83									
	6/16/2010	1593.35	23.32	1570.03									
	7/15/2010	1593.35	24.48	1568.87									
	9/16/2010	1593.35	15.67	1577.68									
	10/20/2010	1593.35	19.35	1574.00									
PC-99R3	1/25/2010	1552.48	24.13	1528.35	extr	26733160.44	831255.55	10.0	50.0	40.0	55.5	Shallow	Qal
	2/15/2010	1552.48	13.07	1539.41									
	3/15/2010	1552.48	23.99	1528.49									
	4/27/2010	1552.48	15.45	1537.03									
	5/25/2010	1552.48	22.14	1530.34									
	6/22/2010	1552.48	23.58	1528.90									
	7/22/2010	1552.48	26.65	1525.83									
	8/1/2010	1552.48	20.87	1531.61									
	9/27/2010	1552.48	19.83	1532.65									
	10/27/2010	1552.48	26.30	1526.18									
PC-101R	1/12/2010	1618.12	29.55	1588.57	mon	26728107.74	828711.72	20.0	50.0	30.0	50.5	Shallow	Qal
	2/10/2010	1618.12	29.21	1588.91									
	3/10/2010	1618.12	29.72	1588.40									
	4/13/2010	1618.12	29.42	1588.70									
	5/19/2010	1618.12	29.83	1588.29									
	6/15/2010	1618.12	29.87	1588.25									
	7/13/2010	1618.12	29.80	1588.32									
	8/11/2010	1618.12	29.91	1588.21									
	9/15/2010	1618.12	29.96	1588.16									
	10/13/2010	1618.12	29.53	1588.59									
PC-103	1/13/2010	1599.49	24.72	1574.77	mon	26730205.73	829110.87	9.0	29.0	20.0	29.5	Shallow	Qal
	2/10/2010	1599.49	24.00	1575.49									
	3/10/2010	1599.49	24.11	1575.38									
	4/13/2010	1599.49	24.22	1575.27									
	5/19/2010	1599.49	23.68	1575.81									
	6/16/2010	1599.49	23.83	1575.66									
	7/15/2010	1599.49	24.29	1575.20									
	9/16/2010	1599.49	23.45	1576.04									
	10/20/2010	1599.49	22.44	1577.05									
PC-115R	1/25/2010	1554.71	13.18	1541.53	extr	26733131.33	831148.64	10.0	50.0	40.0	55.5	Shallow	Qal

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
	2/15/2010	1554.71	11.49	1543.22									
	3/15/2010	1554.71	13.09	1541.62									
	4/27/2010	1554.71	9.61	1545.10									
	5/25/2010	1554.71	11.97	1542.74									
	6/22/2010	1554.71	12.53	1542.18									
	7/22/2010	1554.71	13.15	1541.56									
	8/16/2010	1554.71	14.65	1540.06									
	9/27/2010	1554.71	12.46	1542.25									
	10/27/2010	1554.71	8.80	1545.91									
PC-116R	1/25/2010	1552.10	20.34	1531.76	extr	26733203.15	831348.43	10.0	50.0	40.0	55.5	Shallow	Qal
	2/15/2010	1552.10	19.75	1532.35									
	3/15/2010	1552.10	20.35	1531.75									
	4/27/2010	1552.10	19.97	1532.13									
	5/25/2010	1552.10	18.45	1533.65									
	6/22/2010	1552.10	18.38	1533.72									
	7/22/2010	1552.10	19.06	1533.04									
	8/16/2010	1552.10	21.23	1530.87									
	9/27/2010	1552.10	16.79	1535.31									
	10/27/2010	1552.10	16.15	1535.95									
PC-117	1/25/2010	1552.26	13.54	1538.72	extr	26733275.94	831422.37	11.0	51.0	40.0	53.0	Shallow	Qal
	2/15/2010	1552.26	10.74	1541.52									
	3/15/2010	1552.26	13.13	1539.13									
	4/27/2010	1552.26	11.15	1541.11									
	5/25/2010	1552.26	10.09	1542.17									
	6/22/2010	1552.26	10.53	1541.73									
	7/22/2010	1552.26	13.27	1538.99									
	8/16/2010	1552.26	13.38	1538.88									
	9/27/2010	1552.26	12.90	1539.36									
	10/27/2010	1552.26	12.26	1540.00									
PC-118	1/25/2010	1554.53	10.27	1544.26	extr	26733167.39	831051.99	9.0	49.0	40.0	51.0	Shallow	Qal
	2/15/2010	1554.53	8.59	1545.94									
	3/15/2010	1554.53	10.41	1544.12									
	4/27/2010	1554.53	9.00	1545.53									
	5/25/2010	1554.53	8.77	1545.76									
	6/22/2010	1554.53	6.31	1548.22									
	7/22/2010	1554.53	10.27	1544.26									
	8/16/2010	1554.53	11.97	1542.56									
	9/27/2010	1554.53	9.18	1545.35									
	10/27/2010	1554.53	7.95	1546.58									
PC-119	1/25/2010	1554.66	8.36	1546.30	extr	26733188.50	830951.29	15.0	45.0	30.0	47.0	Shallow	Qal
	2/15/2010	1554.66	6.57	1548.09									
	3/15/2010	1554.66	8.19	1546.47									
	4/27/2010	1554.66	7.71	1546.95									
	5/25/2010	1554.66	7.33	1547.33									
	6/22/2010	1554.66	7.93	1546.73									
	7/22/2010	1554.66	8.58	1546.08									
	8/16/2010	1554.66	8.94	1545.72									
	9/27/2010	1554.66	7.86	1546.80									
	10/27/2010	1554.66	6.75	1547.91									
PC-120	1/25/2010	1554.64	3.13	1551.51	extr	26733185.77	830851.47	15.0	45.0	30.0	47.0	Shallow	Qal
	2/15/2010	1554.64	7.92	1546.72									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
	3/15/2010	1554.64	3.64	1551.00									
	4/27/2010	1554.64	5.91	1548.73									
	5/25/2010	1554.64	5.56	1549.08									
	6/22/2010	1554.64	6.15	1548.49									
	7/22/2010	1554.64	6.71	1547.93									
	8/16/2010	1554.64	7.13	1547.51									
	9/27/2010	1554.64	6.03	1548.61									
	10/27/2010	1554.64	5.05	1549.59									
PC-121	1/25/2010	1554.10	5.99	1548.11	extr	26733180.39	830751.31	6.5	36.5	30.0	38.5	Shallow	Qal
	2/15/2010	1554.10	7.86	1546.24									
	3/15/2010	1554.10	5.36	1548.74									
	4/27/2010	1554.10	5.91	1548.19									
	5/25/2010	1554.10	5.48	1548.62									
	6/22/2010	1554.10	6.14	1547.96									
	7/22/2010	1554.10	6.66	1547.44									
	8/16/2010	1554.10	7.08	1547.02									
	9/27/2010	1554.10	5.98	1548.12									
	10/27/2010	1554.10	5.07	1549.03									
PC-122	1/12/2010	1618.02	32.89	1585.13	mon	26728145.17	829675.17	22.5	37.5	15.0	38.0	Shallow	Qal
	2/10/2010	1617.39	32.87	1584.52									
	3/10/2010	1617.39	32.73	1584.66									
	4/14/2010	1617.39	32.69	1584.70									
	5/19/2010	1617.39	32.85	1584.54									
	6/16/2010	1617.39	32.94	1584.45									
	7/14/2010	1617.39	33.03	1584.36									
	8/12/2010	1617.39	32.99	1584.40									
	9/16/2010	1617.39	32.86	1584.53									
	10/20/2010	1617.39	32.65	1584.74									
PC-123	2/1/2010	1626.44	22.91	1603.53	mon	26727358.44	829485.04	20.0	35.0	15.0	35.2	Shallow	Qal/xMCf/UMCf
	5/3/2010	1626.44	22.87	1603.57									
	8/1/2010	1626.44	22.94	1603.50									
PC-124	2/1/2010	1635.73	24.53	1611.20	mon	26726741.58	830132.95	20.3	35.3	15.0	35.5	Shallow	Qal/xMCf/UMCf
	5/3/2010	1635.73	24.88	1610.85									
	8/1/2010	1635.73	25.00	1610.73									
PC-125	2/1/2010	1635.06	23.14	1611.92	mon	26726739.82	829925.95	18.7	33.7	15.0	33.9	Shallow	Qal/xMCf/UMCf
	5/3/2010	1635.06	23.02	1612.04									
	8/1/2010	1635.06	23.08	1611.98									
PC-126	2/1/2010	1634.33	22.16	1612.17	mon	26726737.84	829724.72	19.5	34.5	15.0	34.7	Shallow	Qal
	5/3/2010	1634.33	22.12	1612.21									
	8/1/2010	1634.33	22.12	1612.21									
PC-127	2/1/2010	1632.42	18.82	1613.60	mon	26726735.62	829316.65	15.0	35.0	20.0	35.5	Shallow	Qal/xMCf/UMCf
	5/3/2010	1632.42	18.78	1613.64									
	8/1/2010	1632.42	18.84	1613.58									
PC-128	2/1/2010	1633.36	21.23	1612.13	mon	26726732.39	828953.97	14.8	34.8	20.0	35.0	Shallow	Qal/xMCf/UMCf
	5/3/2010	1633.36	18.46	1614.90									
	8/1/2010	1633.36	18.74	1614.62									

TABLE 5-1
Well Construction Details and Water Level Measurements

Well ID	Measurement Date	POM feet above msl	DTW feet below POM	GWE feet above msl	Type	Northing	Easting	Screen Top feet bgs	Screen Bottom feet bgs	Screen Length feet	Total Well Depth feet bgs	WBZ	Lithology
PC-129	2/1/2010	1633.99	18.43	1615.56	mon	26726730.81	828747.28	38.0	12.8	37.8	39.0	Shallow	Qal
	5/3/2010	1633.99	18.58	1615.41									
	8/1/2010	1633.99	18.68	1615.31									
PC-130	2/1/2010	1633.21	19.12	1614.09	mon	26726729.31	828538.19	14.8	49.8	35.0	50.0	Shallow	Qal/xMCf/UMCf
	5/3/2010	1633.21	19.16	1614.05									
	8/1/2010	1633.21	19.38	1613.83									
PC-131	2/1/2010	1633.58	11.03	1622.55	mon	26726725.41	828123.28	9.8	39.8	30.0	40.0	Shallow	Qal/xMCf/UMCf
	5/3/2010	1633.58	10.97	1622.61									
	8/1/2010	1633.58	11.21	1622.37									
PC-132	2/1/2010	1634.84	9.68	1625.16	mon	26726723.10	827913.94	9.8	39.8	30.0	40.0	Shallow	Qal/xMCf/UMCf
	5/3/2010	1634.84	9.66	1625.18									
	8/1/2010	1634.84	9.85	1624.99									
PC-134A	9/2/2010	1618.57	29.70	1588.87	mon	26728143.15	828775.80	59.7	69.7	10.0	70.0	Shallow	UMCf
PC-135A	9/2/2010	1618.58	30.03	1588.55	mon	26728143.03	828767.49	30.7	50.7	20.0	51.0	Shallow	Qal
PC-141	9/2/2010	1619.53	28.28	1591.25	mon	26728106.63	828446.31	44.7	54.7	10.0	55.0	Shallow	Qal
PC-142	9/2/2010	1619.64	28.23	1591.41	mon	26728106.76	828436.04	21.7	31.7	10.0	32.0	Shallow	Qal
PC-143	9/2/2010	1619.20	30.48	1588.72	mon	26728238.64	828698.71	29.7	39.7	10.0	65.0	Shallow	Qal
PC-144	9/2/2010	1618.63	31.04	1587.59	mon	26728223.86	828903.75	29.7	39.7	10.0	40.0	Shallow	Qal
	10/13/2010	1618.63	30.69	1587.94	mon	26728223.86	828903.75	29.7	39.7	10.0	40.0	Shallow	Qal
PC-145	9/2/2010	1617.76	33.82	1583.94	mon	26728324.97	829536.07	24.7	39.7	15.0	40.0	Shallow	Qal
PC-146	9/2/2010	1617.67	30.03	1587.64	mon	26728152.19	829812.54	19.7	29.7	10.0	30.0	Shallow	Qal
PC-147	9/2/2010	1617.51	31.39	1586.12	mon	26728153.17	829767.43	21.7	31.7	10.0	32.0	Shallow	Qal
PC-148	9/2/2010	1617.96	28.28	1589.68	mon	26728124.42	829249.33	24.5	44.5	20.0	50.0	Shallow	Qal
PC-149	9/2/2010	1618.93	30.05	1588.88	mon	26728122.90	829117.97	24.5	44.5	20.0	50.0	Shallow	Qal
PC-150	9/2/2010	1619.09	30.52	1588.57	mon	26728104.18	828915.29	19.5	39.5	10.0	50.0	Shallow	Qal
TR-2	6/10/2010	1751.79	24.60	1727.19	mon	26719954.57	826156.85	144.5	174.5	30.0	175.0	Middle	UMCf
TR-7	6/10/2010	1829.03	14.43	1814.60	mon	26716525.47	826724.99	260.0	290.0	30.0	290.5	Middle	UMCf
TR-8	6/10/2010	1829.08	50.70	1778.38	mon	26716512.15	826722.81	63.0	93.0	30.0	93.5	Middle	UMCf

Notes and Abbreviations:
bgs = below ground surface
DTW = depth to water
extr = extraction or recovery
GWE = groundwater elevation
mon = monitoring well or piezometer
msl = mean sea level
POM = point of measurement
WBZ = water-bearing zone

Shallow WBZ water levels contoured within KT3D
vertical grad analysis

TABLE 4-1
Perchlorate Groundwater Plume Mass Estimates

Total Plume[1]

Isolevel (ppm)	Perchlorate Mass (kg)
1	2.57E+06

Upgradient of the IWF

Isolevel (ppm)	Perchlorate Mass (kg)	% of Total Plume	% of This Plume Portion
0	9.64E+05	38%	100%
1	9.55E+05	37%	99%
5	9.43E+05	37%	98%
10	9.32E+05	36%	97%
25	9.04E+05	35%	94%

IWF to AWF

Isolevel (ppm)	Perchlorate Mass (kg)	% of Total Plume	% of This Plume Portion
1	1.59E+06	62%	100%
5	1.56E+06	61%	98%
10	1.52E+06	59%	96%
25	1.46E+06	57%	92%

AWF to Wash

Isolevel (ppm)	Perchlorate Mass (kg)	% of Total Plume
1	2.45E+04	1%

Notes and Abbreviations:

1. Estimates derived from three-dimensional plume model generated with EVS software based on 2009/2010 data from Tronox and regional BMI database, as depicted in Figures 4-1 and 4-2. These estimates include perchlorate on the TIMET site, but do not include input from the other areas farther east/northeast that are shown on Figures 4-1 and 4-2.

AWF = Athens Road Well Field
IWF = Interceptor Well Field
kg = kilogram
ppm = parts per million

TABLE 3-6
Estimates of Recharge to the Shallow WBZ

Recharge Component	Recharge Amount (in/year)	Notes	Reference
Precipitation			
Precipitation (on undeveloped land)	0.08	<2% of total precipitation for areas comparable to Las Vegas Valley	(1)
Applied Water			
Residential recharge	1.88	High end estimate from the DBSA 2009 study	(2)
Golf course irrigation	8.67	From DBSA (2008) report	(3)
Industrial property leaks	1.68	Estimated as 10% of the water delivered to the Tronox Physical Plant in 2009	(4)
Wastewater Discharges and Reinjection			
County of Henderson Bird Preserve	10.63	County of Henderson data on daily flows to the bird preserve from Aug. 2008 - March 2009, corrected for evaporation using pan evaporation rate in Shevenell (1996).	
Tronox lined ponds	0.11	based upon leakage estimates through plastic liners	
Tronox infiltration trenches	428.7	Kerr-McGee data on injection rates (recharge calculated by dividing injection rate by trench footprint used in the regional groundwater model)	

Notes:
(1) NDEP January 16, 2010 memo, Soil to Groundwater Leaching Guidance
(2) DBSA, 2009
(3) DBSA, 2008
(4) Leaching memo 10/18/2010

TABLE 3-5
Well Cluster Vertical Hydraulic Gradients

Well ID[1]	Lithologic Units [2]	Hydrogeologic Unit/ Water Bearing Zone[2]	Top of Casing Elevation (ft msl)	Well Depth (ft bgs)	Top of Screen Depth (ft bgs)	Bottom of Screen Depth (ft bgs)	Well Screen Mid-Point Elevation (ft msl)	Diff. Mid Screen Elev (ft)	Water Level Measurement Date[3]	Groundwater Elevation(4) (ft msl)	Vertical Gradient[5] (ft/ft)	Gradient Direction	Notes
M-74	Qal	Shallow	1744.380	39	9.2	38.8	1720.4		5/5/10	1,715.79	-0.010		
M-133	UMCf	Shallow	1743.62	70	60	70	1678.6	41.8	5/13/10	1,716.21	-0.068		upward gradient from middle to shallow WBZ
M-132	UMCf	Middle	1744.27	90	80	90	1659.3	61.1	5/13/10	1,717.53		upward	
M-135	UMCf	Shallow	1751.853	39	29	39	1717.9		5/4/10	1,721.52	-0.005		
M-134	UMCf	Shallow	1752.14	70	60	70	1687.1	30.7	5/12/10	1,721.66	-0.101		upward gradient from middle to shallow WBZ
M-136	UMCf	Middle	1751.87	90	80	90	1666.9	51.0	5/12/10	1,723.71		upward	
M-71	Qal/xMCf/UMCf	Shallow	1747.04	42.2	17.5	42	1717.3		8/6/2010[4]	1,717.95	-0.05		
M-164	UMCf	Shallow	1747.61	70	60	70	1682.6	34.7	9/2/10	1,719.58	-0.22		upward gradient from middle to shallow WBZ
M-163	UMCf	Shallow/Middle	1747.95	90	80	90	1663.0	54.3	9/2/10	1,723.91	-0.13	upward	
M-162	UMCf	Middle	1747.82	110	99.7	109.7	1642.8	74.5	9/2/10	1,726.51			
M-31A	UMCf	Shallow	1796.87	55	35	55	1751.9		6/22/2010	1,751.60	-0.017		
M-149	UMCf	Middle	1796.81	120	100	120	1686.8	65.1	6/8/2010	1,752.70	-0.26		upward gradient from middle to shallow WBZ
M-153	UMCf	Middle	1796.69	170	150	170	1636.7	115.2	6/8/2010	1,765.71		upward	
M-182	UMCf	Shallow	1761.83	90	79.9	89.7	1677.1		9/2/2010	1,729.71			upward gradient from middle to shallow WBZ
M-181	UMCf	Middle	1761.76	115	104.7	114.7	1652.1	25.1	9/2/2010	1,733.38	-0.146	upward	
M-148A	Qal/UMCf	Shallow	1800.04	50	39.7	49.7	1755.0		9/210	1,753.95			upward gradient from middle to shallow WBZ
M-186	UMCf	Middle	1797.99	115	104.7	114.7	1690.6	64.4	9/2/2010	1,755.36	-0.020	upward	
M-36	UMCf	Shallow	1759.82	35	20	35	1732.3		6/22/2010	1,727.91	-0.053		
M-150	UMCf	Middle	1758.86	145	125	145	1623.9	108.5	6/8/2010	1,733.63	-0.24		upward gradient from middle to shallow WBZ
M-154	UMCf	Middle	1758.78	195	175	195	1573.8	158.5	6/8/2010	1,745.70		upward	
M-100	Qal/UMCf	Shallow	1730.93	30	19	29	1706.9		6/22/2010	1,703.70	-0.080		
M-151	UMCf	Middle	1730.64	145	125	145	1595.6	111.3	6/8/2010	1,712.58	-0.235		upward gradient from middle to shallow WBZ
M-155	UMCf	Middle	1730.69	220	200	220	1520.7	186.2	6/8/2010	1,730.20		upward	
M-44	Qal	Shallow	1698.31	35	5	35	1678.3		6/17/2010	1,677.97	0.028	downward	
M-152	UMCf	Middle	1698.50	145	125	145	1563.5	114.8	6/8/2010	1,674.78	-0.106		upward gradient from middle to shallow WBZ
M-156	UMCf	Middle	1698.38	195	175	195	1513.4	164.9	6/8/2010	1,680.08		upward	
M-5A	UMCf	Shallow	1751.8	50	40	50	1706.8		5/4/2010	1,713.87	-0.113		upward gradient from middle to shallow WBZ
TR-2	UMCf	Middle	1751.79	175	144.5	174.5	1592.3	114.5	6/10/2010	1,726.81		upward	
TR-8	UMCf	Middle	1829.08	93.5	63	93	1751.1		6/10/2010	1,778.31	-0.181		upward gradient from deep to middle WBZ
TR-7	UMCf	Deep	1829.03	290.5	260	290	1554.0	197.1	6/10/2010	1,814.05		upward	

Notes

(1) Wells are shown on Figure 3-9

(2) Lithologic and hydrogeologic unit designations follow nomenclature proposed in NDEP guidance letter dated January 6, 2009.

(3) The most recent concurrent sample is used for each well pair. For M-71, the average of groundwater elevation measurements taken on 8/6/2010 and 9/30/2010 was used to compare to M-164 and M-163, which were sampled on 9/2/2010.

(4) Measure groundwater elevation corrected for density following online density calculation (http://www.earthwardconsulting.com/density) and using the water temperature and total dissolved solids concentration reported during sampling. If temperature was not reported an average value of 25.3 °C was used. The equivalent Fresh water head was calculated after Post, V., Looi, H., and Simmons, C., 2007, Using Hydraulic Head Measurments in Variable-Density Ground Water Flow Analyses: Groundwater Volume 45, No.6 November-December 2007 (pages 664-671).

(5) Vertical gradient estimated as the difference between the groundwater elevations of shallow and deep wells divided by the distance between the mid-point elevations of their screen intervals. A negative (-) number indicates an upward gradient.

TABLE 3-4
Laboratory Measurements of Vertical Hydraulic Conductivity and Porosity at the Site

Well Location / Sample ID	Sample Depth (ft bgs)	Lithology[1]	Vertical Hydraulic Conductivity (ft/day)	Hydraulic Conductiv. Method of Analysis	Total Porosity (cc/cc)
M-136	62-62.5	UMCf	8.25E-03	Lab (ASTM D5084)	0.65
M-132	60-60.5	UMCf	8.14E-03	Lab (ASTM D5084)	0.60
PC-135	51-51-.5	UMCf	2.46E-02	Lab (ASTM D5084)	0.61
PC-137	61-61-.5	UMCf	2.98E-03	Lab (ASTM D5084)	0.60
M-130	35.5-36	UMCf	2.74E-03	Lab (ASTM D5084)	-
M-129	35.5-36	?	2.98E-03	Lab (ASTM D5084)	-
M-162	68-68.5	UMCf	8.94E-07	Lab (ASTM D5084)	0.57
M-162	86-86.5	UMCf	4.30E-07	Lab (ASTM D5084)	0.52
M-162	106-106.5	UMCf	5.10E-07	Lab (ASTM D5084)	0.53
M-187	116-116.5	UMCf	4.05E-05	Lab (ASTM D5084)	0.67
M-187	166-166.5	UMCf	3.59E-06	Lab (ASTM D5084)	0.57
RSAJ3-29BSPLP	29	UMCf	1.27E-02	Lab (ASTM D5084)	0.50
SA128-29BSPLP	29	UMCf	1.61E-02	Lab (ASTM D5084)	0.61
RSAM3-30BSPLP	30	UMCf	8.72E-02	Lab (ASTM D5084)	0.52
SA102-30BSPLP	30	UMCf	2.18E-02	Lab (ASTM D5084)	0.32
SA166-31BSPLP	31	UMCf	5.96E-03	Lab (ASTM D5084)	0.55
SA30-35BSPLP	35	UMCf	4.27E-02	Lab (ASTM D5084)	0.65
SA148-35BSPLP	35	UMCf	2.20E-02	Lab (ASTM D5084)	0.63
SA56-37BSPLP	37	UMCf	8.74E-03	Lab (ASTM D5084)	0.61
SA182-38BSPLP	38	UMCf	2.00E-01	Lab (ASTM D5084)	0.46
RSAU4-50BSPLP	50	UMCf	7.13E-02	Lab (ASTM D5084)	0.55
RSAU5-50BSPLP	50	UMCf	1.62E-01	Lab (ASTM D5084)	0.48
		n=22		***n=20***	
		average K =	**3.18E-02**	**average total porosity=**	**0.56**
		geomean K =	**2.24E-03**		
RSAL6-0.5BSPLP	0.5	Qal	1.75E-01	Lab (ASTM D5084)	0.36
RSAU5-0.5BSPLP	0.5	Qal	2.60E-02	Lab (ASTM D5084)	0.34
RSAR3-0.5BSPLP	0.5	Qal	2.67E-01	Lab (ASTM D5084)	0.37
SA30-9BSPLP	9	Qal	5.91E-01	Lab (ASTM D5084)	0.33
SA56-10BSPLP	10	Qal	4.24E+00	Lab (ASTM D5084)	0.38
RSAM3-10BSPLP	10	Qal	3.37E-01	Lab (ASTM D5084)	0.40
SA166-10BSPLP	10	Qal	4.54E-01	Lab (ASTM D5084)	0.36
SA182-10BSPLP	10	Qal	1.02E+00	Lab (ASTM D5084)	0.33
RSAJ3-10BSPLP	10	Qal	2.59E-01	Lab (ASTM D5084)	0.34
SA64-10BSPLP	10	Qal	3.45E-02	Lab (ASTM D5084)	0.35
SA102-10BSPLP	10	Qal	2.64E-01	Lab (ASTM D5084)	0.34
SA128-10BSPLP	10	Qal	1.69E-01	Lab (ASTM D5084)	0.38
SA148-10BSPLP	10	Qal	4.64E-01	Lab (ASTM D5084)	0.36
RSAQ4-10BSPLP	10	Qal	1.58E-01	Lab (ASTM D5084)	0.32
RSAN8-10BSPLP	10	Qal	5.22E-01	Lab (ASTM D5084)	0.37
RSAQ8-10BSPLP	10	Qal	1.23E+00	Lab (ASTM D5084)	0.37
SA34-10BSPLP	10	Qal	3.92E-01	Lab (ASTM D5084)	0.36
RSAI7-10B	10	Qal	3.89E-02	Lab (ASTM D5084)	0.38
SA52-15BSPLP	15	Qal	4.44E-01	Lab (ASTM D5084)	0.48
RSAU4-20BSPLP	20	Qal	1.04E+00	Lab (ASTM D5084)	0.36
RSAL6-28BSPLP	28	Qal	4.34E+00	Lab (ASTM D5084)	0.37
RSAN8-28BSPLP	28	Qal	2.26E+00	Lab (ASTM D5084)	0.31
SA52-28BSPLP	28	Qal	1.20E+00	Lab (ASTM D5084)	0.40
RSAQ8-31BSPLP	31	Qal	6.99E-01	Lab (ASTM D5084)	0.52
SA34-31BSPLP	31	Qal	6.34E-02	Lab (ASTM D5084)	0.58
RSAQ4-32BSPLP	32	Qal	1.96E-02	Lab (ASTM D5084)	0.59
RSAR3-35BSPLP	35	Qal	4.24E-02	Lab (ASTM D5084)	0.65
		n=27			
		average K =	**7.68E-01**	**average total porosity=**	**0.40**
		geomean K=	**3.14E-01**		

Notes:

[1] Lithology determined from grain size analysis or boring log

TABLE 3-3
Measurements of Hydraulic Conductivity in the Study Area

Site	Well	Aquifer thickness (ft)	Lithology[1]	K (ft/d)	S	Test type	Analysis	Notes	Used to calculate Qal/MCf hydraulic K range for model calibration?	Report Source[2]
Pittman Lateral	PC-70	32	Qal	207		pumping test	Jacobs, drawdown	channel deposits	not used	(1)
Pittman Lateral	PC-70	32	Qal	292		pumping test	Jacobs, recovery	channel deposits		(1)
Pittman Lateral	PC-70	33	Qal	201	0.08	pumping test- PC-17 obs	Jacobs, drawdown	channel deposits	not used	(1)
Pittman Lateral	PC-70	33	Qal	227	0.03	pumping test- PC-17 obs	Theis, drawdown	channel deposits		(1)
Pittman Lateral	PC-70	33	Qal	190	0.04	pumping test- PC-17 obs	Boulton, drawdown	channel deposits		(1)
Pittman Lateral	PC-70	33	Qal	321		pumping test- PC-17 obs	Jacobs, recovery	channel deposits		(1)
Pittman Lateral	PC-70	33	Qal	166	0.03	pumping test- PC-18 obs	Jacobs, drawdown	channel deposits	not used	(1)
Pittman Lateral	PC-70	33	Qal	220	0.08	pumping test- PC-18 obs	Theis, drawdown	channel deposits		(1)
Pittman Lateral	PC-70	33	Qal	218	0.09	pumping test- PC-18 obs	Boulton, drawdown	channel deposits		(1)
Pittman Lateral	PC-70	33	Qal	438		pumping test- PC-18 obs	Jacobs, recovery	channel deposits		(1)
Pittman Lateral	PC-70	37	Qal	239	0.11	pumping test- PC-55 obs	Jacobs, drawdown	channel deposits	not used	(1)
Pittman Lateral	PC-70	37	Qal	169	0.03	pumping test- PC-55 obs	Theis, drawdown	channel deposits		(1)
Pittman Lateral	PC-70	37	Qal	143	0.04	pumping test- PC-55 obs	Boulton, drawdown	channel deposits		(1)
Pittman Lateral	PC-70	37	Qal	477		pumping test- PC-55 obs	Jacobs, recovery	channel deposits		(1)
A, Pittman Lateral	PC-70	30	Qal	228		tracer & hydraulic tests		channel deposits	not used	(2)
B, COH-RIBs	PC-98R	25	Qal	295		tracer & hydraulic tests		channel deposits	not used	(2)
C, Lower Ponds/Seeps	PC- 99R	32	Qal	616		tracer & hydraulic tests		alluvial deposits	not used	(2)
TIMET Facility	CLD1-R	8	Qal	70		pumping test	Cooper & Jacob, recovery		Y for Qal	(3)
TIMET Facility	CLD3-R	10	Qal	12		pumping test	Cooper & Jacob, recovery		Y for Qal	(3)
TIMET Facility	J2D2-R2	9	Qal	125		pumping test	Cooper & Jacob, recovery		Y for Qal	(3)
TIMET Facility	PC-54	19	Qal	118		pumping test	Cooper & Jacob, recovery		Y for Qal	(3)
TIMET Facility	PC-65	13	Qal	19		pumping test	Cooper & Jacob, recovery		Y for Qal	(3)
TIMET Facility	PC-67	25	Qal	22		pumping test	Cooper & Jacob, recovery		Y for Qal	(3)
TIMET Facility	TMMW-101	25	Qal	2		pumping test	Cooper & Jacob, recovery		Y for Qal	(3)
TIMET Facility	TMMW-102	15	Qal	0.07		slug test	Bouwer and Rice, 1976		not used	(3)
TIMET Facility	TMMW-103	14	Qal	1.4		pumping test	Cooper & Jacob, recovery		Y for Qal	(3)
TIMET Facility	TMMW-104	16	Qal	1.3		pumping test	Cooper & Jacob, recovery		Y for Qal	(3)
TIMET Facility	TMPZ-110	8	Qal	5		pumping test	Cooper & Jacob, recovery		Y for Qal	(3)
Tronox Industrial area	M-2	4	Qal	41.8		slug test	Bouwer and Rice, 1976		Y for Qal	(4)
Tronox Industrial area	M-2	4	Qal	60.6		pumping test	Jacob			(4)
Tronox Industrial area	M-3	2	Qal	131		slug test	Bouwer and Rice, 1976		Y for Qal	(4)
Tronox Industrial area	M-4	5	Qal	6.7		slug test	Bouwer and Rice, 1976		Y for Qal	(4)
Tronox Industrial area	M-8	4	Qal/xMCf/UMC	111		slug test	Bouwer and Rice, 1976		Y for Qal	(4)
Tronox Industrial area	M-15	15	UMCf	40.9		slug test	Bouwer and Rice, 1976		not used	(4)
Tronox Industrial area	M-27	16	Qal	200		slug test	Bouwer and Rice, 1976	channel deposits	not used	(4)
Stauffer Chemical	H-36	13	Qal/UMCf	235	0.09	delayed yield	Boulton	channel deposits	not used	(5)
Stauffer Chemical	H-36	11	Qal/UMCf	245	0.051	distance drawdown	Jacob	channel deposits		(5)
Stauffer Chemical	H-53	20	Qal	136	0.09	delayed yield	Boulton	channel deposits	not used	(5)
Stauffer Chemical	H-53	16	Qal	125	0.064	distance drawdown	Jacob	channel deposits		(5)
Stauffer Chemical	H-54	11	Qal	130	0.083	delayed yield	Boulton	channel deposits	not used	(5)
Stauffer Chemical	H-54	20	Qal	235	0.035	distance drawdown	Jacob	channel deposits		(5)
Stauffer Chemical	H-54	20	Qal	116	0.043	distance drawdown	Jacob	channel deposits	not used	(5)
Stauffer Chemical	H-10	10	Qal	2		drawdown			Y for MCf	(5)
Stauffer Chemical	H-10	10	Qal	3		slug			Y for MCf	(5)

TABLE 3-3
Measurements of Hydraulic Conductivity in the Study Area

Site	Well	Aquifer thickness (ft)	Lithology[1]	K (ft/d)	S	Test type	Analysis	Notes	Used to calculate Qal/MCf hydraulic K range for model calibration?	Report Source[2]
Stauffer Chemical	H-17	14	Qal	79		drawdown		channel deposits	not used	(5)
Stauffer Chemical	H-43	14	Qal/UMCf	301		drawdown			not used	(5)
Stauffer Chemical	H-49A	18	Qal	84		drawdown		H-49 in report, H49A in db	Y for Qal	(5)
Stauffer Chemical	H-51	24	Qal	81		drawdown			Y for Qal	(5)
Stauffer Chemical	H-52	2	Qal	9		slug		small diameter well	Y for Qal	(5)
Stauffer Chemical	H-52	2	Qal	15		slug		small diameter well		(5)
Stauffer Chemical	MC21	4	Qal/UMCf	51		slug		small diameter well	Y for Qal	(5)
Stauffer Chemical	MC25	5	Qal/UMCf	6		slug		small diameter well	Y for Qal	(5)
Stauffer Chemical	MC32	5	Qal	4		slug		small diameter well	Y for Qal	(5)
Stauffer Chemical	H-18	14	Qal/UMCf	618		drawdown		channel deposits	not used	(6)
Stauffer Chemical	H-19	8	Qal/UMCf	22		drawdown			not used	(6)
Stauffer Chemical	H-19	8	Qal/UMCf	382	0.016	drawdown	Theis H-46 obs well		not used	(6)
Stauffer Chemical	H-21R	15	Qal	129		pumping		H-21 in report, H-21R in db	Y for Qal	(6)
Stauffer Chemical	H-14	2	Qal/UMCf	45		drawdown			Y for Qal	(6)
Stauffer Chemical	H-14	2	Qal/UMCf	110	0.0027	drawdown	Theis H-37 obs well			(6)
BMI Common Area	AA-23R	10	Qal	8.84		Slug in 1	Bouwer and Rice, 1976		Y for Qal	(7)
BMI Common Area	AA-23R	10	Qal	10		Slug out 1	Bouwer and Rice, 1976			(7)
BMI Common Area	AA-23R	10	Qal	8.6		Slug in 2	Bouwer and Rice, 1976			(7)
BMI Common Area	AA-23R	10	Qal	12.5		Slug out 2	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-16	10	Qal	0.87		Slug in 1	Bouwer and Rice, 1976		not used	(7)
BMI Common Area	DBMW-16	10	Qal	0.38		Slug out 1	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-19	10	Qal	1.35		Slug in 1	Bouwer and Rice, 1976		Y for Qal	(7)
BMI Common Area	DBMW-19	10	Qal	2.75		Slug out 1	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-19	10	Qal	0.83		Slug in 2	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-19	10	Qal	2.9		Slug out 2	Bouwer and Rice, 1976			(7)
BMI Common Area	AA-26	5	Qal	4.1		Slug in 1	Bouwer and Rice, 1976		Y for Qal	(7)
BMI Common Area	AA-26	5	Qal	1.58		Slug out 1	Bouwer and Rice, 1976			(7)
BMI Common Area	AA-26	5	Qal	2.45		Slug in 2	Bouwer and Rice, 1976			(7)
BMI Common Area	AA-26	5	Qal	1.65		Slug out 2	Bouwer and Rice, 1976			(7)
BMI Common Area	AA-08B	10	Qal	50		Slug in 1	Bouwer and Rice, 1976		not used	(7)
BMI Common Area	AA-08B	10	Qal	70.1		Slug out 1	Bouwer and Rice, 1976			(7)
BMI Common Area	AA-08B	10	Qal	40		Slug in 2	Bouwer and Rice, 1976			(7)
BMI Common Area	AA-08B	10	Qal	62.1		Slug out 2	Bouwer and Rice, 1976			(7)
Tronox	AA-30		Qal	29.6		Slug	Hvorslev		Y for Qal	(8)
Tronox	AA-30		Qal	24.1		Slug	Bouwer and Rice			(8)
BMI Common Area	AA-20		Qal	29		Slug in 1	Bouwer-Rice		Y for Qal	(9)
BMI Common Area	AA-20		Qal	32.5		Slug out 1	Bouwer-Rice			(9)
BMI Common Area	AA-20		Qal	44		Slug out 2	Bouwer-Rice			(9)
BMI Common Area	MCF-16C		Qal	0.24		Slug in	Bouwer-Rice		not used	(9)
BMI Common Area	AA-13		Qal	12.2		Slug in 1	Bouwer-Rice		Y for Qal	(9)
BMI Common Area	AA-13		Qal	14.2		Slug out 1	Bouwer-Rice			(9)
BMI Common Area	AA-13		Qal	11.2		Slug in 2	Bouwer-Rice			(9)
BMI Common Area	AA-13		Qal	12.5		Slug out 2	Bouwer-Rice			(9)
BMI Common Area	AA-07		Qal	8		Slug in 1	Bouwer-Rice		Y for Qal	(9)

TABLE 3-3
Measurements of Hydraulic Conductivity in the Study Area

Site	Well	Aquifer thickness (ft)	Lithology[1]	K (ft/d)	S	Test type	Analysis	Notes	Used to calculate Qal/MCf hydraulic K range for model calibration?	Report Source[2]
BMI Common Area	AA-07		Qal	6.5		Slug out 1	Bouwer-Rice			(9)
BMI Common Area	AA-07		Qal	5		Slug in 2	Bouwer-Rice			(9)
BMI Common Area	AA-07		Qal	8		Slug out 2	Bouwer-Rice			(9)
BMI Common Area	AA-22		Qal	0.6		Slug in 1	Bouwer-Rice		Y for Qal	(9)
BMI Common Area	AA-22		Qal	0.3		Slug out 1	Bouwer-Rice			(9)
BMI Common Area	AA-22		Qal	0.5		Slug in 2	Bouwer-Rice			(9)
BMI Common Area	AA-22		Qal	0.6		Slug out 2	Bouwer-Rice			(9)
BMI Common Area	AA-09		Qal	67.3		Slug out 1	Bouwer-Rice		Y for Qal	(9)
BMI Common Area	AA-09		Qal	58.4		Slug out 2	Bouwer-Rice			(9)
BMI Common Area	AA-09		Qal	62		Slug out 3	Bouwer-Rice			(9)
BMI Common Area	MCF-06C		Qal	1.5		Slug in	Bouwer-Rice		Y for Qal	(9)
BMI Common Area	AA-09		Qal	12		Step test			Y for Qal	(9)
BMI Common Area	AA-09		Qal	9.6		Constant rate pump test				(9)
BMI Common Area	AA-09		Qal	15.4		Constant rate pump test				(9)
BMI Common Area	AA-09		Qal	9.6		Recovery (pump test)				(9)
BMI Common Area	AA-09		Qal	14.4		Recovery (pump test)				(9)
BMI Common Area	AA-20		Qal	33.6		Step test			Y for Qal	(9)
BMI Common Area	AA-20		Qal	22.7		Constant rate pump test				(9)
BMI Common Area	AA-20		Qal	69		Constant rate pump test				(9)
BMI Common Area	AA-20		Qal	29.7		Recovery (pump test)				(9)
BMI Common Area	AA-20		Qal	52.1		Recovery (pump test)				(9)
BMI Common Area	AA-08		Qal	192		Step test			Y for Qal	(9)
BMI Common Area	AA-08		Qal	654		Constant rate pump test				(9)
BMI Common Area	AA-08		Qal	564		Constant rate pump test				(9)
BMI Common Area	AA-08		Qal	846		Constant rate pump test				(9)
BMI Common Area	AA-08		Qal	417		Recovery (pump test)				(9)
BMI Common Area	AA-08		Qal	446		Recovery (pump test)				(9)
BMI Common Area	AA-08		Qal	451		Recovery (pump test)				(9)
CAMU	AA-BW-01		Qal	4.5		Slug in 1	Bouwer-Rice		Y for Qal	(10)
CAMU	AA-BW-01		Qal	5		Slug out 1	Bouwer-Rice			(10)
CAMU	AA-BW-01		Qal	4.5		Slug in 2	Bouwer-Rice			(10)
CAMU	AA-BW-01		Qal	5		Slug out 2	Bouwer-Rice			(10)
CAMU	AA-BW-07A		Qal	4.5		Slug in 1	Bouwer-Rice		Y for Qal	(10)
CAMU	AA-BW-07A		Qal	5		Slug out 1	Bouwer-Rice			(10)
CAMU	AA-BW-07A		Qal	4.7		Slug in 2	Bouwer-Rice			(10)
CAMU	AA-BW-07A		Qal	5.1		Slug out 2	Bouwer-Rice			(10)
CAMU	AA-BW-07A		Qal	4.9		Slug in 3	Bouwer-Rice			(10)
CAMU	AA-BW-07A		Qal	5.3		Slug out 3	Bouwer-Rice			(10)
CAMU	B-17		Qal	6.4		Slug in 1	Bouwer-Rice		Y for Qal	(10)
CAMU	B-17		Qal	9.5		Slug out 1	Bouwer-Rice			(10)
CAMU	B-17		Qal	6.1		Slug in 2	Bouwer-Rice			(10)
CAMU	B-17		Qal	8.7		Slug out 2	Bouwer-Rice			(10)
CAMU	B-17		Qal	6.25		Slug in 3	Bouwer-Rice			(10)
CAMU	B-17		Qal	9.5		Slug out 3	Bouwer-Rice			(10)

TABLE 3-3
Measurements of Hydraulic Conductivity in the Study Area

Site	Well	Aquifer thickness (ft)	Lithology[1]	K (ft/d)	S	Test type	Analysis	Notes	Used to calculate Qal/MCf hydraulic K range for model calibration?	Report Source[2]
CAMU	B-18		na	2.02		Slug in 1	Bouwer-Rice		Y for Qal	(10)
CAMU	B-18		na	2		Slug out 1	Bouwer-Rice			(10)
CAMU	B-18		na	2.2		Slug in 2	Bouwer-Rice			(10)
CAMU	B-18		na	2.42		Slug out 2	Bouwer-Rice			(10)
CAMU	B-18		na	2		Slug in 3	Bouwer-Rice			(10)
CAMU	B-18		na	2.45		Slug out 3	Bouwer-Rice			(10)
CAMU	B-14R		Qal	72.5		Slug in 1	Bouwer-Rice		Y for Qal	(10)
CAMU	B-14R		Qal	80		Slug out 1	Bouwer-Rice			(10)
CAMU	B-14R		Qal	62.5		Slug in 2	Bouwer-Rice			(10)
CAMU	B-14R		Qal	65		Slug out 2	Bouwer-Rice			(10)
CAMU	B-14R		Qal	67		Slug in 3	Bouwer-Rice			(10)
CAMU	B-14R		Qal	67		Slug out 3	Bouwer-Rice			(10)
CAMU	MCF-BW-12A		Qal	20.8		Slug in 1	Bouwer-Rice	not in all wells	not used	(10)
CAMU	MCF-BW-12A		Qal	23.1		Slug out 1	Bouwer-Rice			(10)
CAMU	MCF-BW-12A		Qal	38		Slug in 2	Bouwer-Rice			(10)
CAMU	MCF-BW-12A		Qal	27.5		Slug out 2	Bouwer-Rice			(10)
CAMU	MCF-BW-12A		Qal	22		Slug in 3	Bouwer-Rice			(10)
CAMU	MCF-BW-12A		Qal	31		Slug out 3	Bouwer-Rice			(10)
CAMU	MCF-BW-12A		Qal	31		Slug in 4	Bouwer-Rice			(10)
CAMU	MCF-BW-12A		Qal	18.8		Slug out 4	Bouwer-Rice			(10)
CAMU	AA-BW-08A		Qal	22.6		Slug in 1	Bouwer-Rice		Y for Qal	(10)
CAMU	AA-BW-08A		Qal	26		Slug out 1	Bouwer-Rice			(10)
CAMU	AA-BW-08A		Qal	31		Slug in 2	Bouwer-Rice			(10)
CAMU	AA-BW-08A		Qal	32		Slug out 2	Bouwer-Rice			(10)
CAMU	AA-BW-08A		Qal	30.5		Slug in 3	Bouwer-Rice			(10)
CAMU	AA-BW-08A		Qal	26		Slug out 3	Bouwer-Rice			(10)
		Qal deposits	***n=158***							
			average=	***90.1***	***ft/day***					
			geometric mean=	***22.7***						
			minimum=	***0.1***						
			maximum=	***846***						
AMPAC	TWE-15		xMCf	74.7		Slug	Bouwer-Rice		not used	(11)
AMPAC	TWE-15		xMCf	102		Slug	Bouwer-Rice			(11)
AMPAC	TWE-15		xMCf	40.4		Slug	Bouwer-Rice			(11)
AMPAC	TWE-15		xMCf	23.6		Slug	Bouwer-Rice			(11)
AMPAC	TWE-18		xMCf	6		Slug	Bouwer-Rice		Y for MCf	(11)
AMPAC	TWE-18		xMCf	6.2		Slug	Bouwer-Rice			(11)
CAMU	EC-1		Qal/UMCf	0.65		Slug in 1	Bouwer-Rice		Y for MCf	(10)
CAMU	EC-1		Qal/UMCf	0.65		Slug out 1	Bouwer-Rice			(10)
CAMU	EC-1		Qal/UMCf	0.61		Slug in 2	Bouwer-Rice			(10)
CAMU	EC-1		Qal/UMCf	0.68		Slug out 2	Bouwer-Rice			(10)
CAMU	MCF-BW-10A		UMCf	2.5		Slug in 1	Bouwer-Rice			(10)
CAMU	MCF-BW-10A		UMCf	2.82		Slug out 1	Bouwer-Rice			(10)
CAMU	MCF-BW-10A		UMCf	2.85		Slug in 2	Bouwer-Rice			(10)

TABLE 3-3
Measurements of Hydraulic Conductivity in the Study Area

Site	Well	Aquifer thickness (ft)	Lithology[1]	K (ft/d)	S	Test type	Analysis	Notes	Used to calculate Qal/MCf hydraulic K range for model calibration?	Report Source[2]
CAMU	MCF-BW-10A		UMCf	2.9		Slug out 2	Bouwer-Rice			(10)
CAMU	MCF-BW-11A		UMCf	1.01		Slug in 1	Bouwer-Rice		Y for MCf	(10)
CAMU	MCF-BW-11A		UMCf	1		Slug out 1	Bouwer-Rice			(10)
CAMU	MCF-BW-11A		UMCf	1.1		Slug in 2	Bouwer-Rice			(10)
CAMU	MCF-BW-11A		UMCf	1.05		Slug out 2	Bouwer-Rice			(10)
BMI Common Area	MCF-03B		UMCf	0.18		Slug in	Bouwer-Rice		Y for MCf	(9)
Tronox Industrial area	M-17	8	UMCf	24.3		slug test	Bouwer and Rice, 1976		Y for MCf	(4)
Tronox Industrial area	M9		Qal	7.3		Slug			Y for Qal	(4)
Tronox Industrial area	M11		Qal/xMCf/UMCf	1.1		pumping test	Jacob drawdown		Y for Qal	(4)
Tronox Industrial area	M11		Qal/xMCf/UMCf	0.9		Slug				(4)
TIMET	TPMZ-202	40	xMCF	0.15		single well, pumping test	Cooper & Jacob, recovery		Y for MCf	(12)
TIMET	TPMZ-203	40	xMCF	0.24		single well, pumping test	Cooper & Jacob, recovery		Y for MCf	(12)
TIMET	TMPZ-201	40	xMCF	0.08		single well, pumping test	Cooper & Jacob, recovery		Y for MCf	(12)
TIMET	TMPZ-201	40	xMCF	2.5	0.037	pumping test	Hantush			(12)
TIMET	TMPZ-204	60	xMCF	0.38	na	single well, pumping test	Cooper & Jacob, recovery		Y for MCf	(12)
TIMET	TMPZ-204	70	xMCF	16.85	0.089	pumping test	Theis- TMPZ-603 obs well			(12)
TIMET	TMPZ-204	60	xMCF	2.7	0.004	pumping test	Theis- TMPZ-604 obs well			(12)
TIMET	TMPZ-204	60	xMCF	1.5	0.007	pumping test	Hantush- TMPZ-605 obs well			(12)
BMI Common Area	DBMW-2	10	Qal	0.04		Slug in 1	Bouwer and Rice, 1976		not used	(7)
BMI Common Area	DBMW-2	10	Qal	0.1		Slug out 1	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-4	10	Qal	2.00		Slug in 1	Bouwer and Rice, 1976		Y for Qal	(7)
BMI Common Area	DBMW-4	10	Qal	2.10		Slug out 1	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-4	10	Qal	1.9		Slug in 2	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-4	10	Qal	2.0		Slug out 2	Bouwer and Rice, 1976			(7)
	Qal/xMCf/Qal and MCf		***n=37***							
			average=	***9.1***	***ft/day***					
			geometric mean=	***1.7***						
			minimum=	***0.04***						
			maximum=	***102***						
AMPAC	AMX-40		UMCf	4.3		Slug	Bouwer-Rice		Y for MCf	(11)
AMPAC	AMX-40		UMCf	4		Slug	Bouwer-Rice			(11)
AMPAC	AMX-40		UMCf	4.4		Slug	Bouwer-Rice			(11)
AMPAC	TWE-33		UMCf	0.41		Slug	Bouwer-Rice		Y for MCf	(11)
AMPAC	ADX-112		UMCf	0.001		Slug	Bouwer-Rice		Y for MCf	(11)
AMPAC	AMX-98		UMCf	4.4		Slug	Bouwer-Rice		Y for MCf	(11)
AMPAC	MW-AL		UMCf	3.7		Slug	Bouwer-Rice		Y for MCf	(11)
AMPAC	MW-AL		UMCf	3.8		Slug	Bouwer-Rice			(11)
AMPAC	TWA-180		UMCf	0.027		Slug	Bouwer-Rice		Y for MCf	(11)
AMPAC	TWE-51		UMCf	0.16		Slug	Bouwer-Rice		Y for MCf	(11)
AMPAC	MW-C		UMCf	3.6		Slug	Bouwer-Rice		Y for MCf	(11)
AMPAC	MW-D2D		UMCf	2.6		Slug	Bouwer-Rice		Y for MCf	(11)
AMPAC	MW-D2D		UMCf	2.7		Slug	Bouwer-Rice			(11)
AMPAC	MW-D2D		UMCf	2.6		Slug	Bouwer-Rice			(11)
Tronox Industrial area	M12		UMCf	2.6		Slug			Y for MCf	(4)

TABLE 3-3
Measurements of Hydraulic Conductivity in the Study Area

Site	Well	Aquifer thickness (ft)	Lithology[1]	K (ft/d)	S	Test type	Analysis	Notes	Used to calculate Qal/MCf hydraulic K range for model calibration?	Report Source[2]
Tronox Industrial area	M13		UMCf	4.8		Slug			Y for MCf	(4)
BMI Common Area	DBMW-8	10	Qal	0.5		Slug in 1	Bouwer and Rice, 1976		not used	(7)
BMI Common Area	DBMW-8	10	Qal	0.59		Slug out 1	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-8	10	Qal	0.52		Slug in 2	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-8	10	Qal	0.59		Slug out 2	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-9	5	Qal	0.08		Slug in 1	Bouwer and Rice, 1976		not used	(7)
BMI Common Area	DBMW-9	5	Qal	0.079		Slug out 1	Bouwer and Rice, 1976			(7)
BMI Common Area	DBMW-22	10	Qal	0.06		Slug in 1	Bouwer and Rice, 1976		not used	(7)
BMI Common Area	DBMW-22	10	Qal	0.08		Slug out 1	Bouwer and Rice, 1976			(7)
BMI Common Area	MCF-24B		MCf	0.005		Slug	Hvorslev		Y for MCf	(8)
BMI Common Area	MCF-24B		MCf	0.006		Slug	Bouwer and Rice			(8)
BMI Common Area	MCF-28A		MCf	0.004		Slug	Hvorslev		Y for MCf	(8)
BMI Common Area	MCF-28A		MCf	0.004		Slug	Bouwer and Rice			(8)
BMI Common Area	MCF-28B		MCf	0.044		Slug	Hvorslev		Y for MCf	(8)
BMI Common Area	MCF-28B		MCf	0.043		Slug	Bouwer and Rice			(8)
BMI Common Area	MCF-29A		MCf	0.077		Slug	Hvorslev		Y for MCf	(8)
BMI Common Area	MCF-29A		MCf	0.066		Slug	Bouwer and Rice			(8)
BMI Common Area	MCF-29B		MCf	0.021		Slug	Hvorslev		Y for MCf	(8)
BMI Common Area	MCF-29B		MCf	0.02		Slug	Bouwer and Rice			(8)
BMI Common Area	MCF-30A		MCf	0.032		Slug	Hvorslev		Y for MCf	(8)
BMI Common Area	MCF-30A		MCf	0.034		Slug	Bouwer and Rice			(8)
BMI Common Area	MCF-30B		MCf	0.03		Slug	Hvorslev		Y for MCf	(8)
BMI Common Area	MCF-30B		MCf	0.029		Slug	Bouwer and Rice			(8)
BMI Common Area	MCF-31A		MCf	0.005		Slug	Hvorslev		Y for MCf	(8)
BMI Common Area	MCF-31A		MCf	0.005		Slug	Bouwer and Rice			(8)
BMI Common Area	MCF-31B		MCf	0.007		Slug	Hvorslev		Y for MCf	(8)
BMI Common Area	MCF-31B		MCf	0.009		Slug	Bouwer and Rice			(8)
BMI Common Area	MCF-32B		MCf	0.077		Slug	Hvorslev		Y for MCf	(8)
BMI Common Area	MCF-32B		MCf	0.076		Slug	Bouwer and Rice			(8)
Tronox Industrial area	M-162		MCf	0.106		Slug in 1	avg of Hvorslev & Bouwer Rice		Y for MCf	(13)
Tronox Industrial area	M-162		MCf	0.123		Slug out 1	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-162		MCf	0.117		Slug in 2	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-162		MCf	0.096		Slug out 2	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-162		MCf	0.087		Slug in 3	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-162		MCf	0.037		Slug out 3	avg of Hvorsleve & Bouwer Rice			(13)
Tronox Industrial area	M-163		MCf	0.00504		Slug in 1	avg of Hvorslev & Bouwer Rice		Y for MCf	(13)
Tronox Industrial area	M-163		MCf	0.0041		Slug out 1	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-164		MCf	0.071		Slug in 1	avg of Hvorslev & Bouwer Rice		Y for MCf	(13)
Tronox Industrial area	M-164		MCf	0.096		Slug out 1	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-164		MCf	0.063		Slug in 2	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-164		MCf	0.073		Slug out 2	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-164		MCf	0.079		Slug in 3	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-164		MCf	0.078		Slug out 3	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-187		MCf	0.008		Slug in 1	avg of Hvorslev & Bouwer Rice		Y for MCf	(13)

TABLE 3-3
Measurements of Hydraulic Conductivity in the Study Area

Site	Well	Aquifer thickness (ft)	Lithology[1]	K (ft/d)	S	Test type	Analysis	Notes	Used to calculate Qal/MCf hydraulic K range for model calibration?	Report Source[2]
Tronox Industrial area	M-187		MCf	0.004		Slug out 1	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-187		MCf	0.014		Slug in 2	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-187		MCf	0.006		Slug in 3	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-187		MCf	0.011		Slug out 3	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-187		MCf	0.015		Slug in 4	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-187		MCf	0.009		Slug out 4	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-188		MCf	0.068		Slug in 1	avg of Hvorslev & Bouwer Rice		Y for MCf	(13)
Tronox Industrial area	M-188		MCf	0.083		Slug out 1	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-188		MCf	0.028		Slug in 2	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-188		MCf	0.043		Slug out 2	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-188		MCf	0.070		Slug in 3	avg of Hvorslev & Bouwer Rice			(13)
Tronox Industrial area	M-188		MCf	0.080		Slug out 3	avg of Hvorslev & Bouwer Rice			(13)
	UMCf deposits K		***n=71***							
			average=	***0.7***	***ft/day***					
			geometric mean=	***0.08***						
			minimum=	***0.001***						
			maximum*=	***5***						
Seep Area	M9	35	na	457	na					(14)
Historic Lateral		38	na	526	0.08	pumping test				(14)
Rainbow Gardens		38	na	474	0.1 -0.22	pumping test				(14)
	Las Vegas Wash deposits K		***range=***	***457-526***	***ft/day***					

Notes:

[1] Lithololog ic unit classification for other companies' wells taken from the 'All Wells Database' dated December 22, 2009, or technical report description.

[2] References for hydraulic properties measured within the Study Area

(1) Kerr-McGee Chemical, Preliminary Report on a Hydrogeologic Investigation of Channel-fill Alluvium at Pittman Lateral, Oct 19, 1998
(2) Errol Montgomery & Associates, Analysis of Rate of Groundwater Movement Based on the Results of Tracer and Hydraulic Tests, Dec 19, 2000
(3) Titanium Metals Corp., Conceptual Site Model, Titanium Metals Corp. Facility, Henderson, Nevada, April 25, 2007
(4) Kerr-McGee, Hydrogeological Investigation, July 1985
(5) Stauffer Chemical Company, Hydrogeologic Investigation Report, March 14, 1983
(6) Gerharty & Miller (1980) referenced in the Stauffer Chemical Company Hydrogeologic Investigation Report, March 14, 1983
(7) Kleinfelder, Slug Test Results for the BMI Common Area, Nov. 29, 2007
(8) Converse Consultants, Limited Hydrogeologic Investigation, BMI Common Areas, Nov. 25, 2009
(9) Kleinfelder, Slug test Results, Implementation of Revised Aquifer Testing Work Plan, BMI Common Area, Nov. 16, 2007
(10) Klenifelder, Slug Test Results, CAMU Area, Jan. 25, 2008
(11) Geosyntec/AMPAC, Groundwater Flow Model South of Warm Springs Study Area, Henderson, NV., Feb. 2010
(12) Timet, Design Data Gap Investigation, June 12, 2009
(13) Tronox, Capture Zone Evaluation Work Plan, Henderson, NV., March 25, 2010
(14) McGinley and Associates, Las Vegas Wash Initial Perchlorate Modeling Report, 2003

TABLE 3-2
Well Construction Information

Well Name	Well Type[1]	X Easting	Y Northing	TOC (ft msl)[2]	Ground Elev. (ft msl)[3]	Qal Thick-ness (ft)[4]	Boring TD (ft bgs)[5]	Well Depth (ft bgs)	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Screen Length (ft)	WBZ[6]	Screen Lithology[7]
ARP-1	mon	828593.16	26728365.51	1613.32	1613.33	40	45	44.2	14	44	30	Shallow	Qal
ARP-2A	mon	828856.20	26728402.86	1614.18	1614.75	55	55	54	23.7	53.7	30.0	Shallow	Qal
ARP-3A	mon	828722.80	26728404.34	1614.67	1614.51	41	41	41	20.7	40.7	20.0	Shallow	Qal
ARP-4A	mon	829167.89	26728411.81	1615.47	1615.72	33	35	33.0	17.7	32.7	15.0	Shallow	Qal
ARP-5A	mon	829375.01	26728458.43	1616.10	1616.50	38	40	38.0	12.7	37.7	25.0	Shallow	Qal
ARP-6B	mon	829520.52	26728499.92	1615.56	1615.70	42	43	43.0	27.7	42.7	15.0	Shallow	Qal
ARP-7	mon	829668.22	26728501.08	1613.20	1613.39	42	45	39.2	14	39	25	Shallow	Qal
ART-1A	mon	828536.78	26728122.21	1614.40	1615.80	54	58	56	19	54	35	Shallow	Qal
ART-2A	mon	828618.82	26728085.56	1616.81	1618.33	57	58	58	21	56	35	Shallow	Qal
ART-3A	extr	828768.70	26728084.70	1617.60	1619.14	53	58	55	18	53	35	Shallow	Qal
ART-4A	extr	828844.49	26728084.58	1617.46	1618.91	44	48	46	19	44	25	Shallow	Qal
ART-6	mon	829472.91	26728140.60	1615.31	1616.25	34	38	36	14	34	20	Shallow	Qal
ART-7	mon	829576.52	26728145.71	1615.38	1616.32	39	39	38.9	16.9	36.9	20	Shallow	Qal
ART-7A	mon	829582.79	26728143.19	1614.78	1616.35	41	40	41	18	38	20	Shallow	Qal
ART-7B	extr	829576.25	26728151.94	1619.62	1618.06	45	50	50	29.5	44.5	15.0	Shallow	Qal
ART-8	mon	828697.72	26728084.10	1617.69	1618.54	51	54	50.5	18	48	30	Shallow	Qal
ART-8A	extr	828691.89	26728083.31	1617.10	1618.53	52	58	54	22	52	30	Shallow	Qal
ART-9	extr	829525.57	26728143.32	1615.06	1616.16	40	45	43.0	20.5	40.5	20.0	Shallow	Qal
H-28A	mon	825864.67	26721023.60	1731.75	--	--	--	51.7	37.4	50.5	13.1	Shallow	Qal
I-AA	extr	827174.40	26719770.85	1753.93	1751.08	30	47	46.0	23.7	43.7	20.0	Shallow	UMCf
I-AB	extr	827225.04	26719790.40	1754.03	1753.89	31	51	51.0	25.0	45.0	20.0	Shallow	Qal/UMCf
I-AC	extr	828792.61	26719889.66	1752.76	1750.12	33	50	50	24.5	44.5	20.0	Shallow	Qal/UMCf
I-AD	extr	828806.68	26719794.82	1755.39	1752.94	31	50	50	24.5	44.5	20.0	Shallow	Qal/UMCf
I-AR	extr	827414.35	26719429.52	1758.35	1758.02	27	45	45	25	45	20	Shallow	UMCf
I-B	extr	827282.89	26719808.09	1752.70	1750.00	27	46	43	17.8	42.5	24.7	Shallow	Qal/xMCf/UMCf
I-C	extr	827486.47	26719791.90	1752.80	1752.00	28	45	43	13.2	42.5	29.3	Shallow	UMCf
I-D	extr	827582.21	26719805.21	1752.70	1750.00	29	47	45	16	44.5	28.5	Shallow	Qal/xMCf/UMCf
I-E	extr	827733.37	26719825.39	1752.40	1750.00	27	49	44	21.5	43.5	22	Shallow	UMCf
I-F	extr	827879.70	26719845.58	1749.70	1747.70	30	50	43.8	11.8	43.3	31.5	Shallow	Qal/xMCf/UMCf
I-G	extr	828030.70	26719866.33	1752.50	1749.20	28	44	39.3	9.5	38.8	29.3	Shallow	Qal/xMCf/UMCf
I-H	extr	828177.55	26719887.13	1753.20	1750.30	29	47	43.6	13.6	43.1	29.5	Shallow	UMCf
I-I	extr	828375.04	26719914.40	1745.50	1742.30	27	45	41	11.3	40.5	29.2	Shallow	Qal/xMCf/UMCf
I-J	extr	828573.94	26719940.33	1750.10	1746.50	28	45	41	11.2	40.5	29.3	Shallow	Qal/xMCf/UMCf
I-K	extr	828738.09	26719962.87	1746.00	1750.08	25	43	35.8	7	35.2	28.2	Shallow	UMCf
I-L	extr	827352.86	26719803.23	1751.70	1748.30	28	45	40	9	39	30	Shallow	Qal/xMCf/UMCf
I-M	extr	827669.83	26719817.42	1752.90	1749.20	30	45	40	9	39	30	Shallow	Qal/xMCf/UMCf
I-N	extr	827802.25	26719837.85	1751.40	1747.80	34	45	38	7	37	30	Shallow	Qal/xMCf/UMCf
I-O	extr	828263.13	26719898.00	1752.80	1749.00	30	40	40	9	39	30	Shallow	Qal/xMCf/UMCf
I-P	extr	828221.66	26719892.08	1751.70	1749.20	33	45	44.5	14	44	30	Shallow	Qal/xMCf/UMCf
I-Q	extr	827952.15	26719855.17	1753.10	1749.40	28	40	40	9.6	39.6	30	Shallow	Qal/xMCf/UMCf

TABLE 3-2
Well Construction Information

Well Name	Well Type[1]	X Easting	Y Northing	TOC (ft msl)[2]	Ground Elev. (ft msl)[3]	Qal Thick-ness (ft)[4]	Boring TD (ft bgs)[5]	Well Depth (ft bgs)	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Screen Length (ft)	WBZ[6]	Screen Lithology[7]
I-R	extr	827316.06	26719801.85	1751.35	1749.06	28	45	43	9.8	39.8	30	Shallow	Qal/xMCf/UMCf
I-S	extr	827404.20	26719799.87	1750.03	1747.57	27	45	45.2	12	42	30	Shallow	Qal/xMCf/UMCf
I-T	extr	828073.50	26719873.66	1751.66	1749.03	31	60	45.2	12	42	30	Shallow	Qal/xMCf/UMCf
I-U	extr	828118.60	26719879.67	1752.17	1749.54	29	45	45	12	42	30	Shallow	Qal/xMCf/UMCf
I-V	mon	828326.28	26719894.97	1752.13	1749.46	33	55	45	12	42	30	Shallow	Qal/xMCf/UMCf
I-W	mon	828245.87	26719895.87	1751.50	1749.12	33	51	50.5	20	50	30	Shallow	Qal/xMCf/UMCf
I-X	mon	827840.23	26719843.08	1748.60	1746.22	33	51	50.5	20	50	30	Shallow	Qal/xMCf/UMCf
I-Y	extr	827334.69	26719800.78	1751.40	1748.89	28	51	50.5	20	50	30	Shallow	Qal/xMCf/UMCf
I-Z	mon	828467.92	26719923.37	1743.78	1742.19	25	40	35	15	35	20	Shallow	Qal/xMCf/UMCf
M-10	mon	828536.18	26716636.63	1836.21	1834.11	27	75	67	43	63	20	Shallow	Qal/xMCf/UMCf
M-100	mon	827659.99	26720820.26	1730.93	1728.63	29	31	30.5	19	29	10	Shallow	Qal
M-101	mon	828060.83	26720786.74	1730.81	1728.57	27	30	29	17	27	10	Shallow	Qal
M-102	mon	828437.98	26720705.96	1740.24	1738.18	39	42	41.4	19.4	39.4	20.0	Shallow	Qal
M-11	mon	828617.03	26717608.56	1815.53	1813.45	45	60	58	33.3	53	19.7	Shallow	Qal/xMCf/UMCf
M-111A	mon	827447.19	26719134.86	1768.77	1766.25	30	40	40	29.7	39.7	10	Shallow	UMCf
M-115	mon	827243.65	26718612.90	1783.44	1787.64	38	45	45.2	35	45	10	Shallow	Qal/xMCf/UMCf
M-12A	mon	828178.52	26717575.29	1812.76	1812.72	38	50	50	40	50	10	Shallow	UMCf
M-126	mon	826569.37	26719505.57	1759.01	1756.40	20	50	40	19.7	39.7	20	Shallow	UMCf
M-130	mon	828832.01	26719919.70	1749.23	1746.55	25	40	--	20	40	20	Shallow	Qal/UMCf
M-131	mon	827158.08	26719770.57	1754.13	1751.05	30	40	39.0	28.7	38.7	10	Shallow	UMCf
M-135	mon	827154.48	26719890.17	1751.85	1749.17	30	39	39.0	28.7	38.7	10	Shallow	UMCf
M-137	mon	827666.01	26716034.02	1847.54	1845.02	30	37	75	52	72	20	Shallow	UMCf
M-138	mon	827816.34	26716058.31	1846.35	1844.06	32	65	65	51	66	15	Shallow	UMCf
M-139	mon	829044.25	26717213.06	1813.47	1813.71	29	60	60	45	60	15	Shallow	UMCf
M-140	extr	827428.84	26719889.51	1748.21	1745.67	25	45	43	22.7	42.7	20	Shallow	Qal/UMCf
M-141	mon	828465.43	26718195.34	1797.16	1797.52	42	40	40	37.5	47.5	10	Shallow	UMCf
M-142	mon	827191.75	26718713.09	1773.55	1774.04	22	45	--	--	--	--	--	--
M-143	mon	827413.88	26717408.39	1813.33	1813.38	32	45	45	35	45.0	10	Shallow	UMCf
M-144	mon	827644.50	26717026.00	1813.31	1813.20	27	45	45	35	45.0	10	Shallow	UMCf
M-145	mon	829205.27	26717451.15	1812.18	1812.70	36	60	60	45	60.0	15	Shallow	UMCf
M-146	mon	827774.94	26716991.91	1812.65	1812.97	27	50	50	40	50.0	10	Shallow	UMCf
M-147	mon	828824.17	26718857.89	1778.39	1778.57	27	40	40	25	40.0	15	Shallow	UMCf
M-148A	mon	829030.35	26718357.14	1800.04	1797.74	45	50	50	39.7	49.7	10	Shallow	Qal/UMCf
M-14A	mon	827045.36	26719382.67	1760.93	1758.38	28	40	40.2	20	40	20	Shallow	UMCf
M-159	mon	826758.00	26719824.06	1754.88	1752.41	26	75	75	64.7	74.7	10	Shallow	UMCf
M-160	mon	826769.05	26719826.22	1754.73	1752.14	26	50	50	39.7	49.7	10	Shallow	UMCf
M-163	mon	827873.42	26719939.04	1747.95	1745.63	35	90	90	79.7	89.7	10	Shallow	UMCf
M-164	mon	827870.17	26719949.61	1747.61	1745.19	35	70	70	59.7	69.7	10	Shallow	UMCf
M-166	mon	827230.05	26719779.41	1751.09	1751.49	28	32	32	21.7	31.7	10	Shallow	Qal/UMCf
M-167	mon	827337.72	26719787.69	1749.95	1749.84	25	30	30	19.7	29.7	10	Shallow	Qal/UMCf

TABLE 3-2
Well Construction Information

Well Name	Well Type[1]	X Easting	Y Northing	TOC (ft msl)[2]	Ground Elev. (ft msl)[3]	Qal Thick-ness (ft)[4]	Boring TD (ft bgs)[5]	Well Depth (ft bgs)	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Screen Length (ft)	WBZ[6]	Screen Lithology[7]
M-168	mon	827408.08	26719788.50	1748.46	1748.71	27	35	32	21.7	31.7	10	Shallow	Qal/UMCf
M-169	mon	827469.30	26719786.63	1750.22	1750.64	27	35	35	24.7	34.7	10	Shallow	Qal/UMCf
M-170	mon	827577.55	26719796.38	1750.66	1750.51	29	35	35	24.7	34.7	10	Shallow	Qal/UMCf
M-171	extr	827718.15	26719905.85	1749.48	1746.87	27	45	45	24.7	44.7	20	Shallow	Qal/UMCf
M-172	mon	827894.87	26719835.83	1750.58	1750.39	31	38	37	26.7	36.7	10	Shallow	Qal/UMCf
M-173	mon	828181.82	26719875.60	1749.88	1749.83	30	40	40	24.7	39.7	15	Shallow	Qal/UMCf
M-174	mon	828379.00	26719902.97	1742.29	1742.16	25	30	28	17.7	27.7	10	Shallow	Qal/UMCf
M-175	mon	828471.22	26719911.14	1742.74	1742.79	25	30	29	18.7	28.7	10	Shallow	Qal/UMCf
M-176	mon	828586.42	26719948.07	1745.35	1745.45	30	35	30	19.7	29.7	10	Shallow	Qal
M-177	mon	828724.83	26719965.79	1743.23	1743.26	25	35	30	19.7	29.7	10	Shallow	Qal/UMCf
M-178	extr	828012.64	26719955.96	1749.65	1747.10	26	46	46	25.7	45.7	20	Shallow	Qal/UMCf
M-179	extr	828317.19	26720002.95	1749.98	1747.28	35	55	53	33.7	52.7	19	Shallow	Qal/xMCf/UMCf
M-18	mon	828665.45	26720182.87	1740.48	1738.95	24	28	28	14	24	10	Shallow	Qal
M-180	mon	828806.85	26719785.94	1755.79	1753.23	31	43	39	23.7	38.7	15	Shallow	Qal/UMCf
M-182	mon	828815.50	26719588.73	1761.83	1759.40	32	90	90	79.7	89.7	10	Shallow	UMCf
M-19	mon	828846.19	26719350.03	1766.77	1764.41	31	40	40	14.5	34.5	20	Shallow	UMCf
M-22A	mon	828270.11	26719531.63	1759.46	1758.90	29	37	36.4	16	36	20	Shallow	Qal/xMCf/UMCf
M-23	mon	827373.96	26721391.25	1720.35	1717.54	38	43	43	9.4	37.4	28	Shallow	Qal
M-25	mon	827677.80	26719503.57	1759.93	1756.89	25	40	39	24	39	15	Shallow	Qal/xMCf/UMCf
M-31A	mon	828368.37	26718289.58	1796.87	1796.94	43	55	55	35	55	20	Shallow	UMCf
M-34	mon	828318.25	26718833.45	1777.10	1774.04	35	40	40	25	40	15	Shallow	Qal/xMCf/UMCf
M-35	mon	828509.37	26718840.13	1775.95	1773.05	34	40	40	25	40	15	Shallow	UMCf
M-36	mon	828069.09	26719556.63	1759.82	1756.89	28	35	35	20	35	15	Shallow	UMCf
M-37	mon	827414.22	26719422.01	1761.06	1758.13	27	35	35	20	35	15	Shallow	UMCf
M-38	mon	827877.66	26719523.27	1759.73	1757.82	26	35	35	20	35	15	Shallow	UMCf
M-39	mon	828548.82	26719525.34	1761.13	1758.61	34	40	40	24.9	39.9	15	Shallow	Qal/xMCf/UMCf
M-44	mon	827005.61	26722699.15	1698.31	1695.74	20	35	35	5	35	30	Shallow	Qal/xMCf/UMCf
M-50	mon	828083.47	26718315.58	1795.64	1793.08	40	60	60	39.6	59.6	20	Shallow	UMCf
M-55	mon	827683.04	26719819.36	1750.88	1749.43	31	46	44.6	14.6	44.6	30	Shallow	Qal/xMCf/UMCf
M-56	mon	827980.36	26719859.52	1750.83	1749.65	25	40	40	15	40	25	Shallow	Qal/xMCf/UMCf
M-57A	mon	826993.31	26719716.74	1753.44	1751.23	25	40	40.2	20	40	20	Shallow	UMCf
M-58	mon	828276.62	26719900.55	1751.25	1748.72	30	45	45	15	45	30	Shallow	Qal/xMCf/UMCf
M-5A	mon	826179.29	26719961.12	1751.80	1749.69	31	50	50	40	50	10	Shallow	UMCf
M-60	mon	828079.11	26719872.48	1750.94	1749.31	28	43	43	17.8	42.8	25	Shallow	UMCf
M-61	mon	828673.67	26719955.76	1747.55	1744.51	27	41	39	9.3	38.8	29.5	Shallow	Qal/xMCf/UMCf
M-64	mon	827601.30	26719748.40	1749.76	1748.80	23	38	37.5	12.7	37.3	24.6	Shallow	Qal/xMCf/UMCf
M-65	mon	827899.72	26719746.36	1753.91	1751.84	29	40	39.2	14.4	39	24.6	Shallow	Qal/xMCf/UMCf
M-66	mon	828183.64	26719787.47	1754.24	1751.70	33	43	42.5	17.5	42.3	24.8	Shallow	Qal/xMCf/UMCf
M-67	mon	828508.52	26719829.72	1745.91	1743.64	23	38	38	7.8	37.8	30	Shallow	Qal/xMCf/UMCf
M-68	mon	828751.00	26719864.47	1750.23	1747.16	25	41	41	11.2	39.8	28.6	Shallow	Qal/xMCf/UMCf

TABLE 3-2
Well Construction Information

Well Name	Well Type[1]	X Easting	Y Northing	TOC (ft msl)[2]	Ground Elev. (ft msl)[3]	Qal Thick-ness (ft)[4]	Boring TD (ft bgs)[5]	Well Depth (ft bgs)	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Screen Length (ft)	WBZ[6]	Screen Lithology[7]
M-69	mon	827265.73	26719885.28	1749.75	1747.80	30	40	40	19.9	39.3	19.4	Shallow	Qal/xMCf/UMCf
M-6A	mon	825984.54	26721013.69	1733.19	1730.84	34	46	43.6	26.8	41.5	14.7	Shallow	Qal/xMCf/UMCf
M-70	mon	827567.35	26719904.69	1748.25	1746.00	31	41	40.2	15.3	40	24.7	Shallow	Qal/xMCf/UMCf
M-71	mon	827859.71	26719943.63	1747.04	1744.87	33	43	42.2	17.5	42	24.5	Shallow	Qal/xMCf/UMCf
M-72	mon	828172.13	26719977.14	1746.49	1744.62	25	36	35	10.1	34.8	24.7	Shallow	Qal/xMCf/UMCf
M-73	mon	828427.82	26720018.47	1741.14	1738.87	24	36	36	11	35.8	24.8	Shallow	Qal/xMCf/UMCf
M-74	mon	828713.65	26720062.18	1744.38	1742.51	24	39	39	9.2	38.8	29.6	Shallow	UMCf
M-76	mon	827550.73	26718659.92	1785.22	1781.68	37	51	51.4	34.6	49.3	14.7	Shallow	UMCf
M-77	mon	828933.94	26718047.69	1799.61	1798.09	39	46	45.9	29	43.8	14.8	Shallow	Qal/xMCf/UMCf
M-78	mon	827777.45	26719838.17	1751.50	1749.54	32	44	43.6	21.5	41.5	20	Shallow	Qal/xMCf/UMCf
M-79	mon	827382.10	26720048.92	1742.53	1742.57	27	38	37.6	10.8	35.4	24.6	Shallow	Qal/xMCf/UMCf
M-7B	mon	826106.50	26720979.66	1732.83	1730.35	30	53	52.5	25.5	50.5	25	Shallow	Qal/xMCf/UMCf
M-80	mon	827759.79	26720112.87	1746.04	1743.66	32	44	43.7	11.5	41.5	30	Shallow	Qal/xMCf/UMCf
M-81A	mon	828139.67	26720176.85	1744.16	1742.58	32	40	40	30	40	10	Shallow	Qal/xMCf/UMCf
M-83	mon	827586.44	26720161.50	1742.77	1739.89	33	43	42.5	10.8	40.3	29.5	Shallow	Qal/xMCf/UMCf
M-84	mon	827766.70	26720189.13	1741.03	1738.48	25	37	36.6	11.8	34.1	22.3	Shallow	Qal/xMCf/UMCf
M-85A	mon	827963.24	26720228.81	1741.80	1739.43	25	35	35	19.7	34.7	15.0	Shallow	Qal/UMCf
M-86A	mon	828141.69	26720245.83	1744.32	1741.35	30	45	45	24.7	44.7	20.0	Shallow	Qal/UMCf
M-87	mon	828358.13	26720276.13	1744.13	1741.51	30	41	41	9.3	38.8	29.5	Shallow	UMCf
M-88	mon	828588.75	26720313.96	1739.35	1736.93	28	39	39	7.3	36.8	29.5	Shallow	Qal/xMCf/UMCf
M-89	mon	827890.08	26719294.84	1766.19	1763.69	36	40	38.2	18	38.2	20.2	Shallow	Qal/xMCf/UMCf
M-92	mon	827138.09	26717531.94	1800.76	1797.99	20	46	45.5	34.9	44.9	10	Shallow	UMCf
M-93	mon	827143.44	26717685.92	1797.54	1797.81	24	46	46	35.4	45.4	10	Shallow	UMCf
M-95	mon	827222.85	26722695.81	1695.07	1695.27	21	26	22	12	22	10	Shallow	Qal
M-96	mon	827626.08	26722700.30	1693.52	1693.80	21	22	20.5	10.5	20.5	10	Shallow	Qal
M-97	mon	827492.47	26717795.18	1800.85	1798.35	22	50	45.5	35	45	10	Shallow	UMCf
M-99	mon	827309.69	26720851.72	1730.74	1728.29	30	34	33	16	31	15	Shallow	Qal
MC-29	mon	825566.30	26721514.06	1723.40	--	49	50	50	37.5	50	13	Shallow	Qal/UMCf
MC-45	mon	825400.47	26722229.62	1710.98	--	34	34	34	30	34	4	Shallow	Qal
MC-50	mon	825534.89	26722075.95	1713.32	1711.99	49	50	49	26	49	23	Shallow	Qal
MC-53	mon	825942.62	26721919.63	1715.27	1713.34	37	40	38	19	38	19	Shallow	Qal/UMCf
MC-65	mon	826119.34	26722421.15	1705.43	1703.62	39	41	41	20	41	21	Shallow	Qal/UMCf
MC-69	mon	825235.62	26721806.62	1718.66	1716.98	43	44	44	29	44	15	Shallow	Qal/UMCf
MC-93	mon	825948.84	26721672.78	1719.26	1717.92	39	42	42	32	42	10	Shallow	Qal/UMCf
MC-97	mon	825838.55	26721425.52	1723.95	1723.10	40	42	41	31	41	10	Shallow	Qal/UMCf
MW-K4	mon	828994.00	26728410.00	1615.70	1615.70	35	50	50	9.5	50	40.5	Shallow	xMCf
MW-K5	mon	829617.00	26730252.00	1598.87	1589.30	13	44	44	28.5	44	15.5	Shallow	xMCf/UMCf
PC-101R	mon	828711.72	26728107.74	1618.12	1618.12	51	52	50.5	20	50	30	Shallow	Qal
PC-103	extr	829110.87	26730205.73	1599.49	1597.02	29	30	29.5	9	29	20	Shallow	Qal
PC-115R	extr	831148.64	26733131.33	1554.71	1554.79	50	58	55.5	10	50	40	Shallow	Qal

TABLE 3-2
Well Construction Information

Well Name	Well Type[1]	X Easting	Y Northing	TOC (ft msl)[2]	Ground Elev. (ft msl)[3]	Qal Thick-ness (ft)[4]	Boring TD (ft bgs)[5]	Well Depth (ft bgs)	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Screen Length (ft)	WBZ[6]	Screen Lithology[7]
PC-116R	extr	831348.43	26733203.15	1552.10	1552.04	49	58	55.5	10	50	40	Shallow	Qal
PC-117	extr	831422.37	26733275.94	1552.26	1551.23	51	58	53	11	51	40	Shallow	Qal
PC-118	extr	831051.99	26733167.39	1554.53	1553.65	50	52	51	9	49	40	Shallow	Qal
PC-119	extr	830951.29	26733188.50	1554.66	1554.34	47	49	47	15	45	30	Shallow	Qal
PC-120	extr	830851.47	26733185.77	1554.64	1554.41	45	48	47	15	45	30	Shallow	Qal
PC-121	extr	830751.31	26733180.39	1554.10	1554.70		41	38.5	6.5	36.5	30	Shallow	Qal
PC-122	mon	829675.17	26728145.17	1617.39	1617.55	37	40	38	22.5	37.5	15	Shallow	Qal
PC-123	mon	829485.04	26727358.44	1626.44	1626.70	33	36	35.2	20	35	15	Shallow	Qal/xMCf/UMCf
PC-124	mon	830132.95	26726741.58	1635.73	1636.30	32	36	35.5	20.3	35.3	15	Shallow	Qal/xMCf/UMCf
PC-125	mon	829925.95	26726739.82	1635.06	1632.41	32	34	33.9	18.7	33.7	15	Shallow	Qal/xMCf/UMCf
PC-126	mon	829724.72	26726737.84	1634.33	1634.66	--	35	34.7	19.5	34.5	15	Shallow	Qal
PC-127	mon	829316.65	26726735.62	1632.42	1632.92	33	35	35.5	15	35	20	Shallow	Qal/xMCf/UMCf
PC-128	mon	828953.97	26726732.39	1633.36	1633.62	32	35	35	14.8	34.8	20	Shallow	Qal/xMCf/UMCf
PC-129	mon	828747.28	26726730.81	1633.99	1634.36	--	39	39.0	12.8	38.0	37.8	Shallow	Qal
PC-130	mon	828538.19	26726729.31	1633.21	1633.50	48	50	50	14.8	49.8	35	Shallow	Qal/xMCf/UMCf
PC-131	mon	828123.28	26726725.41	1633.58	1634.28	40	40	40	9.8	39.8	30	Shallow	Qal/xMCf/UMCf
PC-132	mon	827913.94	26726723.10	1634.84	1635.21	32	40	40	9.8	39.8	30	Shallow	Qal/xMCf/UMCf
PC-133	extr	831758.00	26733209.00	1553.00	1551.84	38	40	40.2	5	40	35	Shallow	Qal/xMCf/UMCf
PC-134A	mon	828775.80	26728143.15	1618.57	1618.84	49	70	70	59.7	69.7	10	Shallow	UMCf
PC-135A	mon	828767.49	26728143.03	1618.58	1618.77	51	55	51	30.7	50.7	20	Shallow	Qal
PC-136	mon	829517.91	26728191.38	1618.04	1618.78	41	41	41	20.7	40.7	20	Shallow	Qal
PC-141	mon	828446.31	26728106.63	1619.53	1617.12	32	55	55	44.7	54.7	10	Shallow	Qal
PC-142	mon	828436.04	26728106.76	1619.64	1617.14	32	32	32	21.7	31.7	10	Shallow	Qal
PC-143	mon	828698.71	26728238.64	1619.20	1619.25	65	65	65	29.7	64.7	35	Shallow	Qal
PC-144	mon	828903.75	26728223.86	1618.63	1618.93	38	45	40	29.7	39.7	10	Shallow	Qal
PC-145	mon	829536.07	26728324.97	1617.76	1618.10	40	45	40	24.7	39.7	15	Shallow	Qal
PC-146	mon	829812.54	26728152.19	1617.67	1617.78	30	35	30	19.7	29.7	10	Shallow	Qal
PC-147	mon	829767.43	26728153.17	1617.51	1617.76	32	35	32	21.7	31.7	10	Shallow	Qal
PC-148	mon	829249.33	26728124.42	1617.96	1617.79	25	50	50	24.5	44.5	20	Shallow	UMCf
PC-149	mon	829117.97	26728122.90	1618.93	1618.93	32	50	50	24.5	44.5	20	Shallow	UMCf
PC-150	mon	828915.29	26728104.18	1619.09	1618.36	39	45	50	19.5	39.5	20	Shallow	Qal
PC-18	mon	828636.25	26728079.97	1618.47	1618.55	52	53	52	11.5	51.5	40	Shallow	Qal
PC-28	mon	828530.65	26725375.67	1650.85	1651.17	18	22	20	10	19.5	9.5	Shallow	Qal
PC-31	mon	826781.65	26725195.83	1657.86	1658.13	50	52	50	14.5	49.5	35	Shallow	Qal
PC-37	mon	826612.10	26722172.24	1707.72	1706.64	41	44	42	16.8	41.8	25	Shallow	Qal
PC-40	mon	826476.78	26723971.04	1679.23	1677.05	56	60	55.2	15	55	40	Shallow	Qal
PC-53	mon	829941.58	26730225.29	1595.03	1593.14	32	35	33	13	32.5	19.5	Shallow	Qal
PC-54	mon	828296.34	26722067.79	1704.43	1704.40	40	38	35	9.5	34.5	25	Shallow	Qal
PC-55	mon	828530.49	26728056.66	1617.19	1617.39	52	55	54.9	4	54	50	Shallow	Qal/xMCf/UMCf
PC-56	mon	830645.29	26732289.43	1568.25	1568.99	52	58	55	4.8	54.8	50	Shallow	Qal/xMCf/UMCf

TABLE 3-2
Well Construction Information

Well Name	Well Type[1]	X Easting	Y Northing	TOC (ft msl)[2]	Ground Elev. (ft msl)[3]	Qal Thick-ness (ft)[4]	Boring TD (ft bgs)[5]	Well Depth (ft bgs)	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Screen Length (ft)	WBZ[6]	Screen Lithology[7]
PC-58	mon	831123.78	26732118.20	1568.01	1568.24	32	36	33	7.8	32.8	25	Shallow	Qal
PC-59	mon	830150.30	26732452.69	1567.92	1568.34	32	38	35	4.8	34.8	30	Shallow	Qal/xMCf/UMCf
PC-60	mon	830405.14	26732358.75	1568.38	1568.80	39	43	40	4.5	39.5	35	Shallow	Qal
PC-62	mon	829764.28	26732733.52	1567.83	1568.45	35	38	38	7.6	37.6	30	Shallow	Qal/xMCf/UMCf
PC-64	mon	827916.52	26723702.44	1675.29	1675.51	19	20	19.5	4	19	15	Shallow	Qal
PC-65	mon	828386.90	26723682.74	1675.21	1676.07	19	22	19.1	4.1	18.7	14.6	Shallow	Qal
PC-66	mon	828779.40	26723966.95	1673.53	1674.05	25	28	27.3	6.9	26.9	20	Shallow	Qal/xMCf/UMCf
PC-67	mon	829207.80	26723846.87	1673.82	1674.38	36	38	36	11	35.6	24.6	Shallow	Qal
PC-68	mon	829616.96	26732906.82	1566.97	1567.66	50	55	55.3	9.9	54.9	45	Shallow	Qal/xMCf/UMCf
PC-71	mon	826805.90	26722687.72	1698.73	1696.11	20	33	30.4	13.4	28.4	15	Shallow	Qal/xMCf/UMCf
PC-72	mon	826604.72	26722688.82	1699.43	1696.89	34	38	37	15	35	20	Shallow	Qal
PC-73	mon	826404.90	26722694.93	1699.50	1697.56	44	48	47.5	20	45	25	Shallow	Qal
PC-86	mon	830826.99	26733185.76	1553.85	1554.08	47	30	28	17.5	27.5	10	Shallow	Qal
PC-90	mon	831271.92	26733192.63	1550.46	1550.53	51	18	15	4.5	14.5	10	Shallow	Qal
PC-91	mon	831729.99	26733110.85	1552.33	1552.42	40	65	37	26.5	36.5	10	Shallow	Qal
PC-92	mon	831749.30	26733109.85	1552.05	1552.12	40	30	22	11.5	21.5	10	Shallow	Qal
PC-94	mon	832189.05	26733122.48	1548.95	1548.84	40	25	20	9.5	19.5	10	Shallow	Qal
PC-97	mon	831565.69	26733441.54	1548.53	1548.78	43	45	33.5	23	33	10	Shallow	Qal
PC-98R	extr	829522.58	26730260.53	1593.35	1593.46	41	42	40.5	20	35	15	Shallow	Qal
PC-99R3	extr	831255.55	26733160.44	1552.48	1551.90	52	58	55.5	10	50	40	Shallow	Qal
TR-6	mon	826594.34	26717608.38	1800.36	1797.53	37	81	80	60	80	20	Shallow	UMCf
TR-8	mon	826722.81	26716512.15	1829.08	1826.54	43	98	93.5	63	93	30	Shallow	UMCf
M-48A	mon	828294.38	26721339.07	1718.36	1718.58	32	40	40	19.7	39.7	20	Shallow	Qal/UMCf
M-117	mon	828917.06	26715198.29	1880.31	1877.98	47	157	155	130	150	20	Middle	UMCf
M-118	mon	828036.40	26715068.01	1876.91	1874.53	52	167	163	138	158	20	Middle	UMCf
M-120	mon	828387.79	26715162.90	1878.58	1875.81	49	107	105	80	100	20	Middle	UMCf
M-121	mon	827694.57	26715011.24	1875.63	1872.90	45	107	102	77	97	20	Middle	UMCf
M-132	mon	828714.61	26720048.49	1744.27	1741.41	22	90	90	80	90	10	Middle	UMCf
M-133	mon	828698.61	26720067.29	1743.62	1740.93	22	70	70	60	70	10	Middle	UMCf
M-134	mon	827144.35	26719889.14	1752.14	1749.39	30	70	70	60	70	10	Middle	UMCf
M-136	mon	827165.34	26719889.77	1751.87	1749.09	31	90	90	80	90	10	Middle	UMCf
M-149	mon	828373.15	26718285.78	1796.81	1797.14	46	120	120	100	120	20	Middle	UMCf
M-150	mon	828059.15	26719569.83	1758.86	1756.50	28	145	145	125	145	20	Middle	UMCf
M-151	mon	827643.03	26720826.75	1730.64	1728.31	34	145	145	125	145	20	Middle	UMCf
M-152	mon	826973.49	26722690.63	1698.50	1695.79	22	145	145	125	145	20	Middle	UMCf
M-153	mon	828385.61	26718287.91	1796.69	1797.15	46	170	170	150	170	20	Middle	UMCf
M-154	mon	828047.74	26719568.61	1758.78	1756.51	28	195	195	175	195	20	Middle	UMCf
M-155	mon	827636.10	26720827.40	1730.69	1728.30	34	220	220	200	220	20	Middle	UMCf
M-156	mon	826964.22	26722690.74	1698.38	1695.84	22	195	195	175	195	20	Middle	UMCf
M-161	mon	827134.13	26719889.85	1752.40	1749.95	31	110	110	99.7	109.7	10	Middle	UMCf

TABLE 3-2
Well Construction Information

Well Name	Well Type[1]	X Easting	Y Northing	TOC (ft msl)[2]	Ground Elev. (ft msl)[3]	Qal Thick-ness (ft)[4]	Boring TD (ft bgs)[5]	Well Depth (ft bgs)	Screen Top (ft bgs)	Screen Bottom (ft bgs)	Screen Length (ft)	WBZ[6]	Screen Lithology[7]
M-162	mon	827877.81	26719946.02	1747.82	1745.67	35	110	110	99.7	109.7	10	Middle	UMCf
M-165	mon	828701.37	26720053.24	1743.84	1741.25	22	120	120	109.7	119.7	10	Middle	UMCf
M-181	mon	828816.30	26719579.72	1761.76	1759.26	32	120	115	104.7	114.7	10	Middle	UMCf
M-186	mon	829022.55	26718356.19	1800.60	1797.99	45	120	115	104.7	114.7	10	Middle	UMCf
M-187	mon	827375.01	26718180.84	1799.77	1797.33	36	170	170	159.7	169.7	10	Middle	UMCf
M-188	mon	827377.14	26718171.32	1799.77	1797.38	36	120	120	109.7	119.7	10	Middle	UMCf
PC-137	mon	829517.61	26728199.10	1618.45	1618.77	40	74	74	63.7	73.7	10	Middle	UMCf
TR-10	mon	827562.53	26715739.77	1854.06	1851.72	45	102	100.5	80	100	20	Middle	UMCf
TR-11	mon	825422.57	26721918.29	1717.12	1714.80	50	255	230.5	210	230	20	Middle	UMCf
TR-12	mon	825286.37	26723271.82	1695.84	1693.44	43	293	292.5	272	292	20	Middle	UMCf
TR-2	mon	826156.85	26719954.57	1751.79	1749.45	37	180	175	144.5	174.5	30	Middle	UMCf
TR-3	mon	826342.89	26718941.61	1772.84	1770.08	27	252	250	219.5	249.5	30	Middle	UMCf
TR-4	mon	826342.53	26718951.58	1772.55	1770.04	27	147	145	124.5	144.5	20	Middle	UMCf
TR-5	mon	826595.86	26717592.13	1800.27	1797.45	37	252	251.5	221	251	30	Middle	UMCf
TR-7	mon	826724.99	26716525.47	1829.03	1826.56	43	292	290.5	260	290	30	Middle	UMCf
TR-9	mon	827560.22	26715752.71	1854.29	1851.75	45	251	250.5	230	250	20	Middle	UMCf
TR-8	mon	826722.81	26716512.15	1829.08	1826.54	43	98	93.5	63	93	30	Middle	UMCf
TR-1	mon	826168.04	26719957.91	1752.18	1749.41	37	312	312	281.5	311.5	30	Deep	UMCf

Notes:

-- Information is not available

1 Primary use of the well: mon is montioring well; extr is extraction well

2 TOC is top of casing; ft msl is feet above mean sea level

3 Ground Elevevation measured at the north side of the well casing

4 Thickness of the alluvium as measured from the ground surface; some wells indicate this as the feet below ground surface to the Upper Muddy Creek Formation contact

5 Well boring total depth measured in feet below ground surface

6 WBZ is water bearing zone

7 Lithology classification from the 'All_Wells' database: Qal is alluvium; UMCf is Upper Muddy Creek Formation; xMCf is transitional Upper Muddy Creek Formation (distinction is interpretive)

= Replacement well

= New extraction well

= New monitoring well

TABLE 3-1
Historical Potential Source Areas of Chromium and Perchlorate Contamination

ID[1]	Source	Description
Hexavalent Chromium Potential Source Areas		
LOU 5	On-Site Beta Ditch	From 1945-1976, chromium-containing waste streams from the sodium perchlorate and ammonium perchlorate process were discharged to the BMI Ponds via the unlined Beta Ditch
LOU 7/ 8	Old P-2 and P-3 Ponds (and conveyance facilities)	From 1978- 1986 these surface impoundments were used to collect and concentrate dilute sodium chlorate process solutions via evaporation. They were constructed with single-layer synthetic liners and experienced numerous reported leaks and liner failures before being closed and replaced with the double-lined P-3 Pond.
LOU 9	New P-2 Pond (and associated piping)	Replaced Old P-2 & P-3 Ponds noted above and received same wastes. Initially constructed with two liners (a 36-mil unreinforced PVC liner and a 36-mil reinforced polyester liner); later an additional 60-mil HDPE liner was installed on top of the top liner.
LOU 11	Sodium Chlorate Filter Cake Drying Pad Area	Pad (north of Unit 3) used to dry particulate material removed from the sodium chlorate process. Demolished in 1991and replaced with a new tank containment system. Chromium contamination of soil around the pad was reported and soil was removed and disposed off-site as hazardous waste prior to installation of the tank system.
LOU 12	Hazardous Waste Storage Area	Located between Units 3 and 4, chromium-containing solid hazardous waste from the sodium chlorate process and sodium chlorate filter cake holding area was stored in an eight-wheeled semi-dump trailer.
LOU 13/14	Ponds S-1 and P-1 (and associated piping)	Single-lined surface impoundments used in the sodium chlorate production process. S-1 Pond was constructed for evaporative disposal of potassium chlorate, sodium chlorate, sodium perchlorate, and boron manufacturing processes (closed January 1983). Sampling after liner removal showed chromium contamination of underlying soil. P-1 Pond received similar process wastes, and KMCC documents reported that the P-1 liner failed in 1975 and was replaced in 1980 (decommissioned in 1983 and closed in 1985). Sampling after liner removal showed chromium contamination of underlying soil.
LOU 15	Platinum Drying Unit	A 20 by 32 foot concrete-floored and -bermed containment pad used to recover platinum from a sodium perchlorate process byproduct. In 1993 TCLP samples of the concrete pad materials detected chromium.
LOU 16/17	Ponds AP-1, AP-2, AP-3	Part of the ammonium perchlorate manufacturing process. These surface impoundments and associated transfer lines contained low-levels of chromium and are not reported to have leaked.
LOU 28	Hazardous Waste Storage Area	Located north of Unit 2, four segregated storage areas on concrete pads constructed to hold hazardous waste prior to transport to an off-site landfill; wastes consisted of used oil, solvents, and hexavalent chromium contaminated materials.
LOU 43	Unit 4 & 5 Basements	1985 KMCC investigations revealed significant volumes of chromium-containing process solutions leaked from the basements of Units 4 and 5 during production of sodium chlorate and sodium perchlorate. Basements served as sumps collecting chromium-laden process liquor, spillage, and wastewater. Deterioration and cracking of the concrete foundations led to release of liquids to underlying soil and groundwater. Initial mitigation efforts included concrete sealing and basement repairs. Unit 4 and 5 operations were discontinued in the late 1990s.
LOU 46	Former Old Main Cooling Tower and Recirculation Lines	Located north of the manganese dioxide process leach plant, it was approximately 50 ft high and 700 ft long. Installed by US government and operated from 1941 to Sep 1989. Experienced several recirculation water upsets, resulting in discharges of high-conductivity water to the Beta Ditch. KMCC records indicate on 5/10/80, sodium chlorate process solution entered the recirculation water system due a gasket failure and due fire concern about chlorate impregnating the wood, approximately 500K- 600K gal. of chromium-contaminated water was routed to the BMI Ponds via the Beta Ditch (LOU 5)
Perchlorate Potential Source Areas		
LOU 5	On-Site Beta Ditch	From 1945-1976, chromium-containing waste streams from the sodium perchlorate and ammonium perchlorate process were discharged to the BMI Ponds via the unlined Beta Ditch

TABLE 3-1
Historical Potential Source Areas of Chromium and Perchlorate Contamination

ID[1]	Source	Description
Perchlorate Potential Source Areas (continued)		
LOUs 16-19	Ponds AP-1 through AP-5	Ponds AP-1, AP-2, AP-3, AP-4, and AP-5 (and associated transfer lines) were part of the ammonium perchlorate manufacturing process. These surface impoundments were not known to have leaked.
LOU 30	Ammonium Perchlorate Area – Pad 35	Pad 35 was an accumulation point for drummed nonhazardous solid waste associated with the ammonium perchlorate process area. The pad was known to suffer deterioration and cracking.
LOU 31	Drum Crushing & Recycling Area	The drum crushing and recycling area consisted of a drum crusher on a concrete pad located to the east of the Old D-1 Building. The drums were typically rinsed in the AP process area prior to being crushed and recycled.
LOU 33	Sodium Perchlorate Platinum by-product filter – Unit 5	The platinum recovery filter press was located on a 75 foot by 100 foot concrete pad east of Unit 5. The pad was a generation point for a platinum bearing filter cake (a by-product from the sodium perchlorate production process) and the press was surrounded by 8" thick by 8" high concrete berms. The pad had a sump that collected and contained process/wash-down liquids that were returned to the process stream via pumps. The concrete pad was known to have cracked; it was eventually sealed using industrial membrane material.
LOU 43	Unit 4 and 5 Basements	Perchlorate and chlorate materials were produced in electrolytic cells located in Units 4 and 5. The basements in Units 4 and 5 served as sumps to collect perchlorate-laden process liquor, spillage, and wastewater. Deterioration and cracking of the concrete foundations led to the release of perchlorate and into underlying soil and groundwater (Kleinfelder, 1993). Initial mitigation efforts to reduce contamination involved concrete sealing and repair of the basements. Operation of the electrolytic cells in Units 4 and 5 was discontinued in the late 1990s (ENSR, 2005).

Note:
(1) LOU is "letter of understanding" Source Area identification (locations are shown on Figure 3-2)

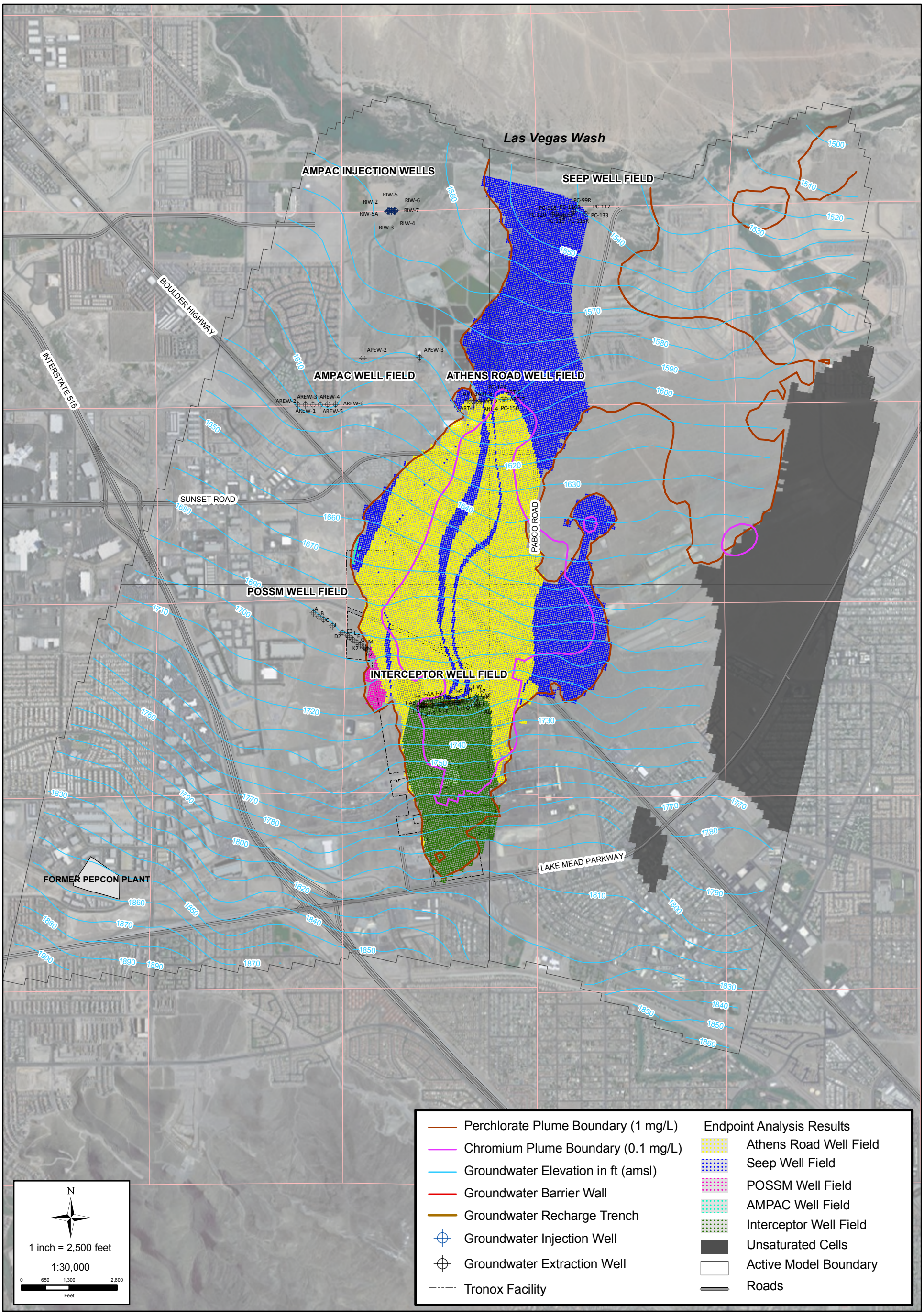
TABLE 1-1
Average Extraction and Injection Rates
Third Quarter 2010

Well ID	Extraction Well Field	Flow Rate[1] (gpm)	Flow Rate[1] (cfd)
I-AR[2]	IWF	0.80	154
I-B	IWF	2.59	499
I-C	IWF	4.41	849
I-D	IWF	5.38	1,035
I-E	IWF	1.84	355
I-F	IWF	3.65	703
I-G	IWF	0.46	89
I-H	IWF	0.48	93
I-I	IWF	5.17	995
I-J	IWF	7.37	1,419
I-K	IWF	3.83	738
I-L	IWF	1.15	220
I-M	IWF	2.38	458
I-N	IWF	3.30	636
I-O	IWF	2.94	565
I-P	IWF	3.92	755
I-Q	IWF	0.87	167
I-R	IWF	1.09	209
I-S	IWF	8.23	1,585
I-T	IWF	0.33	64
I-U	IWF	0.92	176
I-V	IWF	3.99	768
I-Z	IWF	7.52	1,448
	Total IWF	**72.6**	**13,981**
IWF Recharge Trench		(57.6)	(11,082)
ART 1	AWF	10.4	1,996
ART 2	AWF	71.4	13,752
ART 3A	AWF	46.8	9,008
ART 4A	AWF	8.91	1,716
ART 7A	AWF	29.8	5,744
ART 8	AWF	69.1	13,311
ART 9	AWF	44.1	8,483
	Total AWF	**280.6**	**54,010**
PC-99R2/R3	*SWF*	73.9	14,227
East Well (PC-116R)	*SWF*	148.3	28542
West Well (PC-115R)	*SWF*	75.5	14535
PC 117	*SWF*	87.7	16880
PC 118	*SWF*	69.77	13432
PC 119	*SWF*	65.91	12689
PC 120	*SWF*	3.36	647
PC 121	*SWF*	1.33	255
PC 133	*SWF*	5.85	1126
	Total SWF	**457.7**	**88,106**

Notes and Abbreviations:
[1] A positive number denotes an extraction rate. A negative number (#) denotes an injection rate.
[2] I-AB presented in the 12/3 CZE report submittal has been corrected to I-AR; Figure 5-2 has also been updated
cfd = cubic feet per day
gpm = gallons per minute
AWF = Athens Road Well Field
IWF = Interceptor Well Field
SWF = Seep Well Field

FIGURES

\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_Fig_8-2_Endpoint_analyses_GW_model__layer_3_additional_pumping_101208_931.mxd Last updated 12/8/2010 3:30:00 PM



SHEET NUMBER:	FIGURE NUMBER:
1	8-2

ENDPOINT ANALYSIS: LAYER - 3
CAPTURE ENHANCEMENTS
REGIONAL GROUNDWATER MODEL

Capture Zone Evaluation Report
Tronox LLC, Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 2,500 ft	12/10/2010	2027.02 T28

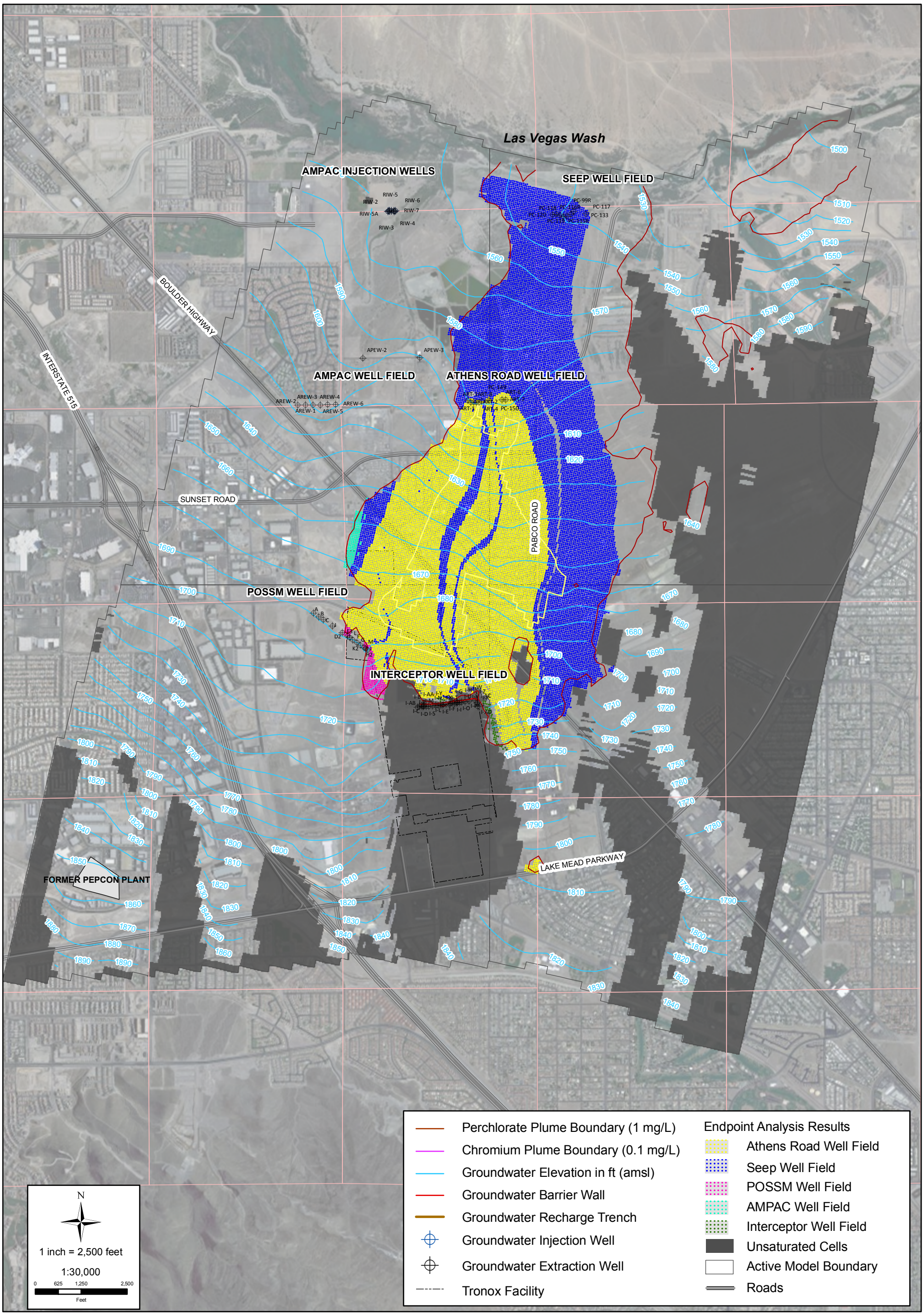
DESIGNED BY:	REVISIONS			
AS	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
AS				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

northgate environmental management, inc.

TRONOX

www.ngem.com

\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_Fig_8-1_Endpoint_analyses_GW_model__layer_2_additional_pumping_101208.mxd Last updated 12/8/2010 2:29:22 PM



SHEET NUMBER:	FIGURE NUMBER:
1	8-1

ENDPOINT ANALYSIS: LAYER - 2
CAPTURE ENHANCEMENTS
REGIONAL GROUNDWATER MODEL

Capture Zone Evaluation Report
Tronox LLC, Henderson, Nevada

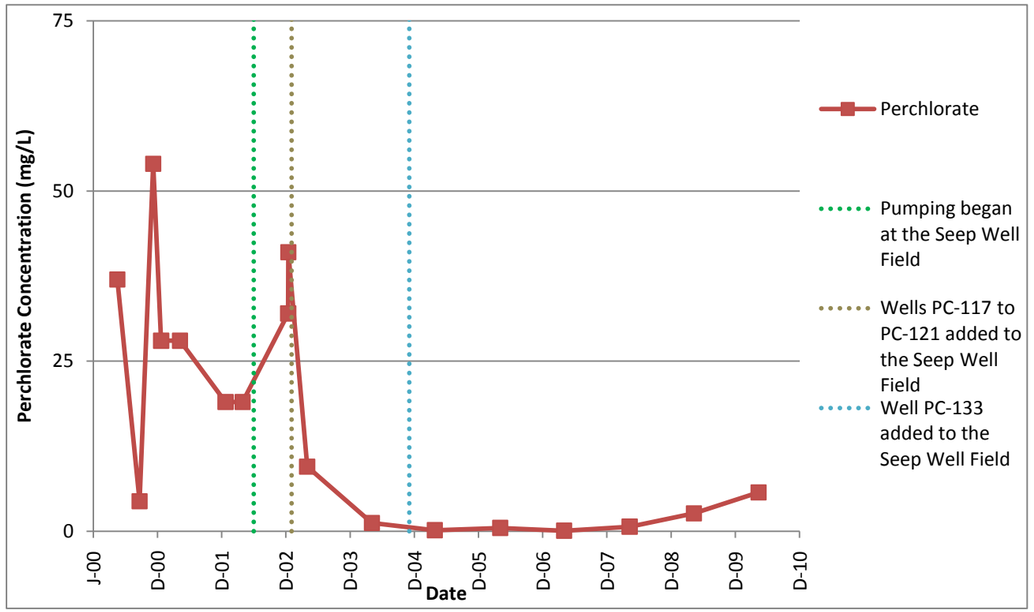
SCALE:	DATE:	PROJECT NUMBER:
1 in = 2,500 ft	12/10/2010	2027.02 T28

DESIGNED BY:	REVISIONS			
AS	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
AS				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

northgate environmental management, inc.
TRONOX
www.ngem.com

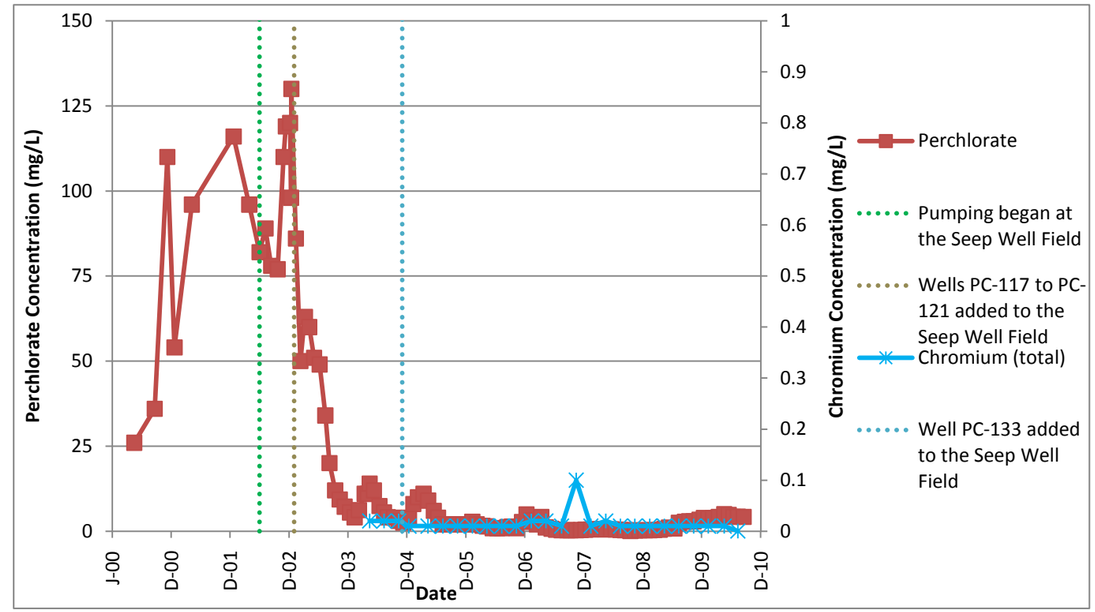
FIGURE 7-7
Wells Downgradient of the Seep Well Field

Well PC-96



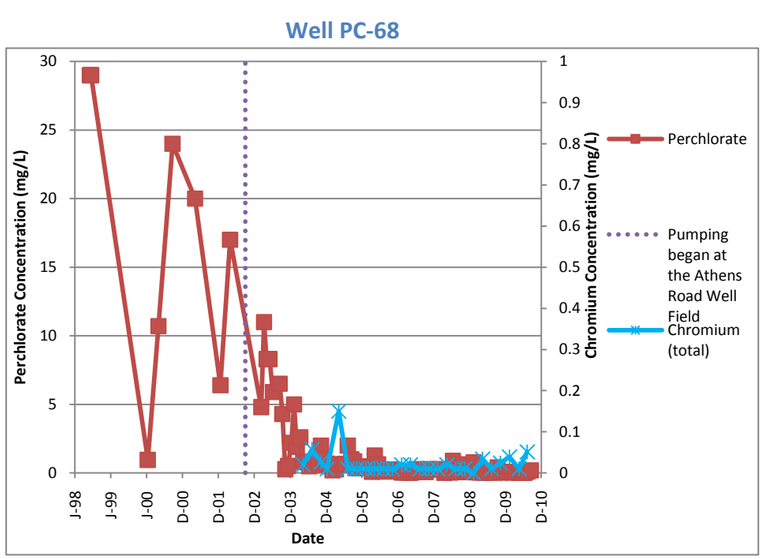
Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

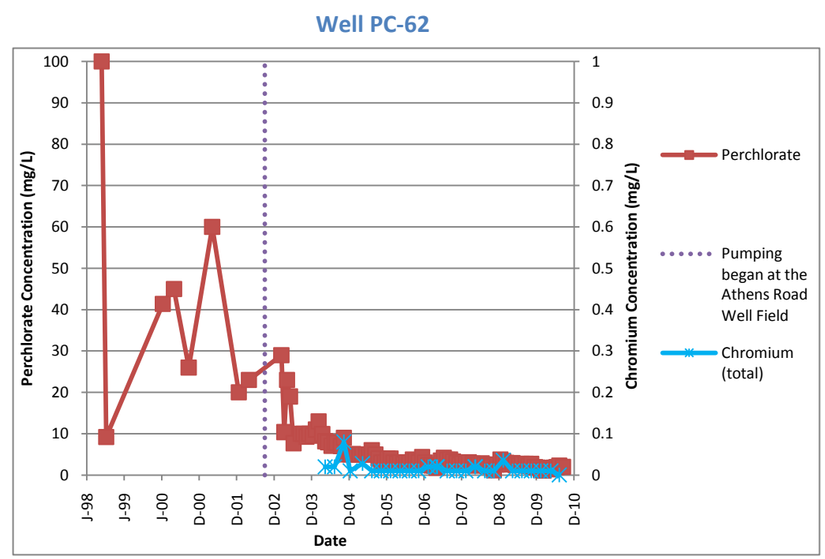
Well PC-97

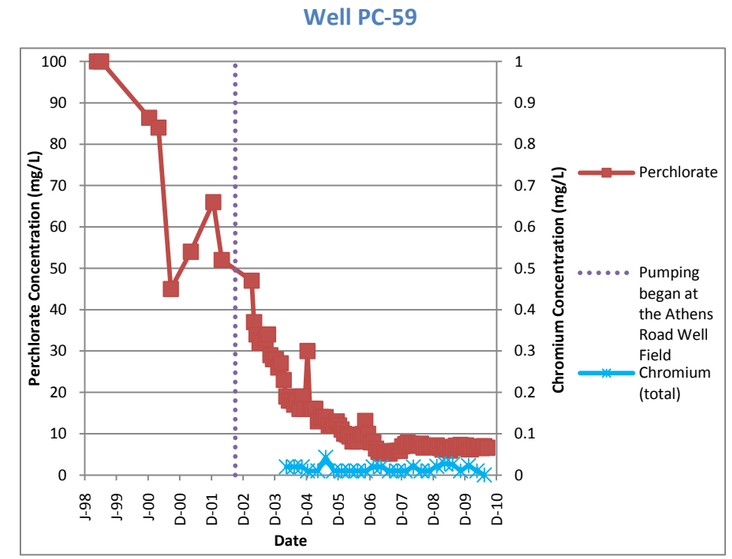


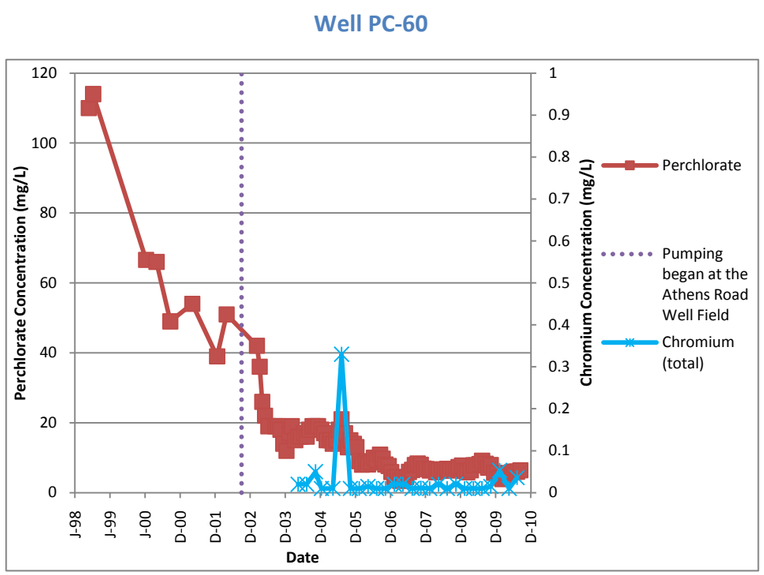
Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted
Chromium concentrations are all ND

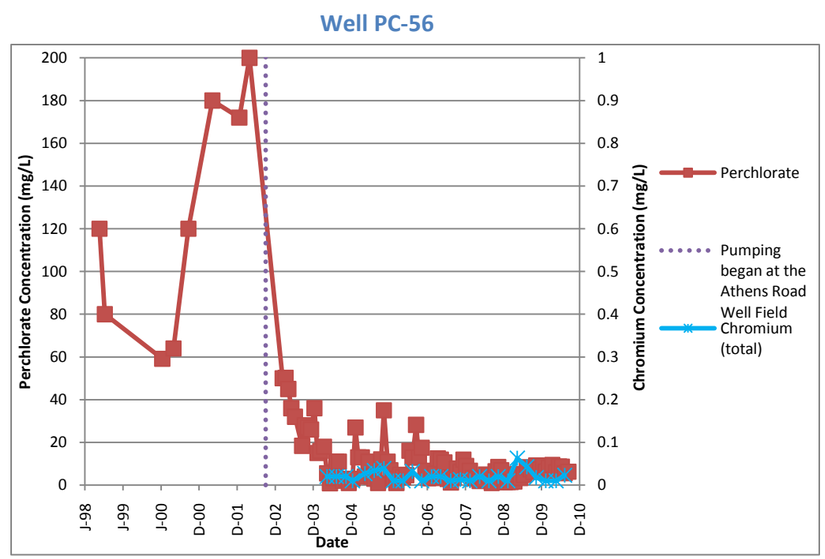
FIGURE 7-6
Lower Pond Wells

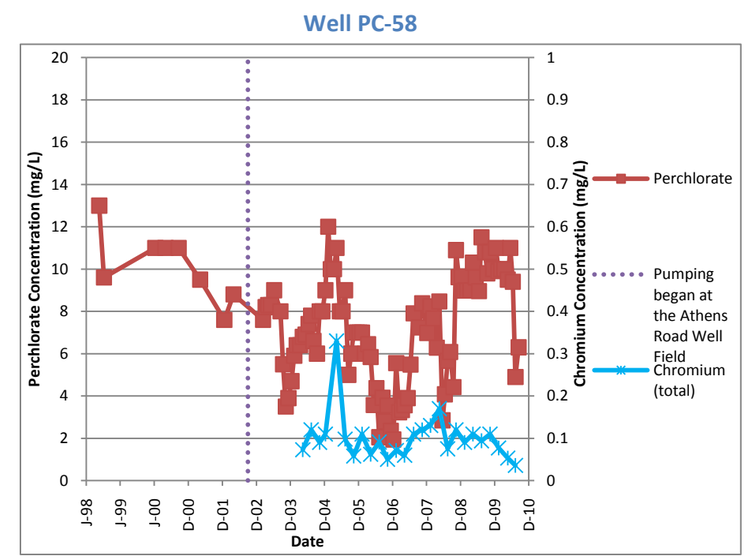








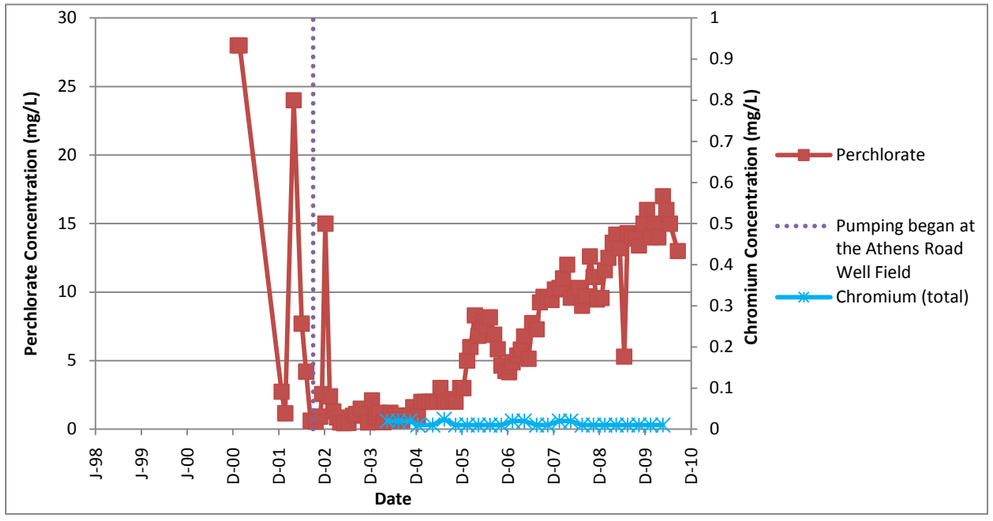




Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted
Chromium concentrations are all ND

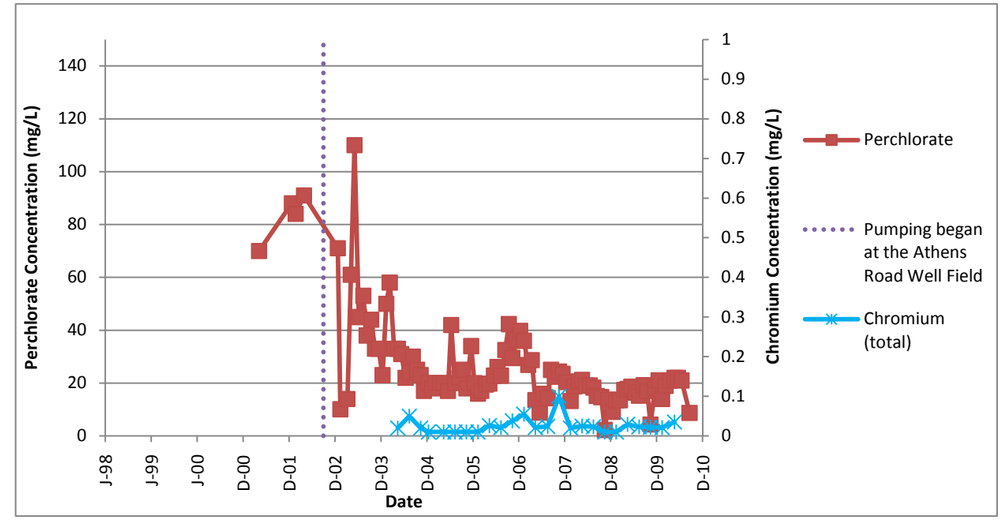
FIGURE 7-5
City of Henderson Wells

Well PC-103



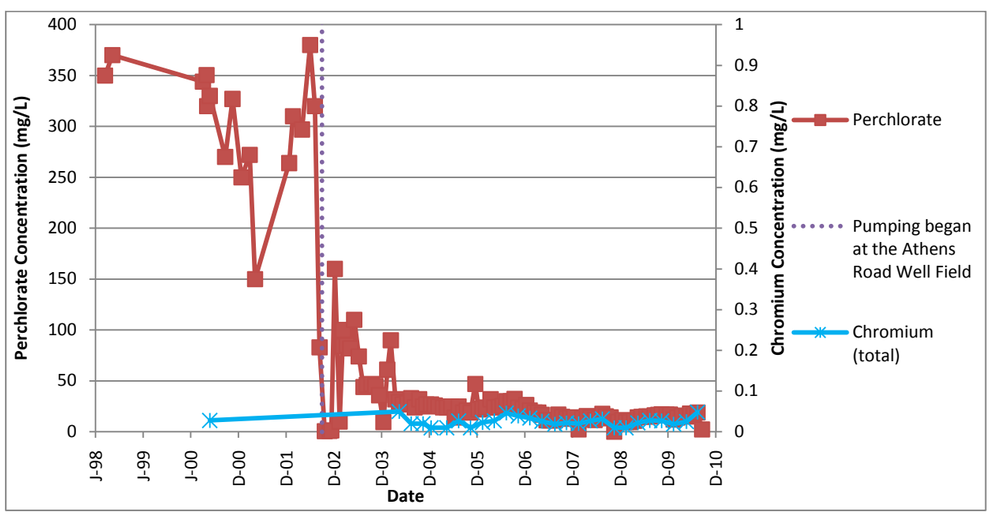
Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted
Chromium concentrations are all ND
Perchlorate data for May 2001 (approximately 10x average historical concentrations) was eliminated from this plot

Well PC-98R



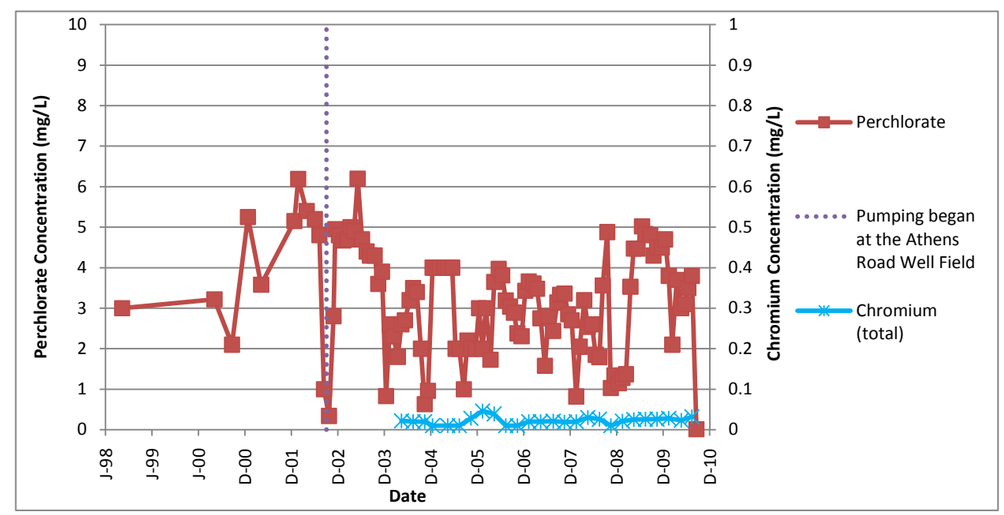
Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted
Chromium concentrations are all ND

Well MW-K5



Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted
Chromium concentrations are all ND

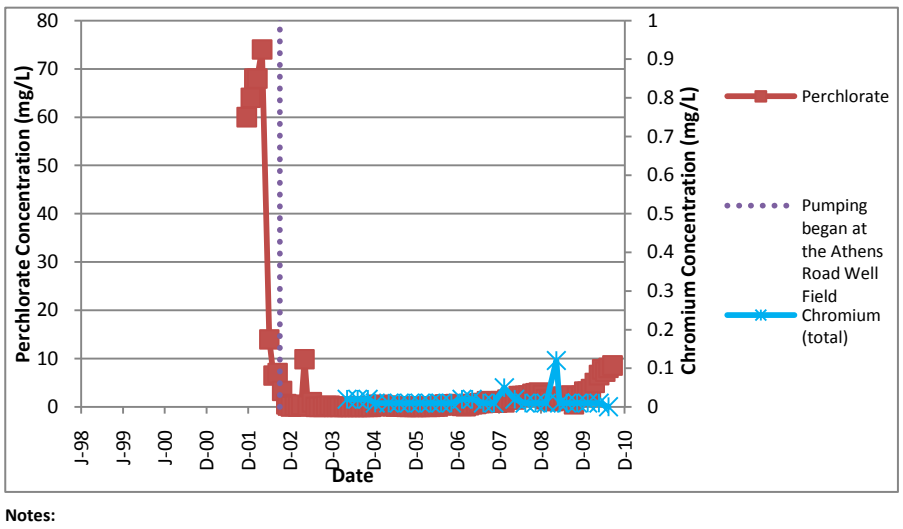
Well PC-53



Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted
Chromium concentrations are all ND

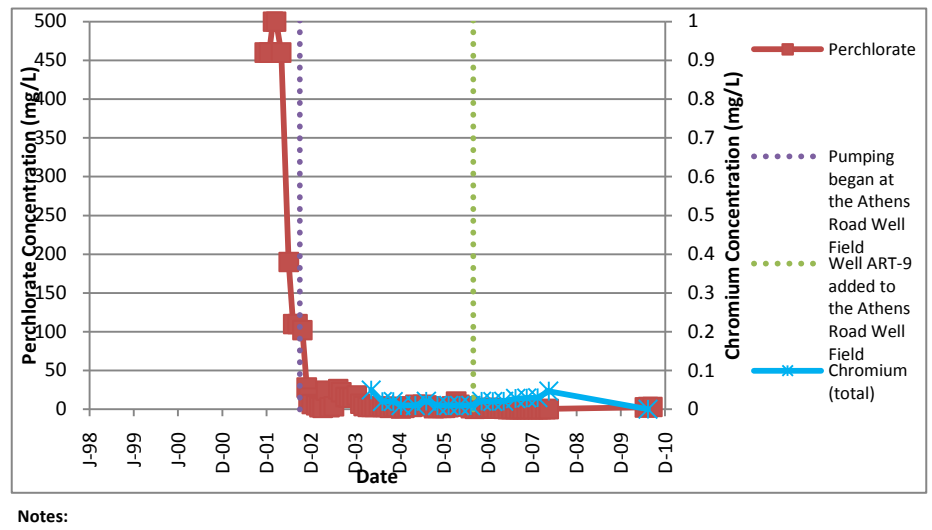
FIGURE 7-4
Athens Road Piezometer Wells

Well ARP-1



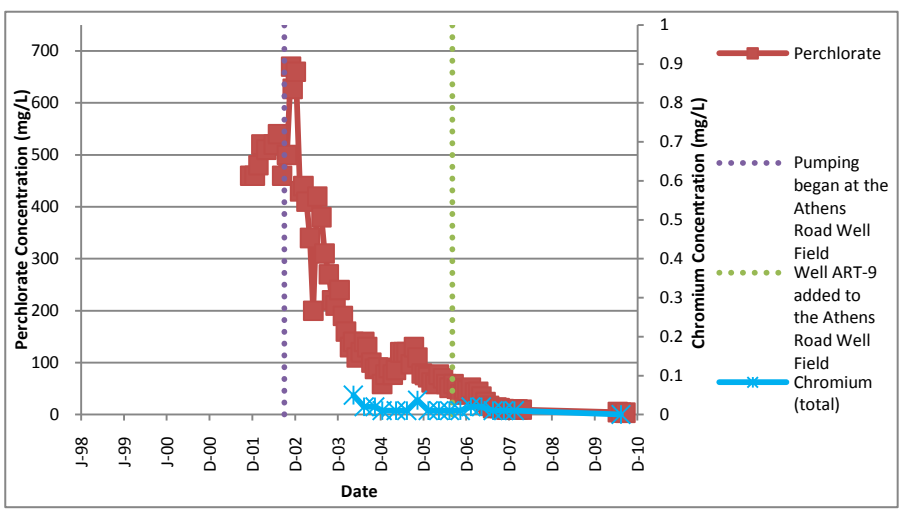
Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

Well ARP-2A



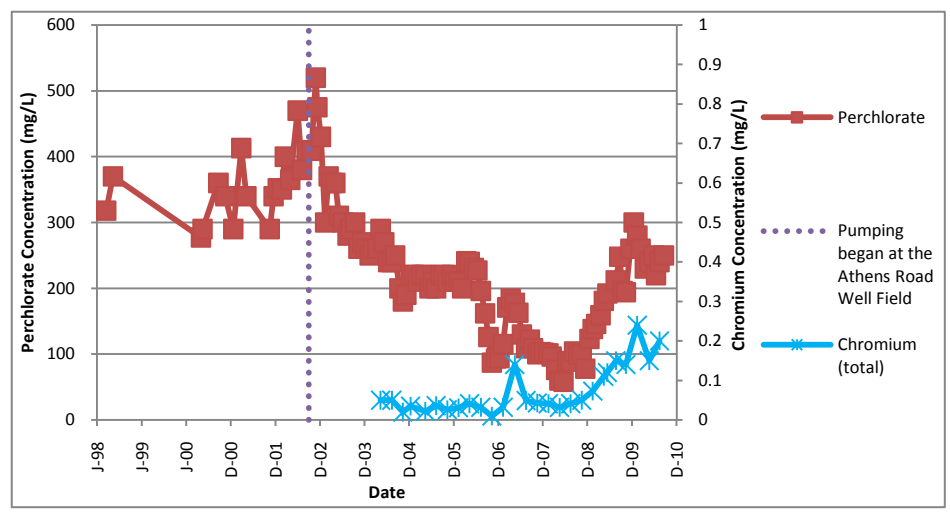
Notes:
ARP-2A is the replacement well for ARP-2
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

Well ARP-3A



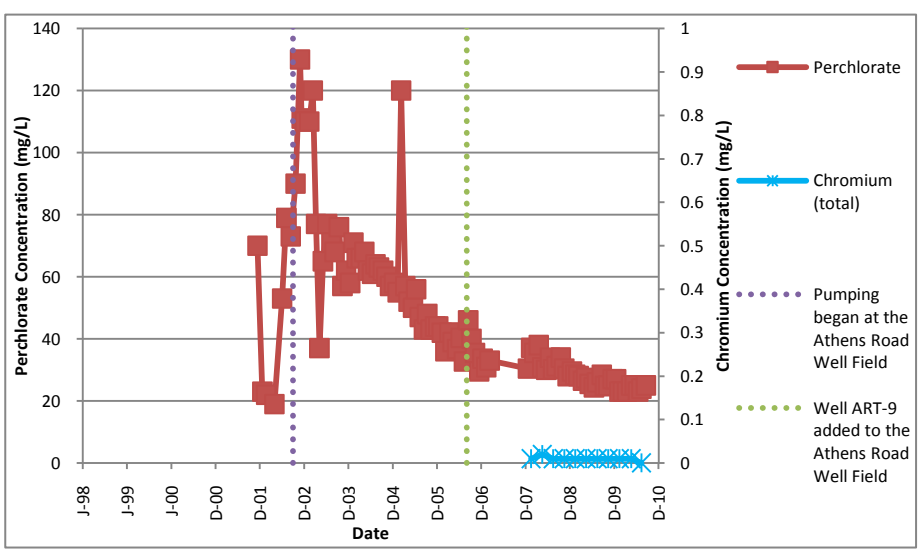
Notes:
ARP-3A is the replacement well for ARP-3
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

Well MW-K4



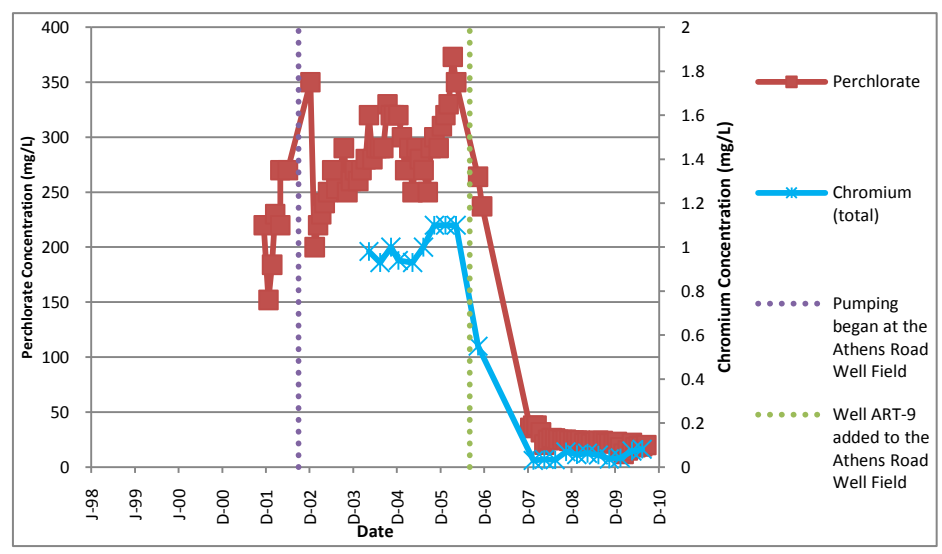
Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted
Chromium concentrations are all ND

Well ARP-4A



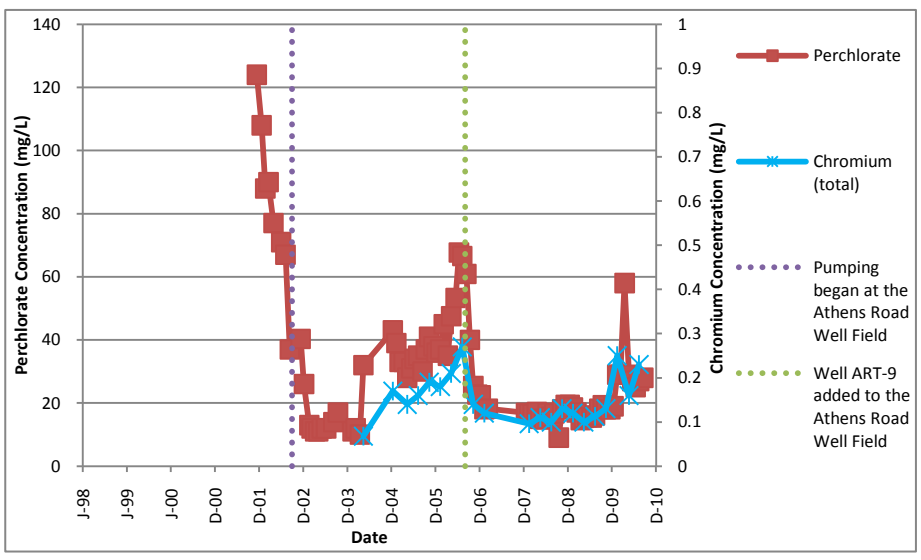
Notes:
ARP-4A is the replacement well for ARP-4
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

Well ARP-5A



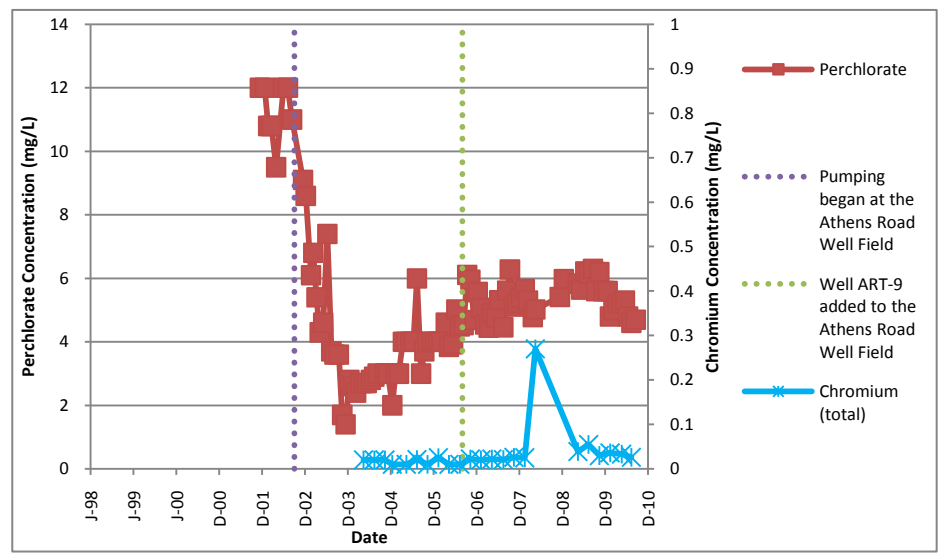
Notes:
ARP-5A is the replacement well for ARP-5
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted
Perchlorate data from September 2003 (approx. 0.01x average historical concentrations) was eliminated from this plot

Well ARP-6B



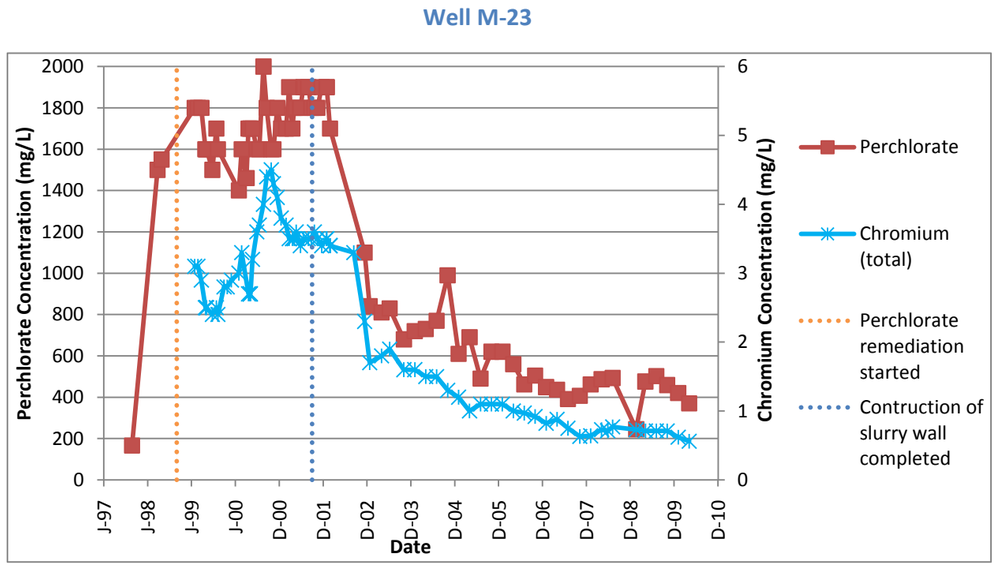
Notes:
ARP-6B is the replacement well for ARP-6A, which was the replacement well for ARP-6
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

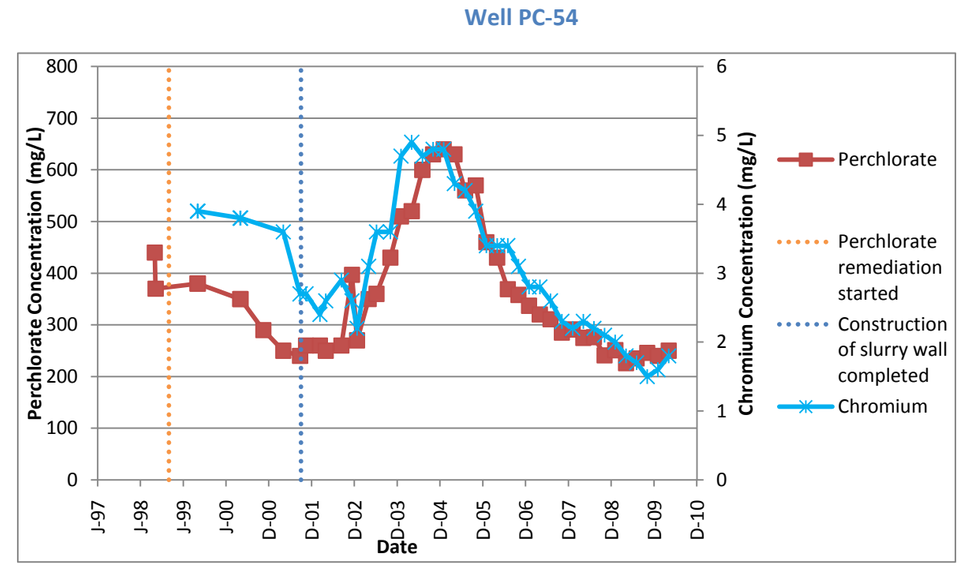
Well ARP-7

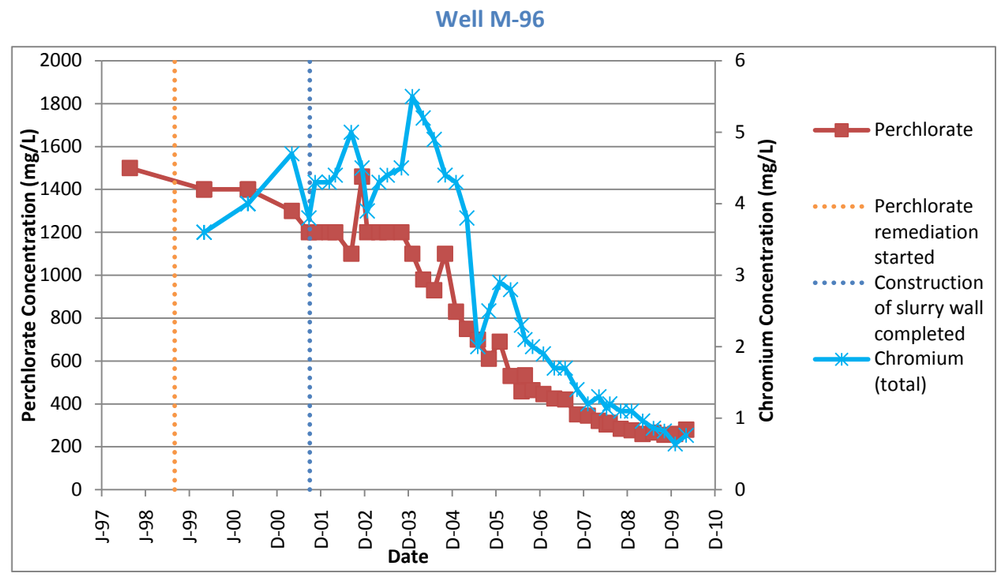


Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

FIGURE 7-3
Wells located downgradient of the Interceptor Well Field at Warm Springs Road

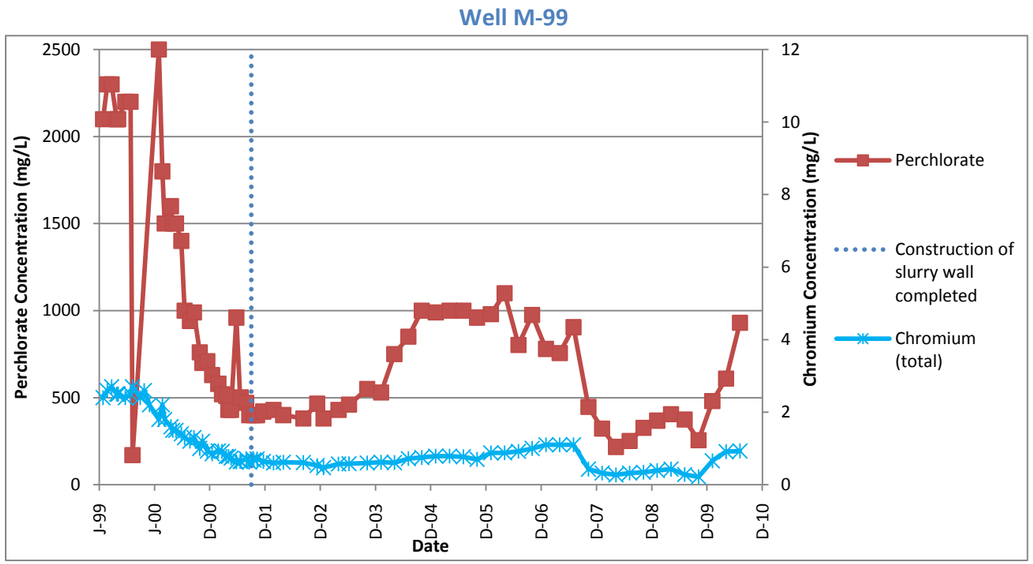


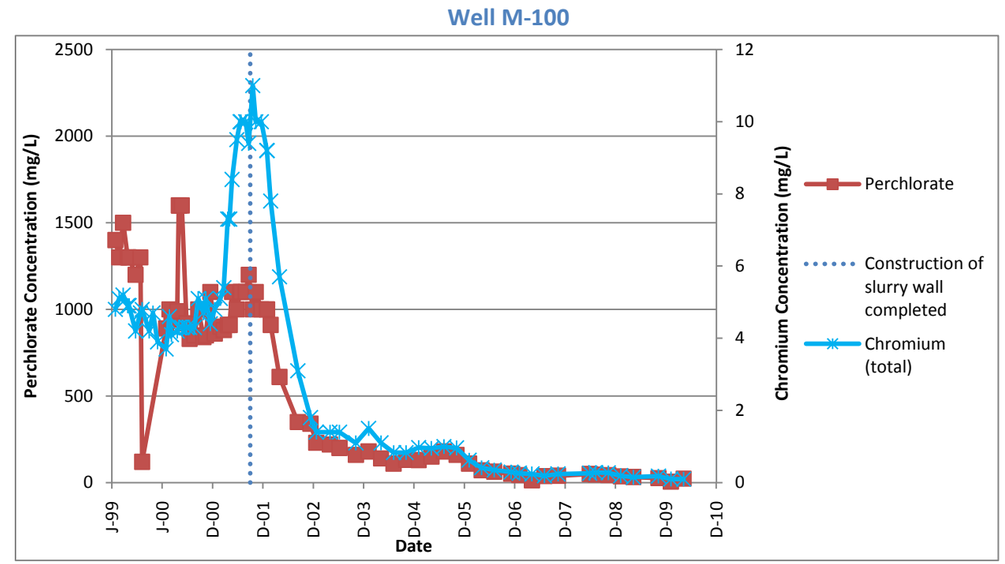


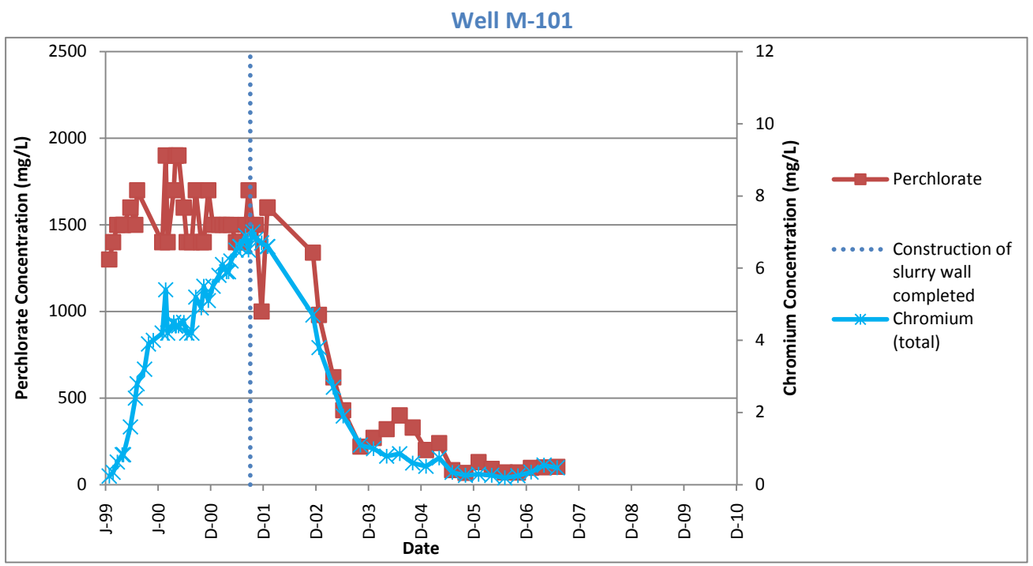


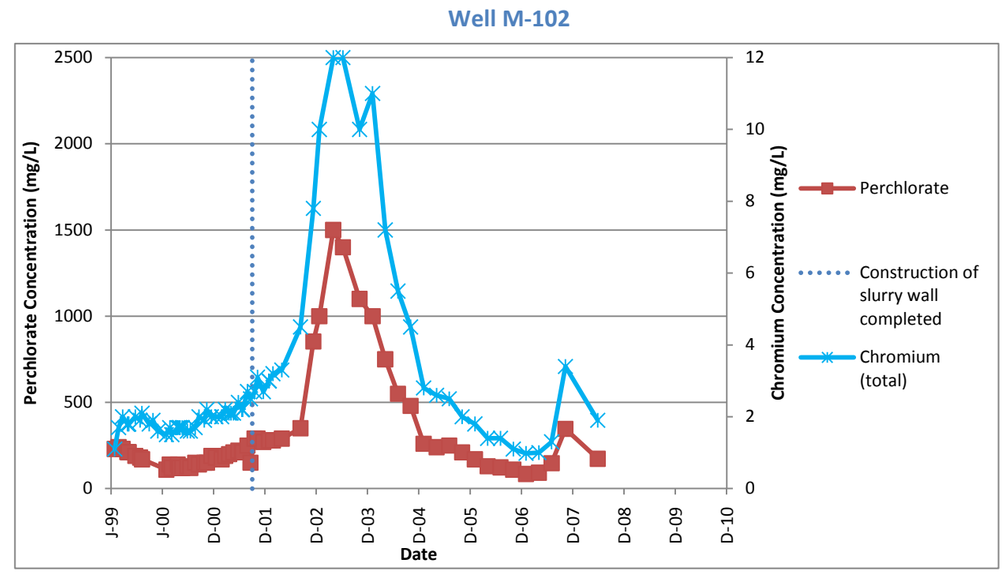
Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

FIGURE 7-2
Wells located approximately 1000 feet north of Interceptor Well Field





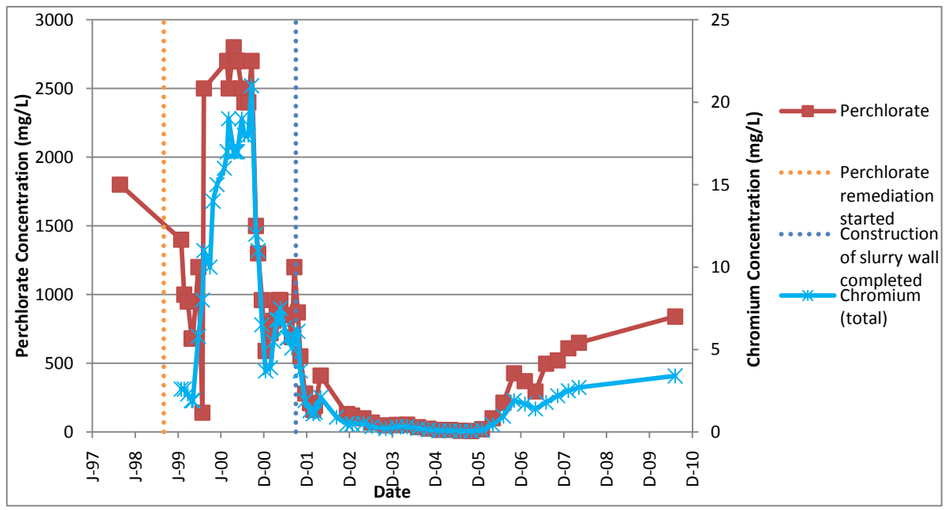




Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

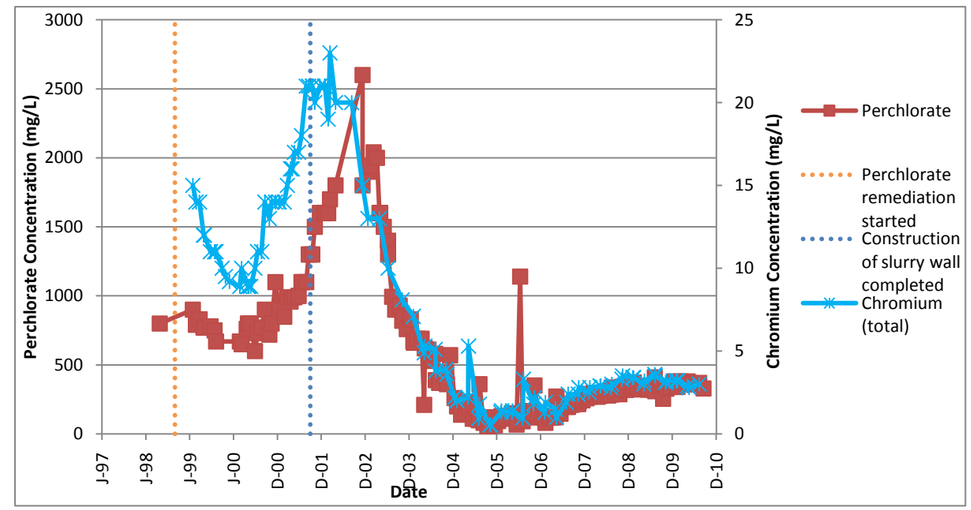
FIGURE 7-1
Wells located immediately downgradient of the infiltration trenches

Well M-86



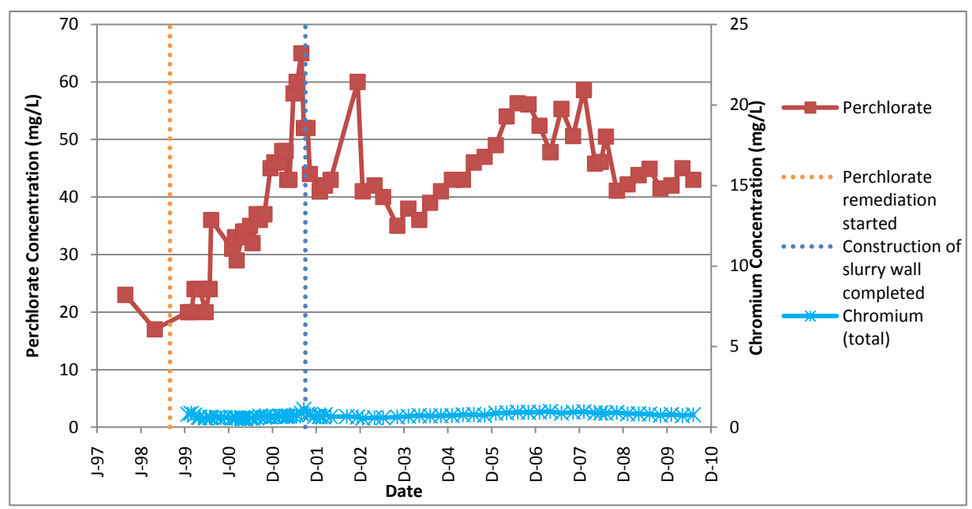
Notes:
M-86A is the replacement well for M-86
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

Well M-87

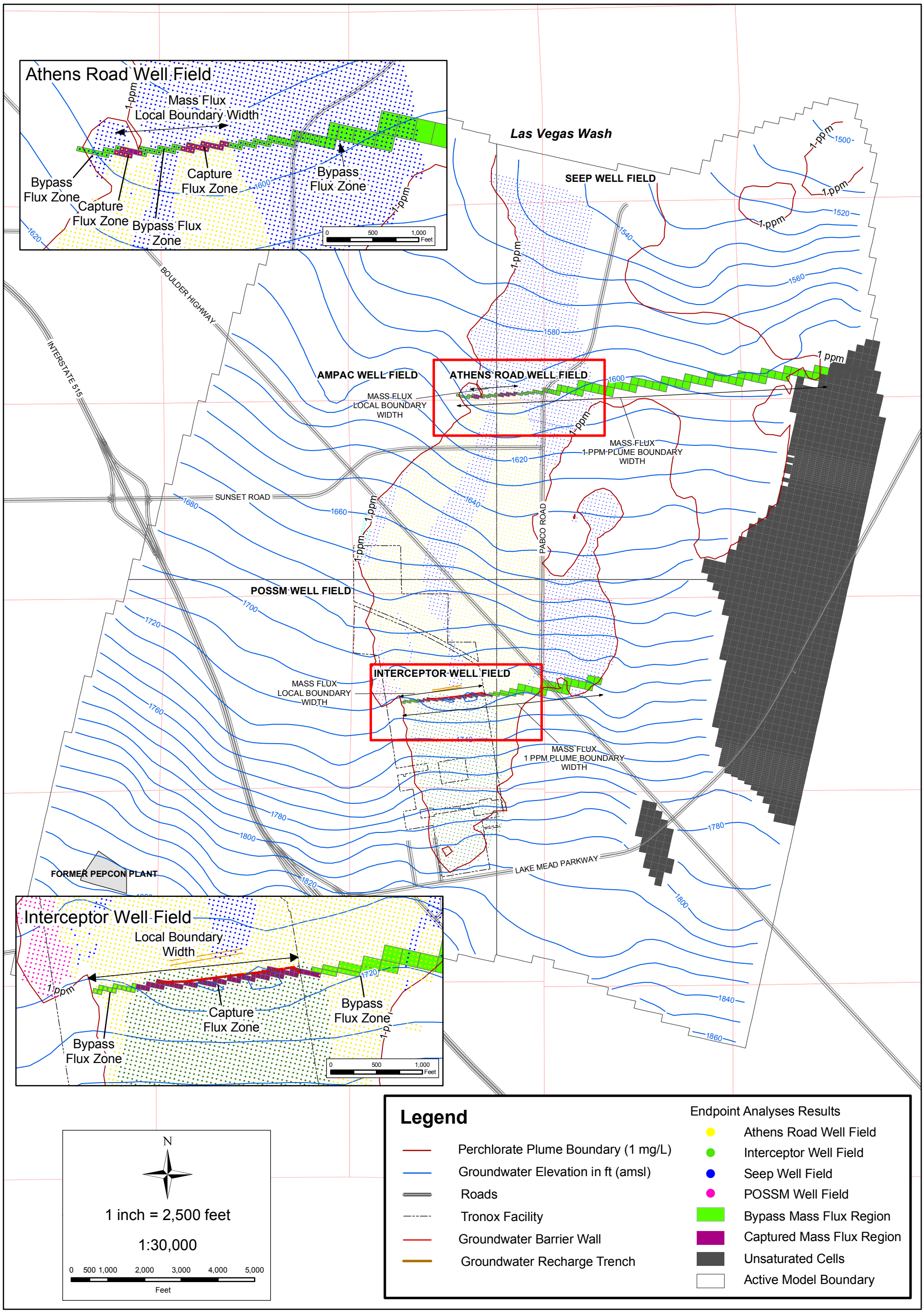


Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted

Well M-88



Notes:
For duplicate samples, the higher concentration was selected
For non-detected "ND" results, the Sample Quantitation Limits (SQLs) were plotted
Perchlorate data from November 2000 (approximately 10x average historical concentrations) and December 2001 (approximately 0.1x average historical concentrations) were eliminated from this plot



SHEET NUMBER: 1

FIGURE NUMBER: 6-9

MASS FLUX ANALYSIS: LAYER - 3
REGIONAL GROUNDWATER MODEL

Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

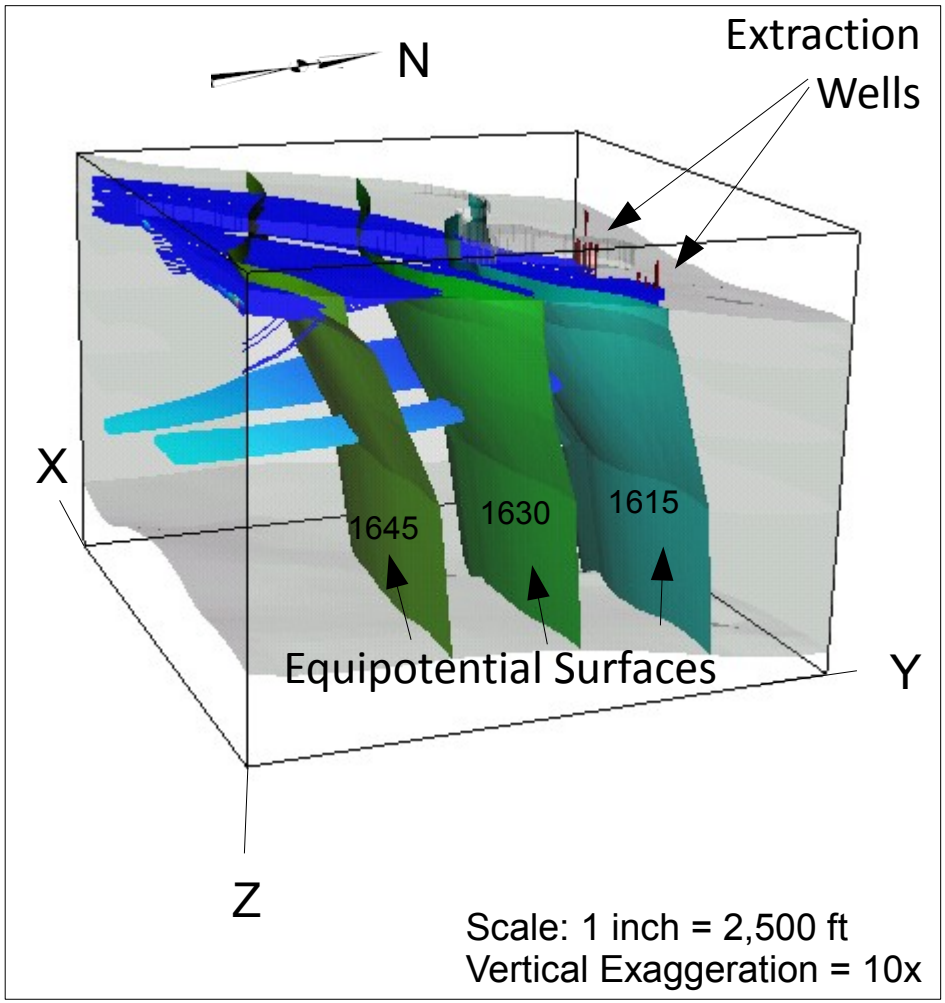
SCALE:	DATE:	PROJECT NUMBER:
1 in = 2,500 ft	12/10/2010	2027.02 T28

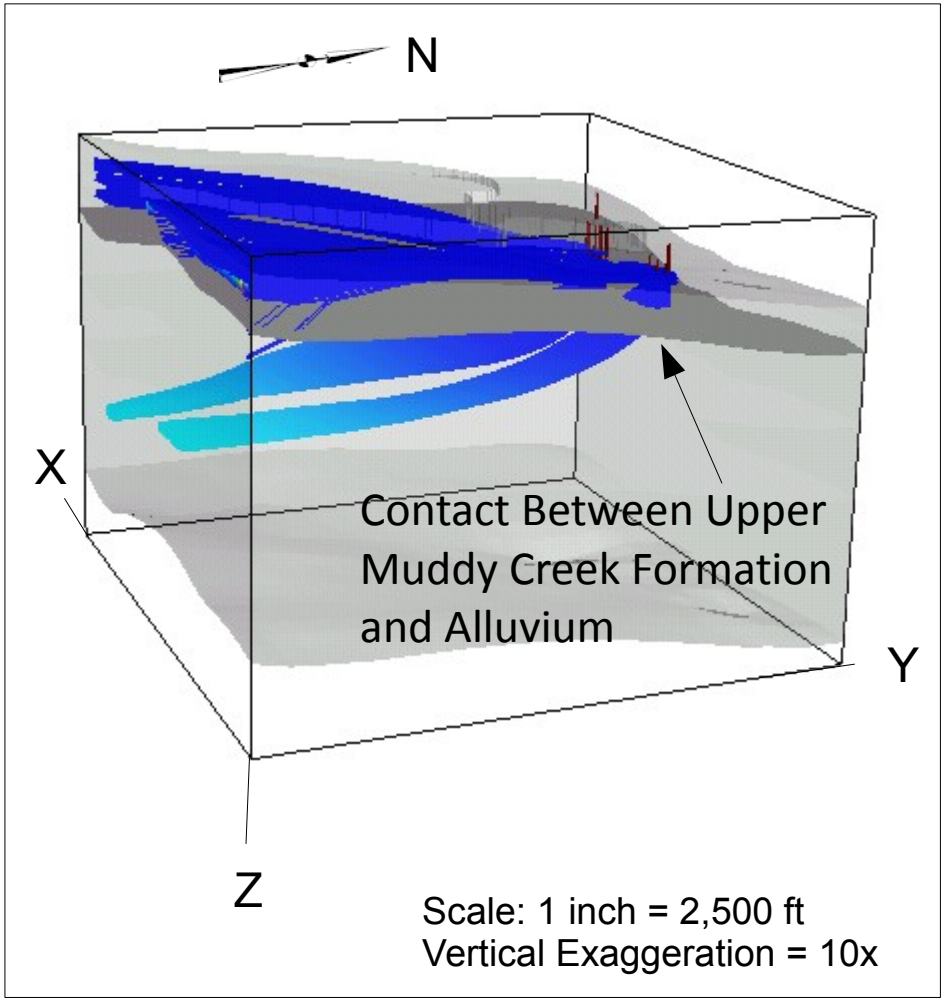
DESIGNED BY:	REVISIONS			
AS	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
AS				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

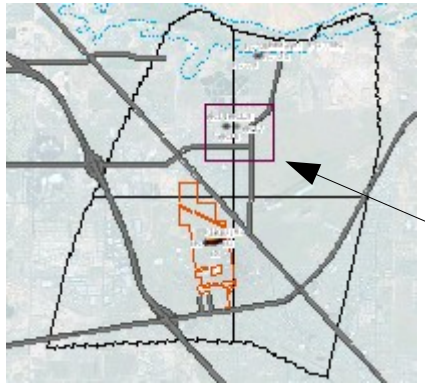
northgate environmental management, inc.

TRONOX

www.ngem.com







Regional Map showing the Boundary of Athens Road Well Field Sub-domain Model

Scale: 1 inch = 8,500 ft

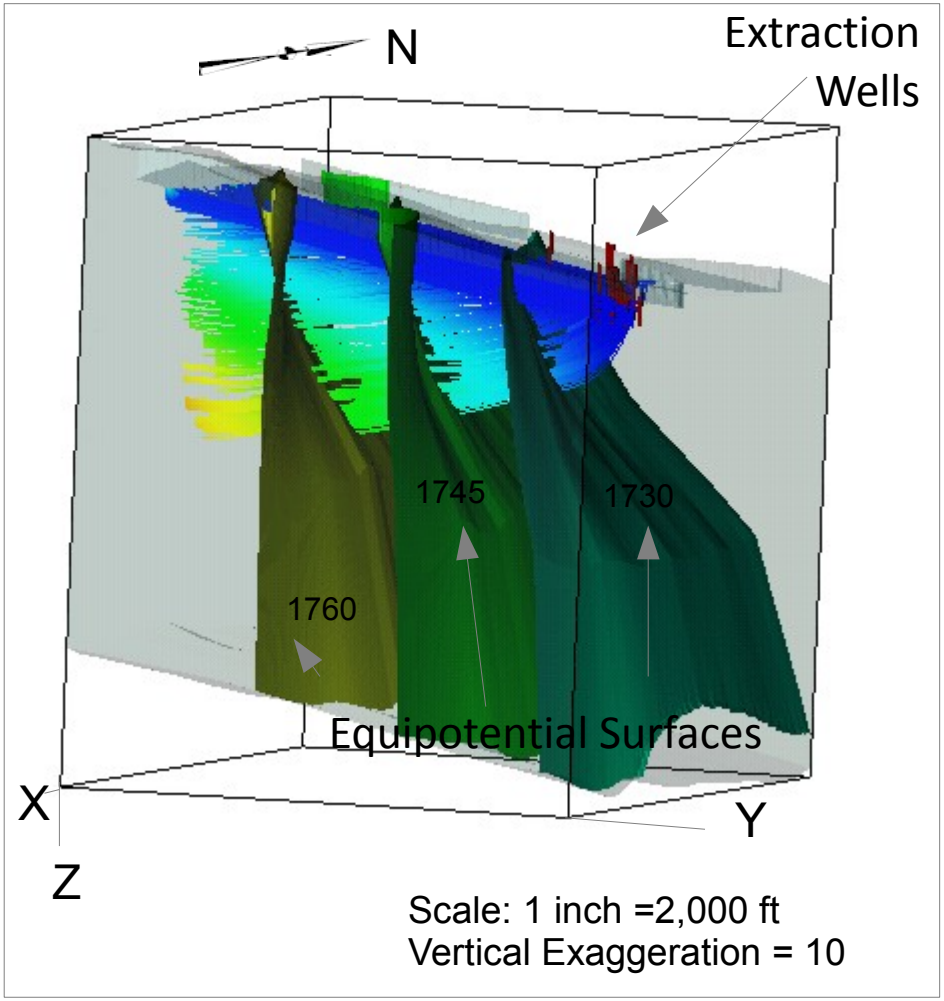
Figure 6-8

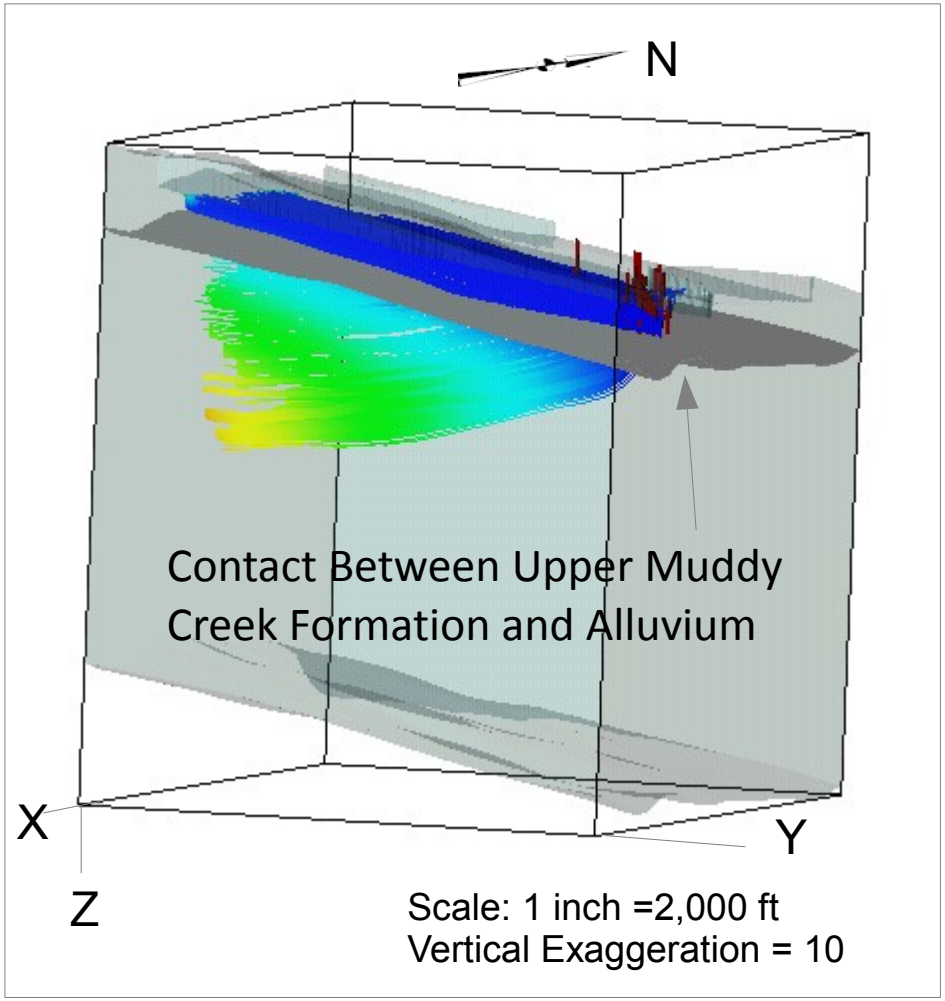
Reverse Particle Tracking, Athens Road Well Field
Tronox LLC, Henderson Nevada

TRONOX

northgate environmental management, inc.

G:\Projects\Temp\2027 Tronox\2027.02 Tronox Perchlorate\T28 2010 Capture Zone Evaluation Rpt\CZE Report\Figures\TMR Figures\P2027_02_T28_CZE_RPT_F6-8_ARWF_reverse_particle_tracks_Diagram_r00_101203.odg





Regional Map showing Boundary of Interceptor Well Field Sub-domain Model

Scale: 1 inch = 8,500 ft

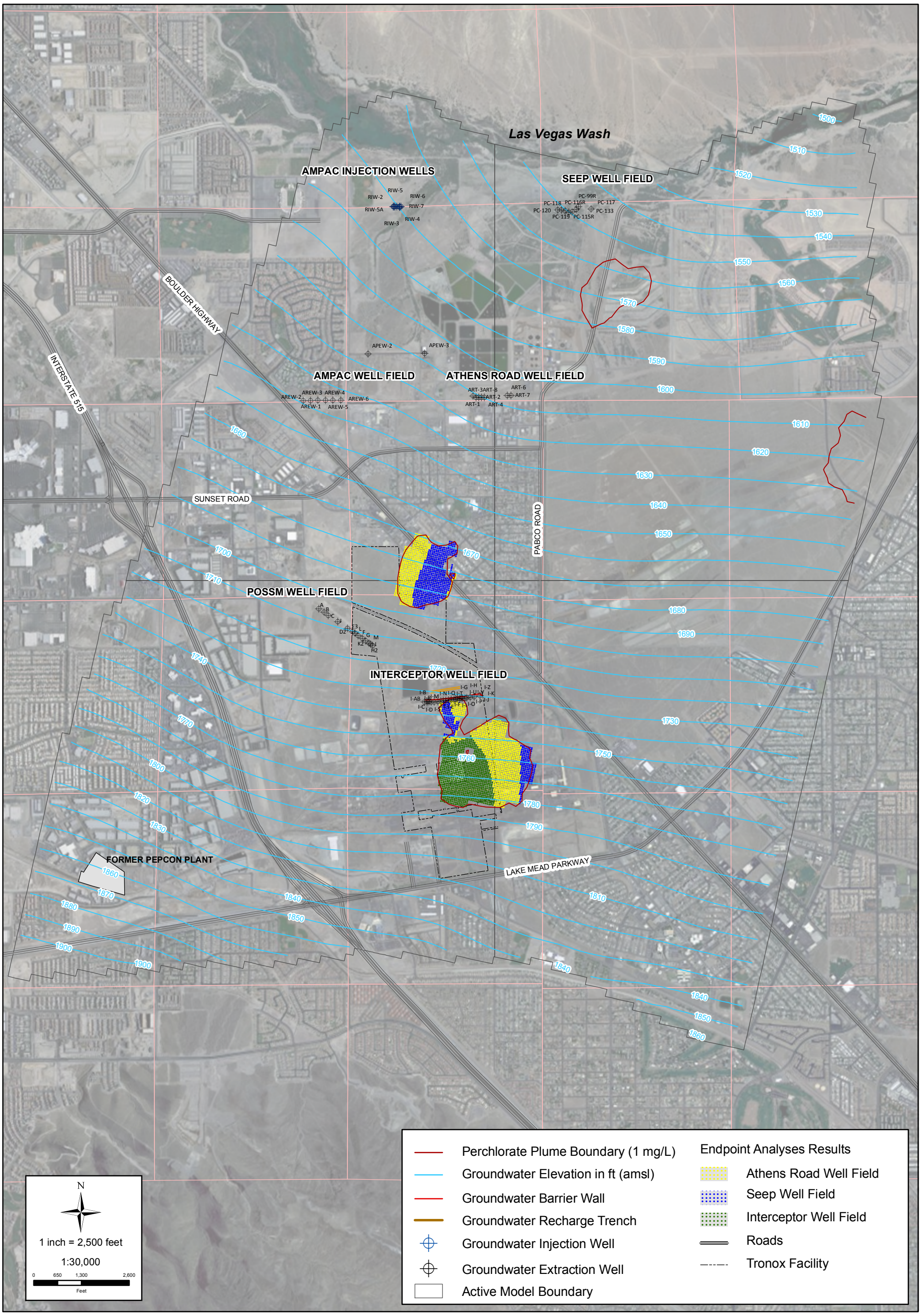
Figure 6-7

Reverse Particle Tracking,Interceptor Well Field
Tronox LLC, Henderson Nevada

TRONOX

northgate environmental management, inc.

G:\Projects\Temp\2027 Tronox\2027.02 Tronox Perchlorate\T28 2010 Capture Zone Evaluation Rpt\CZE Report\Figures\TMR Figures\P2027_02_T28_CZE_RPT_F6-7_IWF_reverse_particle_tracks_Diagram_r00_101203.odg



SHEET NUMBER: 1

FIGURE NUMBER: 6-6

ENDPOINT ANALYSIS: LAYER - 5
REGIONAL GROUNDWATER MODEL

Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 2,500 ft	12/10/2010	2027.02 T28

DESIGNED BY:	REVISIONS			
AS	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
AS				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

northgate
environmental management, inc.
TRONOX
www.ngem.com

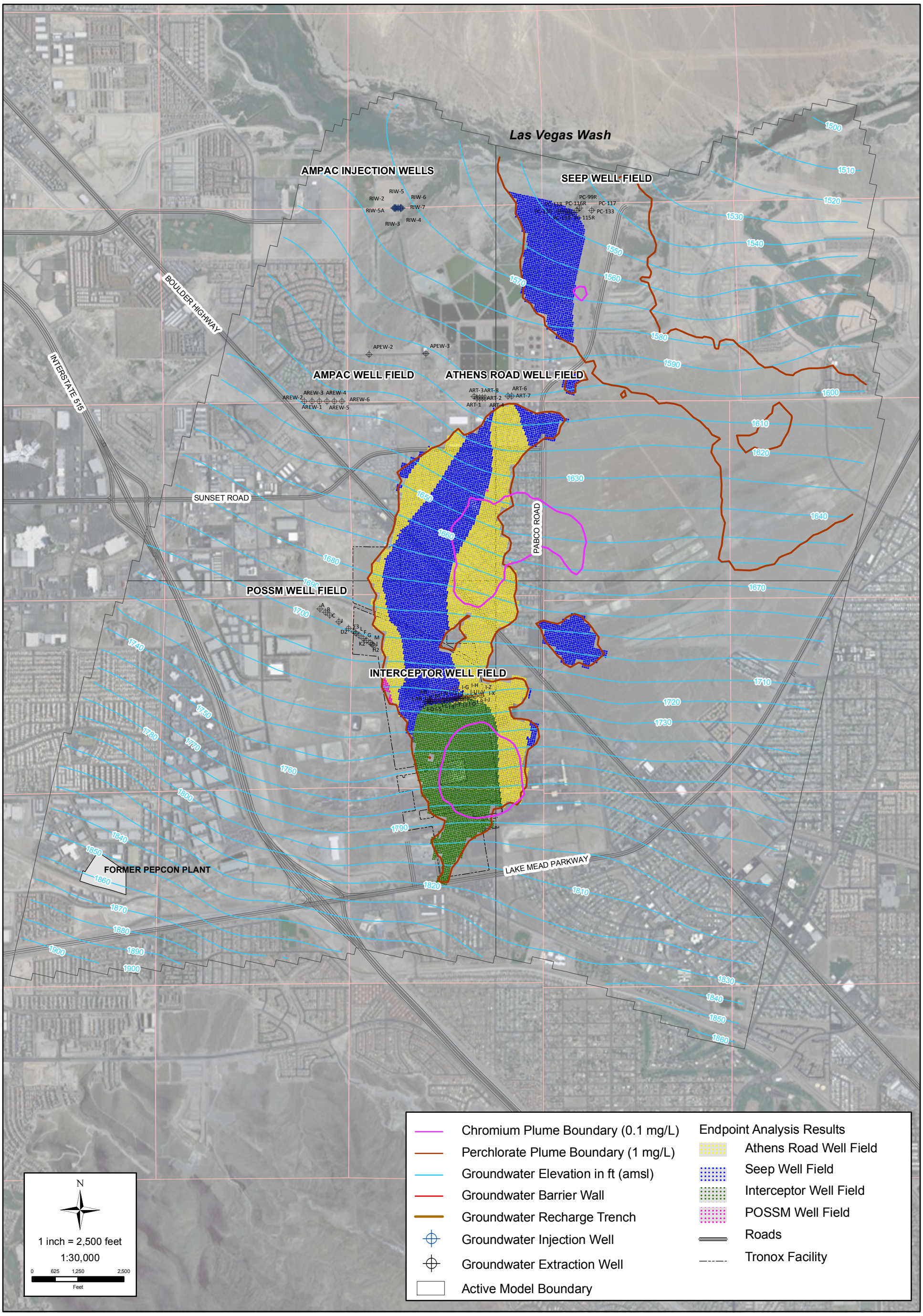


FIGURE NUMBER: 6-5

SHEET NUMBER: 1

ENDPOINT ANALYSIS: LAYER - 4
REGIONAL GROUNDWATER MODEL

Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

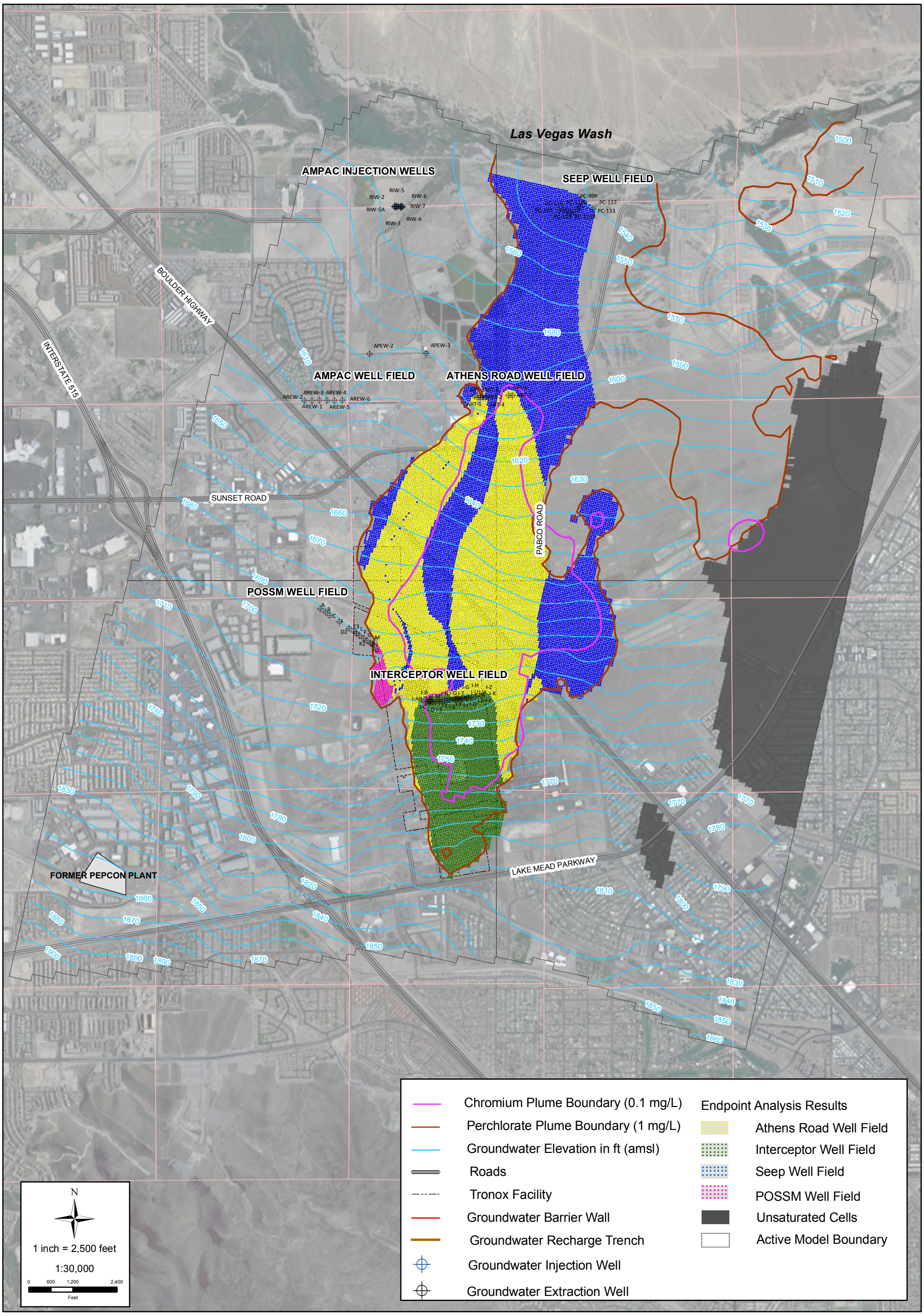
SCALE:	DATE:	PROJECT NUMBER:
1 in = 2,500 ft	12/10/2010	2027.02 T28

DESIGNED BY:	REVISIONS			
AS	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
AS				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

northgate environmental management, inc.

TRONOX

www.ngem.com



SHEET NUMBER:	FIGURE NUMBER:
1	6-4

ENDPOINT ANALYSIS: LAYER - 3
REGIONAL GROUNDWATER MODEL

Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 2,500 ft	12/10/2010	2027.02 T28

DESIGNED BY:	REVISIONS			
AS	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
AS				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

northgate environmental management, inc.

TRONOX

www.ngem.com

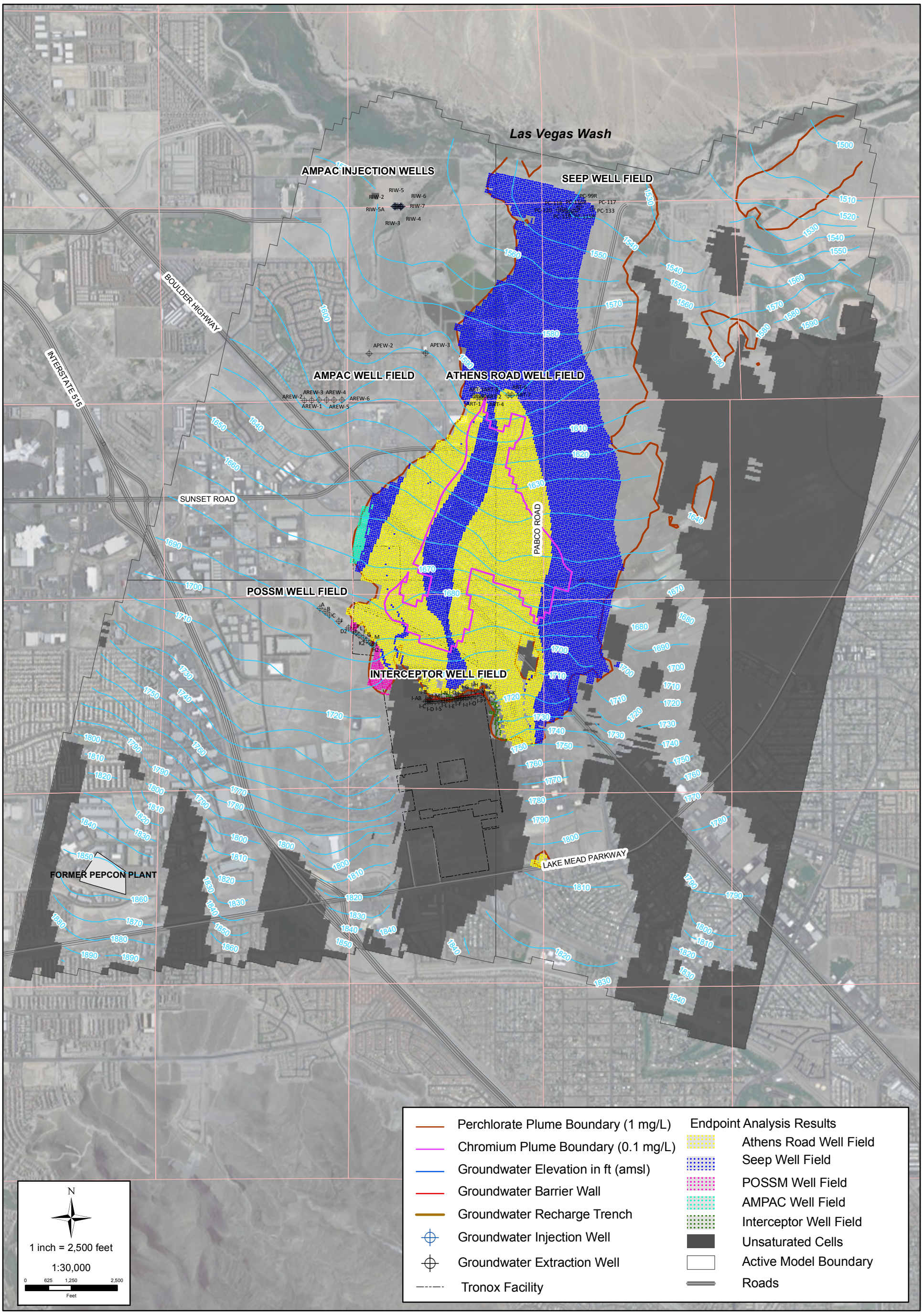


FIGURE NUMBER:	SHEET NUMBER:
6-3	1

ENDPOINT ANALYSES: LAYER - 2
REGIONAL GROUNDWATER MODEL

Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 2,500 ft	12/10/2010	2027.02 T28

DESIGNED BY:	REVISIONS			
AS	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
AS				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

northgate environmental management, inc.
TRONOX
www.ngem.com

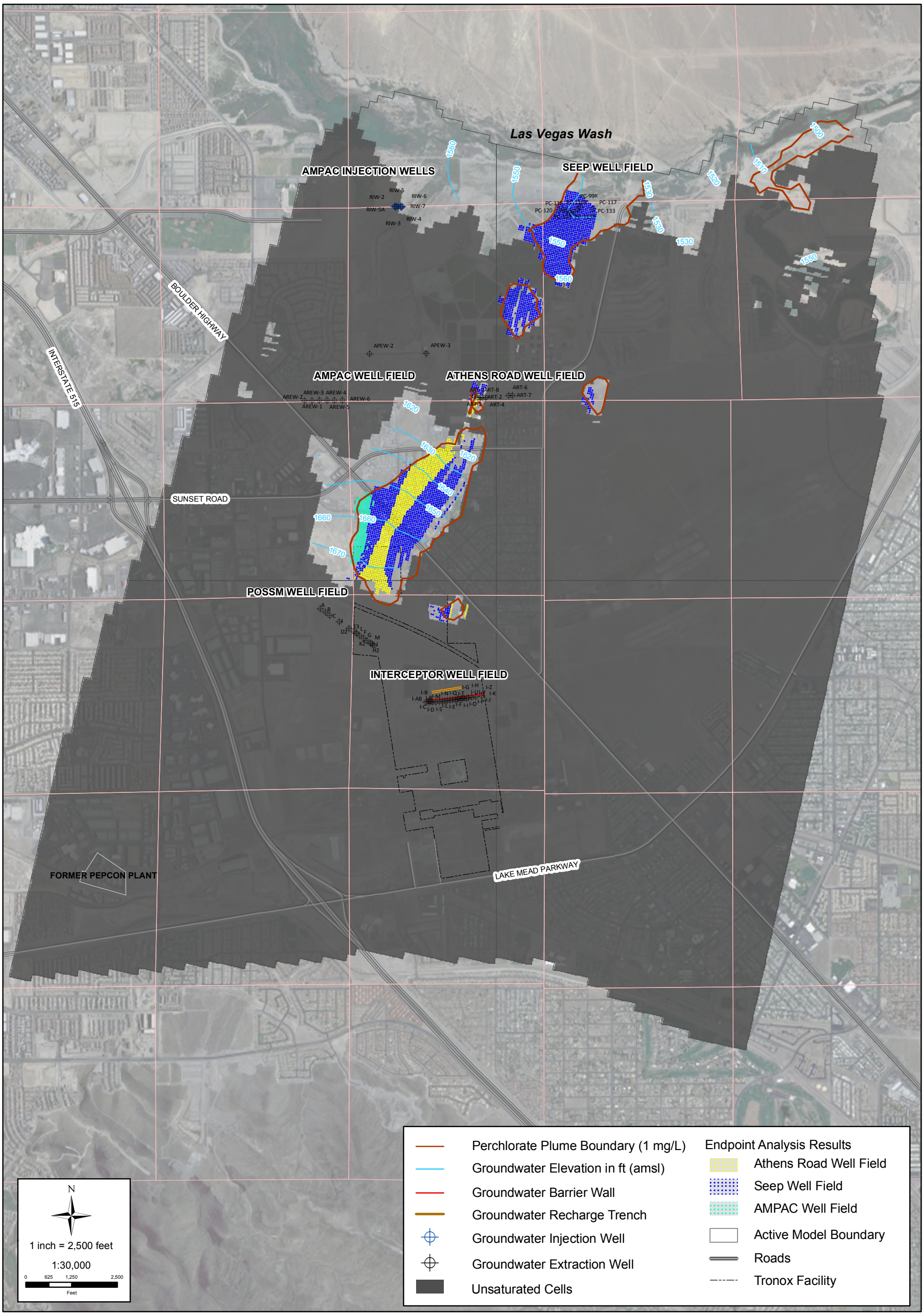


FIGURE NUMBER:	SHEET NUMBER:
6-2	1

ENDPOINT ANALYSIS: LAYER - 1
REGIONAL GROUNDWATER MODEL

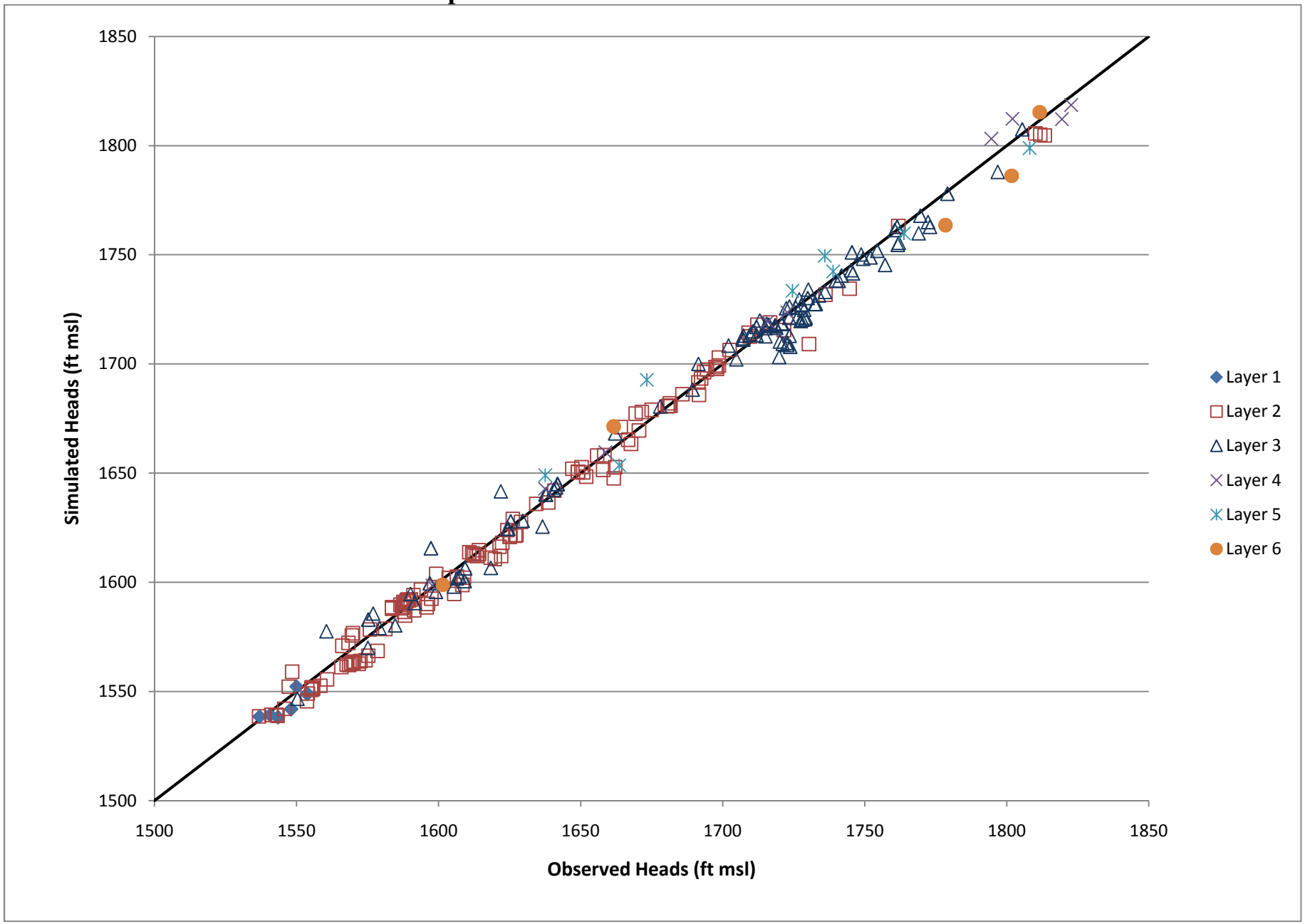
Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 2,500 ft	12/10/2010	2027.02 T28

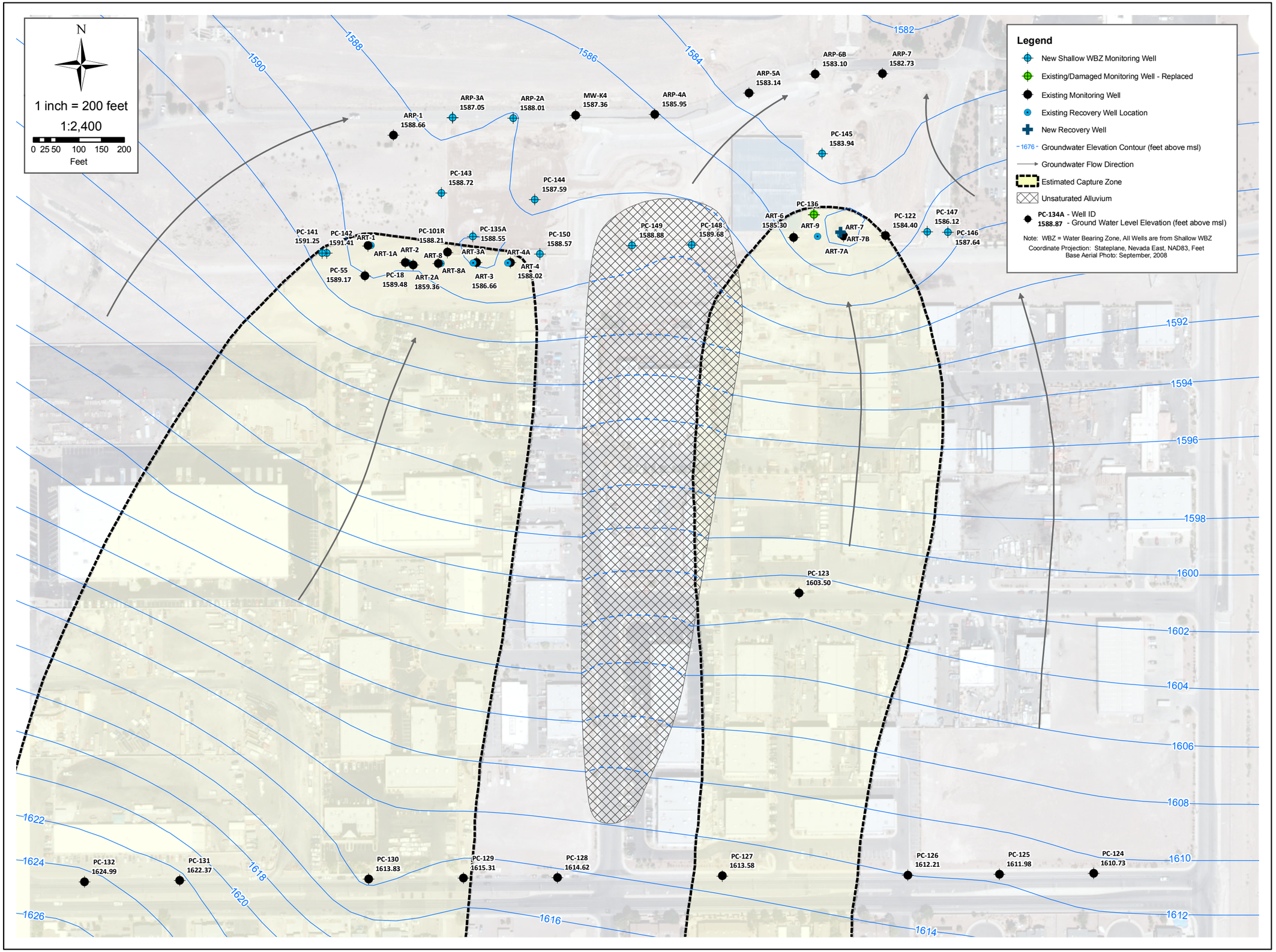
DESIGNED BY:	REVISIONS			
AS	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
AS				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

northgate environmental management, inc.
TRONOX
www.ngem.com

FIGURE 6-1
Comparison of Simulated to Measured Heads



\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_F5-3_Potentiometric_Athens_Rd_KT3D_101208.mxd Last updated 12/8/2010 1:43:11 PM



northgate environmental management, inc.
www.ngem.com
TRONOX

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	DRAWN BY:	CHECKED BY:	APPROVED BY:
AS	SC	LMS	KR

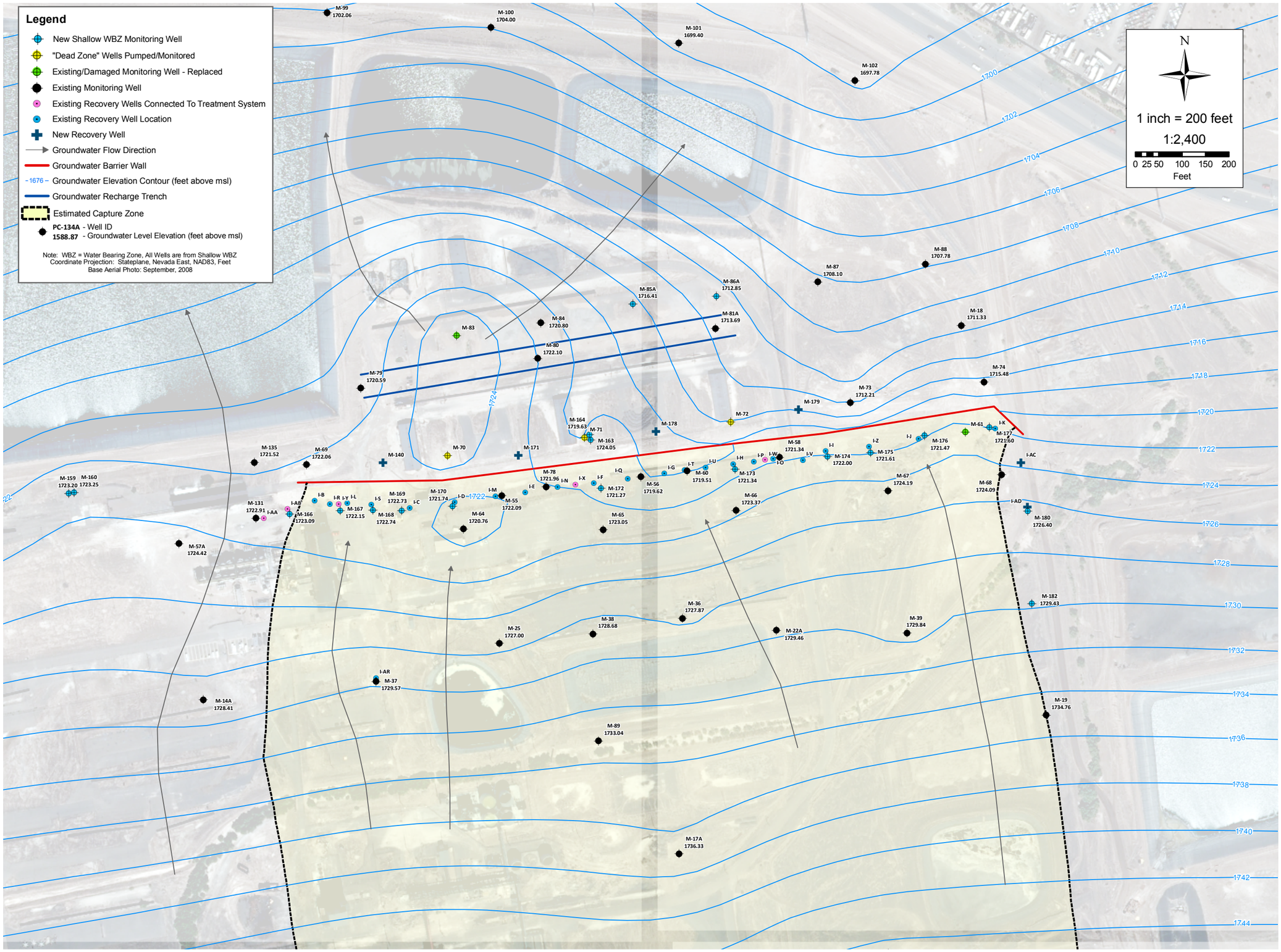
POTENTIOMETRIC SURFACE, SHALLOW WBZ
THIRD QUARTER 2010
ATHENS ROAD WELL FIELD
Capture Zone Evaluation Report
Tronox LLC - Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1:2,400	12/10/2010	2027.02 T28

FIGURE NUMBER:
5-3

SHEET NUMBER:
1

\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_F5-2_Potentiometric_Surface_Interceptor_Well_KT3D_101208.mxd Last updated 12/8/2010 2:51:13 PM



northgate environmental management, inc.

www.ngem.com

TRONOX

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	DRAWN BY:	CHECKED BY:	APPROVED BY:
AS	SC	LMS	KR

POTENTIOMETRIC SURFACE, SHALLOW WBZ
THIRD QUARTER 2010
INTERCEPTOR WELL FIELD
Capture Zone Evaluation Report
Tronox LLC - Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1:2,400	12/10/2010	2027.02 T28

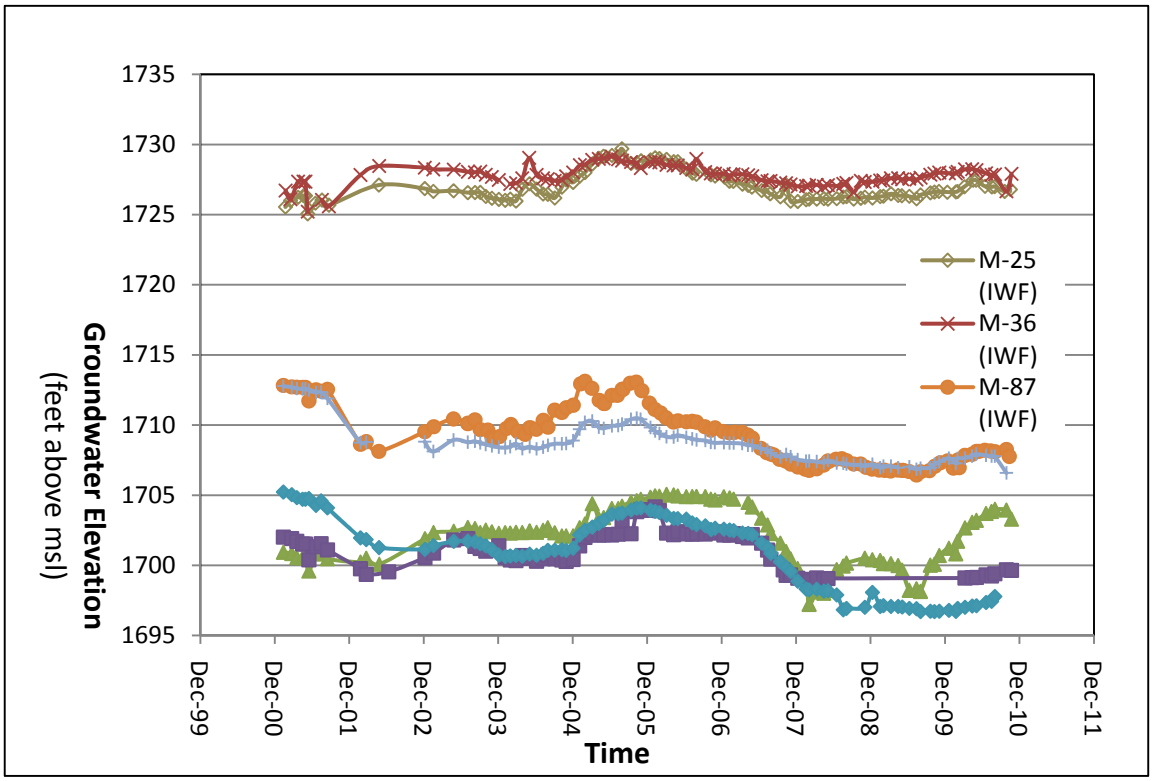
FIGURE NUMBER:

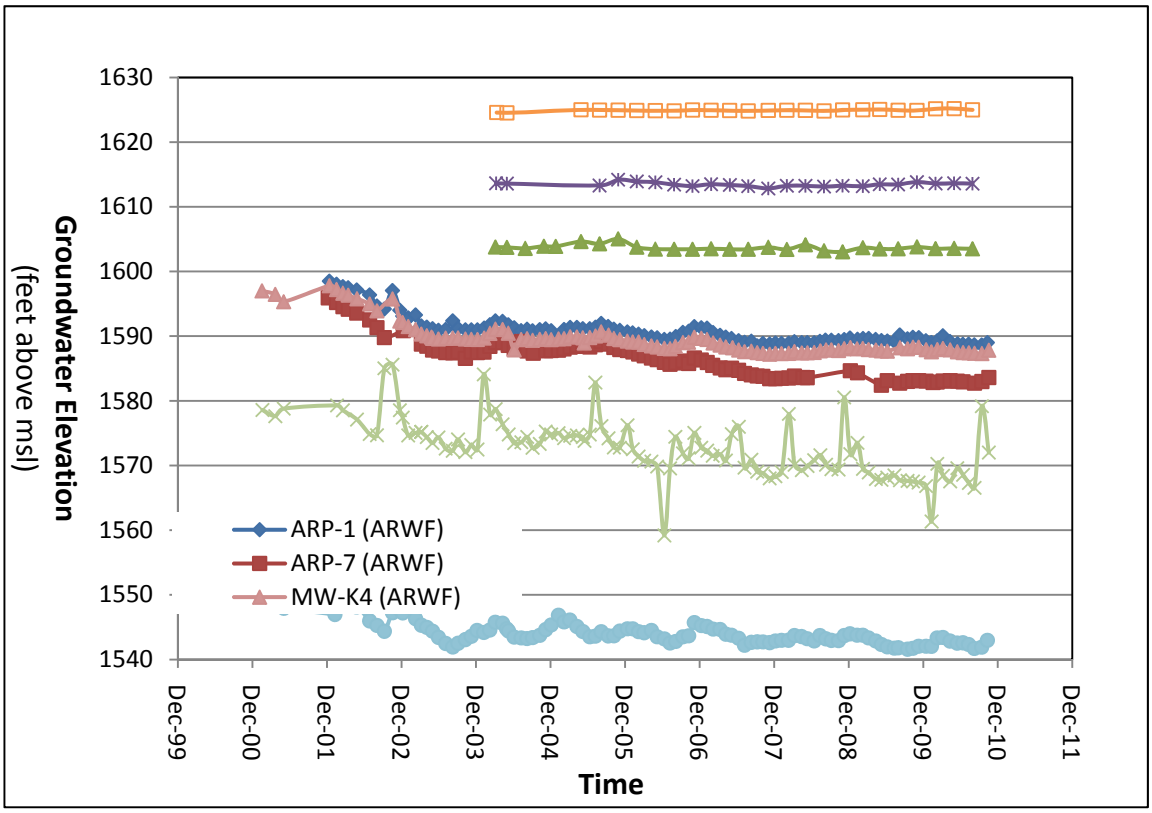
5-2

SHEET NUMBER:

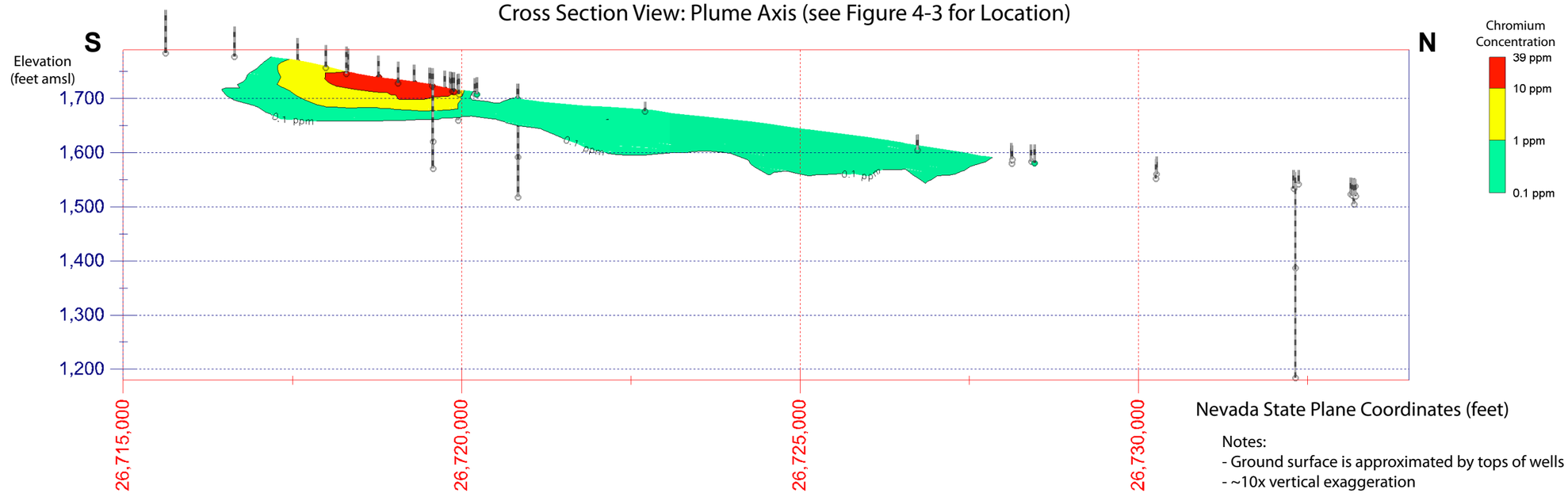
1

FIGURE 5-1
Hydrographs for Select Site Monitoring Wells



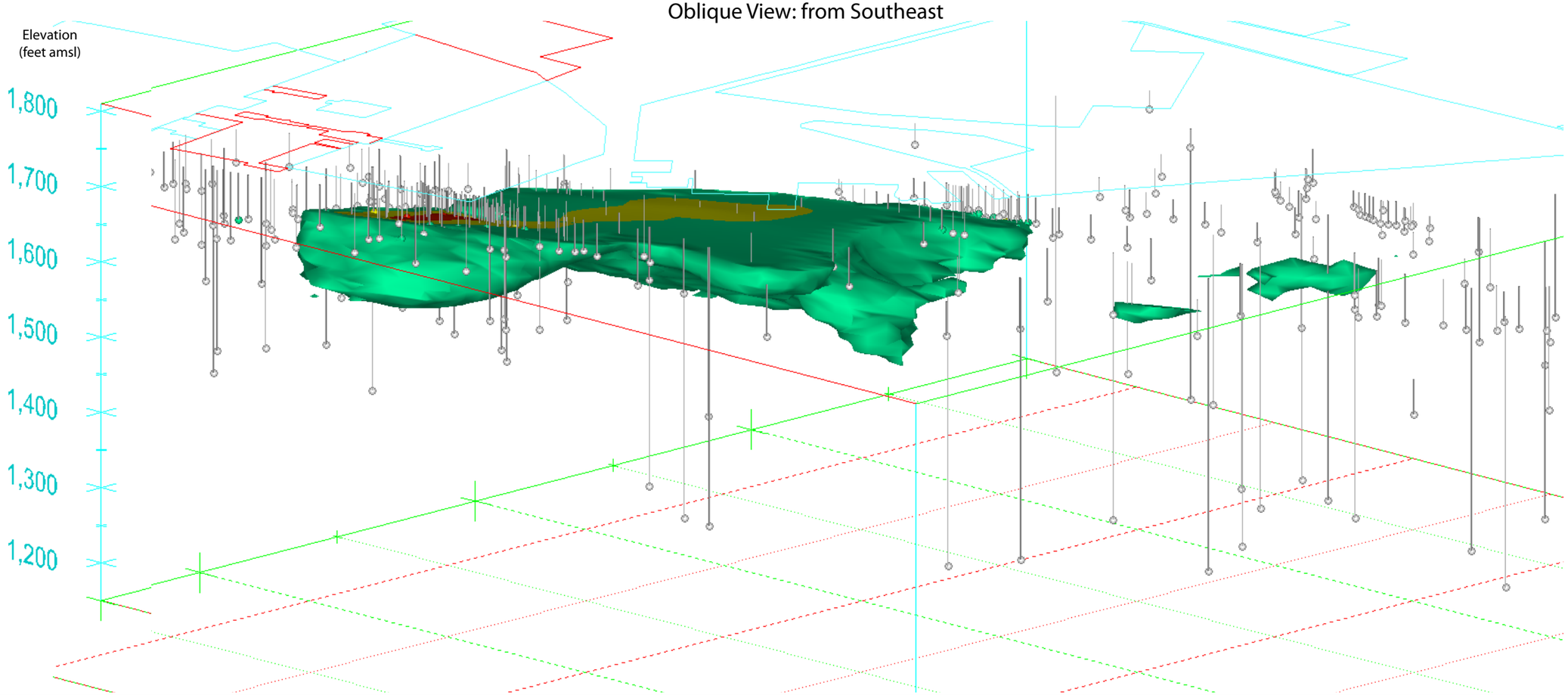


Cross Section View: Plume Axis (see Figure 4-3 for Location)



Notes:
- Ground surface is approximated by tops of wells
- ~10x vertical exaggeration

Oblique View: from Southeast



northgate environmental management, inc.
www.ngem.com
TRONOX

REVISIONS:		
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	AS
DRAWN BY:	CH
CHECKED BY:	MS
APPROVED BY:	KR

Site-wide Chromium Plume
Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

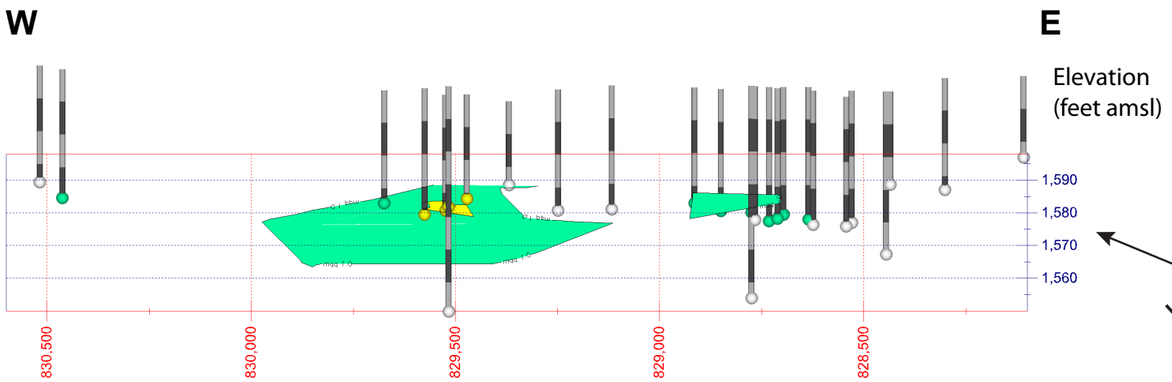
SCALE:	
DATE:	12/10/2010
PROJECT NUMBER:	2027.02 T 28

FIGURE NUMBER:
4-4

SHEET NUMBER:
1

G:\Projects\Temp\2027 Tronox\2027.02 Tronox Perchlorate\T28 2010 Capture Zone Evaluation Rpt\CZE Report\Figures\P2027_02_T28_CZE_RPT_F4-4_ChromePlumeSectionSN_101207.pdf

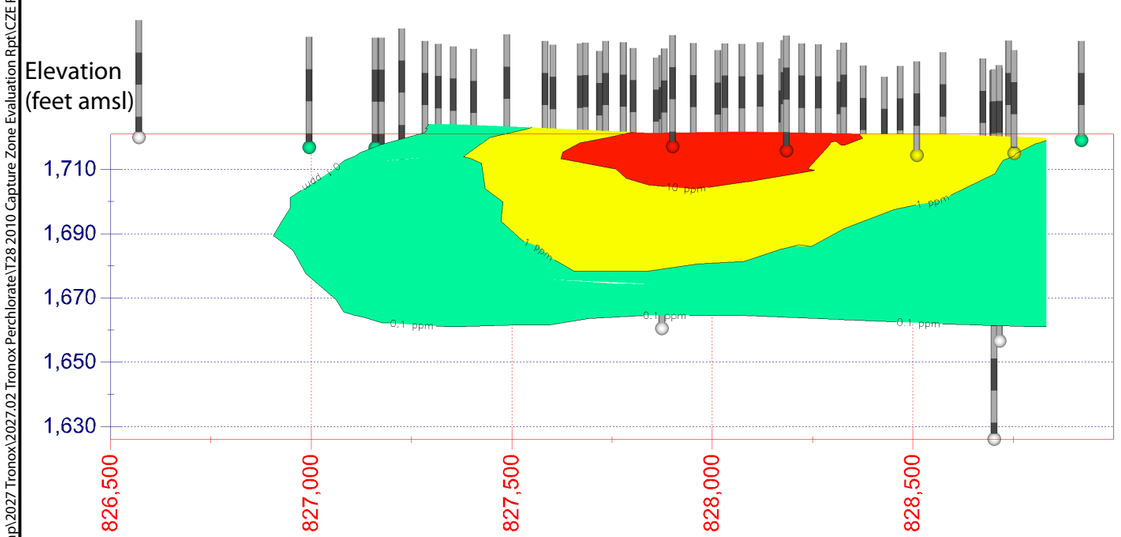
Cross-Section View: Athens Road Well Field



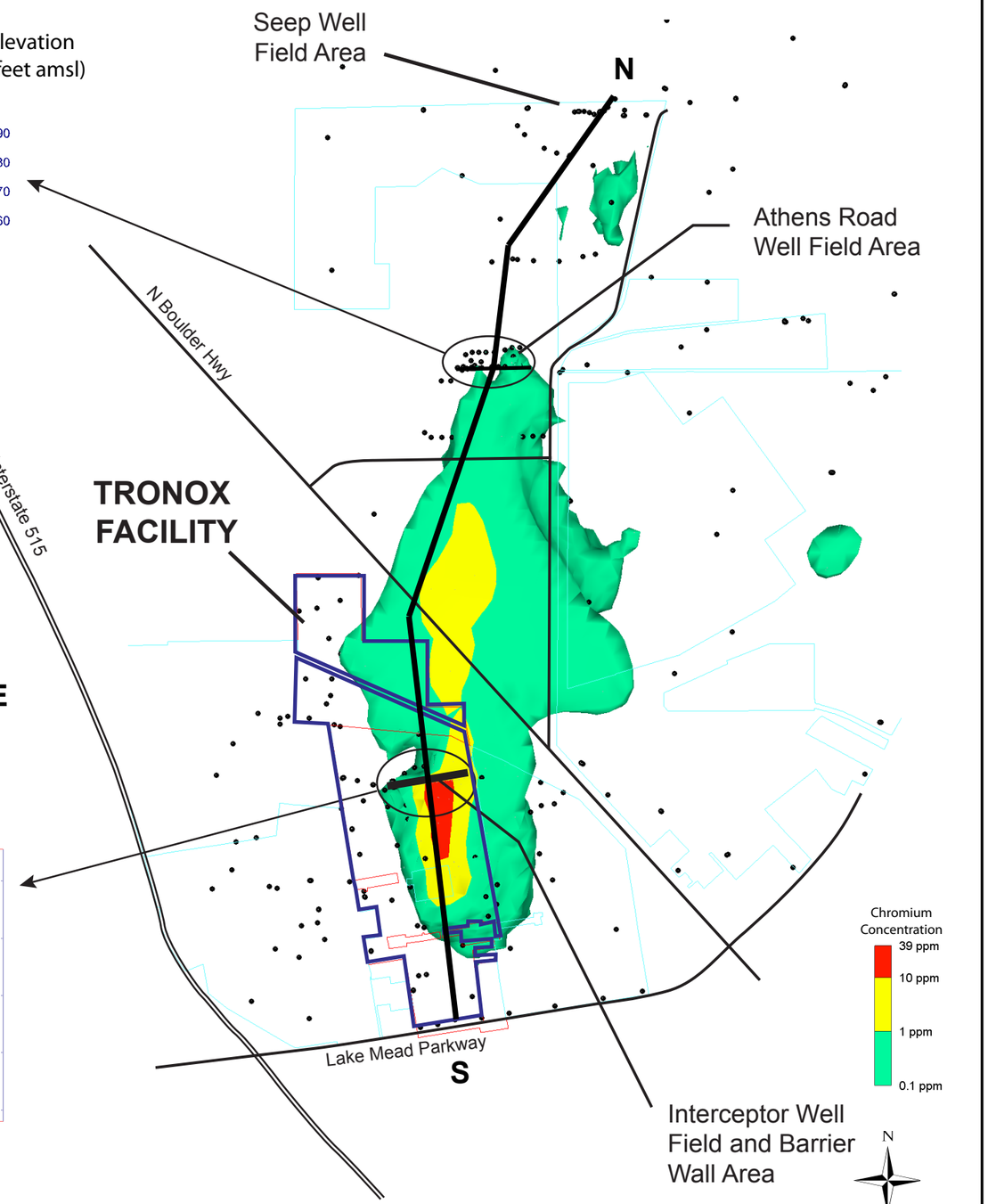
Nevada State Plane Coordinates (feet)

Notes:
- Ground surface is approximated by tops of wells
- ~10x vertical exaggeration

Cross-Section View: Interceptor Well Field



Nevada State Plane Coordinates (feet)



Based on 2008-2010 Data

Approximate Scale
1:35,000

northgate
environmental management, inc.
www.ngem.com
TRONOX

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	AS
DRAWN BY:	CH
CHECKED BY:	MS
APPROVED BY:	KR

Chromium Plume Map
Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

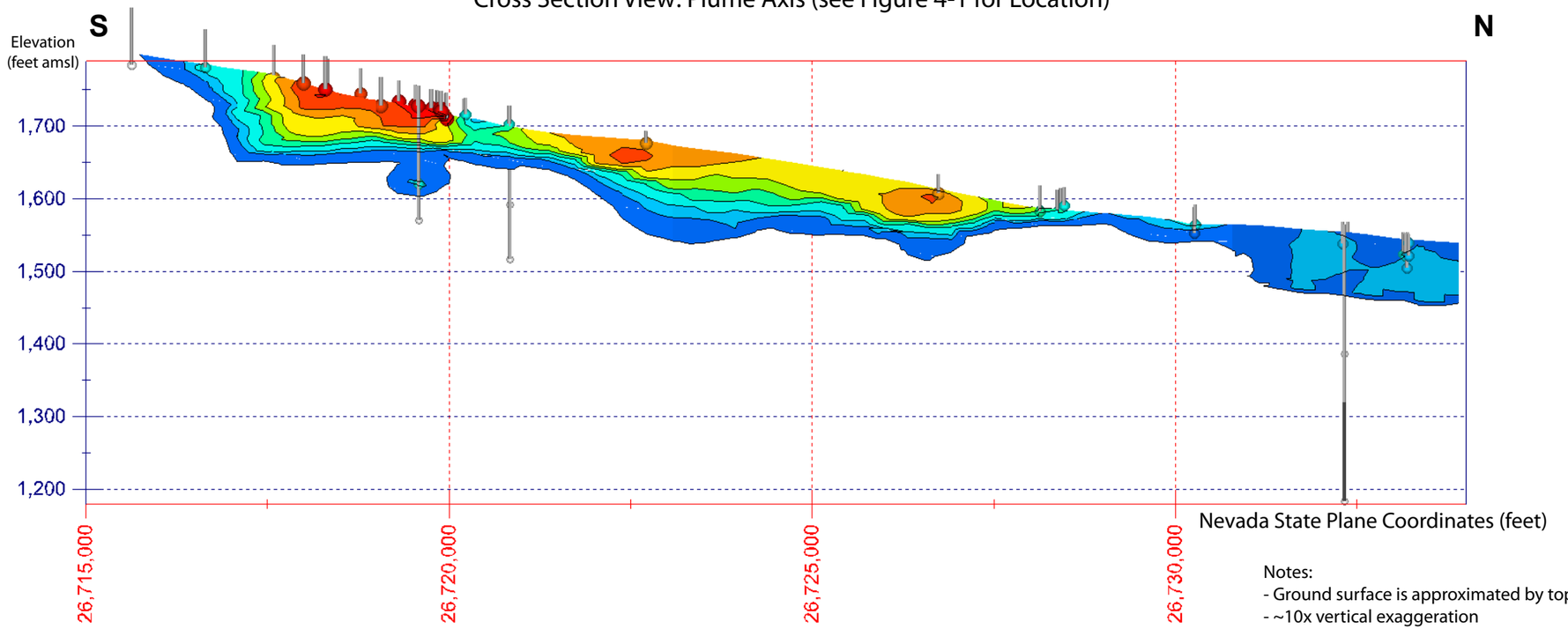
SCALE:	
DATE:	12/10/2010
PROJECT NUMBER:	2027.02 T 28

FIGURE NUMBER:
4-3

SHEET NUMBER:
1

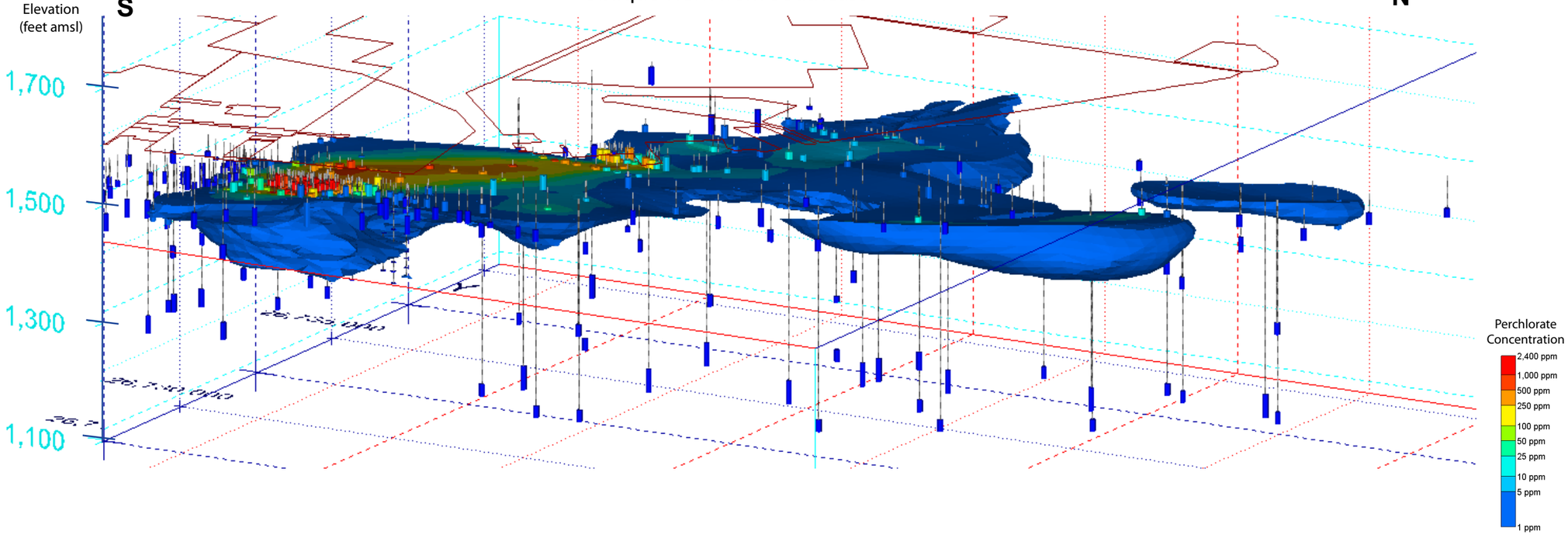
G:\Projects\Temp\2027 Tronox\2027.02 Tronox Perchlorate\T28 2010 Capture Zone Evaluation Rpt\CZE Report\Figures\P2027_02_T28_CZE_Rpt_F4-3_3DChromePlumeMapWE.pdf

Cross Section View: Plume Axis (see Figure 4-1 for Location)



Notes:
- Ground surface is approximated by tops of wells
- ~10x vertical exaggeration

Oblique View: from Southeast



G:\Projects\Temp\2027 Tronox\2027.02 Tronox Perchlorate\T28 2010 Capture Zone Evaluation Rpt\CZE Report\P2027_02_T28_CZE_RPT_F4-2_3DPercPlumeSectionSN.pdf

northgate environmental management, inc.
www.ngem.com
TRONOX

REVISIONS:		
NO:	DESCRIPTION:	DATE:	BY:

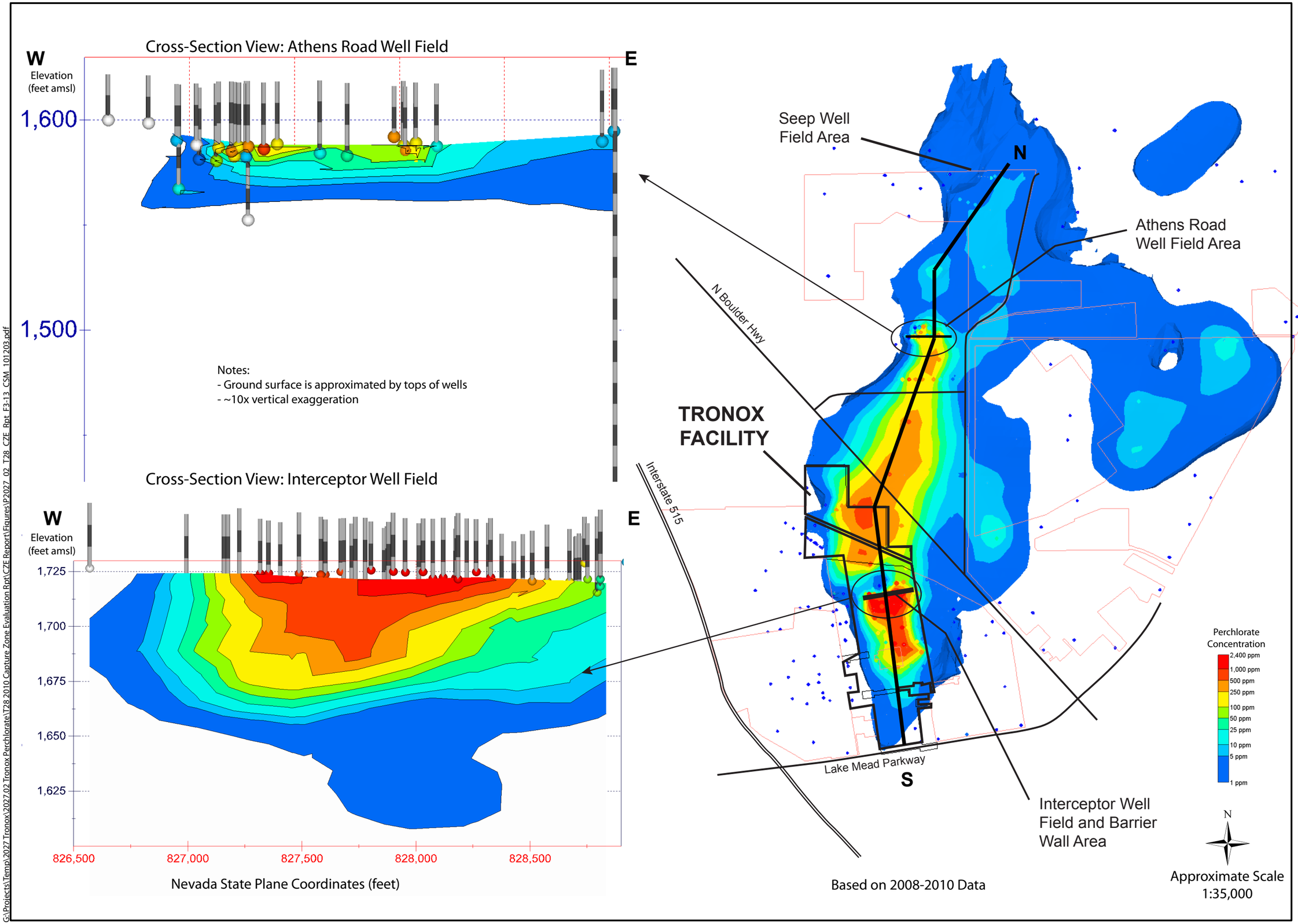
DESIGNED BY:	DRAWN BY:	CHECKED BY:	APPROVED BY:
AS	CH	MS	KR

Site-wide Perchlorate Plume
Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
	12/10/2010	2027.02 T 28

FIGURE NUMBER:
4-2

SHEET NUMBER:
1



northgate environmental management, inc.
www.ngem.com
TRONOX

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	AS
DRAWN BY:	CH
CHECKED BY:	MS
APPROVED BY:	KR

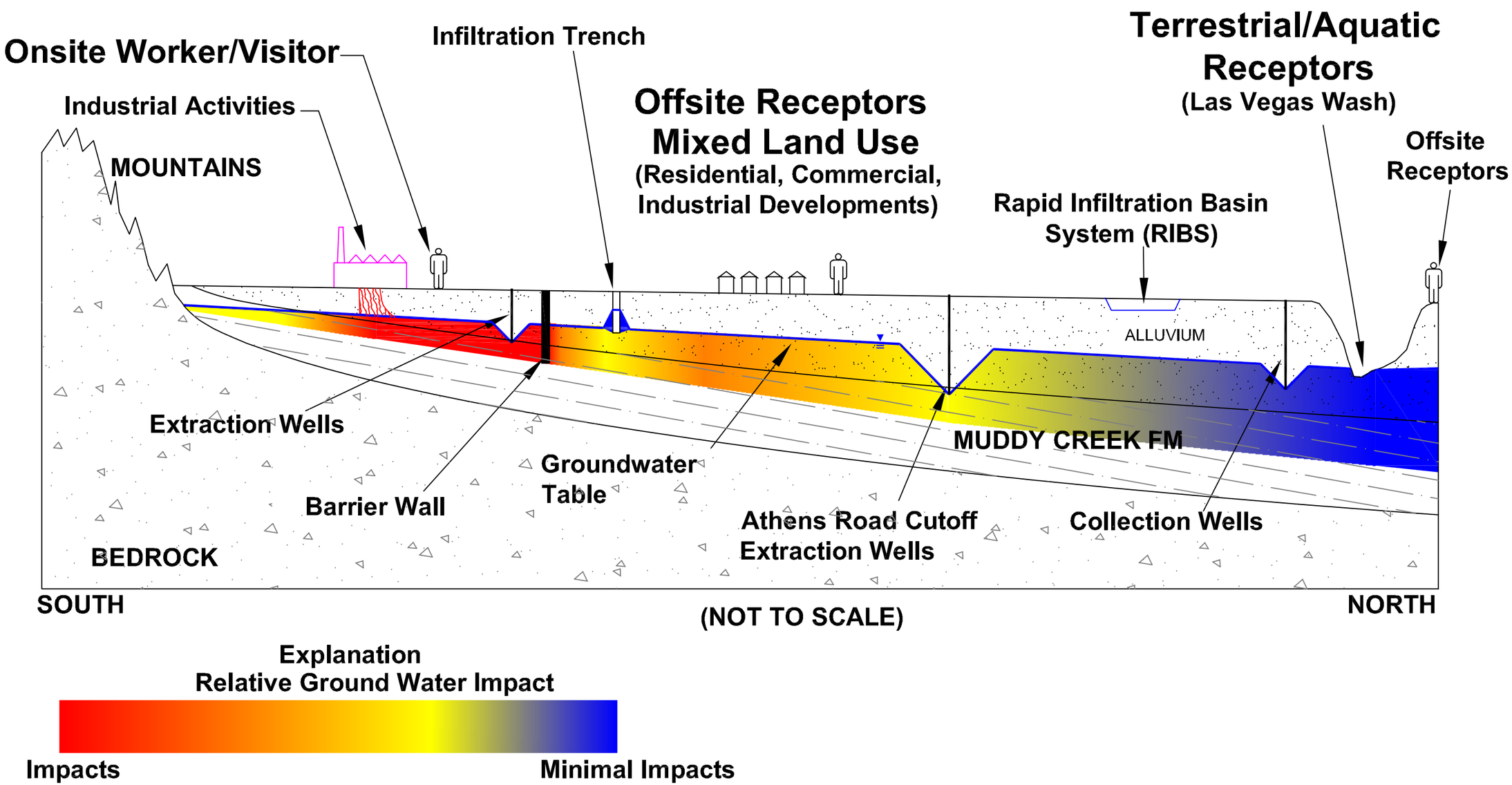
Perchlorate Plume Map
Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1:35,000	12/10/2010	2027.02 T 28

FIGURE NUMBER:
4-1

SHEET NUMBER:
1

G:\Projects\Temp\2027 Tronox\2027.02 Tronox Perchlorate\T28 2010 Capture Zone Evaluation Rpt\CZE Report\Figures\P2027_02_T28_CZE_Rpt_F3-13_CSM_101203.pdf



Source: ENSR|AECOM, 2007

northgate environmental management, inc.
www.ngem.com
TRONOX

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:
DRAWN BY:
CHECKED BY:
APPROVED BY:

Conceptual Site Model
Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE: NOT TO SCALE
DATE: 12/10/2010
PROJECT NUMBER: 2027.02 T 28

FIGURE NUMBER: 3-13
SHEET NUMBER: 1

G:\Projects\Temp\2027 Tronox\2027.02 Tronox Perchlorate\T28 2010 Capture Zone Evaluation Rpt\CZE Report\Figures\P2027_02_T28_CZE_Rpt_F3-13_CSM_101203.pdf

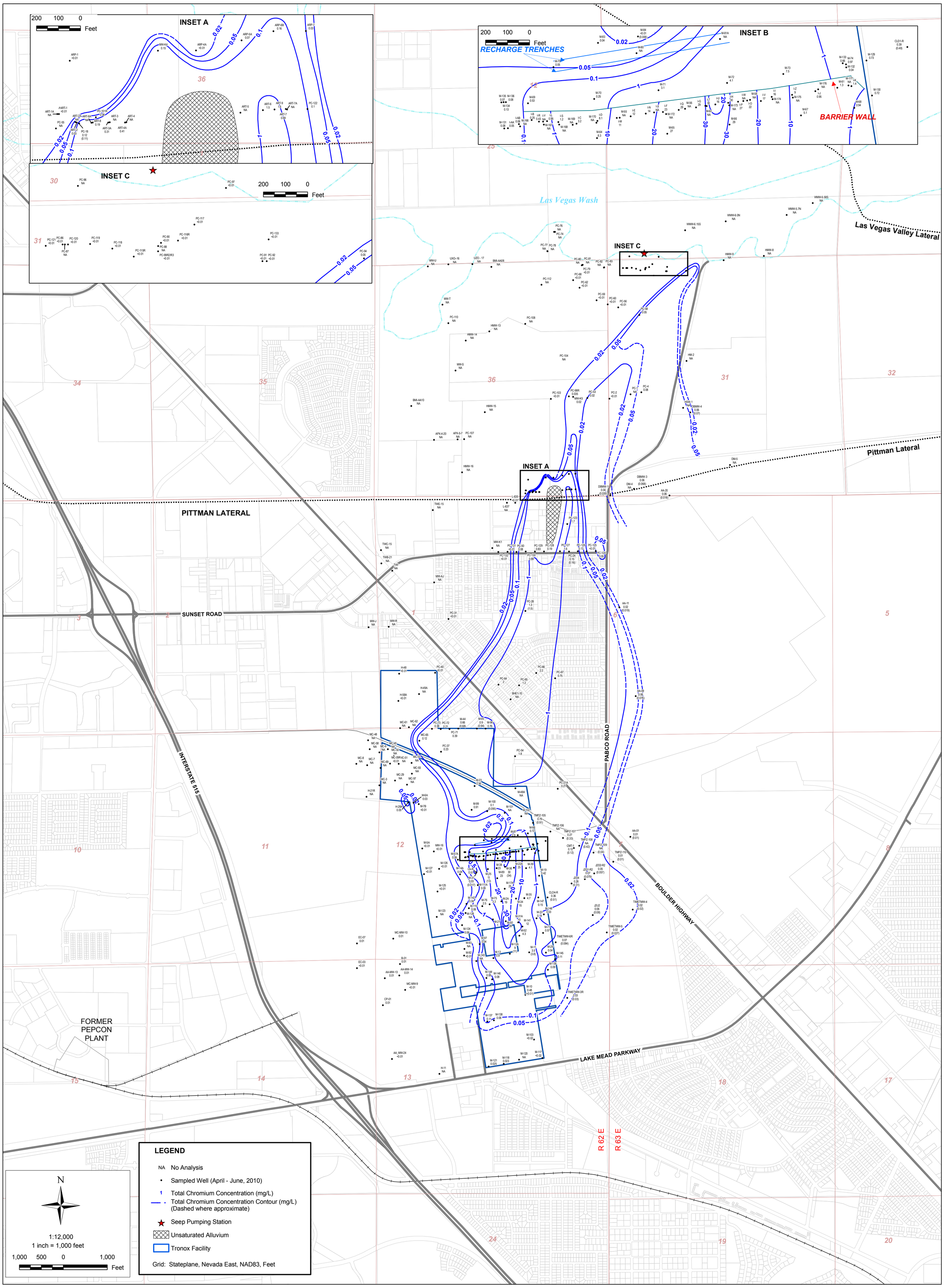


PLATE NUMBER: 3-12

SHEET NUMBER: 1

DISTRIBUTION OF CHROMIUM IN SHALLOW WATER-BEARING ZONE

Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1:12,000	12/10/2010	2027.02 T28

DESIGNED BY:	REVISIONS			
E. Krish	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
NGEM				
CHECKED BY:				
NGEM				
APPROVED BY:				
NGEM				

northgate environmental management, inc.

TRONOX

www.ngem.com

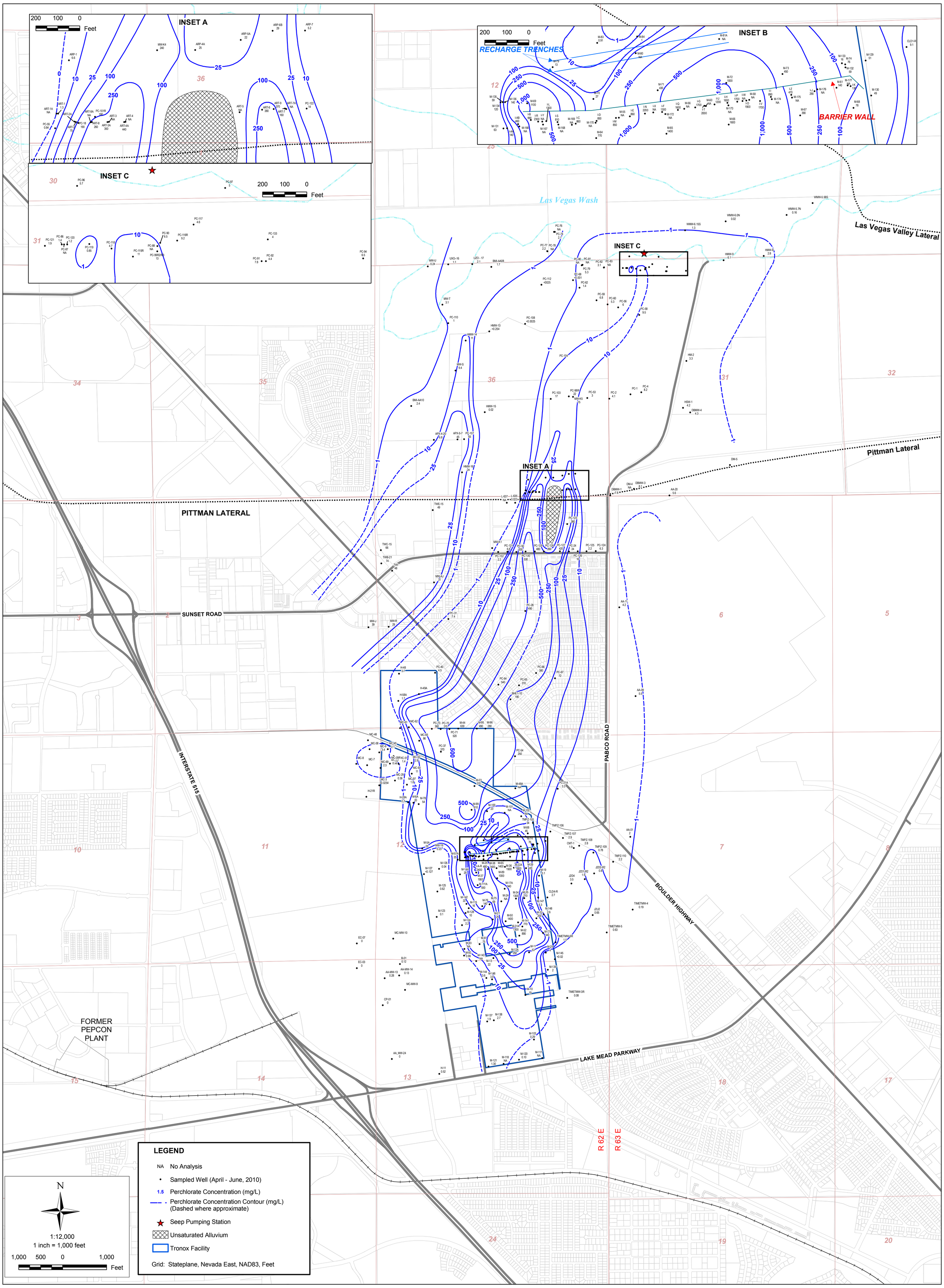


PLATE NUMBER: 3-11

SHEET NUMBER: 1

DISTRIBUTION OF PERCHLORATE IN SHALLOW WATER-BEARING ZONE

Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1:12,000	12/10/2010	2027.02 T28

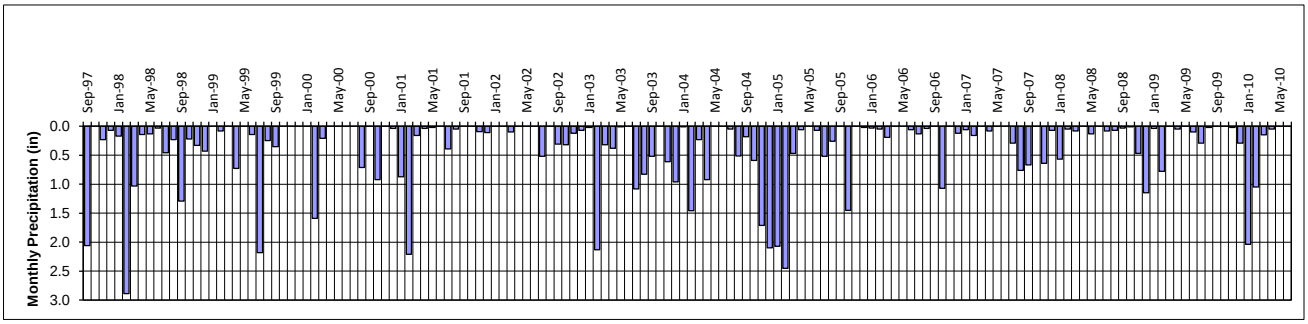
DESIGNED BY:	REVISIONS			
E. Krish	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
NGEM				
CHECKED BY:				
NGEM				
APPROVED BY:				
NGEM				

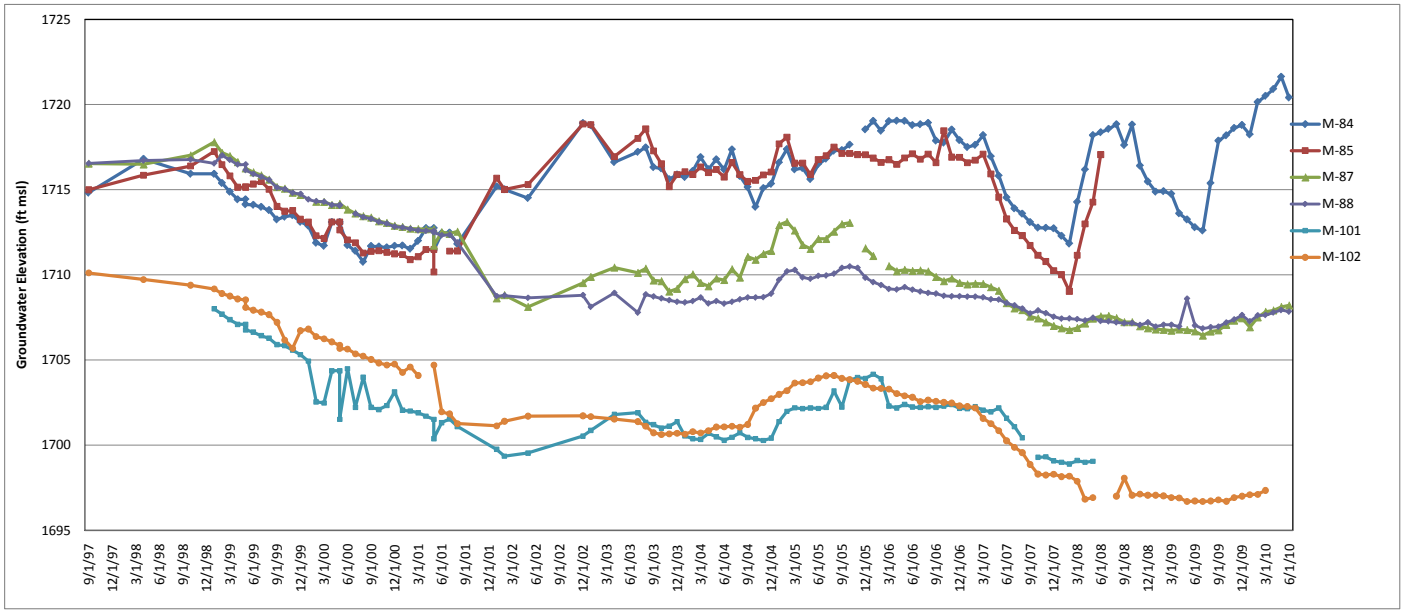
northgate environmental management, inc.

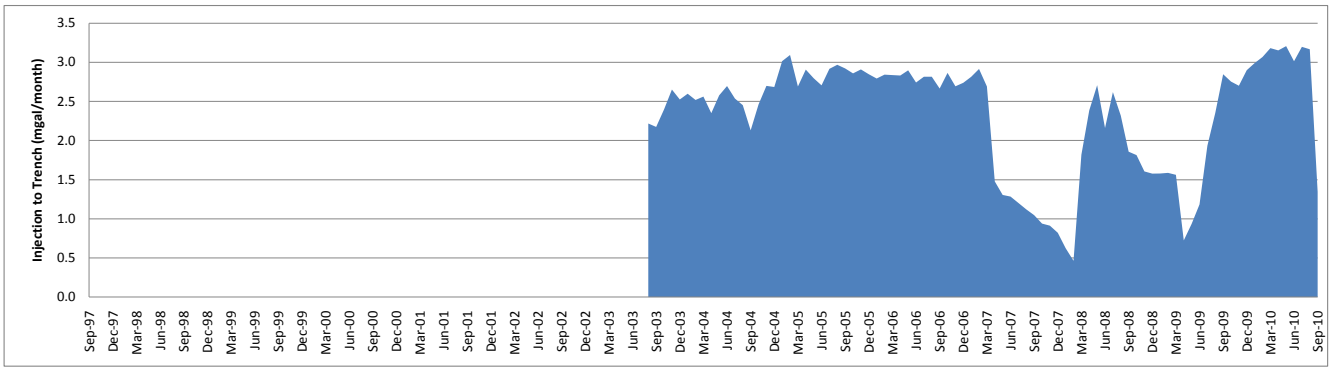
TRONOX

www.ngem.com

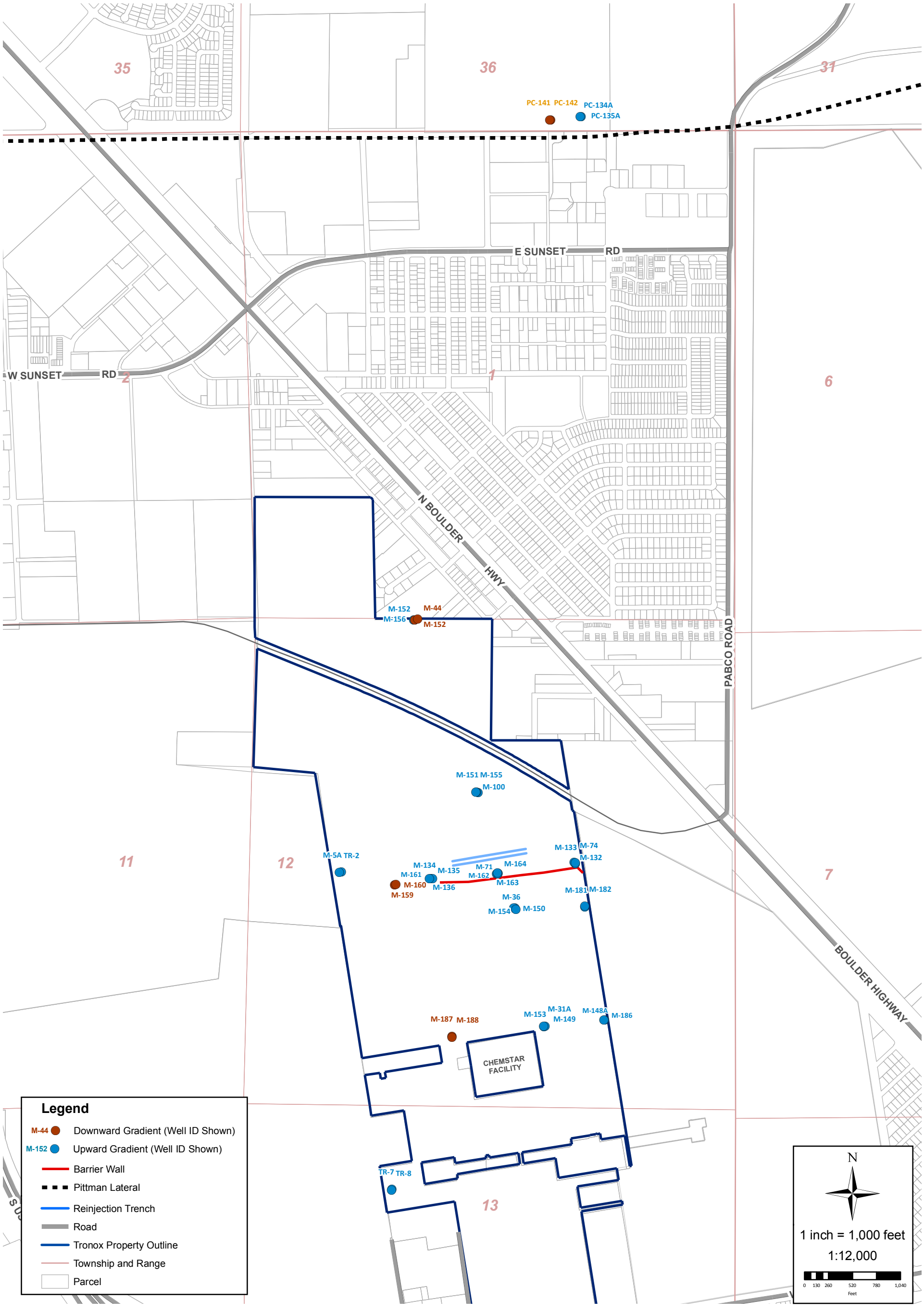
FIGURE 3-10
Monthly Precipitation, Shallow WBZ Well Hydrographs and Applied Water







Top: Las Vegas McCarran Airport, Nevada Monthly Rainfall 1997-2010
Middle: Tronox Property Monitoring Wells Located Downgradient of Tronox Infiltration Trenches
Bottom: Tronox Infiltration Trenches Total Montly Applied Water 2003-2010



SHEET NUMBER:	FIGURE NUMBER:
1	3-9

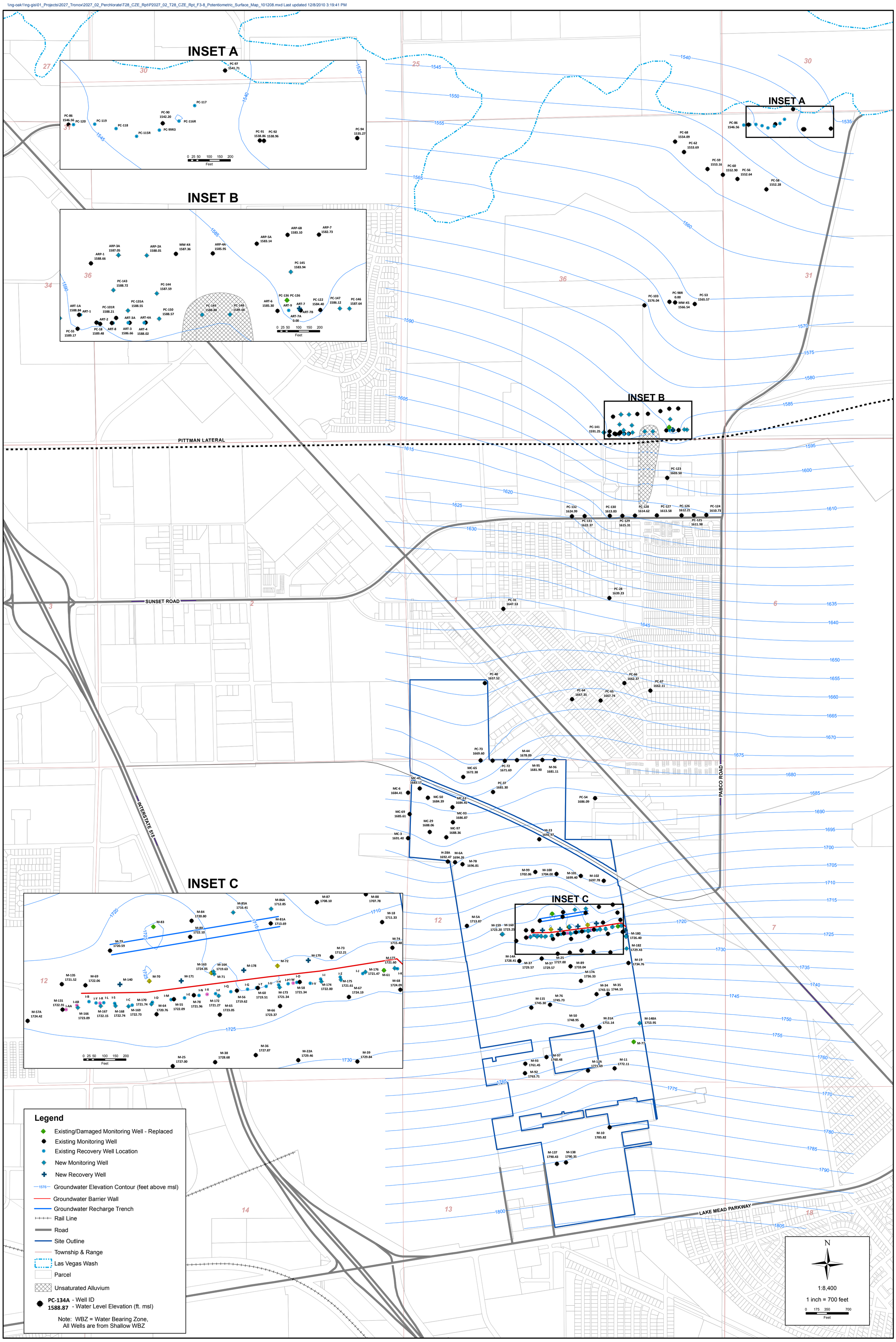
VERTICAL GRADIENT WELL PAIRS
Capture Zone Evaluation Report
Tronox LLC - Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 1,000 ft	12/10/10	2027.02 T28

DESIGNED BY:	REVISIONS			
NGEM	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
NGEM				
CHECKED BY:				
NGEM				
APPROVED BY:				
NGEM				

northgate environmental management, inc.
TRONOX
http://www.ngem.com

\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_F3-8_Potentiometric_Surface_Map_101208.mxd Last updated 12/8/2010 3:19:41 PM



SHEET NUMBER: 1

FIGURE NUMBER: 3-8

POTENTIOMETRIC SURFACE MAP, SHALLOW WBZ
THIRD QUARTER 2010

Capture Zone Evaluation Report
Tronox LLC - Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 700 ft	12/10/2010	2027.02

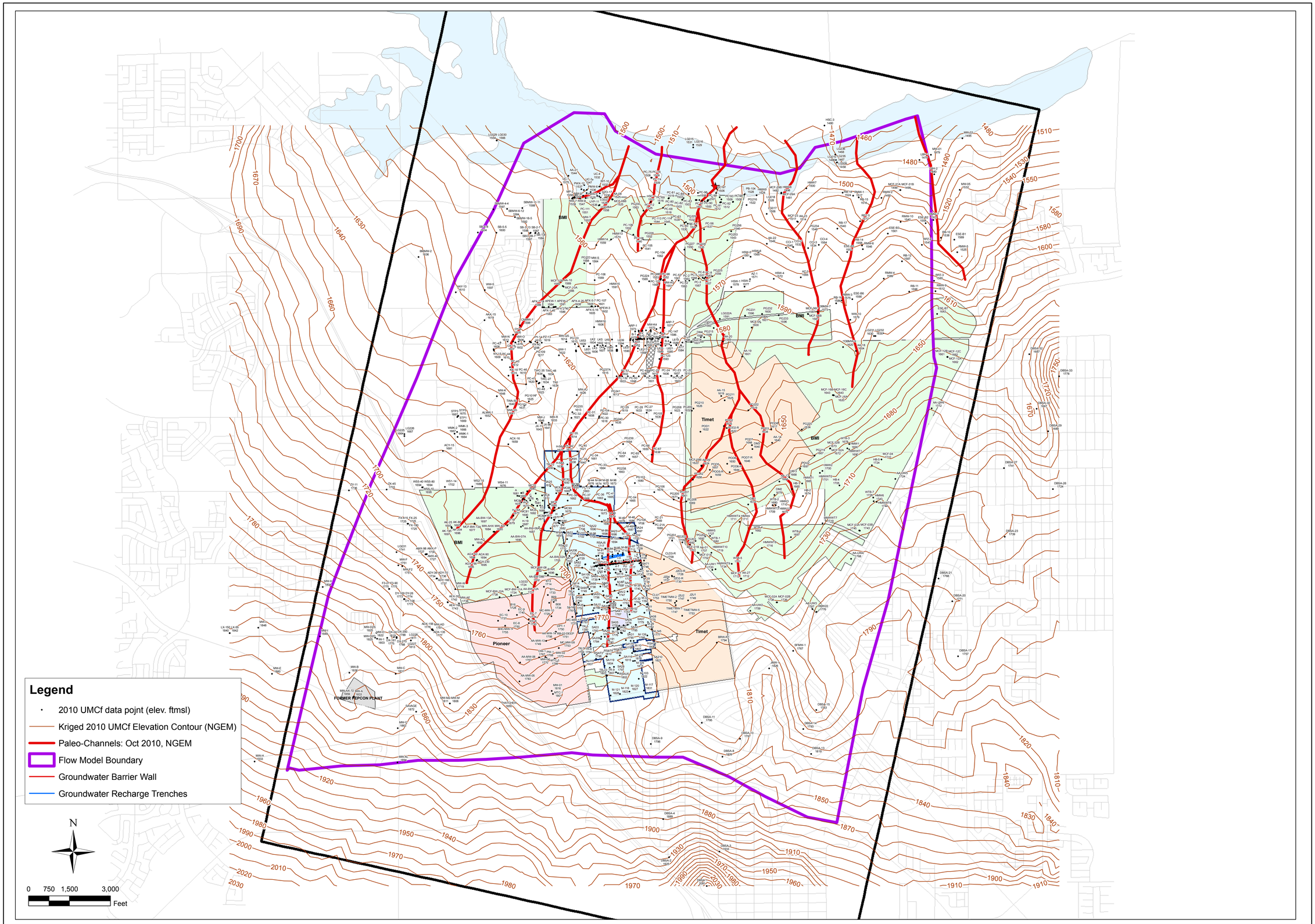
DESIGNED BY:	REVISIONS			
AS	NO.:	DESCRIPTION:	BY	DATE:
DRAWN BY:				
SC				
CHECKED BY:				
LMS				
APPROVED BY:				
KR				

northgate environmental management, inc.

TRONOX

www.ngem.com

\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_F3-7_QAL-UMCf_Contours_101208.mxd Last updated 12/8/2010 3:55:59 PM



northgate environmental management, inc.
www.ngem.com
TRONOX

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

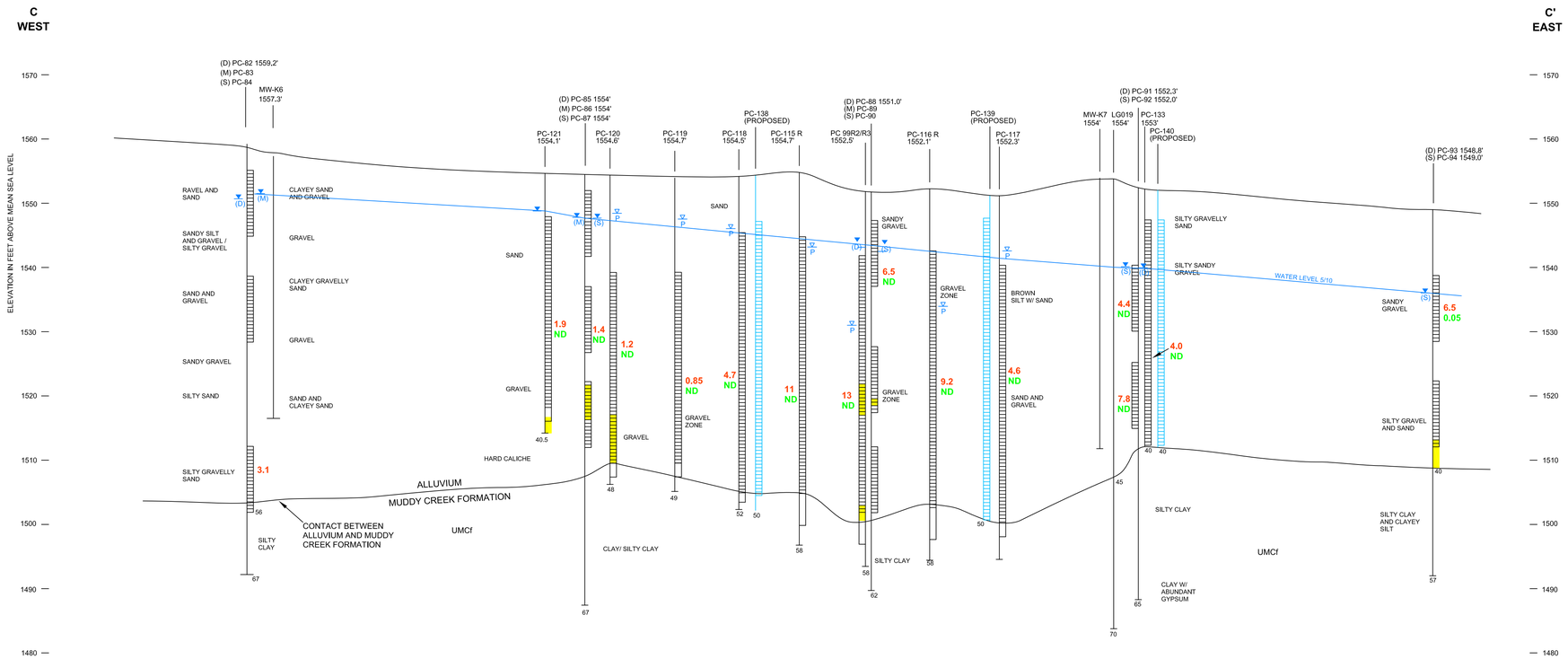
DESIGNED BY:	NGEM
DRAWN BY:	OS
CHECKED BY:	KR
APPROVED BY:	KR

QAL-UMCf CONTOURS AND PALEO-CHANNEL NETWORK
Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

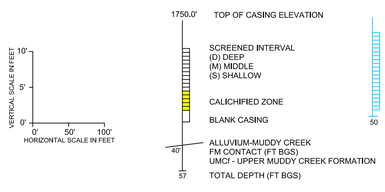
SCALE:	DATE:	PROJECT NUMBER:
1 in = 1,525 ft	12/10/2010	2027.02 T28

FIGURE NUMBER:
3-7

SHEET NUMBER:
1



LEGEND



northgate environmental management, inc.

http://www.ngem.com

REVISIONS			
NO.:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	E. Krish
DRAWN BY:	O. SLIVNYAK
CHECKED BY:	J. OTIS
APPROVED BY:	J. OTIS

WEST - EAST HYDROGEOLOGIC CROSS SECTION C-C'
SEEP WELL FIELD
SEPTEMBER 2010

Capture Zone Evaluation Report
Tronox LLC - Henderson, Nevada

PROJECT NUMBER:	2027.02 T28
DATE:	12/10/2010
SCALE:	as noted

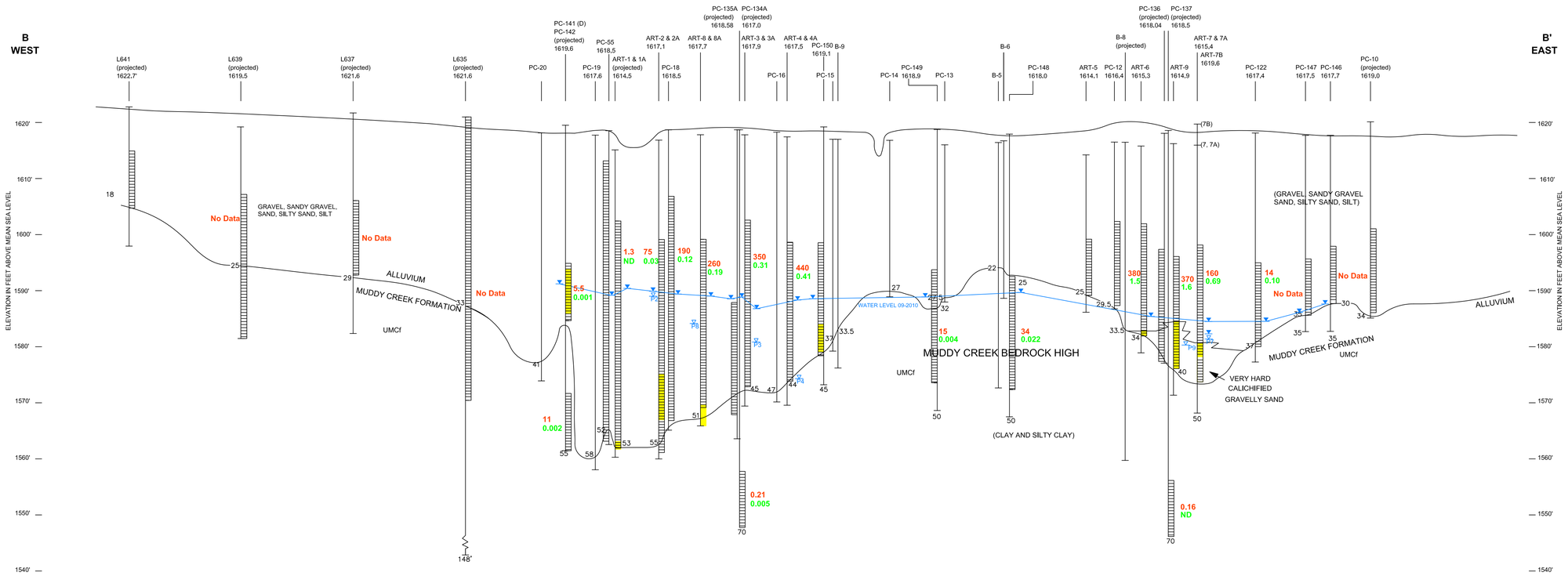
PLATE NUMBER:

3-6

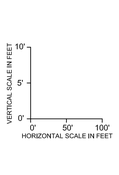
SHEET NUMBER:

X

M:\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_07_T28_CZE_Rpt_F3-4_3-6_CrossSections_101209.dwg Layout: CC seep-wf User: oleg Dec 08, 2010 - 12:22pm



LEGEND



1750.0' TOP OF CASING ELEVATION

SCREENED INTERVAL
(D) DEEP
(M) MIDDLE
(S) SHALLOW

CALICHIFIED ZONE

BLANK CASING

40' ALLUVIUM-MUDDY CREEK FM CONTACT (FT BGS)
UMCf - UPPER MUDDY CREEK FORMATION

57 TOTAL DEPTH (FT BGS)

GROUNDWATER LEVELS MEASURED SEPTEMBER 2010

P PUMPING WELL AND WELL NAME, SEPTEMBER 2010

1.9 PERCHLORATE CONCENTRATION AS OF MAY 2010 (mg/L) ND <0.004 mg/L

1.9 TOTAL CHROMIUM CONCENTRATION AS OF MAY 2010 (mg/L) ND <0.01 mg/L

NOTE: PERCHLORATE AND TOTAL CHROMIUM CONCENTRATION FOR PC-134A AND PC-137 ARE FROM SEPTEMBER AND NOVEMBER 2010, RESPECTIVELY.

northgate environmental management, inc.
http://www.ngem.com

REVISIONS
NO.: | DESCRIPTION: | DATE: | BY:

DESIGNED BY: E. Krish
DRAWN BY: O. SLIVNYAK
CHECKED BY: J. OTIS
APPROVED BY: J. OTIS

WEST - EAST HYDROGEOLOGIC CROSS SECTION B-B'
ATHENS ROAD WELL FIELD
SEPTEMBER 2010

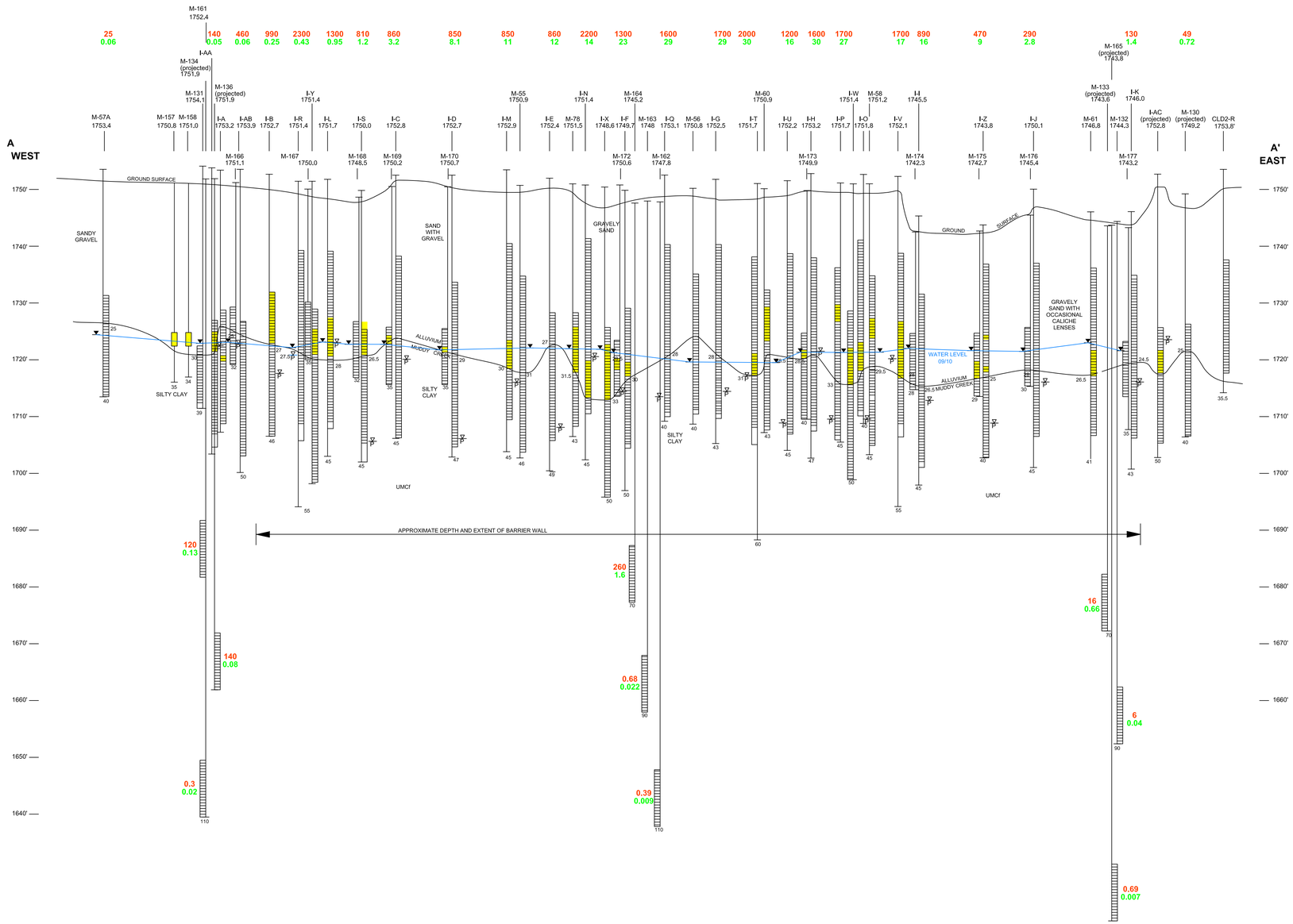
Capture Zone Evaluation Report
Tronox LLC - Henderson, Nevada

SCALE: as noted
DATE: 12/10/2010
PROJECT NUMBER: 2027.02.T.28

PLATE NUMBER: 3-5

SHEET NUMBER: X

M:\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\F2027_07_T28_CZE_Rpt_F3-4_3-6_CrossSections_101209.dwg Layout: BB Athens Rd w/ User: oleg Dec 08, 2010 - 3:55pm



LEGEND

1750.0' TOP OF CASING ELEVATION

SCREENED INTERVAL
(D) DEEP
(M) MIDDLE
(S) SHALLOW

CALICHIFIED ZONE

BLANK CASING

40' ALLUVIUM-MUDDY CREEK FM CONTACT (FT BGS)
UMCf - UPPER MUDDY CREEK FORMATION

57' TOTAL DEPTH (FT BGS)

GROUNDWATER LEVELS MEASURED SEPTEMBER 2010

19/P PUMPING WELL, SEPTEMBER 2010

1.9 PERCHLORATE CONCENTRATION AS OF MAY 2010 (mg/L) ND <0.004 mg/L

1.9 TOTAL CHROMIUM CONCENTRATION AS OF MAY 2010 (mg/L) ND <0.01 mg/L

NOTE: PERCHLORATE AND TOTAL CHROMIUM CONCENTRATION FOR WELLS M-161 THROUGH M-165 ARE FROM SEPTEMBER 2010.

VERTICAL SCALE IN FEET: 10', 5', 0'
HORIZONTAL SCALE IN FEET: 0', 50', 100'

northgate environmental management, inc.
http://www.ngem.com

REVISIONS			
NO.:	DESCRIPTION:	DATE:	BY:

DESIGNED BY: E. Krish
DRAWN BY: O. SLIVNYAK
CHECKED BY: J. OTIS
APPROVED BY: J. OTIS

WEST - EAST HYDROGEOLOGIC CROSS SECTION A-A' INTERCEPTOR WELL FIELD SEPTEMBER 2010

Capture Zone Evaluation Report
Tronox Facility, Henderson, Nevada

SCALE: as noted
DATE: 12/10/2010
PROJECT NUMBER: 2027.02 T28

PLATE NUMBER: 3-4

SHEET NUMBER: X

M:\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\F2\2027_07_T28_CZE_Rpt_F3-4_3-6_CrossSections_101209.dwg Layout: AA Interceptor WF User: oleg Dec 08, 2010 - 12:18pm

\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_F3-3_Well_Locations_101208.mxd Last updated 12/8/2010 3:21:42 PM

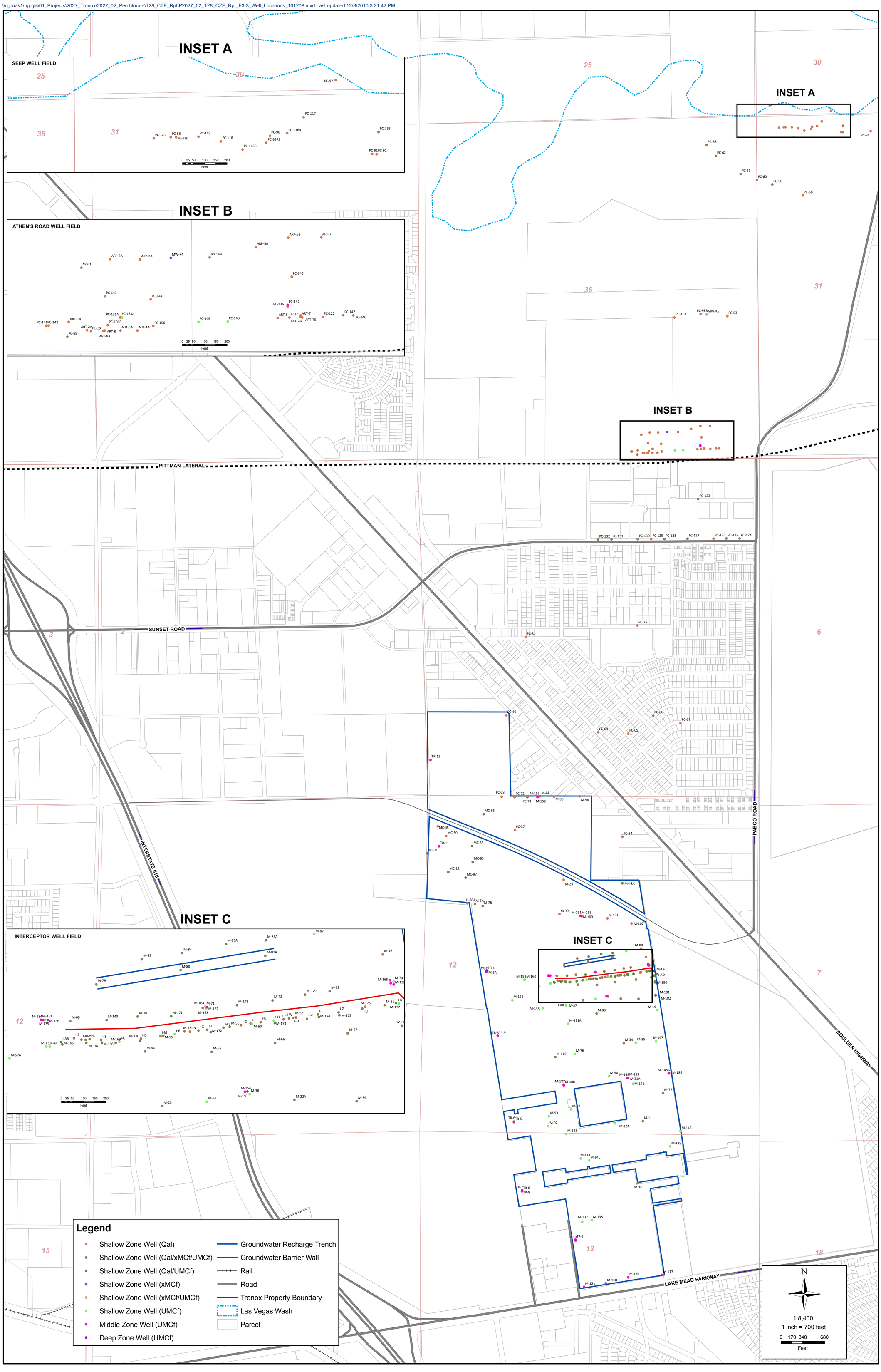


FIGURE NUMBER: 3-3

SHEET NUMBER: 1

WELL LOCATIONS WITHIN THE STUDY AREA

Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 700 ft	12/10/2010	2027.02 T28

DESIGNED BY:	REVISIONS			
SC	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
SC				
CHECKED BY:				
AS				
APPROVED BY:				
KR				

northgate environmental management, inc.

TRONOX

www.ngem.com

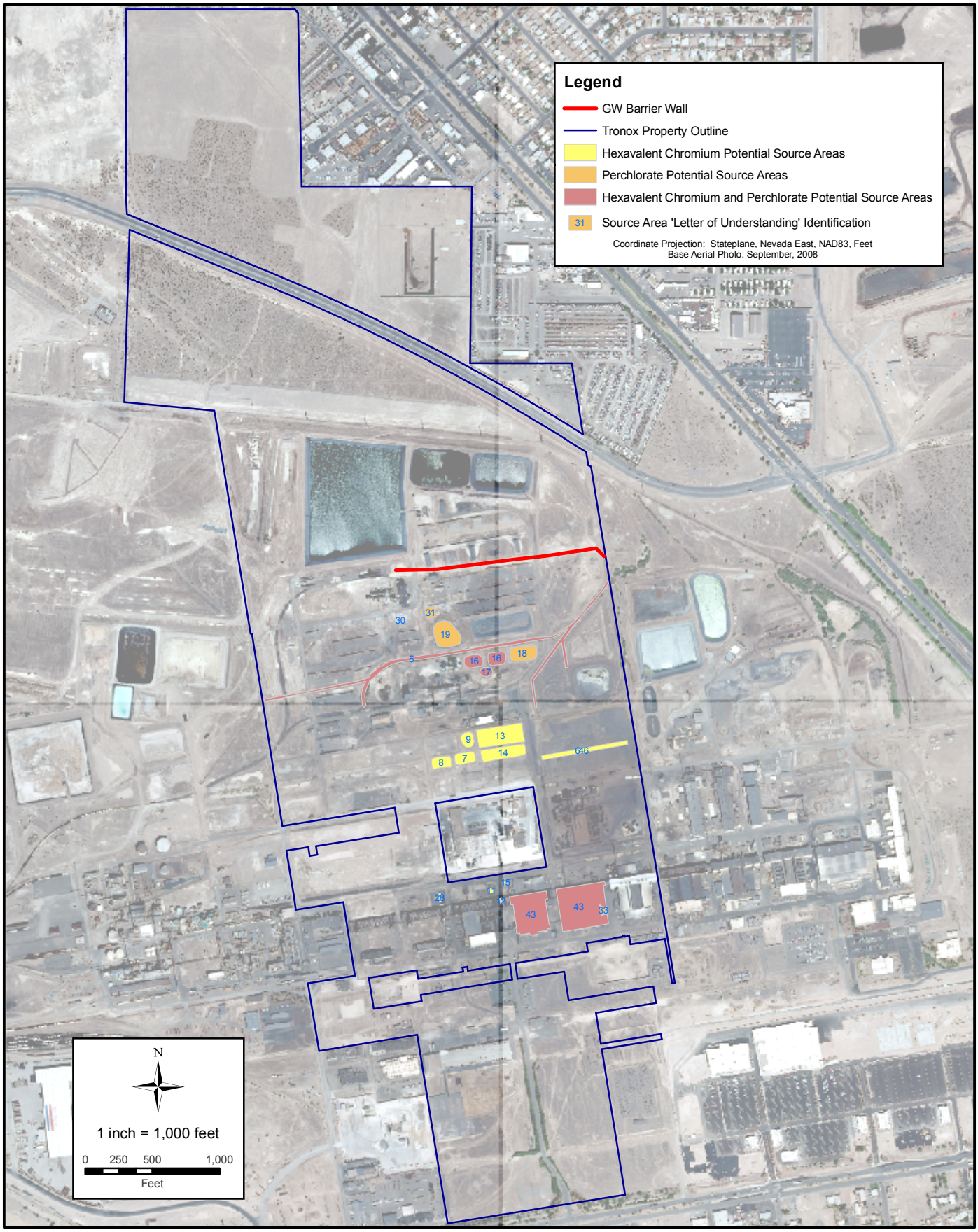


FIGURE NUMBER: 3-2

SHEET NUMBER: 1

HISTORICAL POTENTIAL SOURCE AREAS OF CONTAMINANTS

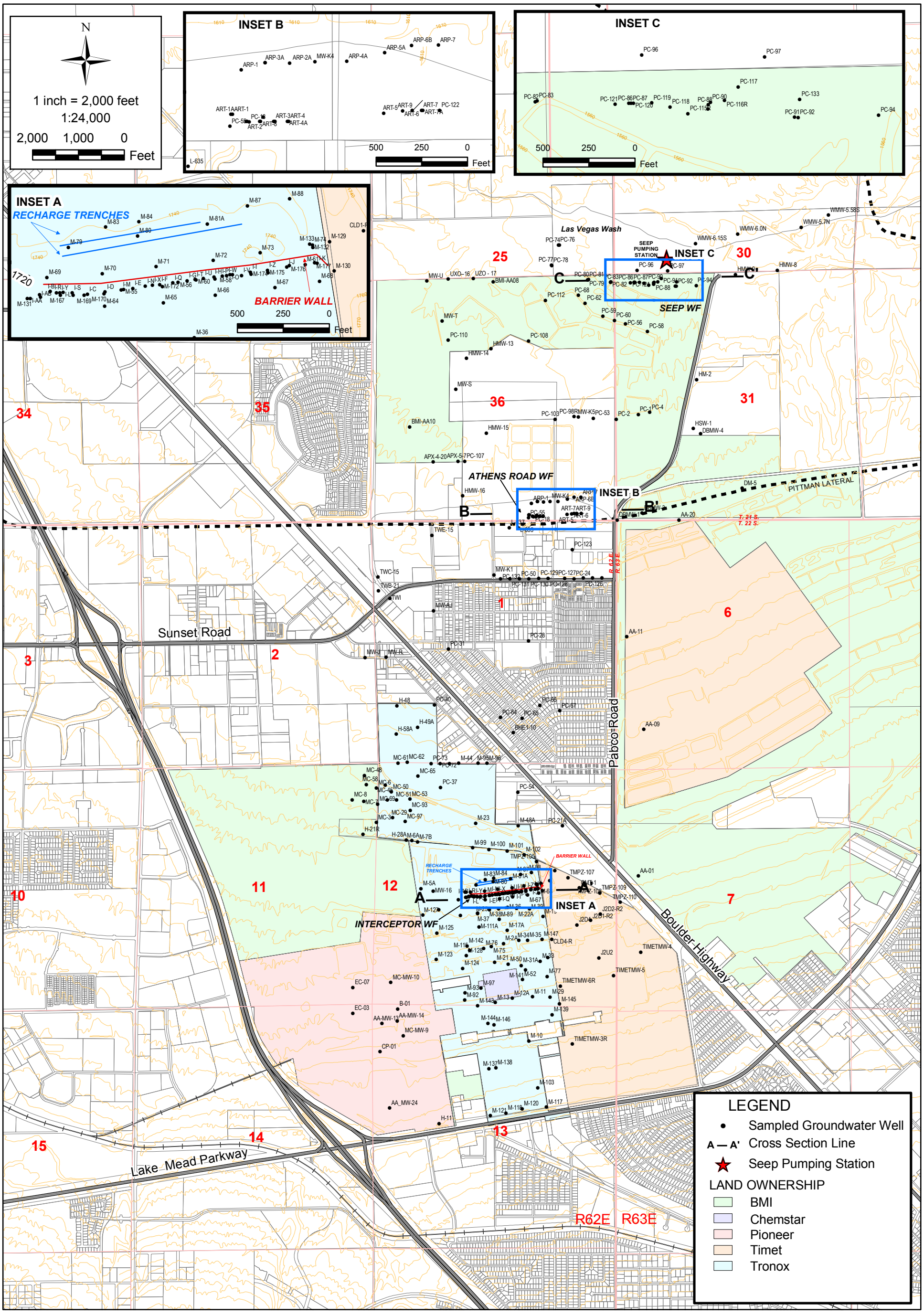
Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 1,000 ft	12/10/10	2027.02 T28

DESIGNED BY:	REVISIONS			
DT	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY: SC				
CHECKED BY: DT				
APPROVED BY: DT				

northgate environmental management, inc.
TRONOX
www.ngem.com

M:\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_F3-1_Cross_Section_Location _101208.mxd



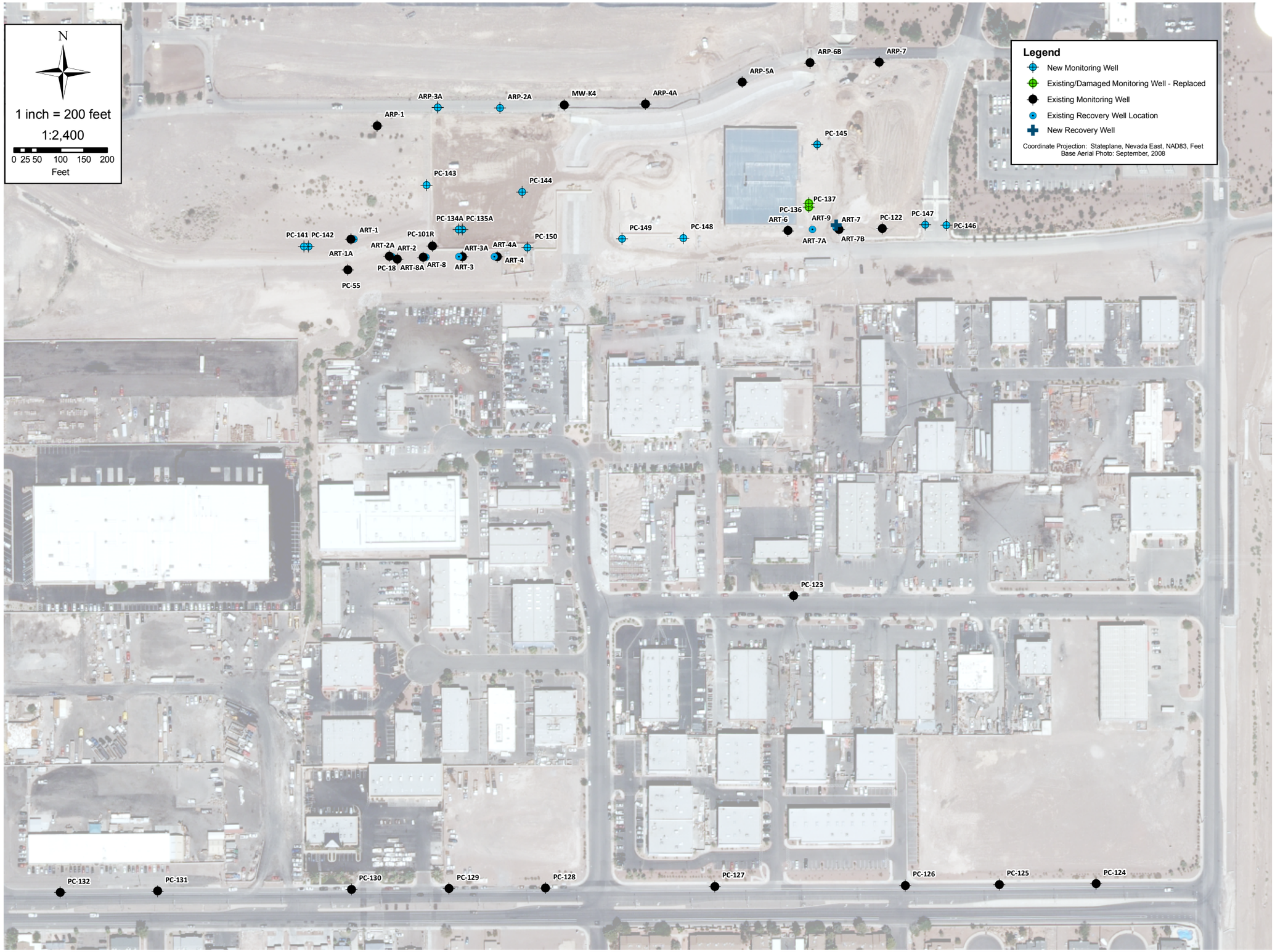
SHEET NUMBER:	FIGURE NUMBER:
1	3-1

LOCATION MAP
Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1:24,000	12/10/10	2027.02 T28

DESIGNED BY:	REVISIONS			
E. Krish	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
NGEM				
CHECKED BY:				
NGEM				
APPROVED BY:				
NGEM				

northgate environmental management, inc.
TRONOX
www.ngem.com



northgate environmental management, inc.
www.ngem.com
TRONOX

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	DRAWN BY:	CHECKED BY:	APPROVED BY:
AS	SC	LMS	KR

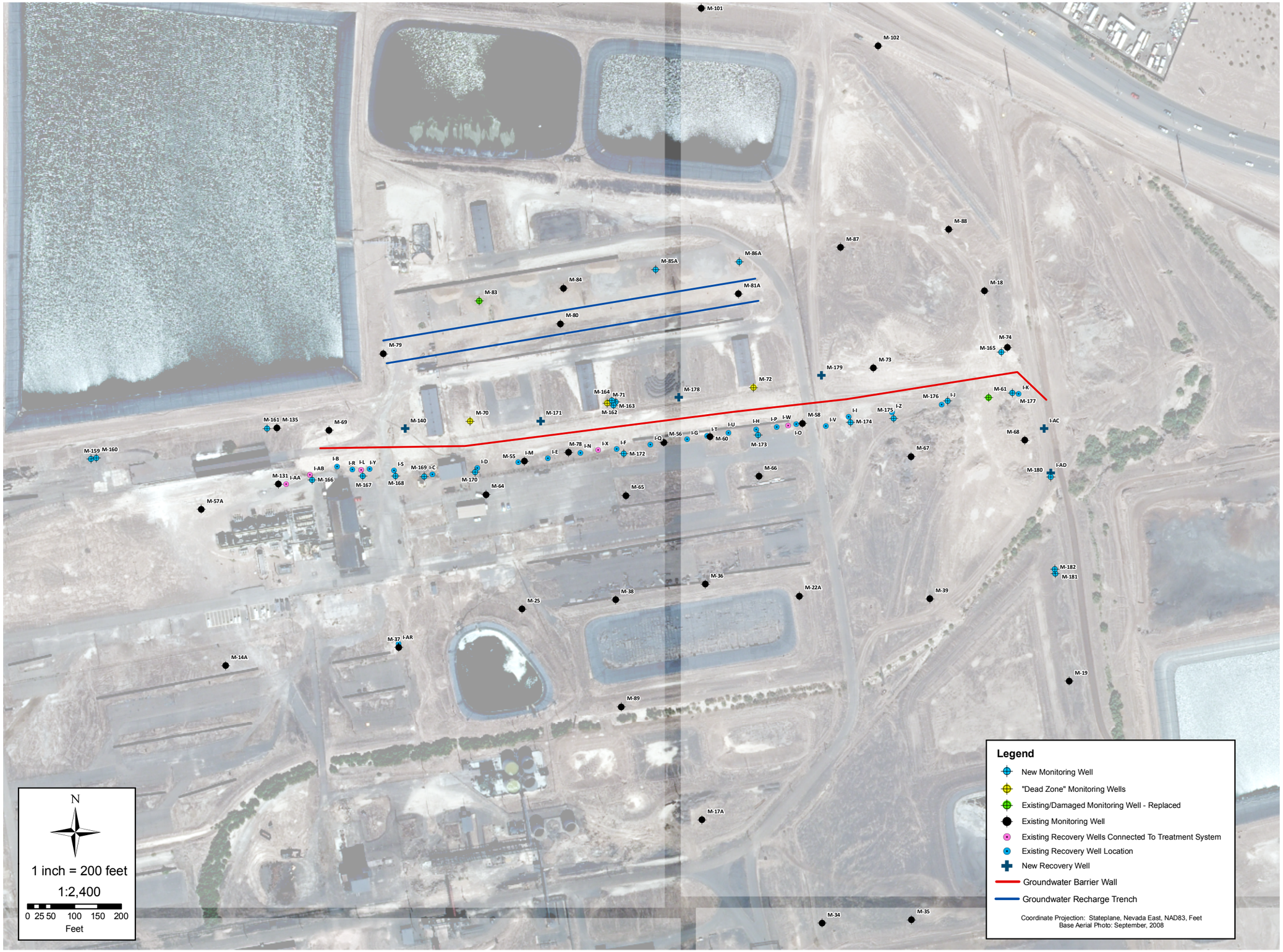
ATHENS ROAD WELL FIELD
Capture Zone Evaluation Report
Tronox, LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1:24,000	12/10/2010	2027.02 T28

FIGURE NUMBER:
1-3

SHEET NUMBER:
1

\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_F1-2_Interceptor_WF_101208.mxd Last updated 12/8/2010 11:15:04 AM



northgate environmental management, inc.

TRONOX

www.ngem.com

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	AS
DRAWN BY:	SC
CHECKED BY:	LMS
APPROVED BY:	KP

INTERCEPTOR WELL FIELD
Capture Zone Evaluation Report
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1:2,400	12/10/10	2027.02 T28

FIGURE NUMBER:

1-2

SHEET NUMBER:

1

\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_F1-1_Tronox_Site_Location _101208.mxd Last updated 12/8/2010 11:28:00 AM

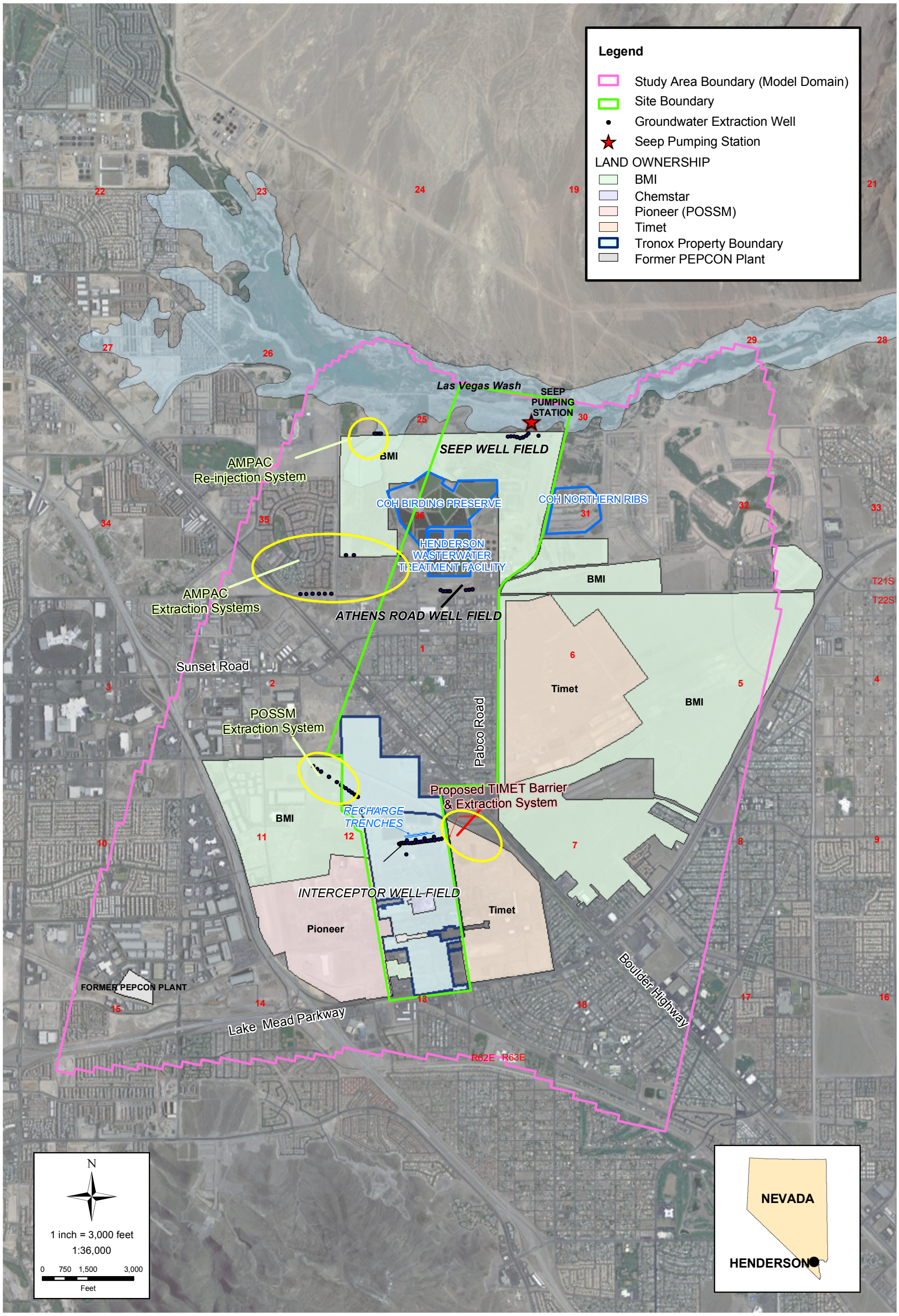


FIGURE NUMBER:	SHEET NUMBER:
1-1	1

GROUNDWATER FLOW MODEL DOMAIN
Capture Zone Evaluation Report
Tronox LLC - Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 3,000 ft	12/10/2010	2027.02 T28

DESIGNED BY:	REVISIONS			
NGEM	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
NGEM				
CHECKED BY:				
NGEM				
APPROVED BY:				
NGEM				

northgate environmental management, inc.
TRONOX
http://www.ngem.com

APPENDIX A
TRONOX FINAL RESPONSE TO NDEP JANUARY 26, 2010 COMMENTS

APPENDIX A

Original and Updated Tronox Responses to NDEP January 26, 2010 Comments Regarding: *Interim Groundwater Capture Evaluation and Vertical Delineation Report*, Tronox LLC, Henderson, Nevada, Dated December 23, 2009

Tronox general response to comments:

To address remaining data gaps identified by NDEP and Tronox in these comments and previous documents, Tronox has prepared a *Capture Zone Evaluation Work Plan* (revised version to be dated March 25, 2010), which proposes significant additional data collection and evaluation activities related to capture zone analysis. A standalone capture zone evaluation report incorporating the results of this enhanced analysis with the previous analysis will be completed by the end of 2010. Therefore, Tronox's changes to this *Interim Groundwater Capture Evaluation and Vertical Delineation Report* in response to NDEP's comments focus on correcting factual errors and misstatements and identifying and acknowledging the remaining data gaps. A specific response to each comment is provided below.

1. *General comment, TRX has failed to use the water bearing zone (WBZ) nomenclature from the NDEP's January 6, 2009 Guidance Letter RE: BMI Plant Sites and Common Areas Projects, Henderson, Nevada Hydrogeologic and Lithologic Nomenclature Unification. The revised Deliverable must comply with this nomenclature or it will be rejected without review and Stipulated Penalties may apply.*

   Tronox Response: The document has been modified to consistently use the BMI unified WBZ nomenclature.

2. *General comment, as NDEP has requested numerous times, in all Deliverables, TRX should provide "live" executable files (spreadsheets) for all tables, including formulas used for calculations.*

   Tronox Response: "Live" executable spreadsheets, including formulas used for calculations, are included with this revised deliverable.

3. *Executive Summary, NDEP has the following comments:*

   a. *Page 1, 2nd paragraph, TRX describes the vertical gradients as being "generally upward". Inspection of the remaining text and tables do not indicate the calculation of any downward gradients; please clarify if downward vertical gradients have been calculated or are suspected to exist at any areas of the Site.*

Tronox Response: The qualifier "generally" has been removed.

b. *Page 1, last paragraph, NDEP has the following comments:*

   i. *TRX notes that for the Athens Road well field "data gaps have been partially addressed." This is unacceptable given the extremely protracted time frame that this work plan was implemented in. NDEP considers TRX's response to be unresponsive.*

   Tronox Response: Comment noted. As indicated in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, completion of this work is scheduled for May/June 2010.

   Tronox Updated Response: Tronox has addressed the following data gaps identified in the CZE workplan for the Athens Road well field:

   Monitor ARWF UMCf High and Further Define Potentiometric Surface Mapping in ARWF :

   In June through September 2010, Northgate installed, developed, and sampled:

   - Two, 6-inch diameter PVC monitoring wells, wells PC-148 and PC-149, within the UMCf high (Figure 1-3). Continuous core samples were collected during the drilling of these two wells. This core will be stored and saved in core boxes. The UMCf was encountered at a depth of 25 ft bgs. The UMCf was reportedly wet at 32 ft bgs. Both wells are screened in the UMCf from between 25 to 45 ft bgs, with 5 ft of blank casing from 45 to 50 ft bgs. The wells were developed following installation, and were subsequently sampled in September 2010.

   - Two additional monitoring wells, PC-146 and PC-147, east of the existing ARWF wells, and two additional monitoring wells, PC-141 and PC-142 west of the existing ARWF wells, to further define the width of the contaminant plume in this area (Figure 1-3). The eastern wells (PC-146 and PC-147) were extended to the Qal/UMCf interface and screened over the bottom 15 feet of Qal. The western wells (PC-141 and PC-142) were installed as a pair, to evaluate potential perchlorate stratification in the thicker Qal channel at the west end.PC-142 was screened in the upper 10 feet of saturated alluvium and PC-141 was screened from 45 to 55 ft bgs through the bottom 10 feet of alluvium. The QAL/UMCf contact was encountered at 32 ft bgs, which is approximately 23 ft higher than anticipated. The saturated thickness of QAL was estimated to be 7 ft. The wells were developed following installation, and were subsequently sampled in September 2010.

   - Three additional monitoring wells, PC-143 through PC-145, were installed between the ARWF and the ARP-series monitoring wells to provide additional definition of the potentiometric surface. Well PC-143 was installed north of ART-3, PC-144 was installed north-northeast of ART-4, and well PC-145 was installed north of ART-9 (Figure 1-3). The depths of the wells range from 45 to 65 feet bgs and all are

screened throughout the saturated Qal. An additional new monitoring well, PC-150, was also installed between ART-4 and the UMCf high. PC-150 was completed as a 50 ft deep, 6-inch diameter PVC well with a screened interval from 20 to 40 ft bgs and a 5 ft section of blank casing from 40 to 45 ft bgs. The wells were developed following installation, and were subsequently sampled in September 2010.

ii. *TRX references the McGinley and Associates 2007 model; however, TRX chooses not to reference the limitations of this model which presents a biased interpretation of the results of the model. This is not acceptable.*

Tronox Response: The document has been revised to acknowledge the limitations and uncertainties associated with the model.

c. *Page 2, 2nd paragraph, TRX should submit the Seep Area Well Field Groundwater Capture Report under separate cover and not revise and combine the Seep evaluation with the On-Site and Athens Road Well Fields Groundwater Evaluation document.*

Tronox Response: The Seep Area Well Field (SWF) capture evaluation will be reported in the revised capture zone evaluation report, scheduled for submittal by the end of 2010.

Tronox Updated Response: Northgate's CZE Workplan proposed to install three additional piezometers in the SWF near recovery wells PC-117, PC-118, and PC-133 (Figure 4). The installation of these three piezometers was originally proposed in the *Revised Work Plan to Evaluate Effective Groundwater Capture* dated August 27, 2007; however, they were not installed because of access issues. The piezometers were proposed for the purpose of to providing additional needed potentiometric data to improve the understanding of groundwater flow in this area.

Tronox has repeatedly requested permission (in writing) from BMI to access the SWF to perform remedial activities, including the installation of these piezometers. Tronox has repeatedly requested access to install these SWF wells, but has not been granted the access necessary by BMI. NDEP recognized this problem in a June 28, 2010 letter, an excerpt from which reads:

> "NDEP understands that, to date, TRX has not received a response to the letter from BMI. NDEP further understands that investigation and evaluation of groundwater capture at the Interceptor (On-Site) Well Field and the Athens (Galleria) Road Well Field is ongoing. The Groundwater Capture Evaluation Report is due to NDEP by December 3, 2010. At this time, NDEP will defer further action on the Seep access issues between TRX and BMI pending the results of the groundwater capture evaluation."

Although the current CZE report does include limited discussion and analysis of capture at the SWF, a thorough capture evaluation of the SWF has not been conducted and is pending the collection of additional data and resolution of access issues with BMI.

4. *Section 1.1, page 5, 1st paragraph, NDEP has the following comments:*

   a. *A high TDS area of up to 19,000 mg/L is referred to east of the Tronox facility; however, this area is not shown on Plate 8. Please clarify.*

      Tronox Response: The cited concentration was an older sample result presented in the 2008 Annual Remedial Performance Report for the Tronox facility, which incorporated data from neighboring sites. This section has been updated to reflect the most recent groundwater monitoring report available from the Timet site.

   b. *The highest TDS concentration for the plume originating onsite is stated as being 15,100 mg/L; however, Plate 8 shows higher concentrations (e.g., well I-T is labeled as 21,100 mg/L. Please rectify.*

      Tronox Response: The text has been modified to be consistent with data shown on Plate 8.

5. *Section 1.3, page 6, NDEP has the following comments:*

   a. *1st paragraph, TRX should revise this paragraph to state that NDEP has requested for the demonstration and verification of mass and hydraulic capture at each well remedial well field.*

      Tronox Response: This statement has been added to the end of Section 1.3, paragraph 1.

      Tronox Updated Response: As noted above in response to comment 3.c, the Seep well field is discussed in this report, but is not the subject of a thorough evaluation due to ongoing access issues with BMI.

   b. *2nd paragraph, TRX should note and use the most current and final guidance issued by USEPA: A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems, Final Project Report (January 2008).*

      Tronox Response: As indicated in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, the January 2008 USEPA capture zone guidance will be followed in the revised capture zone evaluation to be completed by the end of 2010.

Tronox Updated Response: The capture zone evaluation report, *Capture Zone Evlauation Report* (Northgate, December 3, 2010), follows this guidance and is organized according to the six steps described therein.

6. *Section 2.1.1, NDEP has the following comments:*

   a. *Data Gap # 1, pages 8 – 9, NDEP has the following comments:*

      i. *Page 8,1st paragraph, TRX states that "at the present time, no pumping has been performed at any of the wells. Tronox is working on securing a power source..." This is unacceptable. TRX has been working on implementing this scope of work for over two years and has chosen not to fully implement the NDEP-approved scope of work. For example, it is not clear why a power source could not have been secured or a mobile power source (e.g., generator) could not have been used.*

      Tronox Response: Comment noted. As indicated in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, completion of this work is scheduled for April-May 2010.

      Tronox Updated Response: Following a meeting with NDEP on April 16, 2010 to discuss proposed CZE work, Tronox submitted a revised proposal to install new 4-inch diameter wells downgradient of the barrier wall as part of the *Capture Zone Evaluation Work Plan* dated May 13, 2010. The intent was to install wells more suited for groundwater extraction than the 2-inch diameter monitoring wells that had previously been proposed. The four "dead zone" wells were subsequently installed, plumbed into the groundwater treatment plant (GWTP), and began pumping on October 19th, 2010. The pumping wells and adjacent monitoring wells M-69 through M-73 are being routinely monitored for water levels and water quality (perchlorate, TDS, and dissolved chromium). The wells will be monitored for an initial period of three months, after which the chemical data, previously collected geotechnical samples of the wall, and water level analysis will be used to evaluate the integrity of the barrier wall. A technical memorandum will be submitted to NDEP summarizing the results of the barrier wall investigation, along with a determination of whether additional pumping of the "dead zone" wells is necessary.

      ii. *Page 8, 2nd paragraph, NDEP has noted that there is a response between well pair M-56 and M-71. The response in above-barrier well M-56 is smaller than that of M-71 but the groundwater elevations seem to increase and decrease together. Please explain how this would impact the determination that the barrier wall is not leaking.*

      Tronox Response: As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, additional testing to evaluate whether the barrier wall is

leaking is scheduled for April-June 2010. Tronox does not believe the water levels in well M-56 reflect changes occurring below the barrier, but will further evaluate data for well pair M-56 and M-71 and nearby pumping/injection wells to assess this.

Tronox Updated Response: Tronox collected samples of the barrier wall material for permeability testing on July 29 and 20, 2010. The results of the testing were transmitted to NDEP in a letter dated September 29, 2010. Tronox believes that the results of this testing confirm that the barrier wall is an effective barrier wall to groundwater flow as intended. In addition, as described in the updated response to NDEP comment 6.a.i above, Tronox is currently pumping the four new "dead zone" extraction wells and will be monitoring water levels and water quality for use in further evaluating the integrity of the barrier wall. Water levels in paired wells on opposite sides of the barrier wall (including M-56 and M-71) are being monitored to collect additional data. A further evaluation of the groundwater elevations in these wells will be included in the barrier wall investigation technical memorandum referenced above.

iii. *Page 8, 2nd paragraph, TRX states that the "below-barrier wells would not show such a dramatic decrease in water levels as was observed during times of trench shutdown" if the barrier wall was leaking because the "below-barrier wells would be recharged by water coming through the barrier wall from upgradient." NDEP believes that the groundwater mound would dissipate even if the barrier wall were leaking because the groundwater recharge from upgradient would be no greater than approximately the recharge before the installation of the barrier wall. TRX should include discussion on pre-barrier wall gradients and mounding to support this discussion.*

Tronox Response: This text has been removed from the revised document. As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, additional testing to evaluate whether the barrier wall is leaking is scheduled for April-June 2010.

Tronox Updated Response: As described above, permeability testing of the barrier wall material has been completed and the results have been transmitted to NDEP. Tronox is currently pumping the "dead zone" extraction wells and monitoring water level and quality trends as described in the *Capture Zone Evaluation Work Plan* dated May 13, 2010. A technical memo will be submitted to NDEP summarizing the results of the barrier wall investigation following the completion of three months of pumping and monitoring the downgradient "dead zone" wells.

iv. *Page 8, 3rd paragraph, TRX's assumptions in this paragraph appear to be without basis due to the lack of referencing within this paragraph. These assumptions need to be supported and quantified.*

Tronox Response: It is not clear to Tronox what NDEP is referring to with this comment. The first sentence of this paragraph has been revised to make the basis of the assumption in that sentence clearer.

v. *Page 9, 1st paragraph, TRX states that any contaminants passing beneath the barrier wall will eventually daylight into the alluvium. Please provide a conceptual trajectory (i.e., expected vicinity of daylighting) and timeframe for this migration (using an average linear groundwater velocity).*

Tronox Response: As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, this evaluation will be conducted using both analytical methods and the new numerical groundwater flow model.

Tronox Updated Response: The endpoint analysis performed using hydrogeologic flow and presented in the CZE report combines particle tracking with a three-dimensional model of the perchlorate groundwater plume to provide conceptual trajectories for perchlorate contamination originating at a wide range of points within the plume and for each layer of the model. Conceptual timeframes for perchlorate originating in the UMCf are ~~not currently~~ included in the CZE report with a brief discussion in 6.2.6 ~~but will be discussed in the revised *Hydrogeologic Groundwater Model Inputs* technical memorandum due to NDEP on December 10, 2010~~.

b. *Data Gap # 3, page 10, NDEP has the following comments:*

i. *TRX should discuss the mass capture expected in wells I-AB and I-AA.*

Tronox Response: Estimates of mass capture for wells I-AB and I-AA have been added to the revised text.

ii. *Results section, 1st paragraph, TRX states that wells I-AA and I-AB will be hooked up in the 2nd quarter of 2010 (nearly two and a half years after the scope of work was approved). This is unacceptable and not reasonable.*

Tronox Response: Comment noted. As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, this work is scheduled for April-May 2010.

iii. **Tronox Updated Response:** Tronox has issued a notice-to-proceed and a contractor (Las Vegas Paving) is has begun implementing Phase II of the Interceptor Well Field infrastructure improvements, which includes plumbing and connecting seven

additional Interceptor wells (I-W, I-X, I-Y, I-AA, I-AB, I-AC, and I-AD) to the treatment system as well as upgrading the existing electrical service at the water treatment plant to support the additional pumping wells. This includes the two wells referenced above and two new wells (I-AC and I-AD) installed in June 2010 for the purpose of improving capture along the eastern edge of the barrier wall. The recent delays in connecting the wells are due to the inclusion of the two new wells, logistical considerations involved with the major soil excavation and remediation work at the Site, unforeseen complexity in the planning and design phase of the electrical work (e.g, upgrading the electrical service to the entire treatment plant and not just the control panel for the extraction wells as first thought) and added expense.

iv. *NDEP does not consider this data gap addressed.*

Tronox Response: Comment noted. The text has been modified to provide current estimates of flow around the east and west ends of the barrier wall.

c. *Data Gap # 4, pages 11 – 12, NDEP has the following comments:*

i. *Page 11, Results section, 1st paragraph, TRX notes that the length of the pump tests may not have been long enough to assess the influence of the pumping. NDEP notes that this is TRX's failure to collect the appropriate data and fully implement the NDEP-approved scope of work. This is unacceptable.*

Tronox Response: Comment noted. The primary purpose of these pump tests was to provide data for calculating recovery well efficiencies so that a more accurate assessment of capture could be conducted. As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, up to 22 new piezometers near recovery wells in the Interceptor Well Field are scheduled for installation in May/June 2010. These piezometers will provide water level data for assessing capture in this area.

Tronox Updated Response: In April 2010, Northgate installed eleven new Shallow ~~Zone~~ WBZ piezometers adjacent to the IWF recovery wells (Figure 1-2) for potentiometric data that will be incorporated into the capture zone evaluation. The piezometers were installed adjacent to existing recovery wells I-A/B, I-C, I-D, I-F, I-H, I-I,I-J, I-K, I-S, I-Y, and I-Z. The new piezometers are named M-166 through M-170 and M-172 through M-177, and are located as shown Figure 1-2. Lithologic and well completion logs are presented in Appendix B of the CZE report.

ii. *Page 12, table, TRX should additionally represent this data in a figure of the well field.*

Tronox Response: These data have been added to Figure 6.

iii. *Page 12, 2nd paragraph, the presented well triplet analysis shows that northward flow (towards recovery wells) is expected; however, the analysis does not show that hydraulic capture is achieved. Well triplet analysis, for the purpose of capture zone analysis should be performed on down- and/or side-gradient wells and show that inward or reverse flow is achieved.*

Tronox Response: Comment noted.

iv. *TRX should provide the location of well M-61 on the included Site Figures.*

Tronox Response: This well is shown on the Site figures, located adjacent to the upgradient eastern end of the barrier wall.

v. *TRX should include a figure showing the well triplets and the resulting gradients and directions.*

Tronox Response: These well triplets and resulting gradients are shown on revised Figure 6.

vi. *TRX should consider solving for well triplet M-135, M-131, and I-AA.*

Tronox Response: Tronox will consider solving for this well triplet in future capture analyses.

vii. *NDEP does not concur that this data gap has been completely addressed.*

Tronox Response: Comment noted. Additional work to address this data gap is proposed in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010.

7. *Section 2.1.2.1, page 13, NDEP has the following comments:*

a. *This Section lacks the context of a fully defined target capture zone. TRX needs to clearly define the target capture zone based on geometry and concentrations. In addition, TRX needs to discuss the proposed target zone with the NDEP to insure that the target zone is acceptable.*

Tronox Response: Comment noted. Defining target capture zones with input from NDEP is part of the scope presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010.

Tronox Updated Response: The CZE report evaluates the impact of expanding the target capture zone on the calculated mass flux capture. Mass flux calculations for perchlorate were performed using the 1 mg/l isoconcentration contour to bound the

target capture zone, without regarding property boundaries or conceptual plume source models, for the Interceptor and Athens Road well fields. This resulted in wide target capture zones that extended far beyond the well fields. A second set of mass flux calculations were performed using a localized target capture zone for comparison. For both the Interceptor and Athens Road well fields, the difference between the calculated mass flux capture was less than one percent. Both sets of calculations are presented in the CZE report.

b. *2nd paragraph, TRX should include a description of the methods and data used in this analysis, and in the preparation of Table 4.*

Tronox Response: A brief description of the methods and data used in the mass flux analysis has been added to the beginning of the second paragraph of Section 2.1.2.1, and additional detail has been added to Table 4 (see response to Comment 16 below).

8. *Section 2.1.2.2, pages 14 through 16, the NDEP has the following comments:*

a. *Page 14, 2nd bullet, TRX states that the width of the zone is the "length of the barrier wall". This assumption is without technical basis as it is not clear why the width of the zone would not equate to the width of the property.*

Tronox Response: Comment noted. Defining target capture zones with input from NDEP is part of the scope presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010.

Tronox Updated Response: See updated response to comment 7a above. The width of the barrier wall has no impact on the target capture zone(s) used in the current CZE.

b. *Page 14, 3rd bullet, TRX needs to place the precipitation rate into the context of the expected infiltration rate. TRX should also review the NDEP's leaching guidance dated January 16, 2010.*

Tronox Response: Tronox has added a description of the USGS estimated infiltration rate for undeveloped land used in the NDEP leaching guidance. To date, no Site-specific infiltration rate has been developed for the Tronox facility.

c. *Page 15, 1st bullet, NDEP has the following comments:*

i. *NDEP notes that based upon the size of the on-site water supply pipelines that this un-quantified quantity of water can be quite large.*

Tronox Response: Tronox recognizes that pipeline leaks may contribute significantly to subsurface water.

ii. *TRX references a total of 53.8 gpm in the text; however, the associated calculations in Table 4 appear to indicate a value of 54.6 gpm. Please rectify.*

Tronox Response: The number in Table 4 is correct. The text has been revised to state the correct value.

d. *Page 15, 1st full paragraph after 1st bullet, it is not clear what the technical basis is to assume that the eastern and western flow boundaries are "no flow" boundaries. Without justification from TRX, this assumption is rejected.*

Tronox Response: Tronox acknowledges that there may be some flow into or out of the area defined by the barrier wall, but given the flow direction and orientation of the alluvial deposits relative to the barrier wall, this component is expected to be small compared to the two sources considered. The text has been revised to include this explanation.

Page 15, 2nd and 3rd bullets, TRX assumes a cross sectional area without a technical basis for the selected width.

Tronox Response: These calculations were based on the cross section defined by the barrier wall rather than a target capture zone. This will be revisited once the target capture zones have been established with input from NDEP (see response to Comment 7b and 8a above).

Tronox Updated Response: See revised response to comment 7a above.

e. *Page 15, 3rd bullet, TRX references an upward vertical hydraulic gradient average of 0.07. This value appears to be low based on information provided in Table 2. Please list values used for averaging, and/or rectify.*

Tronox Response: The specific values averaged are listed in Note 8 of Table 4 and presented in Table 2. The values used are vertical gradients measured in well triplets on either side of the barrier wall.

f. *Page 16, 1st paragraph, the total flow values listed on page 16 and Table 4 are inconsistent.*

Tronox Response: The number in Table 4 is correct. The text has been revised to state the correct value.

9. *Section 2.1.4, given the already protracted schedule for implementation of the Groundwater Capture Zone Evaluation Work Plan, NDEP finds the continued delay in addressing Data Gap #1 unacceptable.*

Tronox Response: Comment noted. As presented in the revised *Capture Zone Evaluation Work Plan,* to be dated March 25, 2010, this work is scheduled for April-May 2010.

Tronox Updated Response: See updated response to comment 6.b.iii above.

10. *Section 2.2.1, pages 18 through 21, the NDEP has the following comments:*

    a. *Page 19, Results section, 1st paragraph, please explain why temperature measurements were not taken. In addition, please explain this relative to the flow through cell for low flow sampling.*

    Tronox Response: Temperature readings were not collected due to an oversight by sampling technicians who were not fully briefed on the data requirements. Tronox is taking steps to improve communication of sampling protocols and improved data collection and management in the field.

    b. *Page 19, Results section, 2nd paragraph, please explain why the well completions were not adjusted instead of being allowed to be buried under pavement.*

    Tronox Response: Tronox made repeated attempts to alert contractors to the well locations and work with them to preserve the well completions, but unfortunately wells were still covered. As presented in the revised *Capture Zone Evaluation Work Plan,* to be dated March 25, 2010, these wells are scheduled to be re-established or replaced in May/June 2010. In re-establishing or installing these and all other wells associated with the work plan, ongoing well protection will be considered in designing wellhead completions and selecting new well locations.

    Tronox Updated Response: In June and July 2010, Northgate replaced wells PC-134 and PC-135 with new wells PC-134A and PC-135A. Well completion details are provided in Appendix B to the CZE Report. Wells PC-136 and PC-137 were able to be uncovered and put back into service.

    c. *Page 20, tables, TRX should additionally represent this data in a figure of the well field.*

    Tronox Response: These well triplets and resulting flow gradients have been added to revised Figure 11.

    d. *Page 20, 2nd paragraph, TRX should provide a schedule for the clearing or replacement of PC-134 – 137.*

    Tronox Response: As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, these wells are scheduled to be re-established or replaced in May/June 2010.

Tronox Updated Response: See response to comment 10b above.

e. *Page 21, 1st paragraph, if the "currently available and accessible monitoring wells are insufficient to confirm the precise location of these [Athens Road Well Field] contours", then the contours should be dashed or queried.*

Tronox Response: Figure 10 shows contours in these areas as dashed lines.

f. *Page 21, Results section, 2nd full paragraph, please explain why the flow rates in wells ART-3 and ART-9 have not been adjusted.*

Tronox Response: The pumping rate in ART-3 was increased from about 39 gpm to about 45 gpm on December 8, 2009. ART-9 is pumping at full capacity and any increase will have to wait until ART-7 is deepened.

11. *Section 2.2.2, pages 21 – 23, the NDEP has the following comments:*

a. *Page 21, TRX's selection of the boundaries of the target capture zone appear to be a matter of convenience rather than having any technical basis. For example, TRX has selected differing concentrations to define the capture zone. This is unacceptable and as noted above, TRX needs to work with the NDEP to define an acceptable target capture zone.*

Tronox Response: Comment noted. Establishing target capture zones with input from NDEP is part of the work presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010 (see response to Comment 7b and 8a above).

Tronox Updated Response: See updated response to comment 7a above.

b. *Page 22, Flow Budget section, NDEP has the following comments:*

i. *It appears that TRX estimates that up to 655 pounds per day of perchlorate could be captured and estimates that 497 pounds per day is being captured. This is very concerning to the NDEP as it indicates that 158 pounds per day of perchlorate are not being captured. TRX must propose additional work to address this data gap in the separate Deliverable in the form of a new Work Plan (please see in that above-attached letter).*

Tronox Response: The mass actually being captured and removed from the Athens Road well field (ARWF) is calculated at 655 pounds while the mass calculated using a mass flux approach is 257 pounds (the 497 pounds was based on the mass flux calculations with a "flow correction," and has since been removed from the report).

The system is removing *more* mass than calculated using the mass flux approach, not less as interpreted by NDEP based on this comment.

ii. *Additionally, it appears that this section states that the mass flux calculations do not correspond well to the documented flow and mass capture at this sub-system. However, NDEP does not agree that scaling the calculations to the documented flow rates is a valid exercise but that the underpinning assumptions of the calculations are more likely at error. Please revise this Section or omit.*

Tronox Response: The sentence on scaling the mass flux calculations based on a "flow correction" has been deleted.

iii. *TRX speculates that the lower calculated mass flux may be related to reduced in-place hydraulic conductivities. This is an unsupported assumption that should have been verified with field testing. Also, hydraulic conductivities in a formation are not expected to be modified by a factor of two or more due to pumping of localized silts; and furthermore, removal of fines from a formation would result in increased conductivities rather than decreases. Until quantitative information can be provided, these statements are rejected and should be removed from the Deliverable.*

Tronox Response: Fines removal and resultant increases in hydraulic conductivity was offered as a possible explanation for why the mass calculated based on mass flux using 2002 pump test conductivities is *lower* than the actual mass removed, not the reverse as interpreted by NDEP based on this comment. Tronox agrees that this explanation is speculative, however, and has modified this sentence to simply state that the available estimates of parameters used to calculate mass flux are not well constrained. As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, mass flux and capture at the ARWF will be further evaluated during 2010.

Tronox Updated Response: See updated response to comment 7a above.

c. *Pages 22 – 23, Overlapping Cones of Depression, NDEP concurs that considerable net drawdown has been achieved over relatively wide areas, and that drawdown cones may overlap throughout the area. However, NDEP does not agree that net drawdown may be used as a line of evidence for capture.*

Tronox Response: The last sentence of the paragraph on "Overlapping Cones of Depression" has been modified to clarify that net drawdown will not be used as a direct line of evidence for hydraulic capture, and to note that additional capture evaluation following the USEPA 2008 guidance will be completed during 2010.

Tronox Updated Response: The updated capture zone evaluation has been completed following USEPA 2008 guidance.

d. *Page 23, Numerical Modeling section, TRX needs to note that the McGinley model and the NDEP comments clearly stated that the existing concentration contours do not support the referenced 99 percent capture efficiency.*

Tronox Response: The "Numerical Modeling" paragraph has been modified to make this clear.

e. *Page 23, Downgradient Concentration Declines Over Time, TRX must provide some estimate of time to reach asymptotic levels for these monitor wells. TRX should additionally use monitoring points closer to the well field for this demonstration.*

Tronox Response: Based on recent concentration trends in the wells evaluated, an accurate prediction of time to reach asymptotic levels is not possible. Tronox agrees that concentration trends over time in wells closer to the ARWF should also be evaluated, and this will be part of the revised capture zone evaluation to be completed by the end of 2010.

12. *Section 2.2.3, pages 23 and 24, the NDEP has the following comments:*

a. *Page 24, Data Gap #4, NDEP does not concur with TRX's proposed path forward and notes that TRX must work with the NDEP and the City of Henderson to insure that this work transpires immediately.*

Tronox Response: Comment noted. As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, this work is scheduled for May/June 2010.

Tronox Updated Response: See Tronox's updated response to 3.b., second bullet item.

b. Given the already protracted schedule for implementation of the Groundwater Capture Zone Evaluation Work Plan, NDEP finds the continued delay in addressing these Data Gaps unacceptable.

Tronox Response: Comment noted. As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, all of this work is scheduled for May/June 2010.

Tronox Updated Response: Tronox has addressed the data gaps through field work and well installations, the details of which are presented in the CZE report and in Appendix B. The capture evaluation has identified areas where improvements are needed in the Athens Road well field. Tronox has recently increased pumping to the

extent possible in ART-3 and ART-4, and will be working to hook up an additional extraction well (PC-150) to improve capture of perchlorate and chromium by the well field.

13. *Section 3.0, page 25 and 26, the NDEP has the following comments:*

    a. *General comment, as noted above, since TRX has failed to comply with the NDEP's water-bearing zone nomenclature, the NDEP's comments should not be considered comprehensive.*

       Tronox Response: Comment noted. The text has been revised to comply with NDEP's water-bearing zone nomenclature.

    b. *NDEP has noted that TRX has taken over two and a half years to complete and sample these wells since the NDEP approved the Groundwater Capture Evaluation Work Plan. NDEP finds this unacceptable.*

       Tronox Response: Comment noted.

    c. *Page 25, last paragraph, NDEP does not concur with TRX's proposed target capture zone as there is no apparent technical basis for the selected concentrations of 1 mg/l and 5 mg/l given that the NDEP's interim action level is 18 µg/l.*

       Tronox Response: Comment noted. As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, establishing target capture zones with input from NDEP is part of the work planned for 2010 (see response to Comment 7b, 8a and 11a above).

       Tronox Updated Response: In developing concentration/mass-based target capture zones for the CZE report, Tronox considered: 1) the incremental plume mass contained between concentration isocontours considered as targets; 2) whether a plume associated solely with Tronox sources can be defined at the concentrations considered; and, 3) how reliably the Tronox plume can be defined at the concentrations considered. Based on this, 1 mg/L was chosen to define the target capture zones because: 1) more than 99% of the plume mass upgradient of the IWF is contained within this isocontour; 2) below this concentration, the Tronox plume cannot be distinguished from groundwater impacted by sources west and east of the Site; and, 3) there is a large degree of uncertainty in the concentration distribution below this level.

    d. *Page 26, TRX states that "The pending November 2009 results will provide further data to evaluate the vertical extent of the chromium plume. These results will be reported in the updated and revised report." NDEP did not note that chromium was discussed in this*

Deliverable. TRX should note that both the Groundwater Capture Evaluation and the Vertical Delineation portions of this document should discuss chromium capture and vertical extent, respectively. As such, NDEP does not understand why the chromium data from May 2009 was not discussed and analyzed in this Deliverable as this data was included in several Figures and Tables. NDEP finds this unacceptable.

Tronox Response: Comment noted. In addition to addressing perchlorate, the revised capture zone evaluation to be completed by the end of 2010 will include chromium capture and vertical extent.

Tronox Updated Response: Evaluation of chromium capture is addressed in the revised capture zone evaluation report.

14. *Section 4.0, pages 27 – 28, TRX should revise this section as necessary based on the comments found in this Attachment.*

    Tronox Response: Section 4, Conclusions, has been modified to reflect changes made to the rest of the document in response to NDEP's comments.

15. *Table 2, the NDEP has the following comments:*

    a. *Vertical Gradient column, the use of arrows in the right hand column is misleading without explanation; for instance, the arrows appear to indicate that the gradient decreases from M-135 (a shallow well) to M-134 (a middle well). Please arrange the wells in order of elevation midpoint of screen or otherwise clarify the use of the arrows.*

       Tronox Response: Arrows have been deleted from Table 2.

    b. *Note 2, this reference is incorrect as noted above.*

       Tronox Response: This reference has been corrected.

    c. *Note 3, it is not clear why TRX has not surveyed these wells since the scope of work was approved in October 2007.*

       Tronox Response: The note in Table 2 was out of date and has been revised. The eight vertical delineation wells were surveyed and the survey data was presented in Appendix D.

16. *Table 4, NDEP has the following comments:*

    a. *TRX must provide a description of the methods used to prepare the table and its use in mass flux analysis.*

       Tronox Response: The notes for Table 4 have been expanded to include the equation used for calculating mass flux and additional detail on the parameter values selected.

b. *Please consider discretizing hydraulic conductivity across the cross section (as for the Athens Road analysis) or further justify the use of a broad average value.*

Tronox Response: Mass flux and capture calculations will be revisited and enhanced as part of the revised capture zone evaluation. This may include further discretization of hydraulic conductivity and other parameters if necessary. However, Tronox does not have well-specific hydraulic parameters for the IWF wells.

Tronox Updated Response: For the current capture zone evaluation, mass flux and capture calculations were performed using MT3D (a three-dimensional solute transport model) using the hydrogeologic flow model and three-dimensional contaminant plume models as inputs.

c. *Alluvium, ClO4 mg/L (May 2009) and Notes (10), (12), and (14), please provide justification for using an average value from several surrounding wells for the perchlorate concentration in a particular listed well rather than the value measured in that listed well.*

Tronox Response: Averages were used for transect segments with perchlorate concentrations and resultant flux that were interpreted to be best represented by concentrations in more than one monitoring well. Mass flux and capture calculations will be revisited and enhanced as part of the revised capture zone evaluation.

Tronox Updated Response: For the current capture zone evaluation, mass flux and capture calculations were performed using MT3D (a three-dimensional solute transport model) using the hydrogeologic flow model and three-dimensional contaminant plume models as inputs.

d. *Muddy Creek – Ends of Barrier Wall, ClO4 mg/L (May 2009) and Definition *, the value for the perchlorate concentration used in this well was measured at 60.9 ppb; however, the Definition for this value states that an average concentration from contouring was used. Please provide justification for using an estimated value of 250 ppb when the measured value in the well was 60.9 ppb.*

Tronox Response: The estimated value of 250 ppb was considered more representative of average perchlorate concentrations for this mass flux cell than the single well concentration. Mass flux and capture calculations will be revisited and enhanced as part of the revised capture zone evaluation.

Tronox Updated Response: For the current capture zone evaluation, mass flux and capture calculations were performed using MT3D (a three-dimensional solute transport model) using the hydrogeologic flow model and three-dimensional contaminant plume models as inputs.

e. *Muddy Creek – Upflow, ClO4 mg/L (May 2009) and Note (15), please provide justification for the use of the average perchlorate concentration captured for the upflow for the Muddy Creek.*

Tronox Response: The upflow perchlorate concentration used in Table 4 is an average of concentrations measured only in IWF wells where the top of the water table is located in the UMCf. Groundwater in these wells is considered representative of upflow in the well area, and the average concentration for these wells is a reasonable statistic to represent upflow throughout the UMCf upflow area.

f. *Notes, please review the use of the notes in this Table. Notes (3), (4), and (5) appear to be misused.*

Tronox Response: The numbering of notes on Table 4 has been corrected.

g. *Note (8), please provide the vertical gradient values and the resulting calculation to determine the vertical gradient used in Muddy Creek – Upflow calculation.*

Tronox Response: The locations for specific values averaged are listed in Note 8 of Table 4 and the values are presented in Table 2. The values used are vertical gradients measured in well triplets on either end of the barrier wall.

17. *Table 6, TRX should note the reference for the listed hydraulic gradients used in this Table.*

Tronox Response: A note has been added to Table 6 to indicate the source of hydraulic conductivity values used.

18. *Figure 4, the notes regarding the date of the trench refurbishment should be added to all hydrographs.*

Tronox Response: These notes have been added to all hydrographs shown on Figure 4.

19. *Figure 5, the 1720 feet groundwater contour, in vicinities of the west and east barrier wall, are not supported with plotted values. Please dash or query contours where they are not supported by field measurements, or provide measurements.*

Tronox Response: The contour lines shown on Figure 5 were drawn using data from additional wells that are located outside of the boundary of the Figure, and were previously presented in the *Annual Remedial Performance Report for Chromium and Perchlorate* (Northgate, 2009).

20. *Figure 6, the concept of "net drawdown" is meaningless in terms of capture zone analysis and should be removed from this Deliverable.*

Tronox Response: Comment noted. References to net drawdown as a line of evidence for capture have been removed from this document, and will not be included in the revised groundwater capture evaluation.

21. *Figure 7, please discuss why concentrations are not approaching zero as an asymptote for these concentration trends.*

    Tronox Response: Evaluating concentration trends over time in these and other wells will be part of the revised capture zone evaluation.

    Tronox Updated Response: Tronox believes that continued recharge of impacted groundwater from the underlying Muddy Creek formation is contributing to a baseline perchlorate concentration loads in Shallow WBZ wells downgradient of the Interceptor well field.

22. *Figure 8, since there is no data in the Muddy Creek formation (MCf) "ridge" this area is not quantified and is a data gap that must be addressed in the new Work Plan.*

    Tronox Response: As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, two new wells will be installed to investigate the UMCf ridge in May/June 2010

    Tronox Updated Response: In June 2010, Northgate installed two new monitoring wells (PC-148 and PC-149) in the northern portion of the Muddy Creek "high" between the two active . The wells were developed and were subsequently sampled in September 2010, with perchlorate concentrations measured at.

23. *Plate 1, NDEP has noted that the wells located in the MCf are very elevated for perchlorate and chromium and the nature and extent of this contamination is not defined. This issue must be addressed in the new Work Plan.*

    Tronox Response: As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, seven new wells are scheduled for installation in May/June 2010 to help define the lateral and vertical distribution of perchlorate and chromium in the UMCf.

    Tronox Updated Response: Tronox installed several new wells to evaluate the lateral and vertical extent of perchlorate and chromium contamination in the MCf upgradient of the barrier wall: M-159 through M-165, M-181, M-182, and M-186 through M-188. Well construction details and chemical test results from these wells can be found in Appendix B of the CZE report, and this data was incorporated into the three-dimensional perchlorate and chromium contaminant plumes used in the current CZE report.

24. *Plate 2, NDEP is not clear why there is no data for the deeper wells on this Plate. This data gap must be addressed in the new Work Plan.*

    Tronox Response: These wells were not accessible during the May 2009 sampling event and no data were collected. Data from 2008 have been added to the figure, and as presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, these wells will be re-established or replacement wells will be installed.

    Tronox Updated Response: The most recent data for wells PC-134A and PC-137 are shown on Figure 3-5, the Athens Road well field cross-section, in the new CZE report.

25. *Plate 3, as noted above, the NDEP does not agree with the target capture zone depicted on this Plate.*

    Tronox Response: Comment noted. As presented in the revised *Capture Zone Evaluation Work Plan*, to be dated March 25, 2010, establishing target capture zones with input from NDEP is part of the work planned for 2010.

    Tronox Updated Response: See updated response to comment 7a above.

APPENDIX B
CZE INVESTIGATION DATA GAPS INVESTIGATION DATA

PTS Laboratories, Inc.

8100 Secura Way • Santa Fe Springs, CA 90670
Telephone (562) 347-2500 • Fax (562) 907-3610

June 23, 2010

Edward J. Krish
Northgate Environmental Management, Inc.
300 Frank H. Ogawa Plaza, Suite 510
Oakland, CA 94612

Re: PTS File No: 40378
Physical Properties Data
Project No.: 2027.01
Laboratory Task Order No. 1

Dear Mr. Krish:

Please find enclosed report for Physical Properties analyses conducted upon cores received from Project No.: 2027.01; Laboratory Task Order No. 1. All analyses were performed by applicable ASTM, EPA, or API methodologies. An electronic version of the report has previously been sent to your attention via the internet. The samples are currently in storage and will be retained for thirty days past completion of testing at no charge. Please note that the samples will be disposed of at that time. You may contact me regarding storage, disposal, or return of the samples.

PTS Laboratories appreciates the opportunity to be of service. If you have any questions or require additional information, please give me a call at (562) 347-2502.

Sincerely,
PTS Laboratories

Michael Mark Brady, P.G.
Project Manager

Encl.

PTS Laboratories

Project Name: N/A
Project Number: N/A

PTS File No: 40378
Client: Northgate Environmental Management

TEST PROGRAM

CORE ID	Depth ft.	Core Recovery ft.	Grain Size Analysis ASTM D4464M	TOC/foc Walkley-Black	Hydraulic Conductivity Package			Notes
		Plugs:	Grab	Grab	Vert. 1.5"			
Date Received: 6/1/10								
M-162 68'-68.5'	68-68.5	0.5		X	X			
M-162 86'-86.5'	86-86.5	0.5		X	X			
M-162 106'-106.5'	106-106.5	0.5		X	X			
M-187 116'-116.5'	116-116.5	0.5		X	X			
M-187 166'-166.5'	166-166.5	0.5		X	X			
M-187 117.5-118'	117.5-118	N/A	X					
M-187 161'-161.5'	161-161.5	N/A	X					
TOTALS:	5 cores 2 Bags	2.5	2	5	5			

Laboratory Test Program Notes

Hydraulic Conductivity by ASTM D5084.

PTS Laboratories, Inc.

Northgate Environmental Management
PTS File No: 40378

PARTICLE SIZE SUMMARY

(METHODOLOGY: ASTM D422/D4464M)

PROJECT NAME: N/A
PROJECT NO: N/A

Sample ID	Depth, ft.	Mean Grain Size Description (1)	Median Grain Size mm	Particle Size Distribution, wt. percent						Silt & Clay
				Gravel	Sand Size			Silt	Clay	
					Coarse	Medium	Fine			
M-187 117.5'-118'	117.5-118	Silt	0.026	0.00	0.00	0.00	17.74	62.87	19.39	82.26
M-187 161'-161.5'	161-161.5	Silt	0.019	0.00	0.00	0.00	23.94	48.46	27.59	76.06

(1) Based on Mean from Trask

PTS File No: 40378
Client: Northgate Environmental Management

ORGANIC CARBON DATA - TOC (foc)

(METHODOLOGY: WALKLEY-BLACK)

PROJECT NAME: N/A
PROJECT NO: N/A

SAMPLE ID.	DEPTH, ft.	ANALYSIS DATE	ANALYSIS TIME	SAMPLE MATRIX	FRACTION ORGANIC CARBON, g/g	TOTAL ORGANIC CARBON, mg/kg
M-162 68'-68.5'	68.1	6/17/10	1400	SOIL	5.50E-04	550
M-162 86'-86.5'	86.1	6/17/10	1400	SOIL	3.00E-04	300
M-162 106'-106.5'	106.1	6/17/10	1400	SOIL	4.50E-04	450
M-187 116'-116.5'	116.1	6/17/10	1400	SOIL	3.60E-04	360
M-187 166'-166.5'	166.1	6/17/10	1400	SOIL	3.90E-04	390
Blank	N/A	6/17/10	1400	BLANK	ND	ND
SRM D066-542	N/A	6/17/10	1400	SOIL	2.00E-03	2000

QC DATA

SRM ID/Lot No.	REC (%)	Control Limits	Certified Value, mg/kg	QC Performance Acceptance Limits, mg/kg
D066-542	74	34-165	2720	935-4500

ND = Not Detected

PTS File No: 40378
Client: Northgate Environmental Management

PTS Laboratories

PHYSICAL PROPERTIES DATA - HYDRAULIC CONDUCTIVITY PACKAGE

PROJECT NAME: N/A
PROJECT NO: N/A

		METHODS:	API RP 40 / ASTM D2216	API RP 40		API RP 40		API RP 40		API RP 40; EPA 9100	
										25 PSI CONFINING STRESS	
SAMPLE ID.	DEPTH, ft.	SAMPLE ORIENTATION (1)	MOISTURE CONTENT, % weight	DENSITY BULK, g/cc	DENSITY GRAIN, g/cc	POROSITY, %Vb (2) TOTAL	POROSITY, %Vb (2) AIR FILLED	TOTAL PORE FLUID SATURATIONS (3), % Pv	CONFINING PRESSURE, psi	EFFECTIVE (4,5) PERMEABILITY TO WATER, millidarcy	HYDRAULIC CONDUCTIVITY (4,5), cm/s
M-162 68'-68.5'	68.1	V	47.1	1.14	2.67	57.3	3.6	93.6	25.0	0.76	8.10E-07
										1.01	1.08E-06
										0.82	8.77E-07
										0.76	8.10E-07
									Average:	0.86	8.94E-07
M-162 86'-86.5'	86.1	V	37.4	1.29	2.66	51.6	3.3	93.6	25.0	0.43	4.63E-07
										0.43	4.63E-07
										0.37	3.96E-07
										0.37	3.97E-07
									Average:	0.40	4.30E-07
M-162 106'-106.5'	106.1	V	37.5	1.27	2.67	52.5	5.1	90.3	25.0	0.51	5.26E-07
										0.51	5.27E-07
										0.51	5.26E-07
										0.44	4.61E-07
									Average:	0.49	5.10E-07
M-187 116'-116.5'	116.1	V	62.0	0.86	2.61	67.1	13.8	79.3	25.0	38.8	4.04E-05
										38.8	4.05E-05
										38.8	4.05E-05
										38.8	4.05E-05
									Average:	38.8	4.05E-05

(1) Sample Orientation: H = horizontal; V = vertical (2) Total Porosity = no pore fluids in place; all interconnected pore channels; Air Filled = pore channels not occupied by pore fluids (3) Water = 0.9996 g/cc (4) Native State or Effective = With as-received pore fluids in place (5) Permeability to water and hydraulic conductivity measured at saturated conditions; Vb = Bulk Volume, cc; Pv = Pore Volume, cc; ND = Not Detected

PTS File No: 40378
Client: Northgate Environmental Management

PTS Laboratories

PHYSICAL PROPERTIES DATA - HYDRAULIC CONDUCTIVITY PACKAGE

PROJECT NAME: N/A
PROJECT NO: N/A

		METHODS:	API RP 40 / ASTM D2216	API RP 40		API RP 40		API RP 40		API RP 40; EPA 9100	
										25 PSI CONFINING STRESS	
SAMPLE ID.	DEPTH, ft.	SAMPLE ORIENTATION (1)	MOISTURE CONTENT, % weight	DENSITY BULK, g/cc	DENSITY GRAIN, g/cc	POROSITY, %Vb (2) TOTAL	POROSITY, %Vb (2) AIR FILLED	TOTAL PORE FLUID SATURATIONS (3), % Pv	CONFINING PRESSURE, psi	EFFECTIVE (4,5) PERMEABILITY TO WATER, millidarcy	HYDRAULIC CONDUCTIVITY (4,5), cm/s
M-187 166'-166.5'	166.1	V	40.8	1.17	2.69	56.6	8.9	84.2	25.0	3.44	3.58E-06
										3.44	3.59E-06
										3.44	3.58E-06
										3.44	3.59E-06
									Average:	3.44	3.59E-06

(1) Sample Orientation: H = horizontal; V = vertical (2) Total Porosity = no pore fluids in place; all interconnected pore channels; Air Filled = pore channels not occupied by pore fluids (3) Water = 0.9996 g/cc (4) Native State or Effective = With as-received pore fluids in place (5) Permeability to water and hydraulic conductivity measured at saturated conditions; Vb = Bulk Volume, cc; Pv = Pore Volume, cc; ND = Not Detected

40378
6-1-10
JP

Edward J. Krish
Northgate Environmental Management, Inc.
300 Frank H. Ogawa Plaza, Suite 510
Oakland, CA 94612
May 27, 2010

Michael Mark Brady
PTS Laboratories
8100 Secura Way
Santa Fe Springs, CA 90670

Dear Michael,

Enclosed are five split-spoon samples
M-162 68'-68.5'
M-162 86'-86.5'
M-162 106'-106.5'
M-187 116'-116.5'
M-187 166'-166.5'

SS sleeve core JP

and two core samples
M-187 117.5'-118'
M-187 161'-161.5'

ziplock bags JP

Please perform saturated zone properties package measurements (EPA 9100, ASTM D5084, API RP40, ASTM D2216) on each of the five split-spoon samples and grain-size analyses (ASTM 422, D4464M) on each of the two core samples.

Please e-mail the results to me at ekrish@npgcable.com and to Mary Stallard at mary.stallard@ngem.com.

The invoice should be sent to Josh Otis at the Northgate address shown above.

If you have any questions you can e-mail either of us or call Mary at 510-220-6767 or me at 405-760-5777.

Thank you.

Received by
PTS 6-1-10 17:07

Sincerely,

Edward J. Krish

Enterprise Truck Dealer Silverado Lodge

northgate environmental management, inc.

DAILY SITE SAFETY MEETING RECORD

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
(949) 716-0050; fax (949) 716-0055

Recorded By: Dana R. Brown

Date & Time: 9-2-2010 06:35 **Project No.:**

Project Name: Perchlorate Well Study **Project Location:**

Field Activities: Drilling & Soil Sampling, Water level measurement, hydraulic testing

Chemicals Present: HPO_4^- (Perchlorate); Dioxin; SVOC'S including HCB; Metals; Pesticides; VOC'S; See site related chemicals list.

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: Level D: Hardhat, safety goggles, ear protection, coveralls, gloves, steel-toed safety shoes.

Hazards of Chemicals Present: Inhalation, Ingestion, Adsorption

Physical Hazards: Slips-Trips-Falls; Pinch-points; Truck traffic;

Special Hazards:

Other Topics of Concern:

SITE SAFETY CHECKLIST	YES	NO
Attached Signature Page - See Below		X
Written Health and Safety Plan (HASP) is on-site	X	
Information in the HASP matches conditions and activities at the site	X	
Site personnel have appropriate training and certification and medical clearance	X	
Air monitoring equipment has been calibrated daily	X	
Site zones are set up and observed where appropriate	X	
Access to Work Areas is limited to authorized personnel	X	
Decontamination stations (including hand/face wash) are set up and used	X	
Personal protective equipment used matches HASP requirements	X	
Emergency and First Aid equipment is on-site as described in the HASP	X	
Drinking water is readily available	X	

Notes (All "NO" answers must be addressed and corrected immediately. Note additionally health and safety observations here):

Jason Brown Dana R. Brown

Conducted By Print Initials: DRB **Signature:** **Date:** 9/2/10

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER LEVEL DATA FORM

Project Name	Tronox	Date	9/2/10
Project Number		Sample Crew	J Brown
Weather Conditions	clear & hot		

Well Number	Measurement Dates	Time	Depth to Water 1	Depth to Water 2	Comments	Depth to LNAPL	Depth to DNAPL	T.D.
M-148A	9/2/10	750	46.09	46.09	meter erratic, changed battery			52.80
M-186		755	45.30	45.30				118.40
M-180		810	29.39	29.39				42.20
M-182		818	32.40	32.40				92.30
M-181		822	28.15	28.15				118.15
M-179		844	36.71	36.71				56.00
M-165		851	23.67	23.67				123.20
M-178		901	32.23	32.23				52.10
M-162		906	21.03	21.03				112.50
M-163		909	23.96	23.96				92.50
M-164		915	27.98	27.98				72.90
M-140		926	24.51	24.51				46.90
M-161		940	22.71	22.71				113.20
M-159		955	31.68	31.68				77.70
M-160		1001	31.48	31.48				52.80
M-187		1015	37.66	37.66				173.00
M-188		1016	47.55	47.55				123.00
PC-149		1120	30.05	30.05				50.70

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER LEVEL DATA FORM

Project Name	Tronox	Date	9/2/10
Project Number		Sample Crew	J Brown
Weather Conditions	Clear & hot		

Well Number	Measurement Dates	Time	Depth to Water 1	Depth to Water 2	Comments	Depth to LNAPL	Depth to DNAPL	T.D.
PC-148	9/2/10	1134	28.28	28.28				51.20
PC-143		1156	30.48	30.48				65.50
PC-141		1206	28.28	28.28				58.00
PC-142		1210	28.23	28.23				35.00
PC-~~147~~ 146		1216	30.03	30.03	146 & 147 swapped on map			30.28
PC-147		1220	31.39	31.39	I recorded as labeled & matched const. info.			32.30
PC-145		1231	33.82	33.82				40.65
PC-134A		1251	29.70	29.70				70.30
PC-135A		1256	30.03	30.03				50.21
PC-144		1320	31.04	31.04				39.60
PC-150		1417	30.52	30.52				45.20
M-170								

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

SITE WELL DATA

Project Name: Tronox

Project Number:

Date: 9/2/10

Recorded By: J Brown

Well ID	Well Access	Well Diameter (Inches)	Total Depth (ft)	Screened Interval (ft)	Highest Historical Contamination (ppb)	MDL1	Approximate gal to be evacuated	Sampling Device	Comments
M-148A	SU	2	52.80	casing	top ≈ 1'	down	in stick up, nothing in well, no lock, labeled		
M-186	SU	2	118.40	nothing	in well,	no	lock, labeled		
M-180	SU	2	42.20	nothing	in well, no	~~lock~~	lock, labeled		
M-181	SU	2	118.15	nothing	in well, no lock, labeled				
M-182	SU	2	92.80	nothing	in well, no lock, labeled				
M-179	SU	4	56.00	nothing	in well, no lock, labeled				
M-165	SU	2	123.67	nothing	in well, no lock, labeled				
M-178	SU	4	52.10	nothing	in well, no lock, labeled				
M-162	SU	2	112.50	string	tied off & something hanging in		well, did not pull,	no lock, labeled	
M-163	SU	2	92.60	same	as M-162				
M-164	SU	2	72.90	same	as M-162				
M-140	SU	4	46.90	nothing	in well, no lock, labeled				
M-161	SU	2	113.20		"				
M-159	SU	2	77.70		"				
M-160	SU	2	52.00		"				
M-187	SU	2	173.00	string	down well, did not pull, no		lock, labeled		
M-188	SU	2	123.00	same	as 187				
PC-149	f - in gravel planter	6	50.70	nothing	in well, no lock, labeled				
PC-148	f - in gravel planter	6	51.20	nothing	in well, no lock, labeled				

[1] Maximum drawdown limit (NA = Not Applicable; do not monitor)

SU = stick up
f = flush mount

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

SITE WELL DATA

Project Name: Tinox
Project Number:
Date: 9/2/10
Recorded By: J Brown

Well ID	Well Access	Well Diameter (inches)	Total Depth (ft)	~~Screened Interval (ft)~~ Completion	~~Highest Historical Contamination (ppb)~~ Stickup	~~MDL[1]~~ Restriction	Approximate gal to be evacuated	Sampling Device	Comments
PC-43	f-next to well	2	65.50	nothing	in well, no lock,		labeled		
PC-141	su	2	58.00		"				
PC-142	su	2	35.00		"				
PC-146	f-entrance to yd	2	30.28	* 146	& 147 swapped on map. I recorded measurements				
PC-147	f-exit from yard	2	32.30	as wells were labeled & checked const. info.					
* PC-145	f-parking lot	2	40.05	nothing	in well, no lock		labeled		
* PC-134A	f-inside city yd	2	70.30	nothing in well, no lock,			labeled	35' N of concrete pad for sand & gravel storage	
* PC-135A	f-inside city yard	2	50.21	same	as PC-134A				
* PC-144	f-inside city yd	2	39.00	backhoe	parked over		Vance Fleming moved 702-249-2216		
PC-150	bare PVC stick up	6	45.20	Inside	compound,	Michelle's	dive key opens, nothing in well,		
M-170									

* Inside City Facility, call from gate & sign in & out w/ receptionist in "Utility Support Services" Building.

[1] Maximum drawdown limit (NA = Not Applicable; do not monitor)

f = flush
su = stick up

Field Activity Report

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Date: 9-3-2010
Recorded By: Dana R. Brown

Project Name: Perchlorate Well Study
Project No.: 2027.02.235
Client Name: Tronox LLC
Weather: Sunny + Hot, Calm in AM, Breezy PM
Temperature: 80° -
Site Conditions: Graded earth.

NORTHGATE PERSONNEL ON-SITE

Dana R. Brown

VISITORS

Name	Company/Agency	Time Arrived	Time Left

CONTRACTORS

Contractor Name: Confluence Environmental
Phone No.: (916) 760-7641
Supervisor: Jason Brown
Task: Water Sampling Technician

Company	No. of Supervisors	No. of Workers	Remarks
Confluence Env.	1- Jason Brown		Water Sampling Tech.

EQUIPMENT

Bladder Pump, Controller, Nitrogen Bottle
Water level Meter, Water Quality Parameter Meter, Flow Cell
Decon Kit & DI & Reagent Grade Water
PPE Kit
Water Sampling Kit including disposable bailer, bailer twine, airline, discharge tubing

Field Activity Report

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Date: 9-3-2010
Recorded By: Dana R. Brown

Project Name: Tronox Perchlorate Wells
Project No.: 2027.02.235
Client Name: Tronox LLC

ACTIVITIES

Time:	Activities (include event, time, observations, observers, etc.)
04:30	Mob up for groundwater sampling
04:45	Drive to Tronox, Check in with guard, Drive to Trailer.
05:05	Meet Francisco - discuss supply situation. He will retrieve Bubble Wrap.
05:45	Meet Jim Carolan - discuss supply situation. He will retrieve Lg wrap from Condo.
	Continue packaging sample kits & do job documentation.
	Meet Jason Brown, Confluence, Discuss Scope of Work.
	Jason goes to get Ice & create bags for ~~coolers~~ sample coolers.
	Check supplies - all stocks appear adequate. Patrick has DI
	water for delivery today!
	Prep bottle kits, paperwork, COC.
	Discuss sample names & schedule w/ Vivian.
	Discuss protocols w/ Cindy Arnold.
	Jason - Confluence: got Ice + bagged it, got coolers, did prelim
	water levels, and got water levels for Slug Test wells (M-187, M-188,
	M-162, M-163, M-164, M-71). Perform round of water levels.
08:26	M-181 28.130
09:02	M-187 37.700
09:04	M-188 47.460
09:12	M-162 21.030
09:14	M-163 23.91
09:15	M-164 28.020
09:17	M-71 28.120
	Discrepancies in Table of Wells vs. Table to be sampled: As follows,
	Table of well data: M-170 not listed, M-171 Not listed
	Sample Listing Table: M-180, M-181, M-182 not listed ☆
	Call from Josh: M-171
	- IAO M-180 Take more water levels - M-180 Just to monitor I-AO
	- Check water levels & well construction Diagrams - don't sample unless differences exist
	- Advise Josh of
	Download data loggers & upload to Oakland Server. Slug Testing Finished
	- Note: Apparently forgot to restart logger in M-187, No data captured.
09:30	Mob to Holiday Inn to check for delivery from Fisher Scientific = ⊘
	Call from Cindy = Filter Not Sent.
	- Discuss Options,
	Call to Jason @ Confluence: Do round of water levels onsite = Snapshot view.
	Call to Sonny = No Water samples today.
	Call to Derrick = give news of delay.

Print Name: Dana R Brown **Signature:** [signature]

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

EQUIPMENT CALIBRATION RECORD

Project Name:	Tronox Perchlorate Wells	Date:	9-3-2010
Project Number:	2027.02.235	Name:	Dana R. Brown
Site Location:	Henderson, Nevada		

pH Meter

Serial No:	AM	Noon	PM	Exp. Date	Notes:
pH 4.00 Buffer: 4.01	4.01			~~Jun 2011 ORP~~ ~~2412603~~	May ~~2012~~ 2012 2006180
pH 7.00 Buffer:	7.0			May 2012	2005446
pH 10.00 Buffer:	10.0			Jun 2011	2912603
Temperature:					~~2411~~
Comments:					

Conductivity

Serial No:	AM	Noon	PM	Exp. Date	Notes: Horriba 100-4 pH Std Soln
Solution: 1521	1430				→ Calibrated to 1521
Solution: 1413				Jan 2011	2001616
Solution:					
Temperature:					
Comments:					

~~PID/OVM~~ ORP

Serial No:	AM	Noon	PM	Exp. Date	Notes:
100 ppm Iso:					Zobell Solution
10 ppm Iso:					prepared 9/3/2010
Zero Filter:					LOT 10F100001
Background Levels:					expires 6/2012
Comments:					

Turbidity

Serial No:	AM	Noon	PM	Exp. Date	Notes:
100 ntu:					
10 ntu:					
1 ntu:					
DI Water:					
Comments:					

* DO reads @ 94.0% in ambient air.
* Set barometric pressure to 100.8 kPa; station reads 29.78 in. (9/3/10 @ 1500)
* ORP standard of 231, meter reads 232.

DAILY SITE SAFETY MEETING RECORD

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
(949) 716-0050; fax (949) 716-0055

Recorded By: Dana R. Brown

Date & Time: 9-3-2010; 07:00 **Project No.:** 2027.02.235

Project Name: Perchlorate Well Study **Project Location:** Tronox, Henderson, Nevada

Field Activities: Groundwater Sampling

Chemicals Present: Perchlorate ($HClO_4$); Arsenic, Dioxin, HCB, SVOC's, OCP's, VOC's, Metals, Alkali Earth elements, Asbestos.

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: Level D: Hardhat, Safety Glasses, coveralls, ear protection, gloves, steel-toed safety shoes.

Hazards of Chemicals Present: Inhalation, Ingestion, Adsorption.

Physical Hazards: Slips-Trips-Falls; Steel edged splinter cuts/punctures/scrapes; Pinch points; heavy lifting.

Special Hazards: Truck Traffic, Debris in off-road areas, native vegetation

Other Topics of Concern: Dust Hazard: Possible asbestos hazard in airborne dust (in addition to COPC's), avoid making excessive dust when driving and always drive with windows closed and positive pressure to cab of truck/passenger space.

SITE SAFETY CHECKLIST	YES	NO
Attached Signature Page - See Below		X
Written Health and Safety Plan (HASP) is on-site	X	
Information in the HASP matches conditions and activities at the site	X	
Site personnel have appropriate training and certification and medical clearance	X	
Air monitoring equipment has been calibrated daily	X	
Site zones are set up and observed where appropriate	X	
Access to Work Areas is limited to authorized personnel	X	
Decontamination stations (including hand/face wash) are set up and used	X	
Personal protective equipment used matches HASP requirements	X	
Emergency and First Aid equipment is on-site as described in the HASP	X	
Drinking water is readily available	X	

Notes (All "NO" answers must be addressed and corrected immediately. Note additionally health and safety observations here):

Dana R. Brown

Conducted By Print Initials: DRB **Signature:** **Date:** 9/3/2010

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER LEVEL DATA FORM

Project Name: Tronox
Project Number:
Weather Conditions: clear + hot
Date: 9/3/10
Sample Crew: J Brown

Well Number	Measurement Dates	Time	Depth to Water 1	Depth to Water 2	Comments	Depth to LNAPL	Depth to DNAPL	T.D.
M-181	9/3/10	826	28.13	28.13				—
M-187		902	37.70	37.70				—
M-188		904	47.46	47.46				—
M-162		912	21.03	21.03				—
M-163		914	23.91	23.91				—
M-164		915	28.02	28.02				—
M-71		917	28.12	28.12				—
M-148A		1022	46.08	46.08				
M-186		1024	45.28	45.28				
M-181		1032	28.13	28.13				
M-182		1034	32.44	32.44				
M-179		1045	36.71	36.71				
M-178		1047	32.24	32.24				
* M-171		1050	27.20	27.20				
M-140		1100	24.63	24.63				
M-180		1040	29.40	29.40				
M-165		1043	23.48	23.48				
M-161		1105	22.72	22.72				
M-157		1110	31.67	31.67				
M-160		1109	31.48	31.48				

Field Activity Report

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Page 1 of

Date: 9-7-2010
Recorded By: Dana R. Brown

Project Name: Perchlorate Well Study
Project No.: 2027, 02.23S
Client Name: Tronox LLC
Weather: Rainy in AM, Sunny in PM.
Temperature: 80°-100°
Site Conditions: Graded Earth

NORTHGATE PERSONNEL ON-SITE

Dana R. Brown

VISITORS

Name	Company/Agency	Time Arrived	Time Left

CONTRACTORS

Contractor Name: Confluence Env. Field Services
Phone No.: 916.760.7641
Supervisor: Josh Kerns
Task: Water Sampling Tech.

Company	No. of Supervisors	No. of Workers	Remarks
Confluence	1- Josh Kerns	Ø	Water Sample Tech

EQUIPMENT

Water Level Meter
Bladder Pump, Controller, Nitrogen Bottle, Disposable Tubing
Decon Kit + Reagent Grade Water + DI water
0.2 and 0.45 micron filter kits
Flow cell + Horriba multiple parameter meter
Water Sampling Kit: Vigyeen, Disposable Bailers, Bailer Twine

DAILY SITE SAFETY MEETING RECORD

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
(949) 716-0050; fax (949) 716-0055

Recorded By: Dana R. Brown
Date & Time: 9-7-2010; 07:10
Project No.: 2027.02.23S
Project Name: Perchlorate Well Study
Project Location: Tronox, Henderson, Nevada
Field Activities: Groundwater Sampling

Chemicals Present: Perchlorate ($HClO_4$), Arsenic, Dioxin, HCB, SVOC's, OCP's, VOC's, Metals, Alkali Earth Elements, Asbestos.

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: Level D: Hardhat, Safety Glasses, Coveralls, Ear Protection, Gloves, Steel-toed safety shoes.

Hazards of Chemicals Present: Inhalation, Ingestion, Adsorption

Physical Hazards: Slips-Trips-Falls; Steel edge cuts; Pinch Points; Heavy Lifting

Special Hazards: Truck traffic, Debris in off-road areas, native vegetation (Puncture to boot Sole)

Other Topics of Concern: Dust hazard - possible asbestos in airborne dust (in addition to COPC's). Travel with compressed Nitrogen bottle valve cover in place to avoid accidental release.

SITE SAFETY CHECKLIST	YES	NO
Attached Signature Page - See Below		X
Written Health and Safety Plan (HASP) is on-site	X	
Information in the HASP matches conditions and activities at the site	X	
Site personnel have appropriate training and certification and medical clearance	X	
Air monitoring equipment has been calibrated daily	X	
Site zones are set up and observed where appropriate	X	
Access to Work Areas is limited to authorized personnel	X	
Decontamination stations (including hand/face wash) are set up and used	X	
Personal protective equipment used matches HASP requirements	X	
Emergency and First Aid equipment is on-site as described in the HASP	X	
Drinking water is readily available	X	

Notes (All "NO" answers must be addressed and corrected immediately. Note additionally health and safety observations here):

Dana R. Brown Josh Kerns

Conducted By Print Initials: DRB **Signature:** **Date:** 9-7-2010

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

EQUIPMENT CALIBRATION RECORD

Project Name:	Tronox Perchlorate Wells	Date:	9-7-2010
Project Number:	2027.02.235	Name:	Dana R. Brown
Site Location:	Henderson, Nevada		

Horriba — **pH Meter** Envirosupply Rental

Serial No:	AM	Noon	PM	Exp. Date	Notes: Lot #
pH 4.00 Buffer: 4.01				May 2012	2006180
pH 7.00 Buffer: 7.00				May 2012	2005446
pH 10.00 Buffer: 10.00				Jun 2011	2912603
Temperature:					
Comments:					

Horriba — **Conductivity**

Serial No:	AM	Noon	PM	Exp. Date	Notes: Lot #
Solution: 1521					Horriba 100-4 Conductivity Std Soln.
Solution: 1413				Jan 2010	
Solution:					
Temperature:					
Comments:					

Horriba — ~~**PID/OVM**~~ ORP

Serial No:	AM	Noon	PM	Exp. Date	Notes:
~~100 ppm Iso:~~ 231					Zobell Solution - Prepared 9/3/10
~~10 ppm Iso:~~					Lot # 10F 100001
~~Zero Filter:~~					Expires 6/2012
Background Levels:					
Comments:					

~~**Turbidity**~~

Serial No:	AM	Noon	PM	Exp. Date	Notes:
100 ntu:					
10 ntu:					
1 ntu:					
DI Water:					
Comments:					

DECONTAMINATION RECORD

northgate

environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

9-7-2010 DRB 9/7/2010

Date: ~~9-7-2010~~ **Time:** 07:10 **Project No.:** 2027.02.235
Project Name: Perchlorate Well Study **Project Location:** Tronox, Henderson, Nevada
Recorded by: Dana R Brown **Checked by:**

Equipment	Use	Deionized Water	Detergent Water	Steam/Hot Water	Potable Water	Deionized Water	Reagent Water	Methanol	Other - describe	Time/Location
Bladder Pump & Safety Cable	GS		1			2+3	4			Field Blank Prep
Water level Probe	GS		1			2+3	4			↓
Flow Cell	GS		1			2+3	4			↓
BP & SC	GS		1			2+3	4			Filter Blank Prep
WLP	GS		1			2+3				↓
FC	GS		1			2+3	4			↓
BP & SC	GS		1			2+3				M-182
WLP	GS		1			2+3				↓
FC	GS		1			2+3				↓

KEY: GS - groundwater sampling; SS - soil sampling; WP - well purging

COMMENTS

Detergent = Liquinox
DI Water = Arrowhead DI - 5 gallon bottles
Lab Grade Water = Tronox Lab Source = "Reagent Water"

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER LEVEL DATA FORM

Project Name
Project Number
Weather Conditions: Light Showers

Date: 9-7-10
Sample Crew: Josh Keens / Doug Brown

Well Number	Measurement Dates	Time	Depth to Water 1	Depth to Water 2	Comments	Depth to LNAPL	Depth to DNAPL	T.D.
M-181	9-7-10	0750	28.10	28.10	2"			
M-182	9-7-10	0800	32.37	32.37	2"			
M-180	9-7-10	0810	29.39	29.39	2"			
M-165	9-7-10	0820	23.40	23.40	2"			
M-179	9-7-10	0835	36.65	36.65	4"			
M-178	9-7-10	0845	32.41	32.41	4"			
M-162	9-7-10	0850	21.03	21.03	2"			
M-163	9-7-10	0855	23.99	23.99	2"			
M-164	9-7-10	0900	28.30	28.30	2"			
M-171	9-7-10	0905	27.66	27.66	4"			
M-140	9-7-10	0925	25.07	25.07	4"			
M-161	9-7-10	0930	22.70	22.70	2"			
M-159	9-7-10	0939	31.66	31.66	2"			
M-160	9-7-10	0945	31.46	31.46	2"			
M-148A	9-7-10	0955	46.11	46.11	2"			
M-186	9-7-10	1000	45.31	45.31	2"			
M-187	9-7-10	1015	37.54	37.54	2"			
M-188	9-7-10	1020	47.45	47.45	2"			

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

SITE WELL DATA

Project Name:

Project Number:

Date: 9-7-10

Recorded By: Josh Kerns / Dana R. Brown

Well ID	Well Access	Well Diameter (inches)	Total Depth (ft)	Screened Interval (ft)	Highest Historical Contamination (ppb)	MDL1	Approximate gal to be evacuated	Sampling Device	Comments
M-171	Dirt Road	4"	47.55						Standpipe - 2.5'

[1] Maximum drawdown limit (NA = Not Applicable; do not monitor)

COC Number 09-03-2010-01

northgate
environmental management, inc.

1100 Quail Street, Suite 102, Newport Beach, CA 92660
(949) 260-9293

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

Page: 1 of
Cooler # ____ of ____

Required Ship to Lab:

Lab Name:	
Address:	
Lab PM:	
Phone/Fax:	
Lab PM email	
Applicable Lab Quote #:	

Required Project Information:

Site ID #:	
Project #	
Site Address	
City	State
Site PM Name	
Phone/Fax:	
Site PM Email:	

Required Invoice Information:

Send Invoice to:	
Address:	
City/State	Phone #:
Reimbursement project?	Non-reimbursement project? Mark one
Send EDD to	
CC Hardcopy report to	
CC Hardcopy report to	

TAT: Standard 21 day		Rush		Mark One
If Rush, Date due				
QC level Required: Standard		Special		Mark one
NJ Reduced Deliverable Package?				
MA MCP Cert?		CT RCP Cert?		Mark One
Lab Project ID (lab use)				

Valid Matrix Codes

MATRIX		MATRIX	
DRINKING WATER	WP	WATER	W
GROUND WATER	WG	SURFACE WATER	WS
WASTE WATER	WW	WATER QC	WQ
FREE PRODUCT	LF	SLUDGE	SL
SOIL	SO	RINSEATE	WH
OIL	OIL	OTHER	OT
WIPE	SW	ANIMAL TISSUE	TA
AMBIENT AIR	AA		
SVE AIR	AE		
SOIL GAS	GS		

ITEM #	SAMPLE ID One Character per box. (A-Z, 0-9 / ,-) Samples IDs MUST BE UNIQUE	MATRIX CODE	SAMPLE TYPE G=GRAB C=COMP	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	FIELD FILTERED? (Y/N)	Preservatives: Unpreserved	H2SO4	HNO3	HCl	NaOH	Na2S2O3	Methanol	Other	Requested Analyses	Comments/Lab Sample I.D.
1	TB-0907 2010	W	G	9-7-2010	10 00	2	N				X						
2	FB-0107 2010	W	G	9-7-2010	10 45	10	Y	X	X	X	X						
3	FI-0907 2010-0.45 M	W	G	9-7-2010	11 00	1	Y			X							0.45 micron
4	FI-0907 2010-0.2 M	W	G	9-7-2010	11 10	1	Y	X									0.2 micron
5	FI-0907 2010-0.2 M-APP	W	G	9-7-2010	11 15	1	N	X									0.2 m Apparatus
6	M-182_2010009-001	W	G	9-7-2010	12 45	10	Y	X	X	X	X						
7	M-182_2010009-001_MS	W	G	9-7-2010	12 45	10	Y	X	X	X	X						
8	M-182_2010009-001_MSD	W	G	9-7-2010	12 45	10	Y	X	X	X	X						
9																	
10																	
11																	
12																	

Additional Comments/Special Instructions:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME
Daniel R Brown, NAEM	9/7	10 00			

Sample Receipt Conditions

Temp in 0C	Samples on Ice?	Sample intact?	Trip Blank?
	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N

SHIPPING METHOD: (mark as appropriate)
UPS COURIER FEDEX
US MAIL

SAMPLER NAME AND SIGNATURE
PRINT Name of SAMPLER: Daniel R. Brown
SIGNATURE of SAMPLER:
DATE Signed 9-7-10 Time: 10 00

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

0.2 Micron Filter Blank

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I.D.: M-182

LOCATION/ADDRESS: Tronox LLC, Henderson, NV — Sample Designation: FI-0903 2010-0.2M; FI-0903 2010-0.2M-APP

PROJECT NO.: 2027.02.23S — Date: ~~9-3-2010~~ DRB 9-7-2010

CLIENT/CONTACT: Tronox - Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): N/A — Feet below reference elevation _____ Date _____ Time _____

WELL EVACUATION:

Well Depth ____ feet — Well Diameter ____ inches — Casing Volume ____ gallons
Depth to Top of Screen ____ feet

Total No. of Casing Volumes: N/A — Total Gallons Removed _____ — Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other ____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft. below TOC)	Time
N/A								

SAMPLING:

Date 9-7-2010 — Time 11:15

Sample Analysis	Volume	Container Type	Number of Containers	Preservative
314.1	125	HDPE	1	Ø

Sterile, 0.2 micron filtered

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab X Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning ☐ Methanol rinse See Decon Log

NOTES:
2 Samples submitted: FI-0903 2010-0.2M = Tronox Lab Grade Water filtered w/ 0.2 micron assembly
FI-0903 2010-0.2M-APP = Unused 0.2 m filter and 20 ml syringe = Filter assembly.
Filter Lot # ~~431219 Part #~~ DRB 05010013 9-7-10
Corning Part # 431219
Sterile Syringe Filter
Syringe Lot # QA25048
NSW (Henke Sass Wolf) Part # 2010-01
Sterile 24 ml syringe Norm-Ject
Luer Lock

Water Sampling Data

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

0.45 Micron Filter Blank

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-182
LOCATION/ADDRESS: Tronox LLC, Henderson, NV
Sample Designation: FI-0907 2010-0.45M
PROJECT NO.: 2027.02.235
Date: ~~9-8-2010~~ DRB 9-7-2010
CLIENT/CONTACT: Tronox - Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): N/A Feet below reference elevation _____ Date _____ Time _____

WELL EVACUATION: Well Depth _____ feet Well Diameter _____ inches Casing Volume _____ gallons
Depth to Top of Screen _____ feet

Total No. of Casing Volumes: N/A Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump _____ Submersible Pump _____ Bailer _____ Other _____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft. below TOC)	Time
N/A								

SAMPLING: Date 9-7-2010 Time 11:00

Sample Analysis	Volume	Container Type	Number of Containers	Preservative
314.1	125	HDPE	1	0

0.45 micron filtered

SAMPLING METHOD: Stainless Steel Bailer _____ Teflon Bailer _____ Grab _____ Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning ☐ Methanol rinse

See Decon Log

NOTES: Used Tronox Laboratory Grade Reagent Water
Filter Lot # 062410
Joss Filters

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

Field Blank

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-182
LOCATION/ADDRESS: Tronox LLC, Henderson, NV
Sample Designation: FB-09072010
PROJECT NO.: 2027.02.235
Date: ~~9-8-2010 DRB~~ 9-7-2010 10:45
CLIENT/CONTACT: Tronox - Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): N/A Feet below reference elevation _____ Date _____ Time _____

WELL EVACUATION:

Well Depth _____ feet Well Diameter _____ inches Casing Volume _____ gallons
Depth to Top of Screen _____ feet

Total No. of Casing Volumes: N/A Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump _____ Submersible Pump _____ Bailer _____ Other _____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft. below TOC)	Time
N/A								

SAMPLING:

Date 9-7-2010 Time 10:45

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125	HDPE	1	Ø	~~0.2 Micron Filtered~~
6010B/6020	500	HDPE	1	HNO_3	~~0.45 Micron Filtered~~ DRB 9-7-2010
8260B	40	VOA	3	HCl	
8081A	1L	Amber	2	Ø	
9060A	500	Amber	1	H_2SO_4	TOC
9060A	500	Amber	1	Ø	DOC
2540C	1L	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer _____ Teflon Bailer _____ Grab _____ Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Direct pour of Tronox Laboratory Grade Reagent Water into Sample Containers.

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

- MS/MSD -

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-182
LOCATION/ADDRESS: Tronox LLC, Henderson, NV
Sample Designation: M-182_201009-001
PROJECT NO.: 2027.02.23S
Date: 9-7-2010
CLIENT/CONTACT: Tronox - Susan Crowley

Note: MS and MSD Collected
M-182_201009-001_MS
M-182_201009-001_MSD

WATER LEVEL MEASUREMENTS:

Water Level (MSL): ~~32.390~~ Feet below reference elevation: 32.390 Date: 9-7-2010 Time: 11:00

WELL EVACUATION:

Well Depth: 90.0 feet Well Diameter: 2.0 inches Casing Volume: _____ gallons
Depth to Top of Screen: 79.7 feet

Total No. of Casing Volumes: _____ Total Gallons Removed: _____ Elapsed Time: _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Low Flow: Bladder pump set @ 85.0' btoc
Peristaltic pump _____ Submersible Pump _____ Bailer _____ Other: Bladder Pump
Non-Dedicated Equipment Identification: _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (~~umhos/cm~~ MS/cm)	°C Temperature	TDS g/L ~~Turbidity~~ (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft. below TOC)	Time	
					- Broken -		32.80	12:11	400 ml/min
	7.11	20.4	26.48	12.6	0.0	154	32.80	12:18	300 ml/min
	7.16	20.3	26.74	12.6	0.0	153	32.82	12:23	300 ml/min
	7.10	20.3	27.31	12.6	0.0	154	32.80	12:28	250 ml/min
	7.13	20.3	27.72	12.6	0.0	153	32.80	12:32	250 ml/min
	7.15	20.3	27.91	12.6	0.0	156	32.80	12:37	250
	7.16	20.3	28.01	12.6	0.0	156	32.80	12:42	250
					~~Repaired~~			14:25	Finish Filling Bottles
4 gallons	7.14	20.7	29.81	12.8	6.0	195	32.75	14:33	250 ml/min

SAMPLING:

Date: 9-7-2010 Time: ~~12:45~~ 12:45

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125	HDPE	1	Ø	0.2 micron Filtered Sterile
6010B/6020	500	HDPE	1	HNO_3	0.45 micron Filtered
8260B	40	VOA	3	HCl	
8081A	1L	Amber	2	Ø	
9060A	500	Amber	1	H_2SO_4	TOC
9060A	500	Amber	1	Ø	DOC
2540C	1L	HDPE	1	Ø	

Note: 3x this number collected for primary, MS, MSD

SAMPLING METHOD: Stainless Steel Bailer _____ Teflon Bailer _____ Grab X Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES:

Field Activity Report

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Page 1 of

Date: 9-8-2010
Recorded By: Dana R. Brown

Project Name: Perchlorate Well Study
Project No.: 2027.02.235
Client Name: Tronox LLC
Weather: Sunny + Windy, Gusts to 25 mph
Temperature: 85° - 99°
Site Conditions:

NORTHGATE PERSONNEL ON-SITE

Dana R. Brown

VISITORS

Name	Company/Agency	Time Arrived	Time Left

CONTRACTORS

Contractor Name: Confluence Environmental, Inc.
Phone No.: (916) 760-7641
Supervisor: Josh Kerns
Task: Groundwater Sampling

Company	No. of Supervisors	No. of Workers	Remarks
Confluence	1- Josh Kerns	Ø	Sampling Technician

EQUIPMENT

Bladder Pump, Controller, Nitrogen Bottle, Disposable Tubing, Water Level Probe
Flow Cell + Horriba multimeter
Decon Kit, DI Water, Laboratory Grade Water
PPE Kit
Water Sampling Kit, Visqueen
0.2 and 0.45 micron disposable filters, disposable bailers, bailer twine

Field Activity Report

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Date: 9-8-2010

Recorded By: Dana R Brown.

Project Name: Perchlorate Well Study

Project No.: 2027.02.235

Client Name: Tronox LLC

ACTIVITIES

Time:	Activities (include event, time, observations, observers, etc.)
04:45	Mobup for Water Sampling
05:00	Drive to Tronox, check in with guard, mob to Trailer
05:17	Meet Josh Kerns, Confluence. Discuss scope of work and supplies.
	Get supplies, ice, sample bottles, DI water, Lab Grade Water.
	Mob to M-181. Set up for water sampling. Set up decon line. HASP mtg
05:59	DTW = 28.070 Prepare to purge well using bladder pump + disposable tubing.
06:29	Purge started. Trip Blank = TB-09082010-02 @ 07:00
07:32	Begin sample collection.
09:37	Finish sample collection M-181_201009-001 and collect field duplicate sample

Print Name: _____ **Signature:** _____

DAILY SITE SAFETY MEETING RECORD

northgate environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
(949) 716-0050; fax (949) 716-0055

Recorded By: Dana R. Brown

Date & Time: 9-8-2010 05:30 **Project No.:** 2027.02.235

Project Name: Perchlorate Well Study **Project Location:** Henderson, NV

Field Activities: Water Sampling

Chemicals Present: Perchlorate, Arsenic, VOC's, OCP's, Asbestos, Metals, SRC List

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: Level D: Hardhat, safety glasses, coveralls, gloves, steel-toed safety shoes.

Hazards of Chemicals Present: Inhalation, Ingestion, Adsorption

Physical Hazards: Slips-Trips-Falls; Heavy Lifting; Cuts/Punctures from steel casing

Special Hazards: Truck traffic; Debris in off-road areas; native vegetation - puncture to boot sole.

Other Topics of Concern: Dust Hazard - Possible asbestos hazard in airborne dust.
Pressurized Gas Cylinders: Travel with protective cap over valve assembly.

SITE SAFETY CHECKLIST	YES	NO
Attached Signature Page - See Below		X
Written Health and Safety Plan (HASP) is on-site	X	
Information in the HASP matches conditions and activities at the site	X	
Site personnel have appropriate training and certification and medical clearance	X	
Air monitoring equipment has been calibrated daily	X	
Site zones are set up and observed where appropriate	X	
Access to Work Areas is limited to authorized personnel	X	
Decontamination stations (including hand/face wash) are set up and used	X	
Personal protective equipment used matches HASP requirements	X	
Emergency and First Aid equipment is on-site as described in the HASP	X	
Drinking water is readily available	X	

Notes (All "NO" answers must be addressed and corrected immediately. Note additionally health and safety observations here):

Dana R. Brown Josh Kerns

Conducted By Print Initials: DRB **Signature:** **Date:** 9-8-2010

COC Number_____

northgate
environmental management, inc.

1100 Quail Street, Suite 102, Newport Beach, CA 92660
(949) 260-9293

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

Page: of
Cooler # _____ of _____

Required Ship to Lab:

Lab Name:	
Address:	
Lab PM:	
Phone/Fax:	
Lab PM email	
Applicable Lab Quote #:	

Required Project Information:

Site ID #:			
Project #			
Site Address			
City		State	
Site PM Name			
Phone/Fax:			
Site PM Email:			

Required Invoice Information:

Send Invoice to:			
Address:			
City/State		Phone #:	
Reimbursement project?		Non-reimbursement project?	Mark one
Send EDD to			
CC Hardcopy report to			
CC Hardcopy report to			

TAT: Standard 21 day		Rush		Mark One
If Rush, Date due				
QC level Required: Standard		Special		Mark one
NJ Reduced Deliverable Package?				
MA MCP Cert?		CT RCP Cert?		Mark One
Lab Project ID (lab use)				

Valid Matrix Codes

MATRIX		MATRIX	
DRINKING WATER	WP	WATER	W
GROUND WATER	WG	SURFACE WATER	WS
WASTE WATER	WW	WATER QC	WQ
FREE PRODUCT	LF	SLUDGE	SL
SOIL	SO	RINSEATE	WH
OIL	OIL	OTHER	OT
WIPE	SW	ANIMAL TISSUE	TA
AMBIENT AIR	AA		
SVE AIR	AE		
SOIL GAS	GS		

ITEM #	SAMPLE ID One Character per box. (A-Z, 0-9 / ,-) Samples IDs MUST BE UNIQUE	MATRIX CODE	SAMPLE TYPE G=GRAB C=COMP	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	FIELD FILTERED? (Y/N)	Preservatives: Unpreserved	H2SO4	HNO3	HCl	NaOH	Na2S2O3	Methanol	Other	Requested Analyses	Comments/Lab Sample I.D.
1	[illegible]-02	W	G	9/8 [illegible]	07 [illegible]	2	N										
2	[illegible]	W	G	↓	07 [illegible]	10	Y	X	X	X	X				X		
3	[illegible]-FD	W	G	↓	07 [illegible]	10	Y	X	X	X	X				X		
4	[illegible]	W	G	↓	[illegible]	10	~~Y~~ N	X	X	X	X				X		
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	

Additional Comments/Special Instructions:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME
DANA R. BROWN	9/8				

Sample Receipt Conditions

Temp in 0C	Samples on Ice?	Sample intact?	Trip Blank?
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N

SHIPPING METHOD: (mark as appropriate)
UPS COURIER FEDEX
US MAIL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: Dana R Brown
SIGNATURE of SAMPLER: [signature]
DATE Signed [illegible] Time:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

– Field Duplicate –
"FD"

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-181
LOCATION/ADDRESS: Tronox LLC, Henderson, NV
Sample Designation: M-181_201009-001 + M-181_201009-001_FD
PROJECT NO.: 2027.02.235
Date: 9-8-2010
CLIENT/CONTACT: Tronox - Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation 28.070 Date 9-8-10 Time 05:59

WELL EVACUATION: Well Depth 115.0 feet Well Diameter 2 inches Casing Volume _____ gallons
Depth to Top of Screen 104.7 feet

Total No. of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump _____ Submersible Pump _____ Bailer _____ Other _____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	TDS g/L	pH	Specific Conductance ~~(umhos/cm)~~ mS/cm	Temperature °C	DO% ~~Turbidity (NTU)~~	Dissolved Oxgen (DO) mg/L	Oxidation-Reduction Potential (ORP) mV	DTW (ft. below TOC)	Time	
Pump On = Ø									06:29	400 ml/m
								29.30	06:34	250 ml/m
								29.30	06:37	
								29.35	06:42	
	0.564	8.17	0.882	25.49	12.1	0.75	171	29.35	06:47	
	0.562	8.19	0.878	25.56	11.9	1.01	170	29.40	06:53	~150 ml/m
	0.563	8.19	0.880	25.60	11.8	0.94	171	29.35	06:58	150 ml
	0.563	8.16	0.880	25.68	10.3	0.88	176	29.35	07:02	
2.0 gallons	0.562	8.17	0.878	25.87	10.2	0.85	173	29.21	07:12	
	0.561	8.18	0.876	25.96	10.4	0.84	168	29.20	07:21	
≈ 2.5 gallons	0.564	8.19	0.881	25.94	10.8	0.88	167	29.20	07:26	

See ~~Below~~ Below for final Parameters

SAMPLING: Date 9-8-10 Time 07:32

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125	HDPE	1	Ø	0.2 micron sterile filter
6010B/6020	500	HDPE	1	HNO_3	0.45 micron filtered
8260B	40	VOA	3	HCl	
8081A	1L	Amber	2	Ø	
9060A	500	Amber	1	H_2SO_4	TOC
9060A	500	Amber	1	Ø	DOC
2540C	1L	HDPE	1	Ø	

NOTE: 2x this number collected = FD

2hrs
09:37 finish filling bottles

SAMPLING METHOD: Stainless Steel Bailer _____ Teflon Bailer _____ Grab _____ Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES:

0.45 micron filter = VOSS, Lot # 062410. 0.2 micron filter = Corning #431219, Lot # 05010013
Syringe = HSW, 2010-01 Lot # RA 25048

Water Sampling Data

Final Parameter Set	Casing Volume	TDS	pH	SC	T	DO%	DO	ORP	DTW	Time	Flow Rate
	Ø 4.0 gal	0.566	8.20	0.884	28.05	61.2	4.50	140	29.20	09:37	250 ml/m
									29.20	09:51	250 ml/m

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

- Equipment Blank -
"EB"

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-181
LOCATION/ADDRESS: Tronox LLC, Henderson, NV
Sample Designation: EB-09082010
PROJECT NO.: 2027.02.235
Date: 9-8-2010
CLIENT/CONTACT: Tronox - Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): N/A Feet below reference elevation _____ Date _____ Time _____

WELL EVACUATION: Well Depth _____ feet Well Diameter _____ inches Casing Volume _____ gallons
Depth to Top of Screen _____ feet

Total No. of Casing Volumes: N/A Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump _____ Submersible Pump _____ Bailer _____ Other _____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft. below TOC)	Time
N/A								

SAMPLING: Date 9-8-2010 Time 10:10 = Start Filling 10:27 = End Filling

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125	HDPE	1	Ø	~~0.2 micron sterile filter~~
6010B/6020	500	HDPE	1	HNO3	~~0.45 micron filter~~ ORB 9/8/2010
8260B	40	VOA	3	HCl	
8081A	1L	Amber	2	Ø	
9060A	500	Amber	1	H_2SO_4	TOC
9060A	500	Amber	1	Ø	DOC
2540C	1L	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer _____ Teflon Bailer _____ Grab _____ Other X Reagent grade H_2O pumped through bladder pump.

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse 4 Step; last step = Tronox Lab Grade H_2O, See Decon Log

NOTES: DI = Arrowhead Water DI. Reagent Grade water = Tronox Lab Grade water (step #4)

Field Activity Report

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Page 1 of

Date: ~~9-10-2010~~ 9-9-2010

Recorded By: Dana R. Brown

Project Name: Perchlorate Well Study **Project No.:** 2027.02.235
Client Name: Tronox LLC
Weather: Sunny & Clear **Temperature:** 72°
Site Conditions: Graded Earth

NORTHGATE PERSONNEL ON-SITE

Dana R. Brown

VISITORS

Name	Company/Agency	Time Arrived	Time Left
Kyle Hansen	Northgate (@ Trailer) helped + repair of pump pigtail.		

CONTRACTORS

Contractor Name: Confluence Environmental **Phone No.:** 916.760.7641
Supervisor: Josh Kerns **Task:** Water Sampling Technician

Company	No. of Supervisors	No. of Workers	Remarks
Confluence Environmental	1- Josh Kerns	Ø	Water Sampling Technician

EQUIPMENT

Bladder Pump, Controller, Nitrogen Bottle, disposable tubing.
Jar, Water level meter, Flow cell & Water Quality meter
Submersible pump, generator, control box
PPE Kit
Water Sampling kit. Disposable air line and discharge tubing

DAILY SITE SAFETY MEETING RECORD

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
(949) 716-0050; fax (949) 716-0055

Recorded By: Dana R. Brown

Date & Time: 9-9-2010 / **Project No.:** 2027.02.235

Project Name: Tronox Perchlorate Wells **Project Location:**

Field Activities: Groundwater Sampling

Chemicals Present: Perchlorate, Arsenic, Metals, Dioxin,

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: Level D:

Hazards of Chemicals Present: Inhalation, Ingestion, Adsorption

Physical Hazards: Slips-Trips-Falls; Heavy lifting; Truck traffic

Special Hazards:

Other Topics of Concern:

SITE SAFETY CHECKLIST	YES	NO
Attached Signature Page - See Below		X
Written Health and Safety Plan (HASP) is on-site	X	
Information in the HASP matches conditions and activities at the site	X	
Site personnel have appropriate training and certification and medical clearance	X	
Air monitoring equipment has been calibrated daily	X	
Site zones are set up and observed where appropriate	X	
Access to Work Areas is limited to authorized personnel	X	
Decontamination stations (including hand/face wash) are set up and used	X	
Personal protective equipment used matches HASP requirements	X	
Emergency and First Aid equipment is on-site as described in the HASP	X	
Drinking water is readily available	X	

Notes (All "NO" answers must be addressed and corrected immediately. Note additionally health and safety observations here):

Dana R. Brown Josh Kyns

Conducted By Print Initials: DRB **Signature:** **Date:** 9-9-2010

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

EQUIPMENT CALIBRATION RECORD

Project Name:		Date:	9-9-2010
Project Number:		Name:	
Site Location:			

pH Meter

Serial No:	AM 06:47	Noon	PM	Exp. Date	Notes:
pH 4.00 Buffer: 4.01				May 2012	Lot # 2006180
pH 7.00 Buffer: 7.00	7.01			May 2012	Lot # 2005446
pH 10.00 Buffer: 10.00				Jun 2011	Lot # 2912603
Temperature:					
Comments:					

Conductivity

Serial No:	AM 06:42	Noon	PM	Exp. Date	Notes:
Solution: ~~Hi 100 µ~~					
Solution: 1413 µS	1.58 mS/cm			Jan 2011	Lot # 2001616
Solution:					
Temperature:					
Comments:					

ORP
~~PID/OVM~~

Serial No:	AM	Noon	PM	Exp. Date	Notes:
100 ppm Iso:					YSI 3682 Zobell Solution
10 ppm Iso:					Lot # 10F 100001
Zero Filter:				6/2012	~~Expires 6/2012~~ Mixed 9/3/10
Background Levels:					
Comments:					

Turbidity

Serial No:	AM	Noon	PM	Exp. Date	Notes:
100 ntu:					
10 ntu:					
1 ntu:					
DI Water:					
Comments:					

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER LEVEL DATA FORM

4-9-10

Project Name
Project Number
Weather Conditions

Date ~~9-10-10~~ DRB
Sample Crew 9-9-10

Well Number	Measurement Dates	Time	Depth to Water 1	Depth to Water 2	Comments	Depth to LNAPL	Depth to DNAPL	T.D.
M-162	9-~~10~~ 9-2010 DRB 9-9-10	06:25	21.04	21.04				
M-164	↓	06:42	28.43	28.43				
M-163		06:43	24.04	24.04				
~~M-71~~								
M-160		10:17	31.95					
M-159		10:30	31.64					

COC Number_____

northgate
environmental management, inc.

1100 Quail Street, Suite 102, Newport Beach, CA 92660
(949) 260-9293

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

Page: of
Cooler # ____ of ____

Required Ship to Lab:

Lab Name:	
Address:	
Lab PM:	
Phone/Fax:	
Lab PM email	
Applicable Lab Quote #:	

Required Project Information:

Site ID #:			
Project #			
Site Address			
City		State	
Site PM Name			
Phone/Fax:			
Site PM Email:			

Required Invoice Information:

Send Invoice to:			
Address:			
City/State		Phone #:	
Reimbursement project?		Non-reimbursement project?	Mark one
Send EDD to			
CC Hardcopy report to			
CC Hardcopy report to			

TAT: Standard 21 day		Rush		Mark One
If Rush, Date due				
QC level Required: Standard		Special		Mark one
NJ Reduced Deliverable Package?				
MA MCP Cert?		CT RCP Cert?		Mark One
Lab Project ID (lab use)				

Valid Matrix Codes

MATRIX		MATRIX	
DRINKING WATER	WP	WATER	W
GROUND WATER	WG	SURFACE WATER	WS
WASTE WATER	WW	WATER QC	WQ
FREE PRODUCT	LF	SLUDGE	SL
SOIL	SO	RINSEATE	WH
OIL	OL	OTHER	OT
WIPE	SW	ANIMAL TISSUE	TA
AMBIENT AIR	AA		
SVE AIR	AE		
SOIL GAS	GS		

ITEM #	SAMPLE ID One Character per box. (A-Z, 0-9 / ,-) Samples IDs MUST BE UNIQUE	MATRIX CODE	SAMPLE TYPE G=GRAB C=COMP	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	FIELD FILTERED? (Y/N)	Preservatives: Unpreserved	H2SO4	HNO3	HCl	NaOH	Na2S2O3	Methanol	Other	Requested Analyses	Comments/Lab Sample I.D.
1	[illegible]	[illegible]	G	[illegible]	[illegible]	3	Y										
2	[illegible]	[illegible]	G	[illegible]	[illegible]	3	Y										
3	[illegible]	[illegible]	G	[illegible]	12 22	3	Y										
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	

Additional Comments/Special Instructions:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME
Dana R Brown NGEM	[illegible]		[illegible]	[illegible]	[illegible]

Sample Receipt Conditions

Temp in 0C	Samples on Ice?	Sample intact?	Trip Blank?
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N

SHIPPING METHOD: (mark as appropriate)
UPS COURIER FEDEX
US MAIL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER:	Dana R Brown		
SIGNATURE of SAMPLER:	[signature]	DATE Signed	[illegible]
		Time:	

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I D: M-160
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: M-160-201009-001
PROJECT NO: 2027.02.235
Date: 9-9-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation 31.45 Date 9-9-10 Time 10:17

WELL EVACUATION: Well Depth 50.0 feet Well Diameter ____ inches Casing Volume _____ gallons
Depth to Top of Screen 39.7 feet

Total No. of Casing Volumes: _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other Bladder Pump
Non-Dedicated Equipment Identification: Pump set at 45 below top of casing

FIELD WATER QUALITY TESTS:
Start Pump @ 10:27

Casing Volume	pH	Specific Conductance (umhos/cm) mS/cm	Temperature °C	Turbidity (NTU) DO %	Dissolved Oxgen (DO) mg/L	Oxidation-Reduction Potential (ORP) mV	DTW (ft. below TOC)	Time	flow ml/min
	7.69	4.56	26.62	18.8	1.53	112	31.70	10:35	300
	7.65	4.59	26.53	21.6	1.69	116	31.70	10:37	
	7.67	4.64	26.43	20.0	1.65	119	31.70	10:40	
	7.66	4.68	26.41	19.8	1.66	120	31.70	10:45	
1 gal	7.64	4.70	26.40	19.0	1.62	121	31.70	10:50	
	7.66	4.80	26.37	17.9	1.57	123	31.70	10:55	
	7.68	4.89	26.39	24.1	1.96	122	31.70	11:11	Final Parameters

SAMPLING: Date 9-9-10 Time 10:55

Begin filling 10:55
End 11:04

Sample Analysis	Volume ml	Container Type	Number of Containers	Preservative	
314.1	125	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500	HDPE	1	HNO_3	0.45 micron filtered
2540C	12	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other Bladder Pump

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse 3 Stage decon - see Decon Record form.

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-162
LOCATION/ADDRESS: Tronox LLC, Henderson, NV
Sample Designation: M-162-201009-001
PROJECT NO.: 2027.02.235
Date: 9-9-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 21.04 Date 9-10-2010 Time 06:25

WELL EVACUATION: Well Depth 110.0 feet Well Diameter 2 inches Casing Volume _____ gallons
Depth to Top of Screen 99.7 feet

Total No. of Casing Volumes: _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other Bladder Pump
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:
06:50 = Pump On

Casing Volume	pH	Specific Conductance (~~umhos/cm~~ mS/cm)	Temperature (°C)	Turbidity (~~NTU~~ DO %)	Dissolved Oxgen (DO) (mg/L)	Oxidation-Reduction Potential (ORP) (mV)	DTW (ft below TOC)	Time	
	7.61	1.05	24.59	1.5	0.14	93	21.24	06:55	150 ml/min
	7.66	1.04	24.80	0.0	0.01	92	21.52	06:57	
	7.76	1.02	24.86	0.0	0.0	89	21.70	06:58	
	7.90	1.00	24.92	0.0	0.0	84	22.15	07:02	
	7.99	0.993	24.94	0.0	0.0	80	22.51	07:05	
	8.05	0.988	25.05	0.0	0.0	77	23.05	07:13	
1 gallon	8.04	0.986	25.12	0.0	0.0	74	23.54	07:23	.49
	8.05	0.985	25.29	0.0	0.0	76	23.85	07:32	.31
	8.09	0.985	25.42	0.0	0.0	68	24.12	07:43	.22
	8.09	0.983	25.56	0.0	0.0	64	24.31	07:54	.21
	8.12	0.983	25.59	0.0	0.0	48	24.46	08:04	.15

? Change rate to 100 ml/m

SAMPLING: Date 9-9-10 Time 08:14

Start Sampling @ 08:14
Finish Sampling @ 08:43

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125	HDPE	1	Ø	0.2 micron filtered
6010B/6020	500	HDPE	1	HNO3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other Bladder Pump

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning ☐ Methanol rinse

NOTES:

Final Parameter Set

Water Sampling Data Casing Volume	pH	Cond	Temp	DO%	DO	ORP	DTW	Time	Rate
4.0 gallons	8.14	0.983	26.62	0.0	0.0	71	24.13	08:49	100 ml/m
4.5	8.17	0.993	26.57	0.0	0.0	65	24.10	08:59	

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I.D.: M-186

LOCATION/ADDRESS: Tronox LLC, Henderson, NV — Sample Designation: M-186_201009-001

PROJECT NO.: 2027.02.235 — Date: 9-9-2010

CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation: 45.29 Date: 9-9-10 Time: 14:53

WELL EVACUATION: Well Depth: 115.0 feet Well Diameter: 2 inches Casing Volume: _____ gallons
Depth to Top of Screen: 104.7 feet

Total No. of Casing Volumes: _____ Total Gallons Removed: _____ Elapsed Time: _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other: Bladder Pump

Non-Dedicated Equipment Identification: Pump set @ 110' btoc.

FIELD WATER QUALITY TESTS:

Pump ON = 14:56 DTW = 45.20
15:00 = 45.29

Casing Volume	pH	Specific Conductance (mS/cm ~~umhos/cm~~)	Temperature (°C)	Turbidity (NTU) (DO %)	Dissolved Oxgen (DO) (mg/L)	Oxidation-Reduction Potential (ORP) (mV)	DTW (ft. below TOC)	Time	Flow Rate ml/m
	7.79	8.63	29.54	35.3	2.61	109	45.84	15:15	100
	7.63	9.78	29.59	33.5	2.41	121	46.00	15:27	|
	7.61	10.0	29.09	30.0	2.20	124	46.03	15:33	|
	7.61	10.1	28.99	28.6	2.01	126	46.05	15:40	|
	7.60	10.1	29.10	28.3	2.11	126	46.05	15:45	|
	~~7.57~~	~~10.1~~	~~28.93~~	~~34.2~~ DRS					
									100 ml/min
	7.57	10.8	28.88	34.1	2.52	129	46.08 ✓	16:16	Final Parameters

SAMPLING: Date: 9-9-2010 Time: 15:50

Start Sampling 15:50
End Sampling 16:11

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other: ~~Peristaltic~~ Bladder Pump
DRS 9-9

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning ☐ Methanol rinse

3-Stage decon used. See Decon Log.

NOTES:

45.29
@ 14:43

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-159
LOCATION/ADDRESS: Tronox LLC, Henderson, NV
Sample Designation: M-159_201009-001
PROJECT NO.: 2027.02.235
Date: 9-9-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation 31.64 Date 9-9-2010 Time 10:30

WELL EVACUATION: Well Depth _____ feet Well Diameter _____ inches Casing Volume _____ gallons
Depth to Top of Screen _____ feet

Total No. of Casing Volumes: _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump _____ Submersible Pump _____ Bailer _____ Other Bladder Pump
Non-Dedicated Equipment Identification: Pump set @ 65' below Top of casing

FIELD WATER QUALITY TESTS:
Start Pump @ 11:29

Casing Volume	pH	Specific Conductance (mS/cm ~~umhos/cm~~)	Temperature (°C)	Turbidity (NTU) (DO %)	Dissolved Oxgen (DO) (mg/L)	Oxidation-Reduction Potential (ORP) (mV)	DTW (ft. below TOC)	Time	Flow ml/min
	7.84	3.92	27.88	76.7	6.09	111	32.10	11:39	~~150~~ 80
	7.84	3.89	27.91	66.0	5.04	110	32.21	11:46	80
1/3 → 1/4 gallon	7.85	3.88	27.61	63.4	4.89	108	32.34	11:51	↓
	7.85	3.87	27.42	61.5	4.75	106	32.39	11:59	↓
	7.85	3.86	27.45	73.5	5.15	102	32.35	12:09	↓
≈ 1 gallon	7.86	3.85	27.47	73.0	5.10	101	32.35	12:17	↓
1.5 gallons	7.84	3.84	27.95	49.1	3.00	98	32.28	12:54	Final Parameters

SAMPLING: Date 9-9-10 Time 12:20

Begin filling: 12:20
End filling: 12:48

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer _____ Teflon Bailer _____ Grab _____ Other Bladder Pump

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse 3-Stage decon; See decon record

NOTES:

Field Activity Report

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Page 2 of

Date: 9-10-2010
Recorded By: Dana R. Brown

Project Name: Perchlorate Well Study
Project No.: 2027.02.235
Client Name: Tronox LLC

ACTIVITIES

Time:	Activities (include event, time, observations, observers, etc.)
04:45	Mob up for water sampling.
	Drive to Tronox, check in with guard, mob to trailer.
	Discuss drilling program completion + Randy Rowley
	Mob up for water sampling. Get supplies + sample bottles
	Discuss Scope of Work + Josh Kerns, Confluence. He goes for ice.
	Mob to M-161 & set up to do low-flow sampling.
06:42	Commence purge on M-161
	Well is not recharging.
07:30	Unable to sample M-161, Will return to bail dry + sample 24 hrs later.
	Pack up & clean up. Return to trailer.
	Load up generator, pump reel, controller, parts, discharge drum.
	Mob to M-187 & set up to purge with Grundfos Rediflow II.
	Problem: GFI on generator trips as soon as it is plugged into hose reel.
	Troubleshoot - problem appears to be generator's GFI circuit.
	Mob to trailer & test pump & reel by plugging into 120V outlet
	on side of trailer. Both work. Problem is identified as the
	gender changing pigtail. Need to use pigtail to plug into 25amp
	breaker to keep from tripping GFI on circuit breaker.
	Josh departs for LOWE'S to get parts for pump (pigtail). I do field reports...
10:42	Josh returns + adapter. Setting up pump.
10:55	@ M-188 Set up to purge well dry + Rediflow II submersible pump.
11:22	Purged M-188 dry. Pull pump & decon.
	Set up on M-187 to purge well dry
11:53	Purged M-187 dry. Pull pump & decon.
1240	Setup @ M-161 to purge well dry
1253	Purged well dry, pull & decon pump
1415	Set up M-164 to purge dry
1423	Well purged dry, pull pump and decon
1431	Setup M-163 to purge dry
14:41	Pumped dry. Breakdown
	Mob to 148A
	Set up to pump.
15:15	Pumped dry.
	Mob to M-179
	Set up to purge + Sample groundwater
16:16	Pumped dry.
	Mob to Veolia and dispose of Chrome waste in the sump.
	Return to trailer & finish documentation

Note - Patrick took over the documentation as Dana went to clinic.

14:51 Dana Returns

Print Name: Dana R. Brown **Signature:**

Nicki
949
355
1707

northgate environmental management, inc.

DAILY SITE SAFETY MEETING RECORD

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
(949) 716-0050; fax (949) 716-0055

Recorded By: Dana R. Brown

Date & Time: 9-10-2010 Project No.: 2027.01.235

Project Name: Perchlorate Well Study Project Location: Tronox LLC, Henderson, NV

Field Activities: Water Sampling

Chemicals Present: Perchlorate, Hexavalent Chromium, Arsenic, Metals, Dioxin, Asbestos

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: Level D

Hazards of Chemicals Present: Inhalation, Ingestion, Adsorption

Physical Hazards: Slips-Trips-Falls

Special Hazards: Truck Traffic. Debris in off-road areas of site. Dust - potential asbestos hazard.

Other Topics of Concern:

SITE SAFETY CHECKLIST	YES	NO
Attached Signature Page - See Below		X
Written Health and Safety Plan (HASP) is on-site	X	
Information in the HASP matches conditions and activities at the site	X	
Site personnel have appropriate training and certification and medical clearance	X	
Air monitoring equipment has been calibrated daily	X	
Site zones are set up and observed where appropriate	X	
Access to Work Areas is limited to authorized personnel	X	
Decontamination stations (including hand/face wash) are set up and used	X	
Personal protective equipment used matches HASP requirements	X	
Emergency and First Aid equipment is on-site as described in the HASP	X	
Drinking water is readily available	X	

Notes (All "NO" answers must be addressed and corrected immediately. Note additionally health and safety observations here):

Dana R Brown Josh Kerns

Conducted By Print Initials: DRB Signature: Date: 9-10-2010

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER LEVEL DATA FORM

Project Name	Perchlorate Well Study	**Date**	9-10-2010
Project Number	2027.02.235	**Sample Crew**	Dana Brown / Josh Kerns
Weather Conditions	Clear + Sunny		

Well Number	Measurement Dates	Time	Depth to Water 1	Depth to Water 2	Comments	Depth to LNAPL	Depth to DNAPL	T.D.
M-161	9-10-2010	06:25	22.70	22.70				
M-188	↓	10:55	47.42	47.42				
M-187		11:34	37.67	37.67				
M-161		1240	25.50	25.50				
M-164		1419	28.47	28.47				
M-163		1433	24.14	24.14				
M-148A		15:03	46.09	46.09				
M-179		15:59	36.71	36.71				

DECONTAMINATION RECORD

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Date: 9-10-2010 **Time:** _____ **Project No.:** 2027.02.235
Project Name: Perchlorate Well Study **Project Location:** Henderson, Nevada
Recorded by: Dana R. Brown **Checked by:** _____

Equipment	Use	Deionized Water	Detergent Water	Steam/Hot Water	Potable Water	Deionized Water	Reagent Water	Methanol	Other - describe	Time/Location	
Water Level Meter	GS		1			2+3				06:15	M-161
Bladder Pump	GS		1			2+3				↓	↓
Redi Flow II Submersible	GS		1			2+3				08:35	M-187
Water level Meter	GS		1			2+3				↓	↓
RFII & WLM	GS		1			2+3				10:55	M-188
RFII & WLM	GS		1			2+3				11:34	M-187
RFII → WLM	GS		1			2+3				1254	M-161
RFII → WLM	GS		1			2+3				1425	M-164
RFII & WLM	GS		1			2+3				14:50	M-148A
RFII & WLM	GS		1			2+3				15:50	M-179

KEY: GS - groundwater sampling; SS - soil sampling; WP - well purging

COMMENTS

Redi Flow II submersible = New from Boulder City office.
DI = Arrowhead Water 5 gallon Jugs
RFII = Submersible Pump
WLM = Water level Meter

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

EQUIPMENT CALIBRATION RECORD

Project Name:	Tronox Perchlorate Wells	Date:	9-10-2010
Project Number:	2027.02.235	Name:	Dana R. Brown
Site Location:	Henderson, NV		

pH Meter

Serial No:	AM 06:48	Noon	PM	Exp. Date	Notes:
pH 4.00 Buffer: 4.01	4.09			May 2012	Lot # 2006180
pH 7.00 Buffer: 7.00	7.03			May 2012	2005446
pH 10.00 Buffer: 10.00	9.96			Jun 2011	2912603
Temperature:					
Comments:					

Conductivity

Serial No:	AM 06:51	Noon	PM	Exp. Date	Notes:
Solution:					
Solution: 1413 uS	1427			Jan 2011	Lot # 2001616
Solution:					
Temperature:					
Comments:					

ORP
~~PID/OVM~~

Serial No:	AM 06:53	Noon	PM	Exp. Date	Notes:
~~100 ppm Iso:~~ 231 mV	235				YSI 3682
~~10 ppm Iso:~~ 185 mV	191				Lot # 10F100001
Zero Filter:					Mixed 9/3/10
Background Levels:					
Comments:					

~~Turbidity~~

Serial No:	AM	Noon	PM	Exp. Date	Notes:
100 ntu:					
10 ntu:					
1 ntu:					
DI Water:					
Comments:					

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-148A
LOCATION/ADDRESS: Tronox LLC Henderson, NV
Sample Designation: Not Sampled
PROJECT NO.: 2027.02.233
Date: 9-10-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation 46.09 Date 9-10-10 Time 15:03

WELL EVACUATION: Well Depth 50.0 feet Well Diameter 2 inches Casing Volume ~~X~~ gallons
Depth to Top of Screen 31.7 feet

Total No. of Casing Volumes: _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other ____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
Pump On								15:11
		Did not produce water - probably just filled hose						
							50.0'	15:15
							45.99	15:19

SAMPLING: Date _____ Time _____

Sample Analysis	Volume	Container Type	Number of Containers	Preservative

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Record

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I.D.: M-161

LOCATION/ADDRESS: Tronox LLC, Henderson, NV — Sample Designation: Not Collected.

PROJECT NO: 2027.02.235 — Date: 9-10-2010

CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation: 22.70 Date: 9-10-2010 Time: 06:25

WELL EVACUATION: Well Depth: 110.0 feet Well Diameter: 2 inches Casing Volume: _____ gallons
Depth to Top of Screen: 99.7 feet

Total No. of Casing Volumes: _____ Total Gallons Removed: _____ Elapsed Time: _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other: Bladder Pump

Non-Dedicated Equipment Identification: Pump set @ 110' BTOC

FIELD WATER QUALITY TESTS:

Start Pump: 06:42 and 07:01

Casing Volume	pH	Specific Conductance (~~umhos/cm~~) mS/cm	°C Temperature	NTU Turbidity (NTU)	Dissolved Oxgen (DO) mg/L	Oxidation-Reduction Potential (ORP) mV	DTW (ft below TOC)	Time	Flow Rate ml/min
							20.80	07:08	Water arrives @ Fill 300
Water very Cloudy							22.30	07:11	
	8.14	1.03	24.13	10.6	0.86	123	24.50	07:14	change Rate to 200 then 120
	7.94	1.02	23.98	0.9	0.11	118	26.50	07:18	
	8.22	1.02	24.06	16.3	2.93	113	25.45	07:22	120
	8.22	1.02	24.44	53.3	4.55	115	26.90	07:25	120
							29.31	07:30	120
Not able to be sampled with low flow. Aborted							—	—	ABORTED
		~~SEE~~	~~REVERSE~~			~~SEE~~	~~REVERSE~~		
Final Parameters:			DRB 9-10-10				DRB 9-10-10		

SAMPLING: Date: ~~9-9-10~~ DRB 9-10-2010 Time: _____

Start Sampling

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125	HDPE	1	Ø	0.2 micron sterile filtered
6010 B/6020	500	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

End Sampling

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other: Bladder Pump

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Record

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study Well/Surface Station I.D.: M-161

LOCATION/ADDRESS: Tronox LLC, Henderson, NV Sample Designation: Not Sampled

PROJECT NO.: 2027.02.235 Date: 9-10-10

CLIENT/CONTACT: Susan Crowey

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 25.50 Date 9-10-2010 Time 1240

WELL EVACUATION: Well Depth 110.0 feet Well Diameter 2 inches Casing Volume 13.8 gallons

Depth to Top of Screen 99.7 feet

Total No. of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ✓ Bailer ____ Other ____

Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	TDS	pH	Specific Conductance (~~mmhos/cm~~) mS/cm	Temperature °C	~~Turbidity (NTU)~~ DO %	Dissolved Oxgen (DO) mg/L	Oxidation-Reduction Potential (ORP) mV	DTW (ft below TOC)	Time
Ø									Start Pump 1245
	.710	8.20	1.09	29.50	18.2	1.36	78		1245
	.656	8.28	1.02	28.17	16.3	1.19	66		1247
	.660	8.28	1.04	27.91	20.2	1.46	64		1248
	.664	8.26	1.04	27.55	23.8	1.70	64		1250
	.657	8.29	1.03	27.62	27.2	2.01	56		1251
≈ 20 gallons									

SAMPLING: Date _____ Time _____

Sample Analysis	Volume	Container Type	Number of Containers	Preservative

Not SAMPLED

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES: 3 stage Decon

DECONTAMINATION METHOD: ☐Non Phosphatic detergent wash/distilled water rinse ☐Hot pressure wash/steam cleaning ☐Methanol rinse

See Record

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-163
LOCATION/ADDRESS: Timox LLC, Henderson, NV
Sample Designation: Not Sampled
PROJECT NO.: 2027.02.235
Date: 9-10-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation 24.14 Date 9-10-10 Time 1431

WELL EVACUATION: Well Depth 90.0 feet Well Diameter 2 inches Casing Volume 10.7 gallons
Depth to Top of Screen 79.7 feet

Total No. of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump _____ Submersible Pump ✓ Bailer _____ Other _____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature °C	DO % ~~Turbidity (NTU)~~	Dissolved Oxgen (DO) mg/L	Oxidation-Reduction Potential (ORP)	DTW (ft. below TOC)	Time
Ø	TDS g/L	ms/cm						Start Pump 14:44
	8.47	142	31.27	34.3	2.60	120		14:45 2.5 → 3.0 gpm
11.0 gal	8.41	1.20	30.74	30.7	2.11	115		
	Pumped Dry.						85.0'	14:47

SAMPLING: Date _____ Time _____

Sample Analysis	Volume	Container Type	Number of Containers	Preservative

Not Sampled

SAMPLING METHOD: Stainless Steel Bailer _____ Teflon Bailer _____ Grab _____ Other _____

EQUIPMENT DECONTAMINATION PROCEDURES: 3 Stage Decon

DECONTAMINATION METHOD: ☐Non Phosphatic detergent wash/distilled water rinse ☐Hot pressure wash/steam cleaning
☐Methanol rinse

See Record

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D: M-164
LOCATION/ADDRESS: Tronox, LLC, Henderson, NV
Sample Designation: Not Sampled
PROJECT NO.: 2027.02.235
Date: 9-10-10
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation 28.47 Date 9-10-10 Time 1419

WELL EVACUATION:

Well Depth 70.0 feet Well Diameter 2 inches Casing Volume 6.8 gallons
Depth to Top of Screen 59.7 feet

Total No. of Casing Volumes: _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ✓ Bailer ____ Other _____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	~~Turbidity (NTU)~~ DO%	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft. below TOC)	Time
Ø	TDS 157	mS/cm	°C		mg/L	mV		1921
	7.99	2.45	32.26	61.5	4.42	101		1922
≈6 gallons								

SAMPLING:

Date _____ Time _____

Sample Analysis	Volume	Container Type	Number of Containers	Preservative

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☐Non Phosphatic detergent wash/distilled water rinse ☐Hot pressure wash/steam cleaning ☐Methanol rinse

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

16.3
0.65
8 1 5
9.7 8

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I D: M-179

LOCATION/ADDRESS: Tronox LLC, Henderson, NV — Sample Designation: Not Sampled

PROJECT NO: 2027.02.235 — Date: 9-10-2010

CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 36.71 Date 9-10-2010 Time 15:59

53.0
36.71
16.3

WELL EVACUATION: Well Depth 53.0 feet Well Diameter 4 inches Casing Volume ~~26.5~~ DRB gallons 9.78

Depth to Top of Screen 33.7 feet
52.7

Total No of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

16.3
0.163
8.9
9.7 8
1.63
26.69

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump X Bailer ____ Other ____

Non-Dedicated Equipment Identification: Pump set @ 49' BTOC

FIELD WATER QUALITY TESTS:

C.V.	Casing Volume	TDS g/L	pH	Specific Conductance ~~(umhos/cm)~~ mS/cm	Temperature °C	DO Turbidity (NTU) %	Dissolved Oxgen ~~(DO)~~ mg/L	Oxidation-Reduction Potential (ORP) mV	DTW (ft below TOC)	Time
	Start Pump		-							16:02
	Flow arrives		8.10		35.39	92.3	6.78	60		16:05
	5 gal		8.30	2.15	33.04	88.6	7.46	82		16:07
1.0	10 gal	1.1	8.11	2.12	30.05	67.9	5.11	97		~~16:08~~ 16:09 ~~Rate slower~~
	15 gal	1.0	7.96	2.05	29.52	63.3	4.59	103		16:12:14
2.0	20	1.1	7.83	2.09	29.39	66.4	5.31	107	48.0	16:16:02 Pump Stopped
				— Pumped Dry —						

Flow Rate 5 gal/min

SAMPLING: Date _____ Time _____

Sample Analysis	Volume	Container Type	Number of Containers	Preservative

Not Sampled

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning ☐ Methanol rinse

See Decon Record

NOTES: Purge water disposed of in Veolia cage = Chrome processing intake sump

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-187
LOCATION/ADDRESS: Tronox LLC, Henderson, NV
Sample Designation: Not Sampled
PROJECT NO: 2027.02.235
Date: 9-8-2010
CLIENT/CONTACT: Tronox-Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation ~~37.040~~ 37.340 DRS 9-8-2010 Date 9-8-2010 Time _____

WELL EVACUATION: Well Depth 170.0 feet Well Diameter 2 inches Casing Volume _____ gallons
Depth to Top of Screen 159.7 feet

Total No. of Casing Volumes: _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump _____ Submersible Pump _____ Bailer _____ Other Bladder Pump
Non-Dedicated Equipment Identification: Disposable Tubing & airline. Pump Set @ 165'

FIELD WATER QUALITY TESTS:

14:31 = Pump On

Casing Volume	TDS g/L	pH	Specific Conductance ~~(umhos/cm)~~ mS/cm	°C Temperature	DO% ~~Turbidity (NTU)~~	mg/L Dissolved Oxgen (DO)	mV Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0.832		9.30		31.36	29.3	1.96	-129	35.320	14:37
0.827		9.26	1.29	32.77	14.5	1.05	-179	36.30	14:47
0.826		9.22	1.29	33.40	38.2	2.94	-191	36.45	14:53
0.824		9.22	1.29	33.84	35.9	2.74	-201	36.64	14:56
0.824		9.20	1.29	34.13	34.8	2.48	-203	36.85	15:00
0.821		9.18	1.28	34.45	30.0	2.12	-210	37.05	15:05
less than .7 gal 0.820		9.17	1.28	34.41	30.0	2.10	-209	37.23	15:10
0.818		9.16	1.28	34.94	41.6	3.03	-209	37.55	15:25
0.818		9.17	1.28	35.04	28.2	1.97	-211	37.66	15:29
								37.82	

100 ml/m ↓ 75 ml/min

DRS 14:56 ~~36.64~~ 9-8-2010

– CANNOT BE SAMPLED LOW FLOW –

SAMPLING: Date _____ Time _____

Sample Analysis	Volume	Container Type	Number of Containers	Preservative

SAMPLING METHOD: Stainless Steel Bailer _____ Teflon Bailer _____ Grab X Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning ☐ Methanol rinse See Decon Record

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-187
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: Not Sampled
PROJECT NO.: 2027.02.235
Date: 9-10-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 37.67 Date 9-10-2010 Time 11:34

WELL EVACUATION: Well Depth 170.0 feet Well Diameter 2 inches Casing Volume 21.2 gallons
Depth to Top of Screen 159.7 feet

Total No. of Casing Volumes: _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ✓ Bailer ____ Other _____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	TDS g/L	pH	Specific Conductance ~~(umhos/cm)~~ mS/cm	Temperature °C	DO % ~~Turbidity (NTU)~~	Dissolved Oxgen (DO) mg/L	Oxidation-Reduction Potential (ORP) mV	DTW (ft below TOC)	Time
0									Start Pump 11:47
	0.847	8.59	1.32	26.77	68.3	4.58	105		11:48
	0.60	9.14	1.25	26.78	8.3	~~14.1~~ 0.37	-104		11:50
≈ 22 gallons				Purged	Dry				11:53

SAMPLING: Date _____ Time _____

Sample Analysis	Volume	Container Type	Number of Containers	Preservative

Not Sampled

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Record

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I.D.: M-188
LOCATION/ADDRESS: Tronox LLC, Henderson, NV
Sample Designation: Not Collected
PROJECT NO.: 2027.02.238
Date: 9-8-2010
CLIENT/CONTACT: Tronox - Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 47.410 Date 9-8-2010 Time 11:29

WELL EVACUATION: Well Depth 120.0 feet Well Diameter 2 inches Casing Volume _____ gallons
Depth to Top of Screen 109.7 feet

Total No. of Casing Volumes: _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump _____ Submersible Pump _____ Bailer _____ Other _____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time	
0								11:47	Pump ON 200 ml/m
							47.900	11:50	Lowered rate 30 ml/m
							48.050	12:00	30 ml/m
							48.150	12:05	30 ml/m

Aborted - Well is too poor of a producer to sample low-flow

SAMPLING: Date _____ Time _____

Sample Analysis	Volume	Container Type	Number of Containers	Preservative

SAMPLING METHOD: Stainless Steel Bailer _____ Teflon Bailer _____ Grab _____ Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Record

NOTES:
Set bladder pump @ 115' bgs.
DI = Arrowhead DI

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I.D.: M-188

LOCATION/ADDRESS: Tronox LLC, Henderson, NV — Sample Designation: Not Sampled

PROJECT NO.: 2027.02.23S — Date: 9-10-2010

CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation: 47.42 Date: 9-10-2010 Time: 10:55

WELL EVACUATION: Well Depth 120.0 feet Well Diameter 2 inches Casing Volume 11.4 gallons

Depth to Top of Screen _____ feet

Total No. of Casing Volumes: _____ Total Gallons Removed: _____ Elapsed Time: _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump _____ Submersible Pump ✓ Bailer _____ Other _____

Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Flow Rate gal/min

Casing Volume	TDS g/L	pH	Specific Conductance ~~(umhos/cm)~~ mS/cm	Temperature °C	DO % ~~Turbidity (NTU)~~	Dissolved Oxgen (DO) mg/L	Oxidation-Reduction Potential (ORP) mv	DTW (ft. below TOC)	Time
Pump-On									11:08
	0.301	7.86	0.307	24.90	99.4	9.15	158		11:10
12		7.87	1.26	26.22	45.5	3.62	170		11:14
		8.09	1.31	26.58	65.8	5.05	152		11:21
			Pumped	Dry					11:22

SAMPLING: Date _____ Time _____

Sample Analysis	Volume	Container Type	Number of Containers	Preservative

70
.16
420
70
11.40

SAMPLING METHOD: Stainless Steel Bailer _____ Teflon Bailer _____ Grab _____ Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse (3-Stage Decon) ☐ Hot pressure wash/steam cleaning ☐ Methanol rinse

See Decon Record

NOTES:

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER LEVEL DATA FORM

Project Name	Perchlorate Well Study	Date	9-11-2010
Project Number	2027.02.235	Sample Crew	Dana Brown / Josh Kerns
Weather Conditions	Sunny & Calm		

Well Number	Measurement Dates	Time	Depth to Water 1	Depth to Water 2	Comments: Static on 9-10-10	Comments: Depth of 80% Recharge	~~Depth to LNAPL~~ TD	Depth to DNAPL	T.D.
M-187	9-11-2010	0650	40.25	40.25	37.34	63.87	170		
M-188	9-11-2010	0700	47.41	47.41	47.41	61.93	120		
M-163	9-11-2010	0710	30.21	30.21	24.14	37.31	90		
M-164	9-11-2010	0715	28.41	28.41	28.47	36.78	70		
M-161	9-11-2010	0705	25.41	25.41	22.70	40.16	110		
M-179	9-11-2010	0720	36.79	36.79	36.71	39.96	53		
M-178	9-11-2010	07:51	32.58	32.58	—	—	46		
M-163	9-11-2010	09:29	28.92	28.92					
M-164	9-11-2010	09:52	28.40	28.40					
M-171	9-11-2010	10:12	27.84	27.84					
M-140	9-11-2010	13:35	25.04	25.04					
M-179	9-11-2010	11:25	36.76	36.76					
M-161	9-11-2010	14:27	24.54	24.54					
M-187	9-11-2010	15:00	39.09	39.09					
M-188	9-11-2010	14:58	47.39	47.39					

COC Number_____

northgate
environmental management, inc.

1100 Quail Street, Suite 102, Newport Beach, CA 92660
(949) 260-9293

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

Page: of
Cooler # ____ of ____

Required Ship to Lab:

Lab Name:	
Address:	
Lab PM:	
Phone/Fax:	
Lab PM email	
Applicable Lab Quote #:	

Required Project Information:

Site ID #:			
Project #			
Site Address			
City		State	
Site PM Name			
Phone/Fax:			
Site PM Email:			

Required Invoice Information:

Send Invoice to:			
Address:			
City/State		Phone #:	
Reimbursement project?		Non-reimbursement project?	Mark one
Send EDD to			
CC Hardcopy report to			
CC Hardcopy report to			

TAT: Standard 21 day		Rush		Mark One
If Rush, Date due				
QC level Required: Standard		Special		Mark one
NJ Reduced Deliverable Package?				
MA MCP Cert?		CT RCP Cert?		Mark One
Lab Project ID (lab use)				

Valid Matrix Codes

MATRIX		MATRIX	
DRINKING WATER	WP	WATER	W
GROUND WATER	WG	SURFACE WATER	WS
WASTE WATER	WW	WATER QC	WQ
FREE PRODUCT	LF	SLUDGE	SL
SOIL	SO	RINSEATE	WH
OIL	OIL	OTHER	OT
WIPE	SW	ANIMAL TISSUE	TA
AMBIENT AIR	AA		
SVE AIR	AE		
SOIL GAS	GS		

ITEM #	SAMPLE ID One Character per box. (A-Z, 0-9 / ,-) Samples IDs MUST BE UNIQUE	MATRIX CODE	SAMPLE TYPE G=GRAB C=COMP	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	FIELD FILTERED? (Y/N)	Preservatives: Unpreserved	H2SO4	HNO3	HCl	NaOH	Na2S2O3	Methanol	Other	Requested Analyses	Comments/Lab Sample I.D.
1	M-176_2[illegible]	WG	G	9[illegible]	06[illegible]	3	Y	X		X							
2	EB-09112010	WG	G	9[illegible]	09:08	3	N	X		X							
3	M-163_201009[illegible]	WG	G	9[illegible]	09:33	3	Y	X		X							
4	M-164_20[illegible]	WG	G	9[illegible]	01:55	3	Y	X		X							
5	M-171_2[illegible]	WG	G	9[illegible]	12:49	3	Y	X		X							
6	M-171_2[illegible]_FD	WG	G	9[illegible]	12:49	3	Y	X		X							
7	M-179_201009_001	WG	G	9-11-2010	11:31	3	Y	X		X							
8	M-170_201009_001	WG	G	9-11-2010	14:06	3	Y	X		X							
9	M-161_201009_001	WG	G	9-11-2010	14:31	3	Y	X		X							
10	M-187_201009_001	WG	G	9-11-2010	15:03	3	Y	X		X							
11	M-168_201009_001	WG	G	9-11-2010	15:20	3	Y	X		X							
12																	

Additional Comments/Special Instructions:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME
Dan R Brown NGEM	9-11				

Sample Receipt Conditions

	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N
	Temp in 0C	Samples on Ice?	Sample intact?	Trip Blank?

SHIPPING METHOD: (mark as appropriate)
UPS COURIER FEDEX
US MAIL

SAMPLER NAME AND SIGNATURE
PRINT Name of SAMPLER: Dan R Brown
SIGNATURE of SAMPLER:
DATE Signed 9-11-10
Time: 09:30

DAILY SITE SAFETY MEETING RECORD

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
(949) 716-0050; fax (949) 716-0055

Recorded By: Dana R. Brown
Date & Time: 9-11-2010 / 07:10
Project No.: 2027.02.235
Project Name: Perchlorate Well Study
Project Location: Tronox LLC, Henderson, NV
Field Activities: Groundwater Sampling

Chemicals Present: Hexavalent Chrome, Perchlorate, Dioxins, Arsenic, Lead, Metals, Asbestos

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: Level D:

Hazards of Chemicals Present: Inhalation, Ingestion, Adsorption

Physical Hazards: Slips-Trips-Falls; Heavy Lifting;

Special Hazards: Truck Traffic

Other Topics of Concern: Drive slowly on dirt roads & avoid generating dust.

SITE SAFETY CHECKLIST	YES	NO
Attached Signature Page - See Below		X
Written Health and Safety Plan (HASP) is on-site	X	
Information in the HASP matches conditions and activities at the site	X	
Site personnel have appropriate training and certification and medical clearance	X	
Air monitoring equipment has been calibrated daily	X	
Site zones are set up and observed where appropriate	X	
Access to Work Areas is limited to authorized personnel	X	
Decontamination stations (including hand/face wash) are set up and used	X	
Personal protective equipment used matches HASP requirements	X	
Emergency and First Aid equipment is on-site as described in the HASP	X	
Drinking water is readily available	X	

Notes (All "NO" answers must be addressed and corrected immediately. Note additionally health and safety observations here):

9-11-2010 Josh Kerns
Dana R. Brown
Conducted By
Print Initials: DRB **Signature:** **Date:** 9-11-2010

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Wells
Well/Surface Station I D: M-187
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: M-187_201009-001
PROJECT NO: 2027.02.23S
Date: 9-11-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 39.09 Date 9-11-2010 Time 15:00

WELL EVACUATION: Well Depth 170.0 feet Well Diameter 2 inches Casing Volume _____ gallons
Depth to Top of Screen 159.7 feet
-169.7

Total No of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

WELL EVACUATION METHOD Peristaltic pump _____ Submersible Pump _____ Bailer _____ Other _____
Non-Dedicated Equipment Identification _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
N/A								

SAMPLING: Date 9-11-2010 Time 15:03

Begin Collection: 15:03
End Collection 15:16

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	
Total Bottles			3		

SAMPLING METHOD Stainless Steel Bailer _____ Teflon Bailer _____ Grab _____ Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD 3 Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash-steam cleaning
☐ Methanol rinse See Decon Log

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Wells
Well/Surface Station I D: M-161
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: M-161_201009-001
PROJECT NO: 2027.02.23S
Date: 9-11-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 24.54 Date 9-11-2010 Time 14:27

WELL EVACUATION: Well Depth 110.0 feet Well Diameter 2 inches Casing Volume _____ gallons
Depth to Top of Screen 99.7 feet
109.7

Total No of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other ____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
N/A								

SAMPLING: Date 9-11-2010 Time 14:31

Begin Collection: 14:31
End Collection 14:43

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	
Total Bottles			3		

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3 Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash steam cleaning
☐ Methanol rinse See Decon Log

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

17.96
x 0.20
3.5920

28.63' ~~35.5~~ = 80%

PROJECT NAME	Perchlorate Wells	Well/Surface Station I D	M-140
LOCATION/ADDRESS	Tronox LLC Henderson, Nevada	Sample Designation	
PROJECT NO	2027.02.235	Date	9-11-2010
CLIENT/CONTACT	Susan Crowley		

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 25.04 Date 9-11-2010 Time 13:35

43.66
- 25.04
17.96

WELL EVACUATION: Well Depth 43.0 feet Well Diameter 4 inches Casing Volume 11.67 gallons
Depth to Top of Screen 22.7 feet
42.7

Total No of Casing Volumes 3 Total Gallons Removed 36 Elapsed Time 13.0 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

17.960
0.653
53880
89800
15760
27.880

WELL EVACUATION METHOD Peristaltic pump ____ Submersible Pump X Bailer ____ Other ____
Non-Dedicated Equipment Identification Pump Set @ 41' bgs

FIELD WATER QUALITY TESTS:

Pump ON = 13:41. No water produced. Restart pump @ 13:47

~~Casing Volume~~ Gallons Purged	TDS g/L	pH	Specific Conductance ~~(umhos/cm)~~ mS/cm	Temperature °C	Turbidity ~~(NTU)~~	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
1	3.3	8.01	6.11	35.34	clear	4.27	81		13:47
5		7.90	7.74	31.25	Clear	1.09	89		13:49
10		7.89	7.74	~~6.455~~	Clear	0.68	95		13:50:30
15		7.67	6.05	30.19	Clear	1.30	96		13:51:53
20	3.4	7.70	6.21	27.73	Clear	1.46	97		13:53
25		7.76	6.23	27.70	Clear	1.67	100		13:54:30
30		7.78	6.24	27.61	Clear	1.60	100		13:55
35		7.78	6.23	27.66	Clear	1.54	99		13:57
36		End purge							13:57
								27.60	14:00

Rate gal/min
21
66
12.67

SAMPLING: Date 9-11-2010 Time 14:06

Begin Collection: 14:06
End Collection 14:17

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	
Total Bottles			3		

SAMPLING METHOD Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3 Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash steam cleaning
☐ Methanol rinse See Decon Log

NOTES
Purgewater disposed of into sump @ Veolia treatment system (high Cr++)
After purge, water level recovered to 80% = 28.63' or higher before sample

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME _____ Well/Surface Station I D M-179

LOCATION/ADDRESS _____ Sample Designation M-179_201009-001

PROJECT NO _____ Date 9-11-2010

CLIENT/CONTACT _____

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 36.76 Date 9-11-2010 Time 11:25

WELL EVACUATION:

Well Depth ____ feet Well Diameter ____ inches Casing Volume _____ gallons

Depth to Top of Screen ____ feet

Total No of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other ____

Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
N/A								

SAMPLING:

Date 9-11-2010 Time 11:31

Start Sampling: 11:31
Finish sampling 11:43

Sample Analysis	Volume	Container Type	Number of Containers	Preservative

SAMPLING METHOD Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD ☐Non Phosphatic detergent wash/distilled water rinse ☐Hot pressure wash/steam cleaning ☐Methanol rinse

NOTES

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

Field Duplicate
'FD'

PROJECT NAME: Perchlorate Wells
Well/Surface Station I D: M-171
M-171_201009-001_FD

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: M-171_201009-001 +

PROJECT NO: 2027.02.235
Date: 9-11-2010

CLIENT/CONTACT: Susan Crowley

45.00
- 27.84
17.16

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 27.84 Date 9-11-2010 Time 10:12

45.00
- 17.16
27.84

WELL EVACUATION:

Well Depth 45.0 feet Well Diameter 4 inches Casing Volume est 9.0 gallons
Depth to Top of Screen ____ feet

Total No of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

17.16
.80
20

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump X Bailer ____ Other ____
Non-Dedicated Equipment Identification: Pump set ⑤

FIELD WATER QUALITY TESTS:

10:26 = Begin Pumping

Casing Volume gallons	pH	Specific Conductance mS/cm (~~umhos/cm~~)	Temperature °C	Turbidity est (~~NTU~~)	Dissolved Oxygen (DO) mg/L	Oxidation-Reduction Potential (ORP) mV	DTW (ft below TOC)	Time	Flow Rate gal/min
3.0	7.81	7.19	28.11	moderate	1.48	107		10:27	
5.0	7.70	6.21	28.11	mod-	1.70	104		10:28	
10.0	7.66	5.56	27.77	slight	2.26	104		10:30	
15.0	7.60	5.38	27.49	slight	2.33	103		10:32	2.5
20.0	7.58	5.61	27.28	V.slight	1.61	104		10:34	2.5
25.0	7.58	5.68	27.20	V.slight	1.69	105		10:36	2.5
30.0	7.52	5.90	27.22	V.slight	1.71	106		10:38	
Dumpoff - Measure Recharge							30.60	~~10:38~~ 10:41	

slgreenish

SAMPLING:

Date 9-11-2010 Time 10:49

Begin Collection: 10:49
End Collection 11:20

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	0	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	0	
Total Bottles			3		

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3 Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Purge water disposed of to Veolia cage = high Cr content
80% recharge = 31.27

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Wells
Well/Surface Station I D: M-164
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: M-164_201009-001
PROJECT NO: 2027.02.23S
Date: 9-11-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 28.40 Date 9-11-2010 Time 09:52

WELL EVACUATION: Well Depth 70.0 feet Well Diameter 2 inches Casing Volume _____ gallons
Depth to Top of Screen 59.7 feet
69.7

Total No of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other ____
Non-Dedicated Equipment Identification: Well Purged dry on 9-10-10

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
N/A								

SAMPLING: Date 9-11-2010 Time 09:55

Begin Collection: 09:55
End Collection 10:08

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	
Total Bottles			3		

SAMPLING METHOD Stainless Steel Bailer ____ Disposable Teflon Bailer X Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3 Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Well purged dry on 9-10-10 using submersible pump
80% recharge level = 36.78

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Wells
Well/Surface Station I D: M-163
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: M-163_201009-001
PROJECT NO: 2027.02.23S
Date: 9-11-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): _____ Feet below reference elevation 28.92 Date 9-11-2010 Time 28.92

WELL EVACUATION: Well Depth 90.0 feet Well Diameter 2 inches Casing Volume _____ gallons
Depth to Top of Screen 79.7 feet
89.7

Total No of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other ____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
N/A								

SAMPLING: Date 9-11-2010 Time 09:33

Begin Collection: 09:33
End Collection 09:49

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	
Total Bottles			3		

SAMPLING METHOD: Stainless Steel Bailer ____ Disposable Teflon Bailer X Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3 Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Wells — Well/Surface Station I D: M-178

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: M-178_201009-001

PROJECT NO: 2027.02.235 — Date: 9-11-2010

CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 32.58 Date 9-11-2010 Time 07:51

WELL EVACUATION: Well Depth 46.0 feet Well Diameter 4 inches Casing Volume 8.7 gallons

Depth to Top of Screen 25.7 feet
- 45.7

Total No of Casing Volumes 3. Total Gallons Removed 26 Elapsed Time 0:13:00

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump X Bailer ____ Other ____

Non-Dedicated Equipment Identification: Grundfos Redi flow II Ser ⊙ 44' BTOC

FIELD WATER QUALITY TESTS:

08:00 = Pump On

Casing Volume	TDS ppt	pH	Specific Conductance (umhos/cm)	Temperature	est Turbidity ~~(NTU)~~	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
Cloudy ⊙		8.48	1.95	20.57	cloudy	7.19	123		08:01
4 gal	4.0	7.64	7.23	23.15	clearing	1.60	142		08:02
going 7.5 gallons	4.1	7.51	7.33	23.91	greenish	0.90	131		08:04
10 gal	4.4	7.47	~~7.47~~ 7.49	24.62	greenish	0.11	135		08:06
~~16~~ 20	4.5	7.43	8.11	25.50	greenish	1.39	134		08:09
22	4.7	7.42	8.09	25.70		1.44	132		08:10
24	4.9	7.42	8.07	25.79		1.39	130		08:11
26	5.0	7.43	8.06	25.81		1.37	129		08:12
Pump off		7.43	8.07	25.80		1.38	130		08:13
Recharge est.								36.91	08:17
								35.55	08:28
								33.21	08:31

OK to sample ✓

SAMPLING: Date 9-11-2010 Time 08:34

Begin Collection: 08:34
End Collection 09:02

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	⊙	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	⊙	
Total Bottles			3		

SAMPLING METHOD: Stainless Steel Bailer ____ Disposable Teflon Bailer X Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3 Stage Decon ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash steam cleaning ☐ Methanol rinse See Decon Log

NOTES: 80% recharge = 35.26' BTOC.

Note: 0.2 micron filters clogged up after 40 ml volume passed through. Needed 3 filters to collect 125 ml sample for perchlorate.

59.0
46.0
32.58
13.42

13.42
0.65
6710
8052
8230

13.42
.80
10.6560

OK!
35.26

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

Equipment Blank
'EB'
Disposable Bailer

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I D: M-178
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: EB 09112010
PROJECT NO: 2027.02.235
Date: 9-11-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL): N/A Feet below reference elevation _____ Date _____ Time _____

WELL EVACUATION: Well Depth ____ feet Well Diameter ____ inches Casing Volume _____ gallons
Depth to Top of Screen ____ feet

Total No. of Casing Volumes: N/A Total Gallons Removed _____ Elapsed Time _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ~~X~~ Disposable Other ____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
N/A								

SAMPLING: Date 9-11-2010 Time 09:08

Sample Analysis	Volume	Container Type	Number of Containers	Preservative
314.1	125	HDPE	1	Ø
6010B/6020	500	HDPE	1	HNO3
2540C	1L	HDPE	1	Ø

> Not Filtered

SAMPLING METHOD: Stainless Steel Bailer ____ Disposable Teflon Bailer X Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: N/A
☐ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse

NOTES: Laboratory grade water poured into disposable bailer then used to fill sample bottles. No filtration used.

northgate

environmental management, inc

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Wells
Well/Surface Station I D: M-188
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: M-188_201009-001
PROJECT NO: 2027.02.23S
Date: 9-11-2010
CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 47.39 Date 9-11-2010 Time 14:58

WELL EVACUATION: Well Depth 120.0 feet Well Diameter 2 inches Casing Volume _____ gallons
Depth to Top of Screen 109.7 feet
119.7

Total No of Casing Volumes _____ Total Gallons Removed _____ Elapsed Time _____

WELL EVACUATION METHOD Peristaltic pump _____ Submersible Pump _____ Bailer _____ Other _____
Non-Dedicated Equipment Identification _____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

FIELD WATER QUALITY TESTS:

Casing Volume	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
N/A								

SAMPLING: Date 9-11-2010 Time 15:20

Begin Collection: 15:20
End Collection 15:43

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	
Total Bottles			3		

SAMPLING METHOD Stainless Steel Bailer _____ Teflon Bailer Disposable X Grab _____ Other _____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3 Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES

Field Activity Report

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Page 1 of

Date: 9-13-2010
Recorded By: Dana R. Brown

Project Name: Tronox Perchlorate Well Study
Project No.: 2027.01.235
Client Name: Tronox LLC, Henderson, NV
Weather: Sunny & clear.
Temperature: 80° -
Site Conditions: Graded earth.

NORTHGATE PERSONNEL ON-SITE

Dana R. Brown
Kyle Hansen

VISITORS

Name	Company/Agency	Time Arrived	Time Left

CONTRACTORS

Contractor Name: Confluence Environmental
Phone No.: (916) 760-7641
Supervisor: Josh Kerns
Task: Groundwater Sampling Tech

Company	No. of Supervisors	No. of Workers	Remarks
Confluence	1 - Josh Kerns	0	Sampling Tech
	cellular 530.305.2493		

EQUIPMENT

Bladder Pump, Controller Box, Nitrogen Bottle, Disposable tubing & bladders + seals
Submersible pump, generator, controller box, motorized reel
Decon Kit & Purge water storage drums (2)
Water Sampling Kit
Disposable Bailers, bailer twine, 0.45 micron filters, 0.2 micron sterile filters + syringes
PPE Kit
Truck, Water level meter

Field Activity Report

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Page 2 of

Date: 9-13-2010
Recorded By: Dana R. Brown

Project Name: Tronox Perchlorate Well Study
Project No.: 2027.02.235
Client Name: Tronox LLC, Henderson, NV

ACTIVITIES

Time:	Activities (include event, time, observations, observers, etc.)
04:45	Mob up for water sampling
05:00	Drive to Tronox, check in w guard, mobilize to trailer.
	Meet Josh Kerns - Confluence, Discuss scope of work & schedule.
	Get supplies, sample bottles, ice, reports.
	Timesheet & emails regarding supplies, schedule, job progress.
	Mob to Athens Road area for round of water levels
	- See Water Level Data Form -
10:00	Mob to Holiday Inn to pick up packages = Tubing,
	Meet Josh @ site - get final supplies.
	Mob to Athens Road to get water samples.
	Arrive @ PC-150 & set up to collect water sample.
11:40	DTW = 30.51. set up to purge & sample Rediflow II = purge
	Disposable bailer = sample.
11:51	Begin purge of PC-150
	Collect sample PC-150_200109-001 3 bottles, filtered 0.45 + 0.2
	Mob to pond & dump purge water
	Pick up Kyle Hansen @ trailer, Mob to Athens Road area.
	Check in w City of Henderson Yard
	Mob to PC-145
13:43	DTW = 33.79. set up to hand bail (water is in screen, can't sample low flow)
13:56	Begin purge of PC-145 w disposable bailer
14:09	Begin sample collection PC-145_201009-001
	3 bottles collected.
1505	Begin sampling PC-134A_201009-001 & PC-134A_201009-001FD
	6 bottles collected.
1600	Back @ trailer to unload for day

Print Name: Dana R. Brown
Signature: [signature]

DAILY SITE SAFETY MEETING RECORD

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
(949) 716-0050; fax (949) 716-0055

Recorded By: Dana R. Brown

Date & Time: 9-13-2010 / 06:10 **Project No.:** 2027.02.235

Project Name: Perchlorate Well Study **Project Location:** Henderson, Nevada

Field Activities: Groundwater Sampling

Chemicals Present: Chrome 6+ (Hexavalent Chromium); Perchlorate; Dioxin; Arsenic + Metals; Asbestos

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: Level D:

Hazards of Chemicals Present: Inhalation, Ingestion, Adsorption

Physical Hazards: Slips-Trips-Falls; Heavy Lifting; Pinch Points; Metal edge cuts
Native Vegetation - boot sole puncture hazard

Special Hazards: Truck Traffic

Other Topics of Concern: Drive slowly so as not to generate dust = possible ACM'S

SITE SAFETY CHECKLIST	YES	NO
Attached Signature Page - See Below		X
Written Health and Safety Plan (HASP) is on-site	X	
Information in the HASP matches conditions and activities at the site	X	
Site personnel have appropriate training and certification and medical clearance	X	
Air monitoring equipment has been calibrated daily	X	
Site zones are set up and observed where appropriate	X	
Access to Work Areas is limited to authorized personnel	X	
Decontamination stations (including hand/face wash) are set up and used	X	
Personal protective equipment used matches HASP requirements	X	
Emergency and First Aid equipment is on-site as described in the HASP	X	
Drinking water is readily available	X	

Notes (All "NO" answers must be addressed and corrected immediately. Note additionally health and safety observations here):

Dana R. Brown — Josh Kruns — Kyle Hansen

Conducted By
Print Initials: DRB **Signature:** **Date:** 9-13-2010

DECONTAMINATION RECORD

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Date: _____ **Time:** _____ **Project No.:** 2027.02.23S
Project Name: _____ **Project Location:** Tronox LLC, Henderson, NV
Recorded by: _____ **Checked by:** _____

Equipment	Use	Deionized Water	Detergent Water	Steam/Hot Water	Potable Water	Deionized Water	Reagent Water	Methanol	Other - describe	Time/Location

KEY: GS - groundwater sampling; SS - soil sampling; WP - well purging

COMMENTS

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

EQUIPMENT CALIBRATION RECORD

Project Name:	Perchlorate Well Study	Date:	9-13-2010
Project Number:	2027.02.235	Name:	Dana R. Brown
Site Location:	Tronox LLC		

pH Meter

Serial No:	AM	Noon	PM	Exp. Date	Notes:
pH 4.00 Buffer:					
pH 7.00 Buffer:					
pH 10.00 Buffer:					
Temperature:					
Comments:					

Conductivity

Serial No:	AM	Noon	PM	Exp. Date	Notes:
Solution:					
Solution:					
Solution:					
Temperature:					
Comments:					

PID/OVM

Serial No:	AM	Noon	PM	Exp. Date	Notes:
100 ppm Iso:					
10 ppm Iso:					
Zero Filter:					
Background Levels:					
Comments:					

Turbidity

Serial No:	AM	Noon	PM	Exp. Date	Notes:
100 ntu:					
10 ntu:					
1 ntu:					
DI Water:					
Comments:					

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER LEVEL DATA FORM

Project Name	Tronox Perchlorate Well Study	**Date**	9-13-2010
Project Number	2027.02.23S	**Sample Crew**	Dana R Brown / Josh Kerns
Weather Conditions	Clear, Hot & Sunny.		

Round of H_2O Levels "Snapshot"

Well Number	Measurement Dates	Time	Depth to Water 1	Depth to Water 2	Comments	Depth to LNAPL	Depth to DNAPL	T.D.
PC-141	9-13-2010	0805	28.25	28.25	2" Round of Water Levels			
PC-142	9-13-2010	0810	28.22	28.22	2"			
PC-150	9-13-2010	0820	30.51	30.51	6" Inside Violica			
PC-143	9-13-2010	0835	30.47	30.47	2"			
PC-146	9-13-2010	0845	30.05	30.05	2" -Dry-			
PC-147	9-13-2010	0840	31.35	31.35	2" -Dry-			
PC-149	9-13-2010	0855	30.01	30.01	6"			
PC-148	9-13-2010	0900	28.19	28.19	6"			
PC-145	9-13-2010	0920	33.80	33.80	2" Inside USSB Gate 2			
PC-134A	9-13-2010	0930	29.79	29.79	2" Inside USSB Gate 3			
PC-135A	9-13-2010	0935	30.05	30.05	2" "			
PC-144	9-13-2010	0942	31.03	31.03	2" "			
PC-150	9-13-2010	11:40	30.51	30.51	Prior to Sampling			
PC-145	9-13-2010	13:43	33.79	33.79				
PC-134A	9-13-2010	14:39	29.89	29.89				

COC Number_____

northgate
environmental management, inc
1100 Quail Street, Suite 102, Newport Beach, CA 92660
(949) 260-9293

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

Page: of
Cooler # ____ of ____

Required Ship to Lab:

Lab Name:	
Address:	
Lab PM:	
Phone/Fax:	
Lab PM email	
Applicable Lab Quote #:	

Required Project Information:

Site ID #:			
Project #			
Site Address			
City		State	
Site PM Name			
Phone/Fax:			
Site PM Email:			

Required Invoice Information:

Send Invoice to:			
Address:			
City/State		Phone #:	
Reimbursement project?		Non-reimbursement project?	Mark one
Send EDD to			
CC Hardcopy report to			
CC Hardcopy report to			

TAT: Standard 21 day		Rush		Mark One
If Rush, Date due				
QC level Required: Standard		Special		Mark one
NJ Reduced Deliverable Package?				
MA MCP Cert?		CT RCP Cert?		Mark One
Lab Project ID (lab use)				

Valid Matrix Codes

MATRIX		MATRIX	
DRINKING WATER	WP	WATER	W
GROUND WATER	WG	SURFACE WATER	WS
WASTE WATER	WW	WATER QC	WQ
FREE PRODUCT	LF	SLUDGE	SL
SOIL	SO	RINSEATE	WH
OIL	OIL	OTHER	OT
WIPE	SW	ANIMAL TISSUE	TA
AMBIENT AIR	AA		
SVE AIR	AE		
SOIL GAS	GS		

ITEM #	SAMPLE ID One Character per box. (A-Z, 0-9 / ,-) Samples IDs MUST BE UNIQUE	MATRIX CODE	SAMPLE TYPE G=GRAB C=COMP	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	FIELD FILTERED? (Y/N)	Preservatives: Unpreserved	H2SO4	HNO3	HCl	NaOH	Na2S2O3	Methanol	Other	Requested Analyses	Comments/Lab Sample I.D.
1	PC-150_201009-001	WG	G	9-13-2010	12:33	3	Y	X		X							
2	PC-145_201009-001	WG	G	9-13-2010	14:09	3	Y	X		X							
3	PC-134A_201009-001	WG	G	9-13-2010	[illegible]	3	Y	X		X							
4	PC-134A_201009-00[illegible]_FD	WG	G	9-13-2010	[illegible]	3	Y	X		X							
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	

Additional Comments/Special Instructions:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME
Dana R. Brown, NGEM	9/13				

Sample Receipt Conditions

	Temp in 0C	Samples on Ice?	Sample intact?	Trip Blank?
		Y / N	Y / N	Y / N
		Y / N	Y / N	Y / N
		Y / N	Y / N	Y / N
		Y / N	Y / N	Y / N

SHIPPING METHOD: (mark as appropriate) UPS COURIER FEDEX US MAIL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: Dana R. Brown

SIGNATURE of SAMPLER: [signature]

DATE Signed 1-13-10 Time:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I D: PC-145

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: PC-145_200109-001

PROJECT NO: 2027.02.235 — Date: 9-13-2010

CLIENT/CONTACT: Susan Crowley — By: Dana R. Brown

WATER LEVEL MEASUREMENTS:

Water Level (MSL) ____ Feet below reference elevation 33.79 Date 9-13-2010 Time 13:43

WELL EVACUATION: Well Depth 49.0 feet Well Diameter 2 inches Casing Volume 0.99 gallons

Depth to Top of Screen 24.7 feet
-39.7

Total No. of Casing Volumes 3 Total Gallons Removed 3.0 Elapsed Time 8 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer X (Disposable) Other ____

Non-Dedicated Equipment Identification ____

FIELD WATER QUALITY TESTS: Pump ON:

Casing Volume	TDS g/L	pH	Specific Conductance ~~(umhos/cm)~~ mS/cm	Temperature °C	Turbidity ~~(NTU)~~ est.	Dissolved Oxygen ~~(DO)~~ mg/L	Oxidation-Reduction Potential (ORP) mV	DTW (ft below TOC)	Time
0		Start Bailing		27.62					13:56
1.0	8.01	7.67	12.9	~~22.46~~	moderate	3.26	112		13:58
2.0	7.26	7.55	11.7	26.92	mod	2.93	118		14:01
DRY ~~3.0~~ 2.5	7.64	7.50	12.3	26.82	mod	2.70	121		14:03
3.0	7.67	7.50	12.4	26.82	mod	2.65	123		14:04

Flow Rate 9/min

SAMPLING: Date 9-13-2010 Time 14:09

Start Collection: 14:09
End Collection:

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	0	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	0	

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer (Disposable) X Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.
Water level Bisects screen - cannot sample low flow. Not enough water to pump
= Hard Bail to purge

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I D: PC-150

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: PC-150_201009-001

PROJECT NO: 2027.02.235 — Date: 9-13-2010

CLIENT/CONTACT: Susan Crowley — By: Dana R. Brown

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 30.51 Date 9-13-2010 Time 11:40

WELL EVACUATION: Well Depth 50.0 feet — Well Diameter 6 inches — Casing Volume 28.63 gallons

Depth to Top of Screen 19.5 feet
- 34.5

Total No of Casing Volumes 3.0 — Total Gallons Removed 92 — Elapsed Time 37 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump X Bailer ____ Other ____

Non-Dedicated Equipment Identification: Pump Set @ 48.5' BGS

FIELD WATER QUALITY TESTS:

Pump ON: 11:51

Casing Volume	TDS g/L	pH	Specific Conductance ~~(umhos/cm)~~	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time	Flow Rate gpm
0	5/L	7.68	8.10	30.05	clear	5.08	171		11:52	5
15	4.5	7.66	7.74	28.26	clear	3.92	163		11:54	5
30	4.3	7.66	7.74	27.28	turned cloudy	3.44	157		11:57	5
40	— Dewatered — Pump off								11:58	
12:04 restart pumpdown → 45	4.4	7.76	7.90	27.98	mod clear	3.24	~~3.24~~ 119		12:06	
60	4.4	7.66	7.89	27.80	V.Slight	2.85	125		12:11	
75	4.4	7.71	7.89	26.88	V Slight	2.84	117		12:17	
90	4.4	7.69	7.89	26.87	V Slight	2.85	119		12:22	
92		Pump off							12:23	
								32.30	12:28	

80% recharge = 34.41'

SAMPLING: Date 9-13-2010 Time 12:33

Start Collection: 12:33

End Collection:

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer ____ Disposable Teflon Bailer X Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon

☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning

☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.
80% recharge = 34.41'

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

Field Dup
"FD"

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I D: PC-134A
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: PC-134A_200109-001 + PC-134A_201009-001_FD
PROJECT NO: 2027.02.23S
Date: 9-13-2010
CLIENT/CONTACT: Susan Crowley
By: Dana R. Brown

WATER LEVEL MEASUREMENTS:

Water Level (MSL) X ___ Feet below reference elevation 29.89 Date 9-13-2010 Time 14:39

WELL EVACUATION: Well Depth 70 feet Well Diameter 2 inches Casing Volume 1.7 gallons
Depth to Top of Screen 59.7 feet

Total No of Casing Volumes 3 Total Gallons Removed 6 gallons Elapsed Time 12 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ___ Submersible Pump Redi Flow II X Bailer ___ Other ___
Non-Dedicated Equipment Identification

FIELD WATER QUALITY TESTS: Pump ON:

Casing Volume	TDS	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0	2.12	7.96	406	33.5	mud	7.0	93		1446
2.5 gal	2.54	7.78	3.91	35.35	mud	2.47	93		1450
4.0	1.81	7.82	2.81	34.27	clear	3.74	94		1454
5.0	1.84	7.82	2.47	33.80	clear	2.84	95		1456
6.0	1.74	7.8	2.71	33.18	clear	3.99	93		1458
								29.79	15:04
								Recovered over 80%	

SAMPLING: Date 9-13-2010 Time 15:05

Start Collection: 15:05
End Collection: 15:28

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

6 Bottles Collected

"Double" Sample for F.D.

SAMPLING METHOD: Stainless Steel Bailer ___ Teflon Bailer Disposable X Grab ___ Other ___

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.

Field Activity Report

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Page 1 of

Date: 9-14-2010

Recorded By: Dana R Brown / Kyle Hansen

Project Name: Perchlorate Well Study **Project No.:** 2027.02.23S

Client Name: Tronox LLC

Weather: **Temperature:**

Site Conditions:

NORTHGATE PERSONNEL ON-SITE

Dana R. Brown

Kyle Hansen

VISITORS

Name	Company/Agency	Time Arrived	Time Left

CONTRACTORS

Contractor Name: Confluence Environmental **Phone No.:**

Supervisor: Josh Kerns **Task:** Groundwater Sampling Tech

Company	No. of Supervisors	No. of Workers	Remarks
Confluence	1- Josh Kerns	0	Sampling Tech

EQUIPMENT

VOW

Water Level Probe

Bladder Pump

Submersible Pump

Decon

Sampling Kit and Supplies

Field Activity Report

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Page 1 of

Date: 9-14-2010
Recorded By: Kyle Hansen

Project Name: Perchlorate Well Study
Project No.: 2027.02.235
Client Name: Tronox

ACTIVITIES

Time:	Activities (include event, time, observations, observers, etc.)
0455	Arrived on site Josh, Kyle, Dana assembling paperwork ice - calibrating equipment, fuel truck for Josh
0650	Arrived @ PC-148 . pumped w/ Redi-Flo-2 Dewatered well @ 36 gallons
0741	Arrived @ PC-135A - Bailed & sampled @ 0810 Decon equipment
0820	Arrived @ PC-144 - Bailed & sampled @ 0845 - Collected 3 bottles, decon.
0930	Arrived @ PC-149 - Pumped well went dry after 10 min. (35 gal) - 80% recharge @ 34' - decon equipment
1035	Arrived @ PC-143 - Pumped 17 gallons (3 volumes) sampled well @ 1105
1120	Arrived @ PC-142 - Bailed 2.5 gallons sampled @ 1135
1153	Arrived @ PC-141 - Pumped @ 1210 - dewatered after 14.5 gallons (3 volumes)
1231	KGH Back to trailer for paperwork. Josh to lunch & dump water
1425	Back Sampling @ PC-141 Recharged to 28.57
1439	Back to PC-149 - 1445 Start sample 30.02 Rdy
1500	Back to PC-148 1505 Start Sample
1519	Head back to trailer & dump water & trash
1536	Back @ trailer

KGH

Print Name: Kyle S. Hansen
Signature: Kyle S. Hansen

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

EQUIPMENT CALIBRATION RECORD

Project Name:	Perchlorate Well Study	Date:	9-14-2010
Project Number:	2027.02.23S	Name:	Dana R Brown
Site Location:	Tronox LLC, Henderson, Nevada		

pH Meter

Serial No:	AM 06:00	Noon	PM	Exp. Date	Notes:
pH 4.00 Buffer:					
pH 7.00 Buffer:	7.25			May 2012	Lot # 2005446
pH 10.00 Buffer:	10.02			Jun 2011	2912603
Temperature: 7.0 =	30.14				
Comments: 10.0 = ~~29.81~~ 30.10					

Conductivity

Serial No:	AM06:13	Noon	PM	Exp. Date	Notes:
Solution: ~~1413 µS~~	~~1600~~ 1413				
Solution: 1548µS	1540				
Solution:					
Temperature:	30.19				
Comments:					

PID/OVM

Serial No:	AM	Noon	PM	Exp. Date	Notes:
100 ppm Iso:					
10 ppm Iso:					
Zero Filter:					
Background Levels:					
Comments:					

Turbidity

Serial No:	AM	Noon	PM	Exp. Date	Notes:
100 ntu:					
10 ntu:					
1 ntu:					
DI Water:					
Comments:					

COC Number_____

northgate
environmental management, inc.

1100 Quail Street, Suite 102, Newport Beach, CA 92660
(949) 260-9293

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

Page: of
Cooler # ____ of ____

Required Ship to Lab:

Lab Name:	
Address:	
Lab PM:	
Phone/Fax:	
Lab PM email	
Applicable Lab Quote #:	

Required Project Information:

Site ID #:			
Project #			
Site Address			
City		State	
Site PM Name			
Phone/Fax:			
Site PM Email:			

Required Invoice Information:

Send Invoice to:			
Address:			
City/State		Phone #:	
Reimbursement project?		Non-reimbursement project?	Mark one
Send EDD to			
CC Hardcopy report to			
CC Hardcopy report to			

TAT: Standard 21 day		Rush		Mark One
If Rush, Date due				
QC level Required: Standard		Special		Mark one
NJ Reduced Deliverable Package?				
MA MCP Cert?		CT RCP Cert?		Mark One
Lab Project ID (lab use)				

Valid Matrix Codes

MATRIX		MATRIX	
DRINKING WATER	WP	WATER	W
GROUND WATER	WG	SURFACE WATER	WS
WASTE WATER	WW	WATER QC	WQ
FREE PRODUCT	LF	SLUDGE	SL
SOIL	SO	RINSEATE	WH
OIL	OIL	OTHER	OT
WIPE	SW	ANIMAL TISSUE	TA
AMBIENT AIR	AA		
SVE AIR	AE		
SOIL GAS	GS		

ITEM #	SAMPLE ID One Character per box. (A-Z, 0-9 / ,-) Samples IDs MUST BE UNIQUE	MATRIX CODE	SAMPLE TYPE G=GRAB C=COMP	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	FIELD FILTERED? (Y/N)	Preservatives: Unpreserved	H2SO4	HNO3	HCl	NaOH	Na2S2O3	Methanol	Other	Requested Analyses	Comments/Lab Sample I.D.
1	PC-135A_201009-001	WG	G	9-14-2010	08:10	3	Y	X		X							
2	PC-144_201009-001	WG	G	9-14-2010	08:45	3	Y	X		X							
3	PC-143_201009-001	WG	G	9-14 2010	1105	3	Y	X		X							
4	PC-142_201009-001	WG	G	9-14-2010	1135	3	Y	X		X							
5	PC-141_201009-001	WG	G	9-14 2010	1425	3	Y	X		X							
6	PC-149_201009-001	WG	G	9-14-2010	1445	3	Y	X		X							
7	PC-148_201009-001	WG	G	9-14-2010	1505	3	Y	X		X							
8																	
9																	
10																	
11																	
12																	

Additional Comments/Special Instructions:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME
Dana R. Brown, NGEM	9/14				

Sample Receipt Conditions

	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
Temp in 0C	Samples on Ice?	Sample intact?	Trip Blank?

SHIPPING METHOD: (mark as appropriate) UPS COURIER FEDEX US MAIL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: Dana R. Brown

SIGNATURE of SAMPLER: [signature]

DATE Signed 9-14-10 Time:

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

Purged Dry

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I D: PC-148

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: PC-148-201009-001

PROJECT NO: 2027.02.235 — Date: 9-14-2010

CLIENT/CONTACT: Susan Crowley — By: Dana R. Brown / KSH

WATER LEVEL MEASUREMENTS:

Water Level (MSL) ____ Feet below reference elevation 28.18 Date 9-14-2010 Time 0458

WELL EVACUATION: Well Depth 50 feet Well Diameter 6 inches Casing Volume 32 gallons

Depth to Top of Screen ____ feet

Total No of Casing Volumes 3 Total Gallons Removed 36 Elapsed Time 12 min

Reduced Flow 2

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump X Bailer ____ Other ____

Non-Dedicated Equipment Identification ____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

FIELD WATER QUALITY TESTS: Pump ON: 0704

Casing Volume	TDS	pH	Specific Conductance (mS/cm)	Temperature °C	Turbidity (NTU)	Dissolved Oxgen (DO) mg/L	Oxidation-Reduction Potential (ORP) mV	DTW (ft below TOC)	Time
0	1.72	7.48	2.73	24.52	clear	1.46	116.4		0706
16 gal	1.41	7.72	2.66	26.48	clear	1.60	160		0709
32	2.39	7.66	2.63	25.91	clear	1.23	146		0715
Stopped purge			dewatered well @			approx.	40 gal		0718
								36.59	0903
								28.71	

80% 32.4'

SAMPLING: Date 9.14.2010 Time 1505

Start Collection: 1505
End Collection: 1513

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

3 bottles collected

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer X (Disposable) Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning ☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

Purged Dry

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I D: PC-149
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: PC-149-201009-001
PROJECT NO: 2027.02.235
Date: 9.14.2010
CLIENT/CONTACT: Susan Crowley
By: Dana R. Brown / KSH

WATER LEVEL MEASUREMENTS:

Water Level (MSL) ____ Feet below reference elevation 30.01 Date 9.14.2010 Time 0953

WELL EVACUATION: Well Depth 50 feet Well Diameter 6 inches Casing Volume 30 gallons
Depth to Top of Screen 24.5 feet
44.5

Total No of Casing Volumes 3 Total Gallons Removed 35 Elapsed Time 10 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump X (Redi-flow II) Bailer ____ Other ____
Non-Dedicated Equipment Identification ____

FIELD WATER QUALITY TESTS:
Pump ON: 0957

Casing Volume	TDS	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0		7.7	6.44	29.95	clear	3.52	147	30.01	0958
15	3.2	7.71	5.08	28.99	cloudy	7.6	162		1002
30	3.19	7.65	4.96	26.99	"	0.35	212		1006
35 gal	dewatered well								1009
								43.45	1012
								30.02	1440

80% = 34'

SAMPLING: Date 9.14.2010 Time 1445

Start Collection: 1445
End Collection: 1459

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

3 bottles collected

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:
3-Stage Decon
DECONTAMINATION METHOD: ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

Purged Dry

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I.D.: PC-141

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: PC-141_201009-001

PROJECT NO: 2027.02.235 — Date: 9.14.2010

CLIENT/CONTACT: Susan Crowley — By: Dana R. Brown / KSH

WATER LEVEL MEASUREMENTS:

Water Level (MSL) ____ Feet below reference elevation 28.25 Date 9.14.2010 Time 11:55

WELL EVACUATION: Well Depth 55 feet; Depth to Top of Screen 44.7 feet (54.7); Well Diameter 2 inches; Casing Volume 4.5 gallons

Total No. of Casing Volumes 3; Total Gallons Removed 14.5; Elapsed Time 9 min

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump X (Redi-flow II) Bailer ____ Other ____

Non-Dedicated Equipment Identification ____

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

FIELD WATER QUALITY TESTS: Pump ON: 1210

Casing Volume	TDS	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxygen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0	8.49	8.12	13.6	30.31	cloudy	6.76	249		1211
2.5	4.31	7.91	6.8	29.72	"	7.55	220		1212
5	3.99	7.79	6.34	29.5	"	0.49	156		1214
7.5	4.06	7.68	6.46	28.79	"	0.13	101		1215
10	4.02	7.65	6.39	28.30	"	7.90	76		1217
12.5	4.10	7.65	6.45	28.05		3.03	72		1219
			Dewatered @		14.5 gal			42.93'	1220
			Break for lunch @		1231				
								29.57	1420

SAMPLING: Date 9.14.2010 Time 1425

Start Collection: 1425
End Collection: 1434

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	
	3 bottles taken				

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer (Disposable) X Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning ☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I D: PC-135A

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: PC-135A_201009_001

PROJECT NO: 2027.02.235 — Date: 9-14-2010

CLIENT/CONTACT: Susan Crowley — By: Dana R. Brown

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 30.02 Date 9-14-2010 Time 0741

WELL EVACUATION: Well Depth 51 feet Well Diameter 2 inches Casing Volume 3.4 gallons
Depth to Top of Screen 30.7 feet

Total No of Casing Volumes 3 Total Gallons Removed 10.5 Elapsed Time 17 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer X (Disposable) Other ____

Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS: Pump ON: ~~0759~~ 0744

Casing Volume	TDS	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0	8.94	7.43	14.4	26.06	cloudy	-	125		0745
2 gal	9.08	7.48	14.6	25.67	cloudy	0.81	188		0749
4 gal	9.05	7.50	14.6	25.87	"	0.14	184		0752
6 gal	9.05	7.54	14.6	25.89	slightly c.	0.19	225		0756
8 gal	9.03	7.53	14.6	25.81	"	0.10	269		0800
10.5 gal	9.05	7.50	14.6	25.90	"	0.16	264		0803

w/ 30.02

SAMPLING: Date 9-14-2010 Time 0810

Start Collection: 0810
End Collection: 0817

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	0	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	0	

3 bottles collected

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer X (disposable) Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I.D.: PC-144

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: PC-144_201009-001

PROJECT NO: 2027.02.23S — Date: 9-14-2010

CLIENT/CONTACT: Susan Crowley — By: Dana R. Brown / KGH

WATER LEVEL MEASUREMENTS:

Water Level (MSL) ____ Feet below reference elevation 31.02 Date 9-14-2010 Time 08:25

WELL EVACUATION: Well Depth 40.0 feet (39.7) Depth to Top of Screen 29.7 feet — Well Diameter 2 inches — Casing Volume 1.5 gallons

Total No. of Casing Volumes 3 — Total Gallons Removed 4.5 — Elapsed Time 17 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer X (Disposable) Other ____

Non-Dedicated Equipment Identification ____

FIELD WATER QUALITY TESTS:

Casing Volume	TDS	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
~~Pump On~~ Begin Bailing	5.46	7.72	8.67	25.96	clear	2.69	208		08:28
0.75 gal	5.32	7.62	8.43	25.87	cloudy	5.92	210		8:31
1.5	5.25	7.55	8.35	25.99	"	7.47	188		8:34
2.25	5.29	7.53	8.39	25.81	"	8.09	178		8:36
3.0	4.99	7.58	7.70	25.76	"	8.01	177		8:39
3.75	5.30	7.58	8.4	25.67	"	7.2	184		8:41
4.5	5.27	7.56	8.4	25.65		7.82	175		8:45
								31.04	08:47

Recovered over 80%

SAMPLING: Date 9-14-2010 Time 0845

Start Collection: 0845
End Collection: 0857

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

~~3 bottles collected~~

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer X (Disposable) Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon — ☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash steam cleaning ☐ Methanol rinse — See Decon Log

NOTES: Purge water disposed into Veolia pond.

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I D: PC-143
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: PC-143 201009-001
PROJECT NO: 2027.02.235
Date: 9.14.2010
CLIENT/CONTACT: Susan Crowley
By: Dana R. Brown / KGH

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 30.45 Date 9-14-2010 Time 1040

WELL EVACUATION:

Well Depth 65 feet (64.7) Well Diameter 2 inches Casing Volume 5.5 gallons
Depth to Top of Screen 29.7 feet

Total No of Casing Volumes 3 Total Gallons Removed 17 Elapsed Time 10 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump X (Rediflow II) Bailer ____ Other ____
Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Pump ON: 1047

Casing Volume	TDS	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0	3.17	8.19	5.06	31.20	clear	5.19	222		1050
2.5	7.85	7.61	12.7	29.86	cloudy	2.95	213		1052
5	7.95	7.60	12.8	29.21	clear	1.95	201		1054
7.5	7.94	7.62	12.8	28.72	clear	0.70	197		1055
10	8.01	7.51	12.9	28.34	clear	0.17	178		1057
12.5	7.97	7.54	12.9	28.15	clear	2.30	174		1058
15	7.96	7.52	12.9	28.11	clear	2.53	161		1100
								30.46	1103

SAMPLING:

Date 9-14-2010 Time 1105

Start Collection: 1105
End Collection: 1117

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer Disposable X Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study
Well/Surface Station I D: PC-142
LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada
Sample Designation: PC-142 201009-001
PROJECT NO: 2027.02.235
Date: 9-14-2010
CLIENT/CONTACT: Susan Crowley
By: Dana R. Brown / KSH

WATER LEVEL MEASUREMENTS:

Water Level (MSL) ____ Feet below reference elevation 28.21 Date 9-14-2010 Time 1122

WELL EVACUATION:

Well Depth 32 feet Well Diameter 2 inches Casing Volume .75 gallons
Depth to Top of Screen ____ feet

Total No. of Casing Volumes 2.25 Total Gallons Removed 2.5 Elapsed Time 8 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer X (Disposable) Other ____
Non-Dedicated Equipment Identification ____

FIELD WATER QUALITY TESTS:

Pump ON: 1125

Casing Volume	TDG	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0	6.27	7.81	9.95	28.55	clear	1.39	203		1125
.75	6.09	7.75	9.71	26.34	clear	0.63	182		1129
1.5	6.07	7.69	9.66	26.15	clear	7.86	157		1132
2.25	6.10	7.69	9.76	26.10	"	7.97	149	28.21	1133

SAMPLING:

Date 9/14/2010 Time 1135

Start Collection: 1135
End Collection: 1143

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer (Disposable) X Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.

Field Activity Report

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Page 1 of

Date: 9-15-2010

Recorded By: Dana R. Brown

Project Name: Perchlorate Well Study **Project No.:** 2027.02.235
Client Name: Tronox LLC
Weather: **Temperature:**
Site Conditions:

NORTHGATE PERSONNEL ON-SITE

Dana R. Brown
Kyle Hansen

VISITORS

Name	Company/Agency	Time Arrived	Time Left

CONTRACTORS

Contractor Name: Confluence Environmental **Phone No.:** (916) 760-7641
Supervisor: Josh Kerns **Task:** Water Sampling Technician

Company	No. of Supervisors	No. of Workers	Remarks
Confluence	1-Josh Kerns	0	Water Sampling Tech

EQUIPMENT

Van
Water Level Meter, Horriba U-55 water quality meter, calibration kit
Bladder Pump, Nitrogen, controller, disposable tubing
Grundfos submersible pump, controller, motorized reel, generator
PPE kit
Decon kit + DI Water + Reagent Grade Water
Water sampling kit + Disposable Bailers + Bailer twine

Field Activity Report

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

Date: 9-15-2010
Recorded By: Dana R Brown

Project Name: Perchlorate Well Study
Project No.: 2027.02.23S
Client Name: Tronox LLC

ACTIVITIES

Time:	Activities (include event, time, observations, observers, etc.)
04:45	Mob up for water sampling
	Kyle picks me up & we drive to site, check in + guard, mob to trailer.
	Meet Josh Kerns - Confluence, discuss Scope of Work & schedule.
	Prep for water sampling: Bag ice, get sample bottles, get decon water,
	Prep forms & paperwork. Check email.
0628	Mob to 148A. Bail total volume of 1.4 gallons
	not sufficient water recharge MOB to M165, decon
0651	Low flow well for 2 hours. Stabilizes at 38' (from zz)
	150 ml/min
0815	Sampling M-165 low flow, decon
0840	Sampling Done taking Equipment Blank
0850	Taking Equipment Blank on Bladder Pump.
0904	Finished equipment blank
0910	MOB to I-AC
1001	Sampling I-AC Low Flow
1044	Mob to I-AD
1120	Sampling I-AD low flow purged 2gal.
	decon
11:59	MOB to M-180 - hand bail 4.5 gallons
1215	Sampling M-180 - "
1221	end sampling
	Mob to Boulder City - Drop off Pump @ Blder City Hose. Supplies Also
16:40	Mob to Tronox, check in + guard. Mob to Trailer.

Print Name: Dana R. Brown **Signature:** [signature]

DAILY SITE SAFETY MEETING RECORD

northgate
environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
(949) 716-0050; fax (949) 716-0055

Recorded By: Kyle Hansen

Date & Time: 9.15.2010 / 0540 **Project No.:** 2027.02.235

Project Name: Perchlorate Well Analysis **Project Location:** Tronox LLC, Henderson, Nevada

Field Activities: Groundwater Sampling

Chemicals Present: Hexavalent Chrome, Perchlorate, Arsenic, Lead, Metals, Dioxin, Asbestos, SVOC's, VOC's, OCPs

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: Level D

Hazards of Chemicals Present: Inhalation, Injestion, Adsorption

Physical Hazards: Slips, Trip, Fall, Heat, Dehydration, Pinch points, lifting

Special Hazards: Heat stroke, Truck traffic

Other Topics of Concern: Drive Slowly on dirt roads

SITE SAFETY CHECKLIST	YES	NO
Attached Signature Page		X
Written Health and Safety Plan (HASP) is on-site	X	
Information in the HASP matches conditions and activities at the site	X	
Site personnel have appropriate training and certification and medical clearance	X	
Air monitoring equipment has been calibrated daily	X	
Site zones are set up and observed where appropriate	X	
Access to Work Areas is limited to authorized personnel	X	
Decontamination stations (including hand/face wash) are set up and used	X	
Personal protective equipment used matches HASP requirements	X	
Emergency and First Aid equipment is on-site as described in the HASP	X	
Drinking water is readily available	Y	

Notes (All "NO" answers must be addressed and corrected immediately. Note additionally health and safety observations here):

Josh Kemp

Conducted By Print Initials: KSH **Signature:** Kyle Hansen **Date:** 9.15.2010

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I D: M-148A

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: _____

PROJECT NO: 2027.02.235 — Date: 9-15-2010

CLIENT/CONTACT: Susan Crowley — By: Dana R. Brown

50
- 46.11
3.89

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 46.11 Date 9.15.2010 Time 0631

3.89
x 0.163
0.634

WELL EVACUATION:

Well Depth 50.0 feet — Well Diameter 2 inches — Casing Volume 0.63 gallons

Depth to Top of Screen 39.7 feet
49.7

Total No. of Casing Volumes 3 — Total Gallons Removed 1.8 — Elapsed Time 8 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer X (Disposable) Other ____

Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Pump ON: 633

Casing Volume	TDS	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0	3.90	7.25	6.18	24.85	clear	1.45	159		0633
0.6	3.97	7.37	6.13	25.06	cloudy	1.95	155		0637
1.2	3.98	7.42	6.31	25.21	cloudy	1.62	154		0638
1.8	3.97	7.4	6.30	25.22	cloudy	4.93	153	48.91	0641
			not 80% inch to well						
						80% recovery		46.09	13:40

SAMPLING:

Date _____ Time 13:45

Start Collection: 13:45
End Collection:

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	0	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	0	

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer X (Disposable) Grab ____ Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I D: M-165

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: M-165_201009-001

PROJECT NO: 2027.02.235 — Date: 9-15-2010

CLIENT/CONTACT: Susan Crowley — By: Dana R. Brown

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 23.6 Date 9-15-2010 Time 0651

120
− 23.40
96.60

WELL EVACUATION: Well Depth 120.0 feet, Depth to Top of Screen 109.7 feet (119.7) — Well Diameter 2 inches — Casing Volume 15.75 gallons

96.60
× 0.163
15.7458

Total No of Casing Volumes: low flow — Total Gallons Removed: 5 gallons — Elapsed Time: 2 hours

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Bladder ~~Peristaltic~~ pump X — Submersible Pump ____ Bailer ____ Other ____

Non-Dedicated Equipment Identification ____

FIELD WATER QUALITY TESTS: Pump ON: 0715

Casing Volume	TDS	pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0	.695	8.02	1.08	23.65	clear	7.51	153	~~22.09~~	0718
150 ml/min	.745	8.23	1.16	23.85	clear	7.06	137	22.09	0720
	.775	8.23	1.22	23.97	clear	6.69	131	23.22	0725
	.749	8.26	1.17	24.09	clear	6.17	120	24.62	0730
500 ml/min	.737	8.18	1.15	24.38	clear	5.77	120	26.04	0735
	.684	8.10	1.07	24.91	clear	4.84	106	29.19	0740
	.681	8.12	1.12	24.76	tr	5.13	116	33.21	0745
	.668	8.11	1.07	24.91		5.13	111	35.60	0750
	.67	7.99	1.05	25.36	clear	3.62	106	38.40	0755
150 ml/min	.67	8.10	1.05	25.44		2.86	95	~~38.83~~	~~0800~~
	.67	8.13	1.04	25.46		2.60	93	~~38.75~~	0805
	.67	8.15	1.04	25.49		2.52	93	38.69	0810
								38.68	0840

150 ml/min

SAMPLING: Date 9-15-2010 Time ~~0815~~

Start Collection: 0815
End Collection: 0834

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

3 bottles Collected

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other Bladder Pump 0840

.67	8.15	1.05	25.93	5.83	90	38.68

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I D: I-AC

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: I-AC_201009-001

PROJECT NO: 2027.02.235 — Date: 9-15-2010

CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ Feet below reference elevation 28.99 Date 9-15-2010 Time 0918

WELL EVACUATION:

Well Depth ~~50.0~~ 52.91 (tagged) feet — Well Diameter 6 inches — Casing Volume _____ gallons

Depth to Top of Screen 24.5 feet

44.5 5' sump

Total No of Casing Volumes _____ — Total Gallons Removed 2.5 — Elapsed Time 25 min.

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other Bladder Pump

Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Start: 0926

Casing Volume	TDS	pH	Specific Conductance ~~(µmhos/cm)~~ mS/cm	°C Temperature	Turbidity ~~(NTU)~~	Dissolved Oxygen (DO) mg/L	mV Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0	5.68	7.52	9.00	26.21	clear		154	29.92	0930
350 ~~750~~ ml/min	5.8	7.45	9.20	26.19	clear	—	166	29.34	0935
	5.79	7.45	9.19	26.32	clear	-	161	29.45	0940
	5.77	7.46	9.16	26.40	clear		159	29.54	0945
	5.76	7.47	9.15	26.41	clear	-	159	29.53	0950
2.5 gal	5.76	7.47	9.13	26.47	clear		149	29.50	0955
				Sample	3 bottles				
	5.76	7.52	9.14	27.64		6.19	136	29.49	1030

SAMPLING:

Date 9.15.2010 Time 1001

Start: 1001

End: 1026

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6020/ 6010B	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1l	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other Bladder Pump

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☐Non Phosphatic detergent wash/distilled water rinse ☐Hot pressure wash/steam cleaning ☐Methanol rinse

NOTES:

northgate

environmental management, inc.

24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I D: I-AD

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: I-AD_201009-001

PROJECT NO: 2027.02.235 — Date: 9-15-2010

CLIENT/CONTACT: Susan Crowley

WATER LEVEL MEASUREMENTS:

Water Level (MSL) _____ — Feet below reference elevation: 28.94 — Date: 9-15-2010 — Time: 1044

WELL EVACUATION:

Well Depth: ~~59.21~~ 44.5 feet (tagged) — Well Diameter: 6 inches — Casing Volume _____ gallons

Depth to Top of Screen: 24.5 feet

Total No. of Casing Volumes _____ — Total Gallons Removed: 2 gal — Elapsed Time: 25 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer ____ Other: Bladder Pump

Non-Dedicated Equipment Identification _____

FIELD WATER QUALITY TESTS:

Casing Volume		pH	Specific Conductance (mS/cm)	Temperature (°C)	Turbidity (NTU)	Dissolved Oxygen (DO) (mg/L)	Oxidation-Reduction Potential (ORP) (mV)	DTW (ft below TOC)	Time
Ø 300 ml/min		7.59	7.14	28.27	clear		132	29.04	1056
	4:40	7.54	7.06	27.42	clear	–	128	29.24	1108
150 ml/min	4:45	7.56	7.06	28.46	clear	2.64	129	29.23	1109
	4:43	7.56	7.03	28.75	clear	2.63	128	29.27	1114
	4:42	7.55	7.01	29.75		2.35	129	29.23	1119
			Purge & Sample low flow						
	4:36	7.56	6.92	29.99	clear	3.81	123	29.21	1142

TDS

SAMPLING:

Date: 9-15-2010 — Time: 1120

Start: 1120
End: 1138

Sample Analysis	Volume	Container Type	Number of Containers	Preservative
314.1	125 ml	HDPE	1	Ø 0.2 micron sterile filtered
6020/ 6010B	500 ml	HDPE	1	HNO_3 0.45 micron filtered
2540C	1 l	HDPE	1	Ø

3 Bottles collected.

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer ____ Grab ____ Other: Bladder Pump

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: ☐Non Phosphatic detergent wash/distilled water rinse ☐Hot pressure wash/steam cleaning ☐Methanol rinse

NOTES:

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER SAMPLING DATA FORM

PROJECT NAME: Perchlorate Well Study — Well/Surface Station I D: M-180

LOCATION/ADDRESS: Tronox LLC, Henderson, Nevada — Sample Designation: M-180_201009-001

PROJECT NO: 2027.02.235 — Date: 9-15-2010

CLIENT/CONTACT: Susan Crowley — By: Dana R. Brown

39.00
-29.39
9.61

WATER LEVEL MEASUREMENTS:

Water Level (MSL) ____ Feet below reference elevation 29.36 Date 9.15-2010 Time 1159

WELL EVACUATION: Well Depth 39.0 feet (38.7) Well Diameter 2 inches Casing Volume 1.57 gallons
Depth to Top of Screen 23.7 feet

9.61
x 0.163
1.56643

Total No of Casing Volumes 3 Total Gallons Removed 4.5 Elapsed Time 10 min

Factor * Water Column Height Equals Gallons	
Factor	Diameter
0.163	2" Well
0.653	4" Well
1.469	6" Well

WELL EVACUATION METHOD: Peristaltic pump ____ Submersible Pump ____ Bailer X Other ____
Non-Dedicated Equipment Identification ____

FIELD WATER QUALITY TESTS: Pump ON: 1200

Casing Volume	TDS / pH	Specific Conductance (umhos/cm)	Temperature	Turbidity (NTU)	Dissolved Oxgen (DO)	Oxidation-Reduction Potential (ORP)	DTW (ft below TOC)	Time
0	4.44 7.96	7.06	28.03	clear	8.11	121		1201
1.0	4.45 7.80	7.08	27.38	cloudy	0.81	128		1203
2.0	4.48 7.80	7.13	26.83	cloudy	0.92	149		
3	4.43 7.80	6.87	27.14	cloudy	0.91	167	30.0	1208
4.5	4.44 7.82	6.91	27.25	cloud	0.92	156	30.0	1211

SAMPLING: Date 9.15.2010 Time 1215

Start Collection: 1215
End Collection: 1221

Sample Analysis	Volume	Container Type	Number of Containers	Preservative	
314.1	125ml	HDPE	1	Ø	0.2 micron sterile filtered
6010B/6020	500ml	HDPE	1	HNO_3	0.45 micron filtered
2540C	1L	HDPE	1	Ø	

SAMPLING METHOD: Stainless Steel Bailer ____ Teflon Bailer Disposable X Grab X Other ____

EQUIPMENT DECONTAMINATION PROCEDURES:

DECONTAMINATION METHOD: 3-Stage Decon
☒ Non Phosphatic detergent wash/distilled water rinse ☐ Hot pressure wash/steam cleaning
☐ Methanol rinse See Decon Log

NOTES: Purge water disposed into Veolia pond.

northgate
environmental management, inc.
24411 Ridge Route Drive, Suite 130, Laguna Hills, CA 92653
main (949) 716-0050; fax (949) 716-0055

WATER LEVEL DATA FORM

Project Name	Perchlorate Well Study	Date	9-15-2010
Project Number	2027.02.235	Sample Crew	Kyle Hansen / Josh K.
Weather Conditions	Warm Clear		

Well Number	Measurement Dates	Time	Depth to Water 1	Depth to Water 2	Comments	Depth to LNAPL	Depth to DNAPL	T.D.
M-148A	9.15.2010	0631	46.11	46.11				50
M-165	9.15.2010	0651	23.26	23.26				120
I-AC	9.15.2010	0918	28.99	28.99				
I-AD	9-15-2010	1044	28.94	28.94				
M-180	9-15-2010	1159	29.36	29.36				

COC Number_____

northgate
environmental management, inc

1100 Quail Street, Suite 102, Newport Beach, CA 92660
(949) 260-9293

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

Page: of
Cooler # ____ of ____

Required Ship to Lab:

Lab Name:	
Address:	
Lab PM:	
Phone/Fax:	
Lab PM email	
Applicable Lab Quote #:	

Required Project Information:

Site ID #:			
Project #			
Site Address			
City		State	
Site PM Name			
Phone/Fax:			
Site PM Email:			

Required Invoice Information:

Send Invoice to:			
Address:			
City/State		Phone #:	
Reimbursement project?		Non-reimbursement project?	Mark one
Send EDD to			
CC Hardcopy report to			
CC Hardcopy report to			

TAT: Standard 21 day		Rush		Mark One
If Rush, Date due				
QC level Required: Standard		Special		Mark one
NJ Reduced Deliverable Package?				
MA MCP Cert?		CT RCP Cert?		Mark One
Lab Project ID (lab use)				

Valid Matrix Codes

MATRIX		MATRIX	
DRINKING WATER	WP	WATER	W
GROUND WATER	WG	SURFACE WATER	WS
WASTE WATER	WW	WATER QC	WQ
FREE PRODUCT	LF	SLUDGE	SL
SOIL	SO	RINSEATE	WH
OIL	OIL	OTHER	OT
WIPE	SW	ANIMAL TISSUE	TA
AMBIENT AIR	AA		
SVE AIR	AE		
SOIL GAS	GS		

ITEM #	SAMPLE ID One Character per box. (A-Z, 0-9 / ,-) Samples IDs MUST BE UNIQUE	MATRIX CODE	SAMPLE TYPE G=GRAB C=COMP	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	FIELD FILTERED? (Y/N)	Preservatives: Unpreserved	H2SO4	HNO3	HCl	NaOH	Na2S2O3	Methanol	Other	Requested Analyses	Comments/Lab Sample I.D.
1	M-165_201009-001	WG	G	9-15-2010	08:15	3	Y	X		X							
2	EB-09152010	WG	G	9-15-2010	08:50	3	N	X		X							
3	I-AC_201009-001	WG	G	9-15-2010	10:01	3	Y	X		X							
4	I-AD_201009-001	WG	G	9-15-2010	11:20	3	Y	X		X							
5	M-180_201009-001	WG	G	9-15-2010	12:15	3	Y	X		X							
6	M-146A_201009-001	WG	G	9-15-2010	13:45	3	Y	X		X							
7																	
8																	
9																	
10																	
11																	
12																	

Additional Comments/Special Instructions:
EB-09152010 A... M-165 Bladder pump

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME
Dana R Brown, NGEM	9/15				

Sample Receipt Conditions

Temp in OC	Samples on Ice?	Sample intact?	Trip Blank?
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N
	Y / N	Y / N	Y / N

SHIPPING METHOD: (mark as appropriate) SAMPLER NAME AND SIGNATURE

UPS COURIER FEDEX
US MAIL

PRINT Name of SAMPLER: Dana R. Brown
SIGNATURE of SAMPLER:
DATE Signed 9-15-10
Time:

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER ARP-2A

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 7/6/10 **COMPLETED** 7/6/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 24.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES: ARP-2A is 50' north of ARP-2. See lithology log of ARP-2 for lithologic description

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1				
2				
3				
4				
5				
6				
7				
8				
9				Cement/Bentonite Grout
10				
11				
12				2" Schedule 40 PVC Capped Riser
13				
14				
15				
16				
17				
18				Hydrated Bentonite Pellets
19				
20				
21				
22				
23				
24			∇	
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER ARP-2A

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

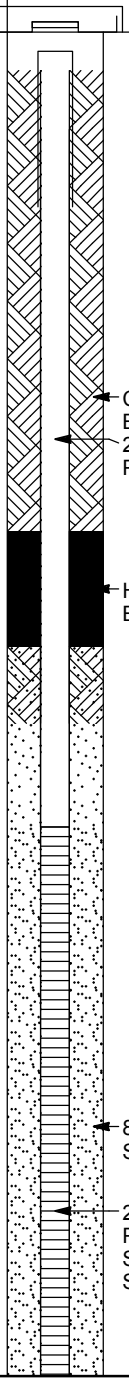
DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36				8-12 Filter Pack Sand
37				
38				
39				2" Schedule 40 PVC 0.020" Slotted Well Screen
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				2" Schedule 40 PVC End Cap
55				

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER ARP-3A

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 7/2/10 **COMPLETED** 7/2/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ∇ **AT TIME OF DRILLING** 26.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: ARP-3A is 50' north of ARP-3. See lithology log of ARP-3 for lithologic description.

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				Cement/ Bentonite Grout
11				2" Schedule 40 PVC Riser
12				
13				
14				
15				Hydrated Bentonite Chips
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26			∇	
27				
28				
29				8-12 Filter Pack Sand
30				
31				2" Schedule 40 PVC 0.020" Slotted Well Screen
32				
33				
34				
35				



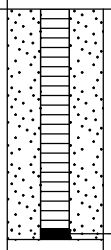
(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER ARP-3A

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36				
37				
38				
39				
40				
41				2" Schedule 40 PVC End Cap

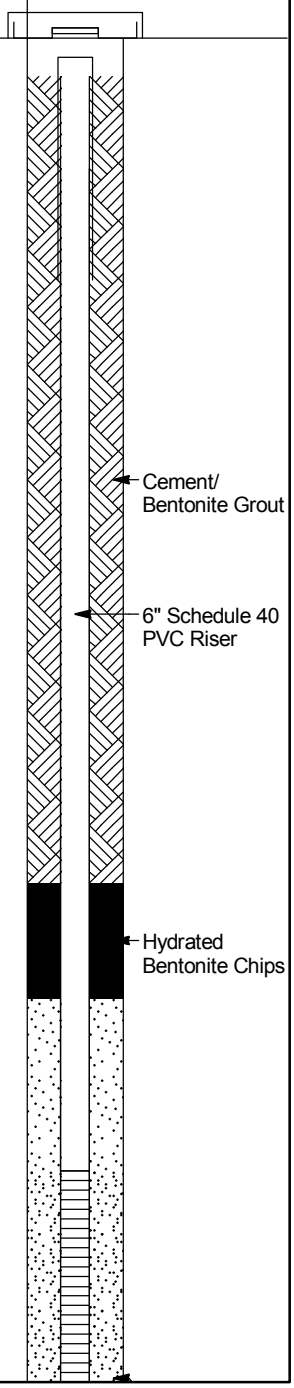
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER ART-7B

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 6/22/10 **COMPLETED** 6/28/10 **TOC ELEVATION** **HOLE SIZE** 18"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ∇ **AT TIME OF DRILLING** 32.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: ART-7B is 5' north of ART-7. See lithology log of ART-7 for lithology above 39'.

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32				∇	
33					
34					
35					

WELL DIAGRAM



GENERAL_NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER ART-7B

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36			GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM); light brownish gray (10YR 6/2), 60-70% angular to sub angular volcanic granules/pea gravel to 1/2", 20-30% fine to very coarse angular to sub rounded sand, 10% silt, moderately calcareous.	8-12 Filter Pack Sand
37						6" Stainless Steel V-Wire 0.040" Well Screen
38						
39						
40						
41						
42						
43						
44						
45						End Cap
46			CL		LEAN CLAY (CL); yellowish gray (5GY 6/2), non-calcareous.	
47						
48						
49						
50						
					Bottom of borehole at 50.0 feet bgs.	

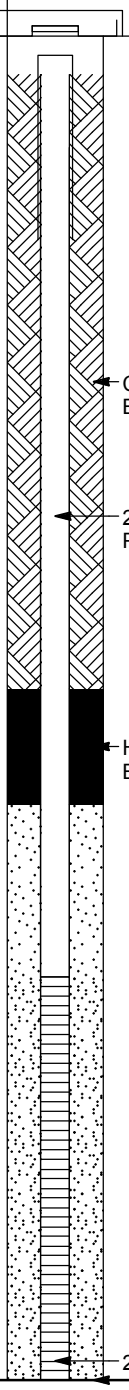
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER I-AC

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/14/10 **COMPLETED** 6/15/10
TOC ELEVATION
HOLE SIZE 9"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 33.00 ft
DRILLING METHOD Sonic
▼ **AFTER DRILLING** 26.2 ft **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SP-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM); reddish brown (5YR 5/4), 75% fine to medium grain with common coarse to very coarse angular to sub rounded well graded sand, 15% granules/pea gravel to 3/4", 10% silt, moderate caliche cement and grain coatings.
6–10		Qal	SP-SM		
11–15		Qal	SP-SM		
16–23		Qal	SP-SM		Common calcareous cement and coatings from 17-23'.
24–25		Qal			SILTY SAND (SM); yellowish brown (10YR 5/4), 80% fine to medium grain with trace coarse to very coarse grain sub angular to sub rounded moderately well sorted sand, 10-25% silt, 5% angular to sub angular volcanic granules, damp at 24'..
26		Qal	SM		Sp(?) calcareous cement/coatings from 23-25'.
27–28		Qal Qal	SM		▼ Common calcareous cement/coatings from 25-28'.
29–30		Qal	ML		SILT WITH SAND (ML); yellowish brown (10YR 5/4), 70% calichified silt, 30% fine to coarse grain sub angular to sub rounded sand, common calichification and grain coatings.
31–32		Qal	ML		
33		Qal	ML		▽
34–35		UMCf	ML		SILT INTERBEDDED WITH SANDY SILT (ML); yellowish brown (10YR 5/4), 10% very fine grain sand, 20-30% very fine grain sand locally, non-calcareous. Sandy zones at: 43-44' 20-30% very fine grain sand, 47.5-50' 20-30% very fine grain sand.

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER I-AC

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					SILT INTERBEDDED WITH SANDY SILT (ML); yellowish brown (10YR 5/4), 10% very fine grain sand, 20-30% very fine grain sand locally, non-calcareous. Sandy zones at: 43-44' 20-30% very fine grain sand, 47.5-50' 20-30% very fine grain sand. *(continued)*	PVC 0.010" Slotted Well Screen 10-20 Filter Pack Sand
37						
38						
39						
40						
41						
42						
43		UMCfML			20-30% very fine grain sand from 43-44' bgs.	
44						
45						
46						
47						2" Schedule 40 PVC Blank Casing
48					20-30% very fine grain sand from 47.5' to 50' bgs.	
49						
50						2" Schedule 40 PVC End Cap
					Bottom of borehole at 50.0 feet bgs.	

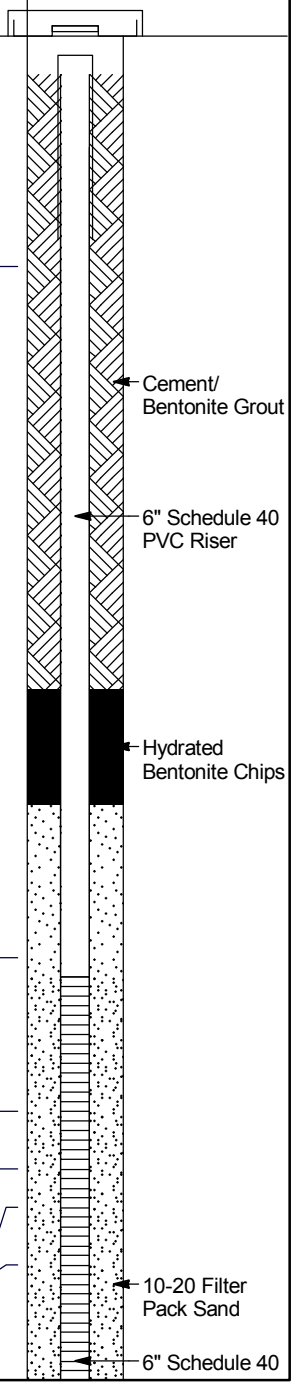
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER I-AD

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 6/15/10 **COMPLETED** 6/16/10 **TOC ELEVATION** **HOLE SIZE** 9"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ∇ **AT TIME OF DRILLING** 33.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: I-AD is 10 ' north of M-180. Lithologic descriptions from M-180

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5					FILL; brown and dark yellowish brown, sands, gravels, cement debris.
6–15			SM		SILTY SAND (SM); reddish brown (5Y 5/4), 60-65% very fine to medium grain with common coarse to very coarse grain sub angular to sub rounded sand, 5-10% angular to sub angular volcanic gravel to 3/4", 20% silt, common calcareous coatings and soft cement t
16–24			SM		Varying amount of calichification, abundant and hard from 18.5-19' and 23-24'.
25–28			SW-SM		WELL GRADED SAND WITH SILT (SW-SM); grayish brown (10YR 5/2), fine to coarse grain sand, <10% silt to 26' then 20% silt, 10-15% volcanic angular to sub angular gravel to 1/2" with trace to 1-2", non calcareous to 26' then moderately calcareous to 28'.
29			ML		SILT (ML); yellowish brown (10YR 5/4), common to abundant hard to soft caliche zones and nodules.
30			SW		SAND (SW); yellowish brown (10YR 5/4), fine to coarse grain poorly sorted sub angular to sub rounded sand, 5-10% volcanic angular to sub angular gravel to 3/8", 6" bed of angular to sub angular gravel to 1" in silty matrix at 30'.
31–32			CL		CLAY (CL); very pale brown (10YR 8/2), abundant caliche zones and nodules to 3-4".
33–35			ML	∇	SILT WITH SAND (ML); very pale brown (10YR 7/4), coarse grain silt, 10-20% very fine grain sand, non calcareous.

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER I-AD

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36			ML		SILT (ML); very pale brown (10YR 7/4), coarse grain silt, trace very fine grain sand.	PVC 0.010" Slotted Well Screen
37						
38						
39						
40			ML			
41						
42						
43						
44						
45						6" Schedule 40 PVC End Cap
46						
47						
48						Native Fill
49						
50					Bottom of borehole at 50.0 feet bgs.	

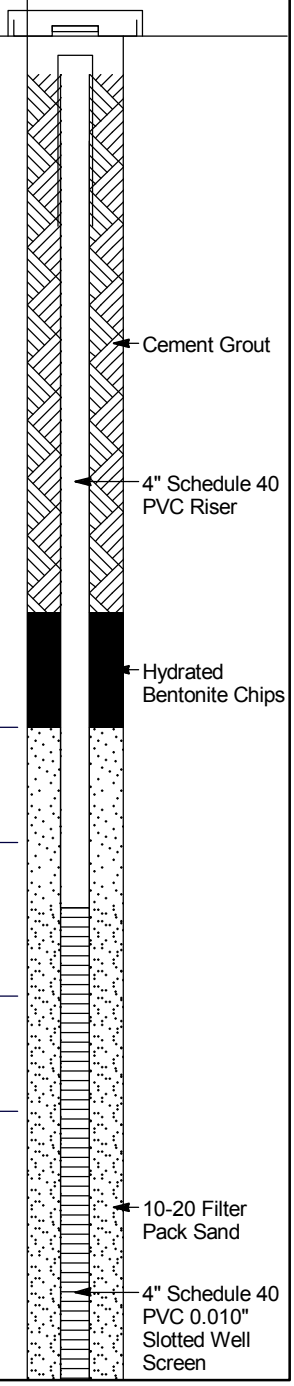
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-140

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/7/10 **COMPLETED** 6/8/10
TOC ELEVATION
HOLE SIZE 8"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 22.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–18		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4) and pinkish gray (5YR 7/2) where common calcareous cement/coatings, 60% very fine to medium grain with common coarse to very coarse grain sub angular to sub rounded poorly sorted sand, 20% granules/pea gravel to 3/4" (predominately 1/4-5/8"), 20% silt. Moderate calcareous coatings and cement throughout. Common to abundant cement coatings at 6-8', 10-10.5', and 17-18'.
19–20		Qal	SW-SM		WELL GRADED SAND WITH SILT (SW-SM); light yellowish brown (10YR 6/4), fining upward sequence.
21–25		Qal	SM	∇	SILTY SAND (SM); Light gray (10YR 7/2), very fine to medium with coarse to very coarse angular to sub angular sand, 5-10% angular to sub rounded volcanic gravels and caliche nodules, 20% silt.
26–28		UMCf	ML		SILT (ML); very pale brown (10 YR 7/4), 10-20% very fine grain sand, 2-3% floating sand/gravel grains to 1/4", moderately calcareous.
29–35		UMCf	ML		SILT INTERBEDDED WITH SANDY SILT(ML); very pale brown (10YR 7/4) and light yellowish brown (10YR 6/4). Sandy silt, 20% very fine grain sand, 32-34', 6" zone of common caliche nodules to 3" @ 33'.

WELL DIAGRAM



GENERAL_NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-140

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					SILT INTERBEDDED WITH SANDY SILT(ML); very pale brown (10YR 7/4) and light yellowish brown (10YR 6/4). *(continued)*	
37						
38					Sandy silt, 20-30% very fine grain sand at 38'-39', 40'-45'.	
39						
40		UMC	ML			
41						
42						
43						4" Schedule 40 PVC End Cap
44						
45						
					Bottom of borehole at 45.0 feet bgs.	

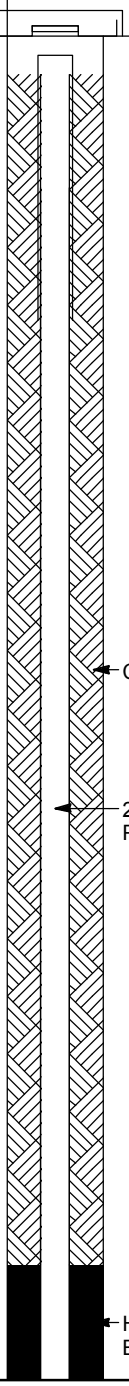
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-148A

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 6/2/10 **COMPLETED** 6/2/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** **AT TIME OF DRILLING** ---
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: M-148A is 10' east of M-186. Lithologic descriptions from M-186.

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–10			SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM); reddish brown (5YR 5/4), 70% very fine to medium grain with coarse to very coarse grain poorly sorted sub angular to sub rounded sand, 20% volcanic angular to sub angular pea gravel to 1/2", 10% silt, moderate calcareous grain coatings.
11–22			SM		SILTY SAND (SM); reddish brown (5 YR 5/4), 70-80% very fine to medium grain with common coarse to very coarse grain poorly sorted sub angular to sub rounded sand, 20-30% silt, 1-2% gravel to 1/4", common calcareous cement and grain coatings.
23–35			SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 60% very fine to coarse grain sub angular to sub rounded moderately poorly sorted sand, 20% pea gravel to 3/4" trace to 2-3", 20% silt. Slight to moderate calcareous coatings.

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

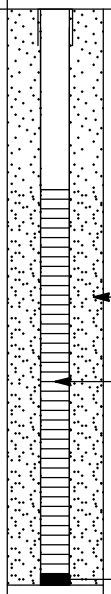
WELL NUMBER M-148A

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
36, 37, 38			SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 60% very fine to coarse grain sub angular to sub rounded moderately poorly sorted sand, 20% pea gravel to 3/4" trace to 2-3", 20% silt. *(continued)*
39, 40, 41, 42, 43, 44, 45			SW-SM		WELL GRADED SAND WITH SILT (SW-SM); reddish brown (5YR 5/4), 80% fine to medium grain with minor coarse to very coarse grain sub angular to sub rounded moderately well sorted sand, 10% volcanic sub angular gravels to 3/8", 10% silt. Common caliche nodules and calcareous cement (semi-hard) 42-45'.
46, 47, 48, 49, 50			ML		SILT (ML); very pale brown (10YR 7/4).
					Bottom of borehole at 50.0 feet bgs.

WELL DIAGRAM



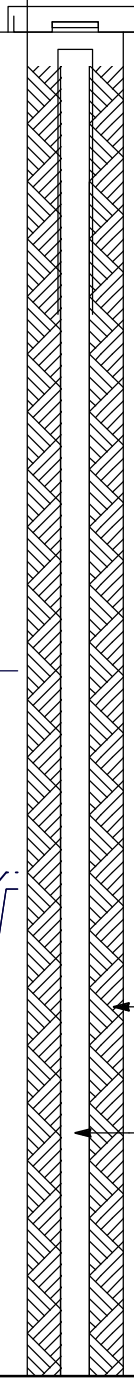
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-159

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 5/22/10 **COMPLETED** 5/23/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ▽ **AT TIME OF DRILLING** 29.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 60-70% very fine to very coarse grain sub angular to sub rounded sand, 10-20% volcanic angular to sub angular gravel/granules to 1", locally large gravel to 3" @ 11-11.5' and 13-14', 20% silt in matrix, slight to moderate calcareous grain coatings.
6–10		Qal	SM		
11–15		Qal	SM		
16–19		Qal	SM		Abundant caliche, moderate hard with calcite veins, white (5Y 8/1) and (N9), 17-19'.
20–25		Qal	SM		SILTY SAND (SM); very pale brown (10YR 7/4) and white (5Y 8/1) where calichified, 70% very fine to fine grain with minor medium to coarse grain sub angular to sub rounded sand, 30% silt in matrix, slight to moderate calcareous grain coatings throughout.
25		Qal	SM		Calichified with abundant <1/4" nodules and grain coatings, very pale brown (10YR 7/4), 24-25'.
26–27		UMC			Gravelly sand, light gray (10YR 7/2), common calcareous nodules and coatings, 60% very fine to medium sub angular to sub rounded sand, 20% pea gravel/granules to 3/8", 20% silt, 25-25.5'.
28–35		UMC	ML		▽ SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), sandy silt contains 20-30% very fine grain sand. Sandy intervals: 30-32', 39-45', 51-55', 58-60', 62-68'. Calichified intervals: 45-54' caliche nodules to 1/4", 56-56.5' common nodules to 1", 62-68' common nodules to 1/4".
36–40		UMC	ML		

WELL DIAGRAM



GENERAL_NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-159

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
41					SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), sandy silt contains 20-30% very fine grain sand. Sandy intervals: 30-32', 39-45', 51-55', 58-60', 62-68'. Calichified intervals: 45-54' caliche nodules to 1/4", 56-56.5' common nodules to 1", 62-68' common nodules to 1/4". *(continued)*	
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54		UMCf	ML			
55						
56						
57						
58						
59						Hydrated Bentonite Chips
60						
61						
62						
63						
64						
65						
66						
67						
68						10-20 Filter Pack Sand
69		UMCf	ML		SILT WITH SAND (ML); very pale brown (10YR 7/4), 70-75% silt, 20% very fine grain sand, 5-10% floating volcanic sub angular to sub rounded gravels to 3/8".	
70					SILT (ML); very pale brown (10YR 7/4) to 79.5, very pale brown (10YR 8/2) 79.5-85. Trace caliche nodules to 1/2" 71-78', common to abundant caliche nodules to 1/2" 78-85'.	2" Schedule 40 PVC 0.010" Slotted Well Screen
71						
72						
73						
74						
75						2" Schedule 40 PVC End Cap
76						
77						
78		UMCf	ML			
79						
80						
81						
82						
83						
84						
85						

Bottom of borehole at 85.0 feet bgs.

GENERAL NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

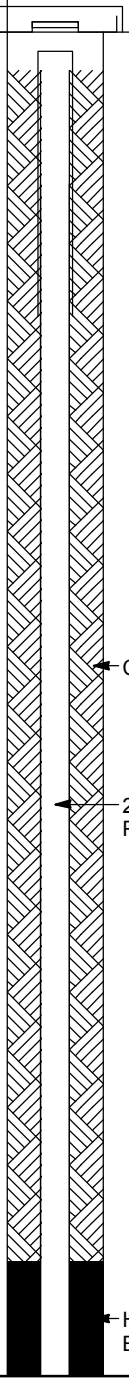
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-160

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 5/23/10 **COMPLETED** 5/23/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ∇ **AT TIME OF DRILLING** 29.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: M-160 is 10' east of M-159. See M-159 lithology log for lithology.

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–10			SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 60-70% very fine to very coarse grain sub angular to sub rounded sand, 10-20% volcanic angular to sub angular gravel/granules to 1", locally large gravel to 3" at 11-11.5' and 13-14', 20% silt in matrix. Slight to moderate calcareous grain coatings.
19–25			SM		SILTY SAND (SM); very pale brown (10YR 7/8), white (5Y 8/1) where calichified, 70% very fine to fine grain with minor medium to coarse grain sub angular to sub rounded sand, 30% silt in matrix, slight to moderate calcareous grain coatings throughout.
26–35			ML		Gravelly sand, light gray (10YR 7/2), common calcareous nodules and coatings, 60% very fine to medium sub angular to sub rounded sand, 20% pea gravel/granules to 3/8", 20% silt, 25-25.5'. SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), sandy silt contains 20-30% very fine grain sand. Sandy Intervals: 30-32', 39-45'. Calichified intervals: caliche nodules to 1/4", 45-50'. ∇

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-160

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

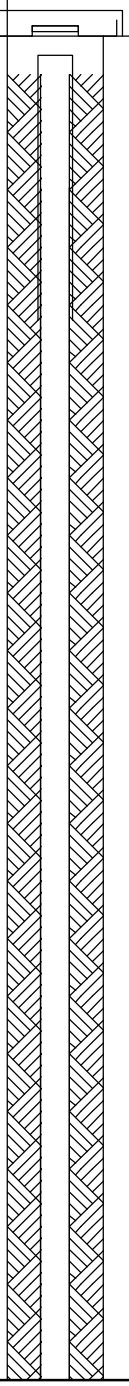
DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), sandy silt contains 20-30% very fine grain sand. Sandy Intervals: 30-32', 39-45'. Calichified intervals: caliche nodules to 1/4", 45-50'. *(continued)*	
37						
38						
39						
40						
41						
42						
43			ML			10-20 Filter Pack Sand
44						
45						2" Schedule 40 PVC 0.010" Slotted Well Screen
46						
47						
48						
49						
50						2" Schedule 40 PVC End Cap
					Bottom of borehole at 50.0 feet bgs.	

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-161

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 5/22/10 **COMPLETED** 5/22/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 28.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1					M-161 is 30' east of M-136. See M-136 lithology log from 0-90'.	
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28					▽	
29						
30						
31						
32						
33						
34						
35						



(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-161

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					M-161 is 30' east of M-136. See M-136 lithology log from 0-90'. *(continued)*	
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						Cement Grout
48						
49						
50						
51						2" Schedule 40 PVC Riser
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75						

GENERAL_NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

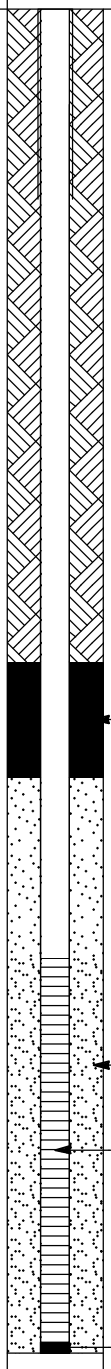
WELL NUMBER M-161

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
76					M-161 is 30' east of M-136. See M-136 lithology log from 0-90'. *(continued)*
77					
78					
79					
80					
81					
82					
83					
84					
85					
86					
87					
88					
89					
90					
91			SM		SILTY SAND (SM); light yellowish brown (10YR 6/4), 60% very fine grain sub angular to sub rounded sand, locally contains minor coarse sand and fine gravel, 40% silt, overall slight calcareous grain coatings. Minor medium to coarse grain sub rounded sand from 90-92'.
92					
93					
94					
95					
96					Minor very coarse sand and gravel to 1/4" from 95-96'.
97			ML		SILT WITH SAND (ML); light yellowish brown (10YR 6/4), 10-20% very fine grain sand.
98					
99					
100					
101					Abundant calichification, very pale brown (10YR 8/2) mottled with very pale brown (10YR 7/4) from 100-103'.
102					
103					
104			ML		SILT (ML); dark yellowish brown (10YR 4/4).
105					
106					
107					
108					
109					
110			CL		CLAY (ML); Mottled white (5Y 8/1) and very pale brown (10YR 7/4), 6" yellowish gray clay bed (volcanic ash?) at 109.5'.

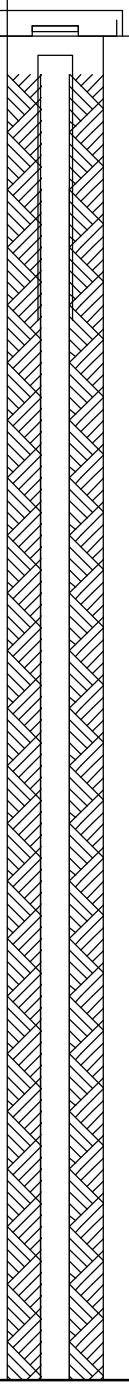
Bottom of borehole at 110.0 feet bgs.



northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-162

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 5/21/10 **COMPLETED** 5/21/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ▽ **AT TIME OF DRILLING** 26.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: Lithologic descriptions from 0' - 60' are from M-104

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	RECOVERY %	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1						M-162 is 15' east of M-104.	
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26						▽	
27							
28							
29							
30							
31							
32							
33							
34							
35							

GENERAL_NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-162

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	RECOVERY %	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36						M-162 is 15' east of M-104. *(continued)*	
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							Cement Grout
48							
49							
50							2" Schedule 40 PVC Riser
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61						SILT WITH SAND (ML); reddish brown (5YR 5/4) and very pale brown (10YR 7/4), 10-30% very fine grain sand, slight calcareous with minor 1/8" caliche nodules scattered throughout.	
62							
63							
64							
65							
66							
67				ML			
68	M-162 Split Spoon #1		100				
69							
70							
71							
72							
73							
74							
75				CL		CLAY, pinkish gray (5YR 7/2), silty.	

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

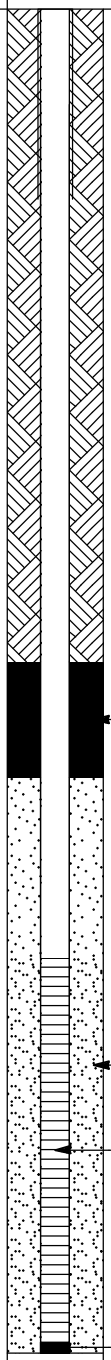
WELL NUMBER M-162

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	RECOVERY %	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
76						SILT (ML); yellowish brown (10YR 5/4), sandy intervals with 20-30% very fine grain sand.
77						
78						
79						
80						
81						
82						
83						
84						
85						
86	M-162 Split Spoon #2		100			
87						
88						
89						
90						
91						
92						
93				ML		
94						
95						
96						
97						Abundant calichification, common nodules to 3/8" from 96.5-97'.
98						
99						
100						Light yellowish brown (10YR 6/4), slight to moderate caliche nodules to 1/4" from 99-100'.
101						
102						
103						
104						Sandy silt, 10-20% very fine grain sand.
105						
106	M-162 Split Spoon #3		100			
107						
108						
109						
110						Bottom of borehole at 110.0 feet bgs.

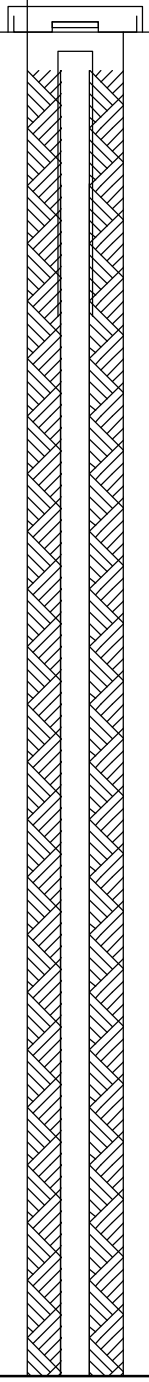
WELL DIAGRAM



northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-163

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 5/20/10 **COMPLETED** 5/20/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ▽ **AT TIME OF DRILLING** 26.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: Lithologic descriptions are from M-104 for 0' - 60', and for 60' - 90' are from M-162

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1					M-163 is 10' SE of M-104 and 10' SW of M-162.	
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26					▽	
27						
28						
29						
30						
31						
32						
33						
34						
35						

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-163

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					M-163 is 10' SE of M-104 and 10' SW of M-162. *(continued)*	
37						Cement Grout
38						
39						
40						2" Schedule 40 PVC Riser
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61					SILT WITH SAND (ML); reddish brown (5YR 5/4) and very pale brown (10YR 7/4), 10-30% very fine grain sand, slight calcareous with minor 1/8" caliche nodules scattered throughout.	
62						
63						
64						
65						
66						
67			ML			
68						
69						
70						
71						
72						
73						
74						Hydrated Bentonite Chips
75			CL		CLAY, pinkish gray (5YR 7/2), silty.	

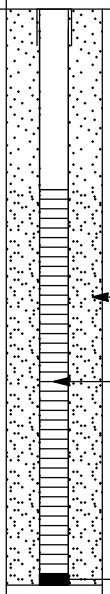
(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-163

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
76					M-163 is 10' SE of M-104 and 10' SW of M-162. *(continued)*	
77					SILT (ML); yellowish brown (10YR 5/4), sandy intervals with 20-30% very fine grain sand.	
78						
79						
80						
81						
82						
83						10-20 Filter Pack Sand
84						
85						2" Schedule 40 PVC 0.010" Slotted Well Screen
86						
87						
88						
89						
90						2" Schedule 40 PVC End Cap
			ML		Abundant calichification, common nodules to 3/8" from 96.5-97'.	
					Light yellowish brown (10YR 6/4), slight to moderate caliche nodules to 1/4" from 99-100'.	
					Sandy silt, 10-20% very fine grain sand.	
					Bottom of borehole at 90.0 feet bgs.	

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-164

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 5/19/10 **COMPLETED** 5/19/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 26.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES: Lithologic descriptions from 0' - 60' are from M-104 and for 60' - 70' are from M-162.

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1					M-164 is 10' NE of M-104 and 10'NW of M-162. See lithology log of M-104 for lithology to 70'.	
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26					▽	
27						Cement Grout
28						
29						
30						2" Schedule 40 PVC Riser
31						
32						
33						
34						
35						

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

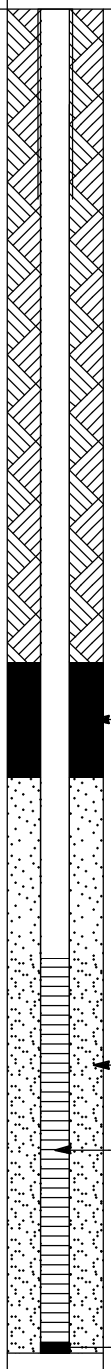
WELL NUMBER M-164

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
36					M-164 is 10' NE of M-104 and 10'NW of M-162. See lithology log of M-104 for lithology to 70'. *(continued)*
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					
53					
54					
55					
56					
57					
58					
59					
60					
61			ML		SILT WITH SAND (ML); reddish brown (5YR 5/4) and very pale brown (10YR 7/4), 10-30% very fine grain sand, slight calcareous with minor 1/8" caliche nodules scattered throughout.
62					
63					
64					
65					
66					
67					
68					
69					
70					Bottom of borehole at 70.0 feet bgs.

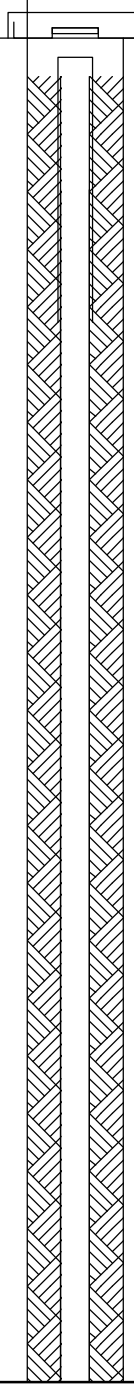
WELL DIAGRAM



northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-165

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 5/18/10 **COMPLETED** 5/19/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 32.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES: Lithologic descriptions for 0' - 90' are from M-132.

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1					M-165 is 10' west of M-132. See lithology log of M-132 for lithology from 0-92'.	
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32					∇	
33						
34						
35						

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-165

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					M-165 is 10' west of M-132. See lithology log of M-132 for lithology from 0-92'. *(continued)*	
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						Cement Grout
53						
54						
55						2" Schedule 40 PVC Riser
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75						

GENERAL_NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-165

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
76					M-165 is 10' west of M-132. See lithology log of M-132 for lithology from 0-92'. *(continued)*	
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
91			ML		SILT INTERBEDDED WITH SANDY SILT (ML); reddish brown (5YR 5/4) and very pale brown (10YR 7/4).	
92						
93						
94						
95						
96					2' zone of common caliche nodules to 1" from 95-97'.	
97						
98						
99						
100						
101						
102						
103						
104						Hydrated Bentonite Chips
105						
106					1" semi-hard caliche layer at 105'.	
107						
108					6" zone with common caliche nodules to 1/2" at 107.5'.	
109						
110						
111						
112						
113						10-20 Filter Pack Sand
114						
115						2" Schedule 40

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-165

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
116					SILT INTERBEDDED WITH SANDY SILT (ML); reddish brown (5YR 5/4) and very pale brown (10YR 7/4). *(continued)*	PVC 0.010" Slotted Well Screen
117					6" zone with common caliche nodules to 1/2" at 115.5'.	
118			ML			
119						
120						2" Schedule 40 PVC End Cap
					Bottom of borehole at 120.0 feet bgs.	

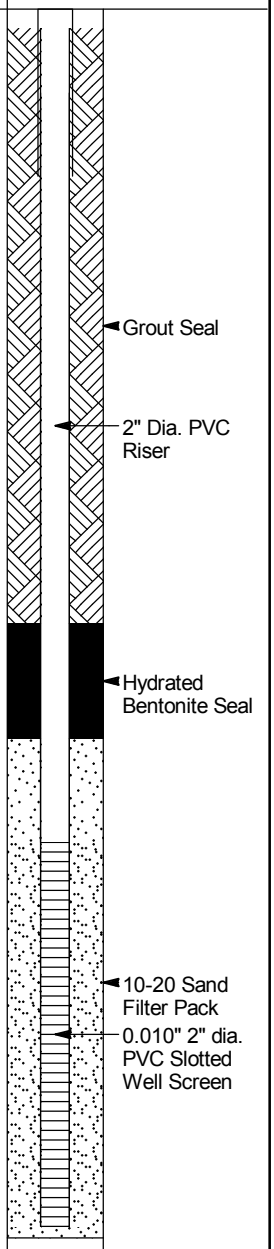
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-166

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/24/10 **COMPLETED** 4/24/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 26.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SM		SILTY SAND WITH GRAVEL (SM): yellowish brown (10YR 5/4), 50% very fine to very coarse sub-angular to sub-rounded sand with 30% volcanic angular to subangular pea gravel to 1/2" (trace to 2"), and 20% silt.
6–10		Qal	SM		Calcareous grain coatings and scattered thin calichified layers
11–15		Qal	SM		
16–18		Qal	SM		
19–20		Qal	SM		SILTY SAND (SM): yellowish brown (10YR 5/4), 60% very fine to fine grained with minor medium to coarse grained sub-rounded to sub-angular sand, 40% silt, some calcareous coatings.
21–23		Qal	SM		SILTY SAND WITH GRAVEL (SM): light brownish gray (10YR 6/2), 50% very fine to coarse grained with very coarse grained sub-angular sand with 20-30% volcanic sub-angular pea gravel to 1/2", 20-30% silt, some calcareous grain coating.
24–25		Qal Qal	SM		Hard caliche layer 24'-25'
26				▽	Dark grayish brown (10YR 4/2)
27		Qal			Hard caliche layer 26'-27.5' Light brownish gray (10YR 6/2)
28–32		UMCf	ML		SILT & SANDY SILT (ML): very pale brown (10YR 7/4), up to 30% very fine grained sand locally, scattered 1/8"-1/4" caliche nodules

Bottom of borehole at 32.0 feet bgs.



GENERAL NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

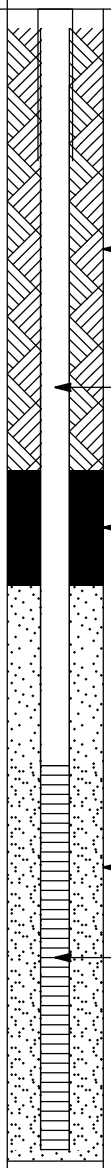
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-167

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/24/10 **COMPLETED** 4/24/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 24.50 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SM		SILTY SAND WITH GRAVEL (SM): yellowish brown (10YR 5/4), 50% very fine to very coarse sub-angular to sub-rounded sand,30% volcanic angular to sub-rounded pea gravel to 3/4", 20% silt.
6–15		Qal	SM		Some calcareous grain coatings, few caliche nodules to 1/2".
16–20		Qal	SM		SILTY SAND (SM): yellowish brown (10YR 5/4),70% very fine to fine grained with trace medium to coarse grained sub-angular to sub-rounded sand, 30% silt, some calcareous grain coatings to 22', common caliche nodules to 2" to 24'.
21–23		Qal	SM		Light gray (10YR 7/2)
24–25		Qal	SP-SM	▽	POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM): grayish brown (10YR 5/2), 60% very fine to very coarse sand, 30% pea gravel to 1/2", 10% silt, some calcareous coatings and caliche nodules.
26–30		UMCf	ML		SILT INTERBEDDED WITH SANDY SILT (ML): up to 40% very fine grained sand, calcareous throughout and scattered caliche nodules to 1/4".

Bottom of borehole at 30.0 feet bgs.



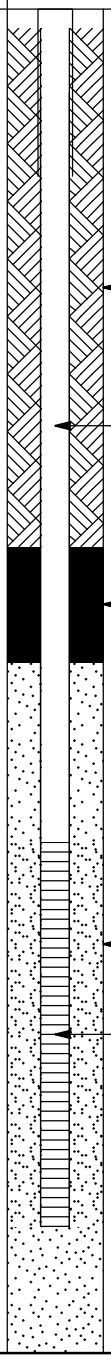
GENERAL NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-168

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/23/10 **COMPLETED** 4/23/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 25.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SW-SM		POORLY GRADED SAND WITH SILT AND GRAVEL (SW-SM): yellowish brown (10YR 5/4), 55% very fine to very coarse sub-angular to sub-rounded sand, 30% volcanic angular to sub-rounded pea gravel to 3/4", trace gravel to 3", 15% silt.
6–10		Qal	SW-SM		Some calcareous grain coatings and scattered caliche nodules up to 3".
11–15		Qal	SW-SM		
16–17		Qal	SW-SM		
17–20		Qal	SM		SILTY SAND (SM): very pale brown (10YR 7/4), 70% very fine to fine sub-angular to sub-rounded sand, trace medium to coarse grained sand, 30% silt.
21–22		Qal	SM		Few calcareous grain coatings, caliche nodules to 3" from 20.5'-22'.
23–25		Qal	SW-SM		SILTY SAND WITH GRAVEL (SW-SM): very pale brown (10YR 7/4), 50% very fine to very coarse sub-angular to sub-rounded sand, 30% volcanic angular to sub-rounded pea gravel to 1/2", 20% silt, calcareous grain coatings throughout. Hard caliche layer 24'-26.5'. ▽
27–35		UMCf	ML		SILT INTERBEDDED WITH SANDY SILT (ML): Up to 40% very fine grained sand, few caliche nodules 1/2"-1" to 28.5' bgs.



Bottom of borehole at 35.0 feet bgs.

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

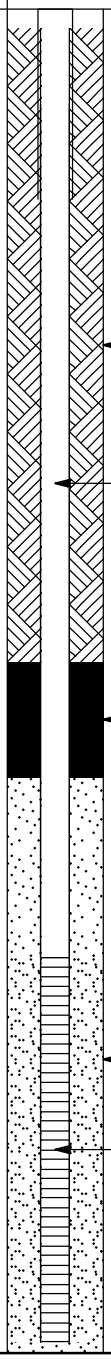
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-169

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/23/10 **COMPLETED** 4/23/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 28.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–18		Qal	SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM): grayish brown (10YR 5/2), 55% very fine to very coarse sub-angular to sub-rounded sand, 30% volcanic angular to sub-rounded pea gravel to 3/4", trace gravel up to 3", 15% silt, calcareous grain coatings and scattered caliche nodules/thin layers up to 3".
19–22		Qal	SM		SILTY SAND (SM): yellow (10YR 7/6), 70% very fine to fine grained sand, 30% silt, few calcareous grain coatings.
23–27		Qal	SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM): very pale brown (10YR 7/4), 70% very fine to medium sand with trace coarse to very coarse sub-angular to sub-rounded sand, 20% volcanic sub-angular pea gravel to 1/2", 10% silt, with calcareous coatings from 22'-26', caliche layers from 26'-27'.
28–35		UMC	ML		∇ SILT (ML): very pale brown (10YR 7/4), scattered caliche nodules to 1", hard caliche layer from 27'-27.5'.

WELL DIAGRAM



Bottom of borehole at 35.0 feet bgs.

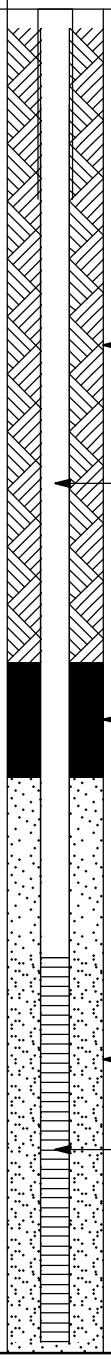
GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-170

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/23/10 **COMPLETED** 4/23/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 29.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–19		Qal	SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM): reddish brown (5YR 5/5), 70% very fine to very coarse sub-angular to sub-rounded sand, 20% volcanic sub-angular gravel to 3/4" diameter, trace gravel to 3", 10% silt, few calcareous grain coatings throughout, semi-hard caliche zones at 6'-7', 9'-10', 10.5'-12', and 18'-19'.
20–21		Qal	SP		POORLY GRADED SAND (SP): light yellowish brown (10YR 6/4), 90% very fine to medium with trace coarse to very coarse sub-angular to sub-rounded sand, 5% granules to 1/3", 5% silt.
22–23		Qal	SM		SILTY SAND (SM): light brownish gray (10YR 6/2), 80% very fine to very coarse sub-angular to sub-rounded sand, 20% silt, with scattered caliche nodules to 2".
24–29		Qal	SW		WELL GRADED SAND (SW): yellowish brown (10YR 5/4), 90% very fine to medium with trace coarse to very coarse sub-angular to sub-rounded sand, 5% volcanic sub-rounded gravels to 1/4", 5% silt, abundant calcareous grain coatings.
29				▽	40% silt in very fine to fine grained sand, light gray (5Y 7/2), abundant hard caliche.
30–35		UMCf	ML		SILT WITH TRACE SANDY SILT (INTERBEDDED) (ML): very pale brown (10YR 7/4), locally up to 30% very fine grained sand, with caliche nodules from 29'-30'.



Bottom of borehole at 35.0 feet bgs.

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

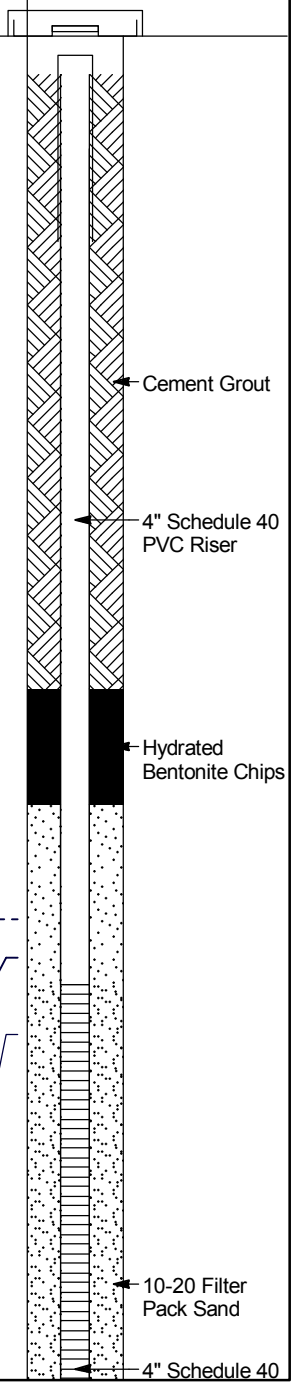
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-171

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/7/10 **COMPLETED** 6/7/10
TOC ELEVATION
HOLE SIZE 8"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 27.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5 YR 5/4) and yellowish brown (10YR 5/4), 70% very fine to medium grain with common coarse to very coarse grain sub angular to sub rounded poorly sorted sand, 15% volcanic sub angular to angular gravel to 3/4" (predominately 3/8-5/8"), 15% silt, moderate to common calcareous coatings and cement throughout.
6–10		Qal	SM		Common calcareous cement 7-15'.
11–15		Qal	SM		
16–20		Qal	SM		
21–23		Qal	SM		
24		Qal	SM		SILTY SAND (SM); light yellowish brown (10YR 6/4), 80% fine to coarse grain sub angular to sub rounded sand and caliche grains, 20% silt in matrix, common calcareous cement.
25			SM		SILTY SAND (SM); yellowish brown (10YR 5/4), 70% very fine to medium grain with moderate to common coarse to very coarse sub angular to sub rounded volcanic sand, 10% volcanic sub angular to sub rounded gravel to 3/8", 20% silt, common calcareous coatings and cement.
26–30		UMCf	ML		SANDY SILT (ML); very pale brown (10YR 7/4), 20-30% very fine grain sand, non-calcareous.
31–35		UMCf	ML		

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-171

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					SANDY SILT (ML); very pale brown (10YR 7/4), 20-30% very fine grain sand, non-calcareous. *(continued)*	PVC 0.010" Slotted Well Screen
37						
38						
39		UMCf	ML			
40						
41						
42						
43					SILT (ML); very pale brown (10YR 7/4), non-calcareous.	
44			ML			
45						4" Schedule 40 PVC End Cap
					Bottom of borehole at 45.0 feet bgs.	

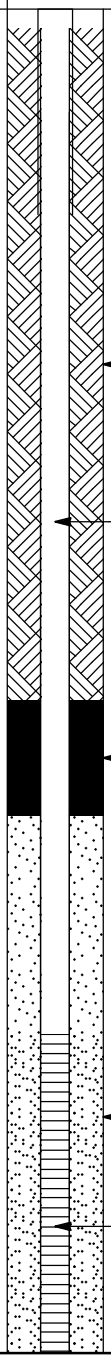
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-172

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/22/10 **COMPLETED** 4/23/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 30.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–10		Qal	SP		SILTY SAND WITH GRAVEL (SM): reddish brown (5YR 5/5), 50% very fine to very coarse sub-angular to sub-rounded sand, 30% volcanic sub-angular gravel 10 2" diameter (locally up to 4"), 20% silt, gravel to 4" @ 2.5'-3', 7'-7.5', 14'-14.5', and 21'-21.5', with calcareous grain coatings.
11–22		Qal	SP		
23–30		Qal	SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM): pinkish gray (10YR 7/2), 60% very fine to very coarse sub-angular to sub-rounded sand, 25% sub-angular volcanic pea gravel to 1/2", 15% silt, common calcareous grain coatings and locally hard caliche zones, (22.5-30.5 common nodules to 2", and very hard 27'-27.3').
31–35		UMCf	ML		SILT AND SANDY SILT (ML): very pale brown (10YR 7/4), locally up to 30% very fine grained sand, scattered caliche nodules to 3/4".

WELL DIAGRAM



(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-172

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

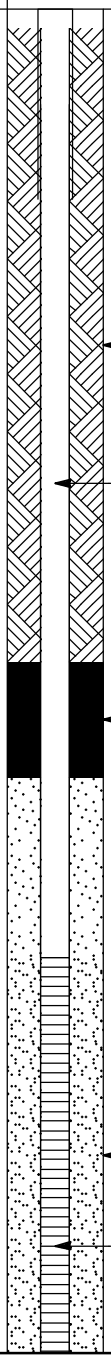
DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36 37 38		UMCf	ML		SILT AND SANDY SILT (ML): very pale brown (10YR 7/4), locally up to 30% very fine grained sand, scattered caliche nodules to 3/4". *(continued)*	
					Bottom of borehole at 38.0 feet bgs.	

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-173

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/22/10 **COMPLETED** 4/22/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 29.50 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–15		Qal	SP-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM): reddish brown (5Y 5/4), 60% very fine to very coarse sub-angular to sub-rounded sand, 30% volcanic sub-angular to sub-rounded pea gravel to 1/2", 10% silt, locally common calcareous grain coatings and caliche nodules (5'-6' hard calichified zone). Hard calichified zone 13'-14'.
16–18		Qal	GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND (GW): reddish brown (5YR 5/5), 60% volcanic sub-angular gravel to 2", 30% fine to very coarse sub-angular to sub-rounded sand, 10% silt.
19–20		Qal	SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM): yellowish brown (10YR 5/4), 60% fine to very coarse sub-angular to sub-rounded sand, 30% volcanic sub-angular gravel to 1", 10% silt.
21–23		Qal	SP		POORLY GRADED SAND (SP): very pale brown (10YR 7/4), 100% very fine to fine grained sub-angular sand.
24–25		Qal	SM		SILTY SAND WITH GRAVEL (SM): light yellowish brown (10YR 6/4), 60% fine to very coarse sub-angular to sub-rounded sand, 20% volcanic pea gravel to 3/8", 20% silt, minor calcareous grain coatings.
26–29		Qal	SM		SILTY SAND (SM): very pale brown (10YR 7/4), 60% fine to very coarse sub-angular to sub-rounded sand, 30% silt, 10% volcanic pea gravel to 1/4", abundant hard caliche layers 28'-29.5'.
30–35		UMCf	ML	▽	SILT (ML): very pale brown (10YR 7/4)



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-173

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					SILT (ML): very pale brown (10YR 7/4) *(continued)*	
37						
38		UMCf	ML			
39						
40						
					Bottom of borehole at 40.0 feet bgs.	

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

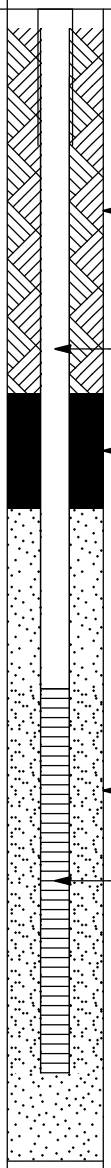
WELL NUMBER M-174

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/22/10 **COMPLETED** 4/22/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 20.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–10		Qal	SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM): reddish brown (5YR 5/4), 60% very fine to very coarse sub-angular to sub-rounded sand, 25% pea gravel to 1/2", 15% silt, common calcareous grain coatings.
11–18		Qal	GP-GM		POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM): grayish brown (10YR 5/2), 60% volcanic sub-angular to angular gravel to 1" diameter, 30% very fine to very coarse sub-angular to sub-rounded sand and 10% silt, common calcareous grain coatings
19–21		Qal	SM	▽	SILTY SAND (SM): light yellowish brown (10YR 6/4), 70% fine to medium with very coarse sand, 20% silt, 10% pea gravel to 1/4", common calichified layers
22–24		Qal	GP-GM		POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM): very pale brown (10YR 7/4), 70% pea gravel to 3/4", 20% very fine to very coarse sand, 10% silt, common hard caliche layers 3"-5" thick.
25–30		UMCf	ML		SILT AND SILT WITH SAND (ML): very pale brown (10YR 7/4), locally 30% very fine grained sand, scattered caliche nodules to 1/2".

Bottom of borehole at 30.0 feet bgs.

WELL DIAGRAM



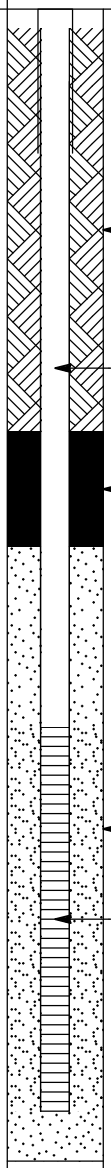
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-175

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/21/10 **COMPLETED** 4/21/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 21.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–13		Qal	SM		SILTY SAND WITH GRAVEL (SM): reddish brown (5YR 5/4), 60% very fine to very coarse sub-angular to sub-rounded sand, 20% volcanic sub-angular pea gravel to 1/2", 20% silt, sparse calcareous grain coatings throughout.
14–25		Qal	GM		SILTY GRAVEL WITH SAND (GM): light brownish gray (10YR 6/2), 50% volcanic gravel to 1/2" trace gravel to 2-3", 30% very fine to very coarse sand, 20% silt.
20					Silty sand (30% silt).
21				▽	
23					Hard calichified zone (22.5'-25').
26–30		UMCf	ML		SILT AND SANDY SILT (INTERBEDDED) (ML): very pale brown (10YR 7/4), locally 20-30% very fine grained sand, scattered caliche nodules to 1".
					Bottom of borehole at 30.0 feet bgs.

WELL DIAGRAM



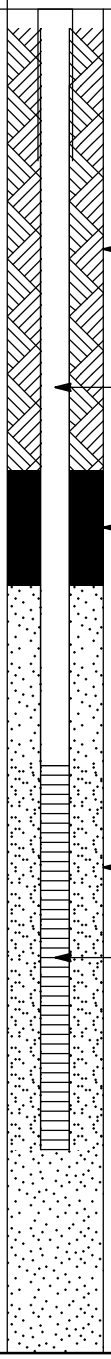
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-176

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/21/10 **COMPLETED** 4/21/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 23.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	GM		SILTY GRAVEL WITH SAND (GM): reddish brown (5YR 5/4), 50% volcanic angular to sub-rounded gravel 1/4"-2" trace to 3", 30% very fine to very coarse sub-angular to sub-rounded sand, 20% silt, common soft calcareous grain coatings @ 1.5'-2- and 5'-5.5'.
6–15		Qal	GM		
16–17		Qal	GM		Gravel up to 3" diameter from 16'-17'.
18–20					Semi-hard calichified pea gravel (to 3/8") from 18'-20'.
21–22		Qal	SM		SILTY SAND WITH GRAVEL (SM): yellowish brown (10RY 5/4), 60% fine to very coarse sub-angular to sub-rounded sand, 20% pea gravel to 3/8", 20% silt.
23–24		Qal	ML	▽	SILT WITH SAND (ML): white (5Y 8/1), 20% very fine grained sand, common caliche nodules to 1".
25–27		Qal	SM		SILTY SAND (SM): light brownish gray (10YR 6/2), 70% very fine to medium sub-angular to sub-rounded sand, 30% silt
28–30		Qal	SM		SILTY SAND WITH GRAVEL (SM): light brownish gray (10YR 6/2), 60% very fine to very coarse sub-angular to sub-rounded sand, 20% volcanic gravel to 1/2", 20% silt.
31–35		UMCf	ML		SILT AND SILT WITH SAND (INTERBEDDED) (ML): very pale brown (10YR 7/4), 20% very fine grained sand, scattered caliche nodules to 1" Caliche zone 32.5'-33'.

WELL DIAGRAM



Bottom of borehole at 35.0 feet bgs.

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

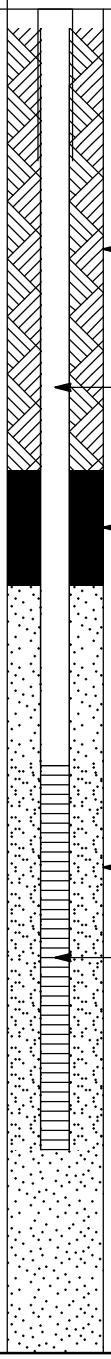
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-177

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 4/21/10 **COMPLETED** 4/21/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR Boart Longyear
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 23.50 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SM		SILTY SAND WITH GRAVEL (SM): reddish brown (5YR 5/4), 35% very fine to coarse with 15-25% very coarse sub-angular to sub-rounded sand, 20% volcanic angular to sub-angular gravel to 2" with minor scattered gravel to 3"-4", 20% silt, minor calcareous grain coatings and caliche nodules to 1".
6–10		Qal	SM		
11–15		Qal	SM		
16–20		Qal	SM		
21–23		Qal	SM		
24		Qal	SM		▽ SILTY SAND (SM): white (5Y 8/1), 50-60% very fine grained sub-angular to sub-rounded sand, common caliche nodules to 1/2",
25–35		UMC	ML		SILT AND SILT WITH SAND (INTERBEDDED) (ML): very pale brown (10YR 7/4), 20-30% very fine grained sub-angular sand, scattered caliche nodules to 1/2".

WELL DIAGRAM



Bottom of borehole at 35.0 feet bgs.

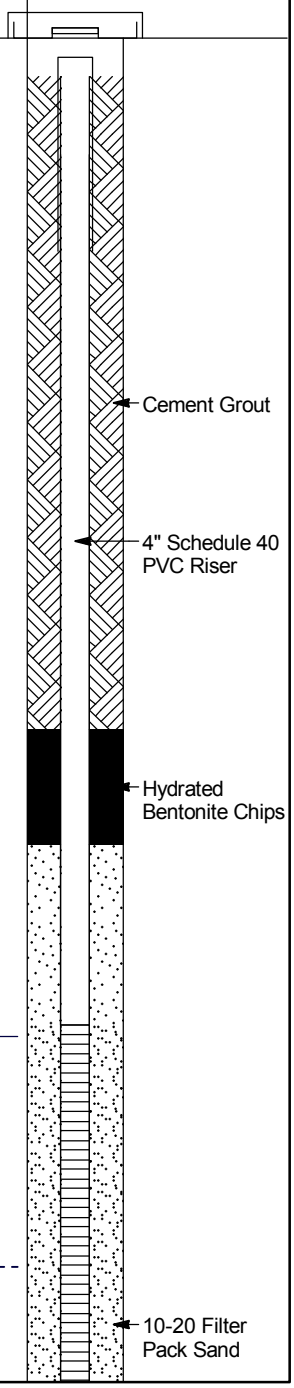
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-178

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/6/10 **COMPLETED** 6/7/10
TOC ELEVATION
HOLE SIZE 8"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 27.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 70% very fine to medium with common coarse to very coarse sub angular to sub rounded poorly sorted sand, 10-20% volcanic angular to sub angular gravel to 1/2" with trace 1" diameter, 15-20% silt in matrix, moderate calcareous coatings and soft cement.
6–10		Qal	SM		Common cement, 5-14'.
11–15		Qal	SM		6" zone with volcanic cobble to 4" at 14'.
26–30		UMCf	ML		∇ SILT (ML); very pale brown (10YR 7/4), 10% very fine grain sand. Semi-hard calichified silt at 26-27'. Common caliche nodules to 1" at 27-30'.
31–35		UMCf	ML		SILT WITH SAND (ML); very pale brown (10YR 7/4), 20-30% very fine grain sand.

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-178

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					SILT WITH SAND (ML); very pale brown (10YR 7/4), 20-30% very fine grain sand. *(continued)*	4" Schedule 40 PVC 0.010" Slotted Well Screen
37						
38						
39						
40					SILT, Very pale brown (10YR 7/4).	
41		UMCf	ML		SILT WITH SAND (ML), Very pale brown (10YR 7/4), 20-30% very fine grain sand.	
42						
43						
44						
45					Common caliche nodules to 1" at 44'-46'.	
46						4" Schedule 40 PVC End Cap

Bottom of borehole at 46.0 feet bgs.

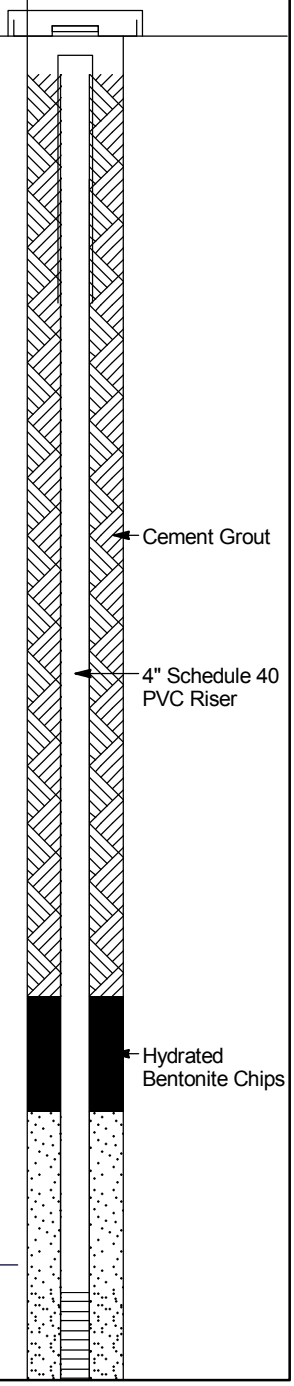
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-179

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/5/10 **COMPLETED** 6/6/10
TOC ELEVATION
HOLE SIZE 8"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 35.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 60-70% very fine to medium with moderate to common coarse to very coarse grain moderately sorted sub angular to sub rounded sand, 10-15% angular to sub angular volcanic gravel to 5/8", 20% silt, moderate to common calcareous coatings throughout. Semi-hard calcareous cement at 3-3.5', 8-15', and 30-32.5'.
6–10		Qal	SM		
11–15		Qal	SM		
16–20		Qal	SM		
21–25		Qal	SM		
26–30		Qal	SM		Layer with 20-30% angular to sub angular gravel, with pebbles to 2-3" at 29-30'.
31–35		Qal	GP-GM		POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM); white (5Y 8/1), 50% angular to sub angular volcanic granules to 1/2" trace 1" to 1-1/2", 40% fine to very coarse sub angular to sub rounded sand, 10% silt, common to abundant hard caliche.

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

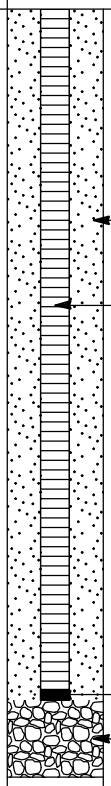
WELL NUMBER M-179

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
36		Qal	SM		SILTY SAND WITH GRAVEL (SM); yellowish brown (10YR 5/4), 60% very fine to medium with common coarse to very coarse poorly sorted sand, 25% silt, 15% angular to sub angular volcanic gravel to 1/2", common calcareous cement.
37		UMCf	ML		SILT (ML); very pale brown (10YR 7/4), 1-2% floating medium to coarse grain sub angular to sub rounded sand.
38					
39		UMCf	ML		SILT WITH SAND (ML); very pale brown (10YR 7/4), 10-20% very fine grain sand, scattered caliche nodules to 1-1/2".
40					
41					SILT (ML); very pale brown (10YR 7/4), coarse grain silt to 50', then fine grain silt, minor scattered caliche nodules to 3/4".
42					
43					
44					
45					
46					
47					
48		UMCf	ML		
49					
50					
51					
52					
53					
54					
55					

Bottom of borehole at 55.0 feet bgs.



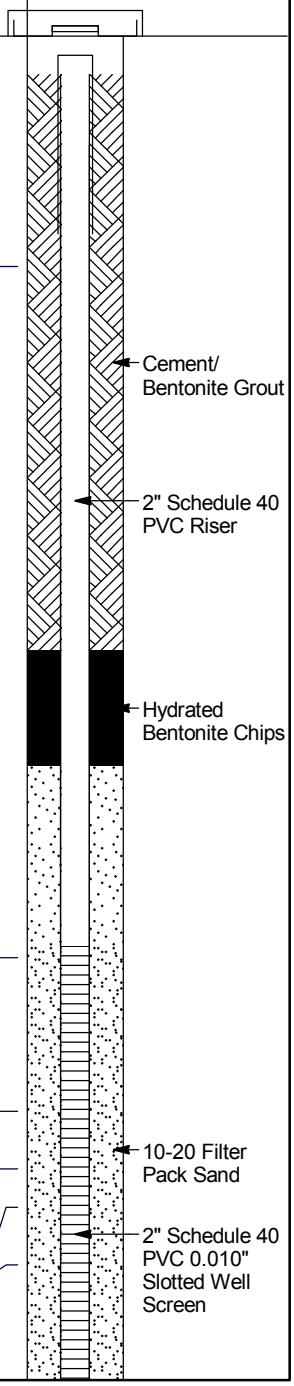
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-180

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/5/10 **COMPLETED** 6/5/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 24.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal			FILL; brown and dark yellowish brown, sands, gravels, cement debris.
6–15		Qal	SM		SILTY SAND (SM); reddish brown (5Y 5/4), 60-65% very fine to medium grain with common coarse to very coarse grain sub angular to sub rounded sand, 5-10% angular to sub angular volcanic gravel to 3/4", 20% silt, common calcareous coatings and soft cement throughout.
16–24		Qal	SM		Varying amount of calichification, abundant and hard from 18.5-19' and 23-24'.
24–28		Qal	SW-SM		∇ WELL GRADED SAND WITH SILT (SW-SM); grayish brown (10YR 5/2), fine to coarse grain sand, <10% silt to 26' then 20% silt, 10-15% volcanic angular to sub angular gravel to 1/2" with trace to 1-2", non calcareous to 26' then moderately calcareous to 28'.
29		Qal	ML		SILT (ML); yellowish brown (10YR 5/4), common to abundant hard to soft caliche zones and nodules.
30		Qal	SW		SAND (SW); yellowish brown (10YR 5/4), fine to coarse grain poorly sorted sub angular to sub rounded sand, 5-10% volcanic angular to sub angular gravel to 3/8", 6" bed of angular to sub angular gravel to 1" in silty matrix at 30'.
31–32		UMCf	CL		CLAY (CL); very pale brown (10YR 8/2), abundant caliche zones and nodules to 3-4".
33–35		UMCf	ML		SILT WITH SAND (ML); very pale brown (10YR 7/4), coarse grain silt, 10-20% very fine grain sand, non calcareous.

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

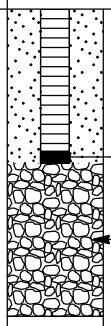
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-180

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36		UMCf	ML		SILT (ML); very pale brown (10YR 7/4), coarse grain silt, trace very fine grain sand.	
37						
38						
39						2" Schedule 40 PVC End Cap
40		UMCf	ML			
41						Native Fill
42						
43						
					Bottom of borehole at 43.0 feet bgs.	

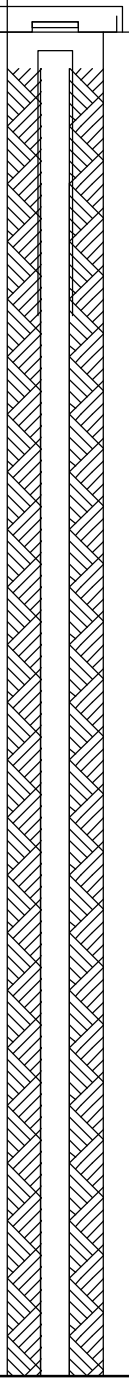


northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-181

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/3/10 **COMPLETED** 6/4/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 32.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1–5		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 70% fine to medium grain with common coarse to very coarse grain sub angular to sub rounded sand, 15% silt in matrix, 15% angular to sub angular volcanic gravel to 1/2". Moderate to common calcareous grain coatings throughout. Cobbles up to 2-3" at 2.5' and 4.5'.	
6–10						
11–13						
13–15		Qal	SM		SILTY SAND (SM); reddish brown (5YR 5/4), 65-70% very fine to fine grain with minor medium to coarse grain sand, 25-40% silt in matrix, 5% fine gravel to 3/8", common to moderate calcareous grain coatings.	
16–20						
21–25					Increasing grain size with common medium to coarse grain sub angular to sub rounded sand, 22-25'.	
26–30						
31–32					∇ 6" zone of abundant caliche cement and grain coatings (moderately soft) at 31.5'.	
33–35		UMCf	ML		SILT (ML); light yellowish brown (10YR 6/4), 80% silt, 10% clay, 10% very fine grain sand, trace floating medium to coarse grain volcanic sub rounded sand, scattered caliche nodules to 3/8".	
36–37						



GENERAL NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-181

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
38, 39, 40, 41, 42, 43, 44, 45		UMCf	ML		SILT (ML); light yellowish brown (10YR 6/4), 80% silt, 10% clay, 10% very fine grain sand, trace floating medium to coarse grain volcanic sub rounded sand, scattered caliche nodules to 3/8". *(continued)* 6" zone of moderately hard caliche, clayey, very pale brown (10YR 8/2) at 38'.	
46, 47, 48, 49, 50, 51, 52						Cement Grout
53, 54, 55, 56, 57, 58, 59, 60		UMCf	ML		SILT WITH SAND (ML); light yellowish brown (10YR 6/4), 20-30% very fine grain sand, 5-10% clay, non-calcareous.	2" Schedule 40 PVC Riser
61, 62, 63, 64, 65		UMCf	ML		SILT (ML); very pale brown (10YR 8/2) and light yellowish brown (10YR 6/4) mottled, very pale brown material is clayey (10-20%) and calcareous.	
66, 67, 68, 69, 70		UMCf	SM		SILTY SAND (SM); light yellowish brown (10YR 6/4), 60% very fine grain sand, 40% silt.	
71, 72					2-4% coarse and very coarse grain sand and fine sub angular to sub rounded gravel to 3/8" floating in sand/silt matrix.	
73, 74, 75, 76, 77, 78, 79		UMCf	ML		SILT (ML); light yellowish brown (10YR 6/4), 10% very fine grain sand, non-calcareous.	

GENERAL NORTHGATE ENV _ FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

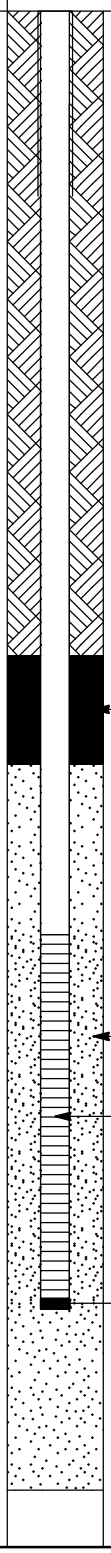
WELL NUMBER M-181

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
80		UMCf	ML		SILT (ML); light yellowish brown (10YR 6/4), 10% very fine grain sand, non-calcareous. *(continued)*
81					
82		UMCf	SM		SILTY SAND (SM); light yellowish brown (10YR 6/4), 65-70% very fine to fine grain sand with 2-5% floating medium to very coarse grain sand and gravel to 5/8", 20% silt in matrix, non-calcareous.
83					
84					
85					
86					Silt decreases to <5%, clean sand (fine to medium with coarse to very coarse), 1-2% gravel to 1/2".
87		UMCf	ML		SILT (ML); light yellowish brown (10YR 6/4), 10% very fine grain sand.
88					
89					
90					
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					
101					
102					
103					
104					
105					
106		UMCf	SM		SILTY SAND (SM); grayish brown (10YR 5/2), 70% fine to medium grain with minor coarse to very coarse grain sub angular to sub rounded sand, 30% silt, trace clay.
107					
108					
109					
110					
111					6" calcareous zone, up to 40% silt/clay, common soft caliche and grain coatings (nodules and irregular zones) at 110'.
112		UMCf	ML		SILT, light yellowish brown (10YR 6/4), 10% very fine grain sand.
113					
114					
115					
116					
117					
118					
119					
120		UMCf	SP		WELL GRADED SAND (SW); grayish brown (10YR 5/2), 90% fine to medium grain with common coarse and very coarse grain sub angular to sub rounded volcanic sand, 10% granules to 3/8", common semi-hard calcareous grain coatings and cement, 10%

WELL DIAGRAM



(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-181

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
					silt in matrix.	

Bottom of borehole at 120.0 feet bgs.

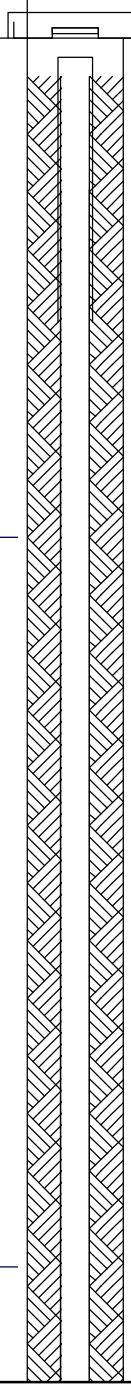
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-182

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/4/10 **COMPLETED** 6/4/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 32.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES: M-182 is 10' north of M-181. Lithologic descriptions from M-181.

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 70% fine to medium grain with common coarse to very coarse grain sub angular to sub rounded sand, 15% silt in matrix, 15% angular to sub angular volcanic gravel to 1/2". Moderate to common calcareous grain coatings throughout. Cobbles up to 2" - 3" in upper five feet.
6–10		Qal	SM		
11–13		Qal	SM		
14–15		Qal	SM		SILTY SAND (SM); reddish brown (5YR 5/4), 65-70% very fine to fine grain with minor medium to coarse grain sand, 25-40% silt in matrix, 5% fine gravel to 3/8", common to moderate calcareous grain coatings.
16–20		Qal	SM		
21–25		Qal	SM		Increasing grain size with common medium to coarse grain sub angular to sub rounded sand, 22-25'.
26–30		Qal	SM		
31–32		Qal	SM	∇	
33–35		UMCf	ML		SILT (ML); light yellowish brown (10YR 6/4), 80% silt, 10% clay, 10% very fine grain sand, trace floating medium to coarse grain volcanic sub rounded sand, scattered caliche nodules to 3/8".

WELL DIAGRAM



GENERAL_NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-182

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					SILT (ML); light yellowish brown (10YR 6/4), 80% silt, 10% clay, 10% very fine grain sand, trace floating medium to coarse grain volcanic sub rounded sand, scattered caliche nodules to 3/8". *(continued)*	Cement Grout
37						
38						
39						
40						2" Schedule 40 PVC Riser
41						
42						
43						
44		UMCf	ML			
45						
46						
47						
48						
49						
50						
51						
52					SILT WITH SAND (ML); light yellowish brown (10YR 6/4), 20-30% very fine grain sand, 5-10% clay, non-calcareous.	
53						
54						
55						
56						
57		UMCf	ML			
58						
59						
60						
61						
62					SILT (ML); very pale brown (10YR 8/2) and light yellowish brown (10YR 6/4) mottled, very pale brown material is clayey (10-20%) and calcareous.	
63						
64		UMCf	ML			
65						
66					SILTY SAND (SM); light yellowish brown (10YR 6/4), 60% very fine grain sand, 40% silt.	
67						
68						
69		UMCf	SM			
70						
71					2-4% coarse and very coarse grain sand and fine sub angular to sub rounded granvel to 3/8" floating in sand/silt matrix.	
72						
73					SILT (ML); light yellowish brown (10YR 6/4), 10% very fine grain sand, non-calcareous.	
74		UMCf	ML			Hydrated Bentonite Chips
75						

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

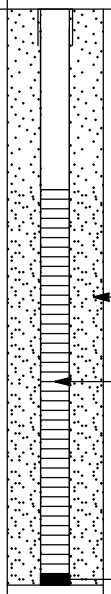
WELL NUMBER M-182

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
76					SILT (ML); light yellowish brown (10YR 6/4), 10% very fine grain sand, non-calcareous. *(continued)*
77					
78		UMCf	ML		
79					
80					
81					
82					SILTY SAND (SM); light yellowish brown (10YR 6/4), 65-70% very fine to fine grain sand with 2-5% floating medium to very coarse grain sand and gravel to 5/8", 20% silt in matrix, non-calcareous.
83					
84		UMCf	SM		
85					
86					Silt decreases to <5%, clean sand (fine to medium with coarse to very coarse), 1-2% gravel to 1/2".
87					SILT (ML); light yellowish brown (10YR 6/4), 10% very fine grain sand.
88		UMCf	ML		
89					
90					
					Bottom of borehole at 90.0 feet bgs.

WELL DIAGRAM



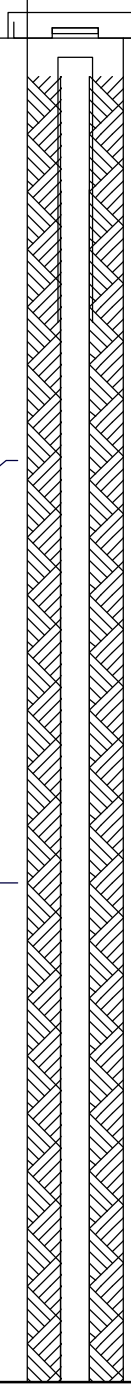
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-186

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/1/10 **COMPLETED** 6/2/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 38.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM); reddish brown (5YR 5/4), 70% very fine to medium with moderate coarse to very coarse grained sub angular to sub rounded sand, 20% volcanic angular to sub angular pea gravel to 1/2", 10% silt, moderate calcareous grain coatings.
6–10		Qal	SW-SM		
11					6" zone of 2"-3" cobbles @10.5'.
11–15		Qal	SM		SILTY SAND (SM); reddish brown (5YR 5/4), 70-80% very fine to medium grain with common coarse to very coarse grain sub angular to sub rounded sand, 1-2% gravel to 1/4", 20-30% silt, common calcareous cement and grain coatings.
16–20		Qal	SM		
21–22		Qal	SM		
23–25		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 60% very fine to coarse grain sub rounded to sub angular moderately poorly sorted sand, 20% pea gravel to 3/4" trace 2"-3", 20% silt. Common calcareous coatings 22'-25', slight to moderate calcareous coatings elsewhere.
26–30		Qal	SM		
31–35		Qal	SM		

WELL DIAGRAM



(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-186

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36, 37, 38		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 60% very fine to coarse grain sub rounded to sub angular moderately poorly sorted sand, 20% pea gravel to 3/4" trace 2"-3", 20% silt. *(continued)*	
39, 40, 41, 42, 43, 44, 45		Qal	SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM); reddish brown (5YR 5/4), wet, 80% fine to medium grain with minor coarse to very coarse grain sub angular to sub rounded moderately well sorted sand, 10% volcanic sub angular gravels to 3/8", 10% silt. Common caliche nodules and calcareous cement (semi-hard) 42'45'.	
46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56		UMCf	ML		SILT (ML); very pale brown (10YR 7/4), 6" hard caliche @ 46'.	Cement Grout 2" Schedule 40 PVC Riser
57, 58, 59, 60, 61, 62, 63		UMCf	SM		SILTY SAND (SM); very pale brown (10YR 7/4), 55% very fine to medium grain with minor coarse to very coarse grain sub angular to sub rounded sand, 2-5% floating sub rounded gravel to 1/4", 40% silt.	
64, 65, 66, 67, 68, 69, 70		UMCf	ML		SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), locally with very fine grain sand, 0-10% clay, non-calcareous. Sandy with 20-30% very fine grain sand from 63'-70'. Moderate caliche nodules to 3/4" from 67'-70'.	
71, 72, 73, 74, 75					Silt 70' - 75'.	

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-186

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
76					SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), locally with very fine grain sand, 0-10% clay, non-calcareous. *(continued)*	
77					30-40% very fine grain sand, 75' - 80'.	
78						
79						
80						
81		UMCf	ML		Silt, 80' - 83'.	
82						
83						
84					20-30% very fine grain sand.	
85						
86		UMCf	SW		WELL GRADED SAND (SW); yellowish brown (10YR 5/4), 90% fine to medium grain with coarse to very coarse grain sand, 1-2" granules to 1/4", 5-10% silt.	
87					SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), 10YR 8/2 where calcareous, locally with very fine grain sand.	
88						
89						
90					20-30% very fine grain sand, non calcareous, 86'-90'	
91					Silt, 90' - 92'.	
92						
93					20-30% very fine grain 1-2% coarse to very coarse grain sand, 92' - 93'.	
94					Silt, abundant calcareous cement very pale brown (10YR 8/2), 93' - 95'.	
95						
96		UMCf	ML		Silt, 10% very fine grain sand, 95' - 106'.	
97						
98						
99						Hydrated Bentonite Chips
100						
101						
102						
103						
104						
105						
106						
107		UMCf	SW-SM		WELL GRADED SAND WITH SILT (SW-SM); yellowish brown (10YR 5/4), 75% very fine to medium grain with coarse to very coarse grain sub angular to sub rounded sand, 15% volcanic granules to 1/4" and pebbles to 1", 10% silt, common calcareous cement.	10-20 Filter Pack Sand
108						
109					SILT (ML); Very pale brown (10YR 8/2), common caliche nodules to 1".	
110		UMCf	ML			2" Schedule 40 PVC 0.010" Slotted Well Screen
111						
112						
113					SILT WITH SAND (ML); light yellowish brown (10YR 6/4), 20-30% very fine grain sand.	
114		UMCf	ML			
115						

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-186

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

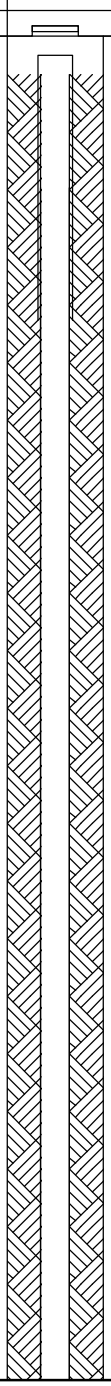
DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
116					SILT WITH SAND (ML); light yellowish brown (10YR 6/4), 20-30% very fine grain sand. *(continued)*	2" Schedule 40 PVC End Cap
117						
118		UMCf	ML			
119						
120						
					Bottom of borehole at 120.0 feet bgs.	

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-187

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 5/24/10 **COMPLETED** 5/25/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ▽ **AT TIME OF DRILLING** 40.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	RECOVERY %	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1–5				SM		SILTY SAND FILL (SM); gray black (N2), 60% very fine to medium grain sand, 40% silt.	
6–10							
11–17				GM		SILTY GRAVEL WITH SAND (GM); yellowish brown (10YR 5/4), 50% angular to sub angular gravel to 3/4", 30% very fine to medium grain sand, cobbles to 4" from 13-13.5' and 16.5-17', moderate calcareous coatings throughout.	
18–35				SM		SILTY SAND (SM); grayish brown (10YR 5/2), 65% very fine to fine grain with minor sub angular medium to very coarse grain sand, 25% silt, 10% angular to sub angular volcanic gravel to 1/2". Slight to common calichification from 30'-32'. Abundant caliche and calcite veinlets, very pale brown (10YR 8/2) from 32-36'.	



(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-187

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	RECOVERY %	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36				SM		Abundant caliche and calcite veinlets, very pale brown (10YR 8/2) from 32-36'. *(continued)*	
37						SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), Silt from 36-40'.	
38							
39							
40						▽ Sandy silt, very fine grain sand with 1-2% medium to very coarse grain sub rounded sand.	
41							
42							
43							
44							
45							
46							
47							
48							
49							
50							
51						Silt, very pale brown (10YR 8/2), common calcification.	
52							
53							
54							
55							
56				ML			
57							
58							
59							
60							
61							
62							
63						Sandy silt, 20-30% very fine grain with 2-3% floating medium to coarse grain sub rounded sand.	
64							
65							
66						Silt, moderate calcareous grain coatings, caliche nodules to 1/4".	
67							
68							
69							
70						Sandy silt, 20-30% very fine grain with 2-3% floating medium to coarse grain sub rounded sand.	
71							
72						Silt.	
73							
74							
75							

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-187

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	RECOVERY %	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
76						SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), *(continued)*	
77						Sandy silt, 20-30% very fine grain sand.	Cement Grout
78							
79							
80							2" Schedule 40 PVC Riser
81							
82							
83						Silt with common caliche nodules to 1/2" and irregular zones, mottled very pale browns (10YR 7/4 and 10YR 8/2).	
84							
85							
86						Silt.	
87							
88						Silt with common irregular caliche zones from 87-94'.	
89							
90							
91							
92							
93							
94							
95				ML			
96							
97							
98							
99						Sandy silt, 20% very fine grain sand.	
100							
101						Silt, common caliche nodules and irregular calichified zones, mottled very pale browns (10YR 7/4 and 10YR 8/2).	
102							
103							
104							
105							
106							
107							
108							
109							
110							
111							
112							
113							
114							
115							

GENERAL_NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-187

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	RECOVERY %	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
116	Split Spoon #1		100			SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), *(continued)*	
117						Sandy silt, 10-30% very fine grain sand.	
118							
119							
120							
121							
122							
123							
124				ML		Silt, common calichification.	
125							
126							
127						Sandy Silt, 10-20% very fine grain sand.	
128							
129						Silt.	
130							
131							
132							
133							
134						LEAN CLAY (CL); grayish yellowish green (5GY 6/2) to 136' then light gray (5Y 7/2), 80% clay, 20% silt.	
135							
136				CL			
137							
138							
139							
140						SILT (ML); Very pale brown (10YR 7/4).	
141							
142							
143							
144							
145							
146							
147				ML			
148							
149							
150							
151							
152							
153						Common calcareous zones, very pale brown mottles from 152'-155'.	
154							Hydrated Bentonite Chips
155							

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

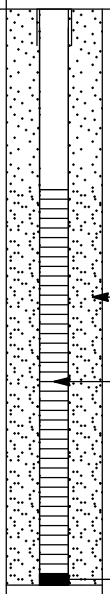
WELL NUMBER M-187

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	RECOVERY %	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
156						SILT WITH SAND (ML); gray orange, trace caliche nodules to 1/2".
157						
158						
159				ML		
160						
161						
162						
163						SILT (ML); moderate to common caliche nodules to 1/2".
164						
165						
166	Split Spoon #2		100	ML		Clay, very pale brown (10YR 8/2), calcareous from 165.5' - 166'.
167						
168						
169						
170						
						Bottom of borehole at 170.0 feet bgs.

WELL DIAGRAM



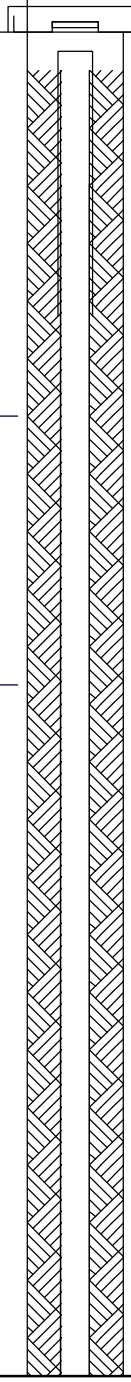
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-188

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 5/25/10 **COMPLETED** **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ▽ **AT TIME OF DRILLING** 40.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: M-188 is 10' south of M-187. Lithologic descriptions are from M-187.

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–10			SM		SILTY SAND FILL (SM); gray black (N2), 60% very fine to medium grain sand, 40% silt.
11–17			GM		SILTY GRAVEL WITH SAND (GM); yellowish brown (10YR 5/4), 50% angular to sub angular gravel to 3/4", 30% very fine to medium grain sand, cobblesto 4" from 13-13.5' and 16.5-17', moderate calcareous coatings throughout.
18–35			SM		SILTY SAND (SM); grayish brown (10YR 5/2), 65% very fine to fine grain with minor sub angular medium to very coarse grain sand, 25% silt, 10% angular to sub angular volcanic gravel to 1/2".
31					Slight to common calichification from 30' - 32'.
33					Abundant caliche and calcite veinlets, very pale brown (10YR 8/2) from 32' - 36'.

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-188

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36			SM		Abundant caliche and calcite veinlets, very pale brown (10YR 8/2) from 32' - 36'. *(continued)*	
37					SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), Silt from 36-40'.	
38						
39						
40					▽	
41					Sandy silt, very fine grain sand with 1-2% medium to very coarse grain sub rounded sand.	
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52					Silt, very pale brown (10YR 8/2), common calcification.	Cement Grout
53						
54						
55						2" Schedule 40 PVC Riser
56			ML			
57						
58						
59						
60						
61						
62						
63						
64					Sandy silt, 20-30% very fine grain with 2-3% floating medium to coarse grain sub rounded sand.	
65						
66						
67					Silt, moderate calcareous grain coatings, caliche nodules to 1/4".	
68						
69						
70						
71					Sandy silt, 20-30% very fine grain with 2-3% floating medium to coarse grain sub rounded sand.	
72						
73					Silt.	
74						
75						

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-188

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
76					SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), *(continued)*	
77					Sandy silt, 20-30% very fine grain sand.	
78						
79						
80						
81						
82						
83					Silt with common caliche nodules to 1/2" and irregular zones, mottled very pale browns (10YR 7/4 and 10YR 8/2) from 82-85'.	
84						
85						
86					Silt.	
87						
88					Silt with common irregular caliche zones from 87-94'.	
89						
90						
91						
92						
93						
94						
95			ML			
96						
97						
98						
99					Sandy silt, 20% very fine grain sand from 98-100'.	
100						
101					Silt, common caliche nodules and irregular calichified zones, mottled very pale browns (10YR 7/4 and 10YR 8/2).	
102						
103						
104						Hydrated Bentonite Chips
105						
106						
107						
108						
109						
110						
111						
112						
113						10-20 Filter Pack Sand
114						
115						2" Schedule 40

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-188

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
116					SILT INTERBEDDED WITH SANDY SILT (ML); very pale brown (10YR 7/4), *(continued)*	PVC 0.010" Slotted Well Screen
117					Sandy silt, 10-30% very fine grain sand.	
118			ML			
119						
120						2" Schedule 40 PVC End Cap
					Bottom of borehole at 120.0 feet bgs.	

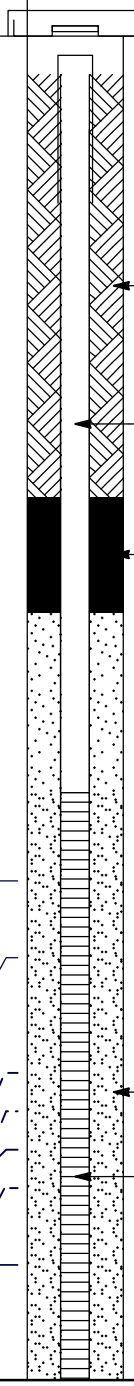
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-48A

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 6/16/10 **COMPLETED** 6/16/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ∇ **AT TIME OF DRILLING** 27.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: Replacement for damaged/plugged and abandoned monitoring well M-48

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM); reddish brown (5YR 5/4), 75% fine to coarse grain with common very coarse grain sub angular to sub rounded sand, 15% well graded granules/pea gravel to 3/8" (trace 3/8-3/4"), 10% silt.
6–10		Qal	SW-SM		Moderate calcareous cement and grain coatings, common soft calcareous cement from 10-15'.
11–15		Qal	SW-SM		
16–20		Qal	SW-SM		
21–22		Qal	SW-SM		
23–24		Qal	GM		SILTY GRAVEL WITH SAND (GM); reddish brown (5YR 5/4), 50% angular to sub rounded volcanic granules/pea gravel to 1-1/2", trace cobbles to 3", 35% very fine to very coarse grain sub angular to sub rounded sand, 15% silt, moderate to common calcareous cement/coatings throughout.
25–27		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4) to 25', light gray (10YR 7/2) to 32'. 65% very fine to medium grain with sporadic coarse to very coarse grain sub angular to sub rounded sand, 20% volcanic angular to sub rounded granules to 1/4", 15% silt, common calichified sand from 25-27', damp at 25'.
28–29		Qal	SM		85% very fine to fine grain with minor medium to coarse grain sub angular to sub rounded sand, 15% silt, 10-20% sand size calichified silt grains, calcareous.
30		Qal	SM		Gravelly at 27-28', granules to 5/8". Silty at 27-28'.
31–32		Qal	SM		Gravelly at 24-27', granules/gravel to 3/4". Calichified zone with discontinuous hard caliche.
33–35		UMCf	ML		SANDY SILT (ML); brownish yellow (10YR 6/6), 10-20% very fine grain sand to 38', 20-30% very fine grain sand to 40'.

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-48A

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

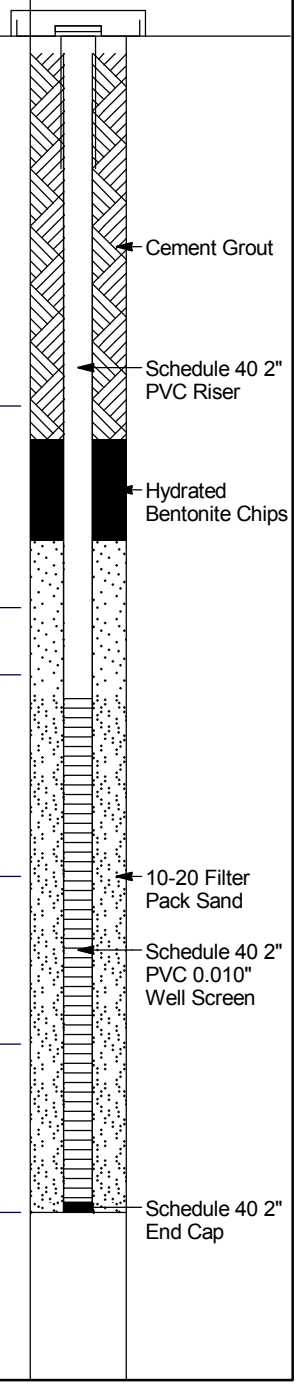
DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36					SANDY SILT (ML); brownish yellow (10YR 6/6), 10-20% very fine grain sand to 38', 20-30% very fine grain sand to 40'. *(continued)*	
37						
38		UMCf	ML			
39						
40						2" Schedule 40 PVC End Cap
					Bottom of borehole at 40.0 feet bgs.	

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-85A

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 5/17/10 **COMPLETED** 5/17/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 25.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SM		SILTY SAND (SM); reddish brown (5YR 5/4), 80% very fine to coarse grained sub rounded to sub angular sand with up to 5% pea gravel to 3/8", 15-20% silt, calcareous coatings throughout.
6–10		Qal	SM		Moderately hard calichified zone 8-8.5'.
11–15		Qal	SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 60% very fine to very coarse sub angular to sub rounded sand, 25-30% volcanic sub angular gravel to 1/2", 15-20% silt, slight calcareous coatings throughout.
16–19		Qal	SM		SILTY SAND (SM); reddish brown (5YR 5/4), 80% very fine to coarse sand, 20% silt.
20–25		Qal Qal	GW-GM		WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM); reddish brown (5YR 5/4), 60% volcanic sub angular pea gravel to 1/2", 30% very fine to very coarse sub angular to sub rounded sand, 10% silt. Calcareous cemented with abundant calcareous grain coatings, white (5Y 8/1), silt up to 30%, wet at 25'.
26–30		UMC	ML		SILT (ML); very pale brown (10YR 7/4), abundant calcareous grain coatings, 10-15% floating medium to coarse sub rounded sand grains.
31–35		UMC	ML		SILT (ML); very pale brown (10YR 7/4), minor interbedded sandy silt, trace clay.
					Bottom of borehole at 35.0 feet bgs.



GENERAL NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

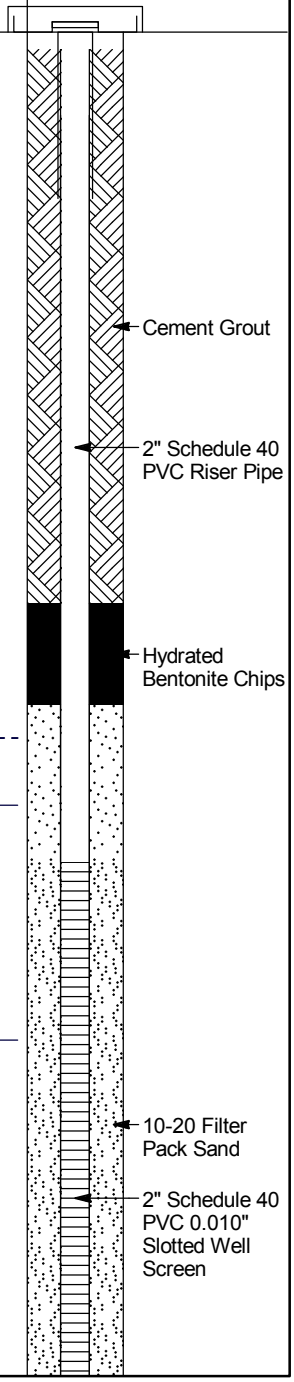
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-86A

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 5/17/10 **COMPLETED** 5/17/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 30.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5		Qal	SM		SILTY SAND (SM); reddish brown (5YR 5/4), 70% very fine to medium with minor coarse to very coarse angular to sub rounded sand, 15% floating volcanic angular to sub angular granules/pea gravel to 3/8", 15% silt in matrix, calcareous grain coatings throughout.
6–10		Qal	SM		Moderately cemented calichified layer at 9'-10'.
11–15		Qal	SM		Moderately cemented calichified layer at 12'-12.5'. Minor large gravel to 1". Moderately cemented calichified layer at 13'-14'.
16–20		Qal	SM		Moderately cemented calichified layer at 19'-21'.
21–23					Gravel to 25% with clasts up to 1/2", 15% silt, moderate calcareous coatings, very pale brown (10YR 8/2), 21'-23'.
24–30		Qal	SM		SILTY SAND (SM); dark reddish brown (5YR 2.5/2) and very pale brown (10YR 8/2), 70% very fine to fine grained with trace medium to very coarse sub angular to sub rounded sand, 30% silt, semi-hard caliche, wet @ 30'.
31–40		UMC	ML		SILT (ML); very pale brown (10YR 7/4), 10% floating medium to coarse sub rounded sand grains.

WELL DIAGRAM



GENERAL_NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER M-86A

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
41 42		UMCf	ML		SILT WITH GRAVEL (ML); yellowish brown (10YR 5/4), 70% silt, 10% very fine grain sand, 20% floating sub rounded gravel to 3/8".	
43 44 45		UMCf	ML		SILT (ML); light yellowish brown (10YR 6/4), 10-15% floating medium to coarse grain sub rounded volcanic sand, trace sub rounded volcanic gravel to 3/4", caliche nodules throughout.	2" Schedule 40 PVC End Cap
					Bottom of borehole at 45.0 feet bgs.	

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-134A

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 6/21/10 **COMPLETED** 6/22/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ∇ **AT TIME OF DRILLING** 26.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: PC-134A is 15' north of PC-134. See lithology log of PC=134 for lithology

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26			∇	
27				Cement/ Bentonite Grout
28				
29				
30				
31				2" Schedule 40 PVC Riser
32				
33				
34				
35				

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-134A

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

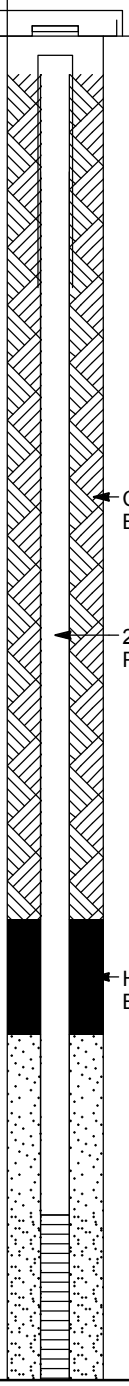
DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				Hydrated Bentonite Chips
55				
56				
57				
58				
59				
60				
61				
62				
63				10-20 Filter Pack Sand
64				
65				2" Schedule 40 PVC 0.010" Slotted Well Screen
66				
67				
68				
69				
70				2" Schedule 40 PVC End Cap

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-135A

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 7/1/10 **COMPLETED** 7/2/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ∇ **AT TIME OF DRILLING** 32.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: PC-135A is 20' north of PC-135. See lithology log of PC-135 for lithologic description

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				Cement/ Bentonite Grout
13				
14				
15				
16				2" Schedule 40 PVC Riser
17				
18				
19				
20				
21				
22				
23				
24				
25				Hydrated Bentonite Chips
26				
27				
28				
29				
30				
31				
32			∇	
33				
34				
35				



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

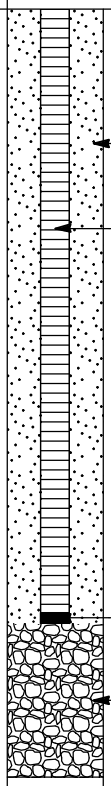
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-135A

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36				
37				
38				
39				8-12 Filter Pack Sand
40				
41				2" Schedule 40 PVC 0.020" Slotted Well Screen
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				2" Schedule 40 PVC End Cap
52				
53				Native Fill
54				
55				



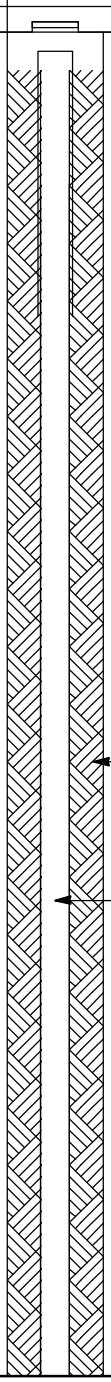
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-141

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/17/10 **COMPLETED** 6/17/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 25.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–15			SP-SM		POORLY GRADED SAND WITH SILT AND GRAVEL(SP-SM); reddish brown (5YR 5/4), 70% very fine to medium grain with minor coarse grain sub rounded to sub angular sand, 20% angular to sub angular volcanic granules/pea gravel to 1", 10% silt, moderate calcareous cement/grain coatings.
16–32			SM		SILTY SAND WITH GRAVEL (SM); light gray (10YR 7/2), 65% very fine to medium grain with minor very coarse grain sub angular to sub rounded sand, 15% angular to sub rounded volcanic granules/pea gravel to 1" (29-30' common cobbles to 4"), 20% silt, common calcareous coatings, locally common hard discontinuous caliche from 24-32'.
33–35			CL		LEAN CLAY (CL); light greenish gray (5GY 8/1) to 35', yellowish gray to 40', common caliche nodules to 2" form 38-40'.

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

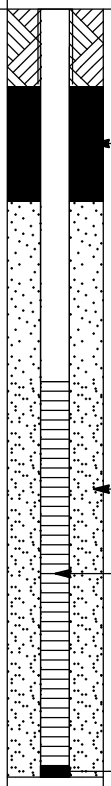
WELL NUMBER PC-141

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
36, 37, 38, 39, 40			CL		LEAN CLAY (CL); light greenish gray (5GY 8/1) to 35', yellowish gray to 40', common caliche nodules to 2" form 38-40'. *(continued)*
41, 42, 43					LEAN CLAY (CL); greenish gray (5GY 7/1). 20% very fine grain sand, 20% silt.
44, 45, 46, 47, 48			CL		20% silt.
49, 50, 51, 52, 53, 54, 55			ML		SANDY SILT (ML) INTERBEDDED WITH SILTY SAND (sm); greenish gray (5GY 7/1) and light gray (10YR 7/2), sandy silt - 70% silt, 30% very fine grain sand, silty sand - 70% very fine grain sand, 30% silt.
					Bottom of borehole at 55.0 feet bgs.

WELL DIAGRAM



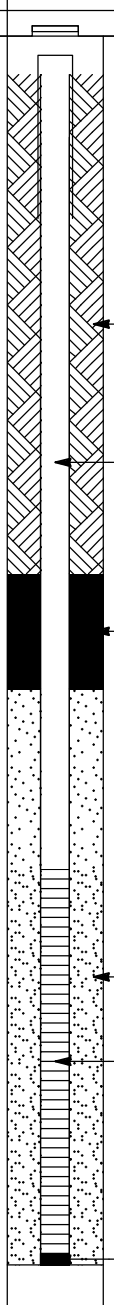
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-142

PROJECT NAME Tronox **BORING LOCATION**
PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV
DATE STARTED 6/17/10 **COMPLETED** 6/17/10 **TOC ELEVATION** **HOLE SIZE** 6"
DRILLING CONTRACTOR WDC **GROUNDWATER LEVELS:** ▽ **AT TIME OF DRILLING** 25.00 ft
DRILLING METHOD Sonic **AFTER DRILLING** --- **AT END OF DRILLING** ---
LOGGED BY EK **CHECKED BY** JWO **SURFACE CONDITIONS:**
NOTES: PC-142 is 10' west of PC-141. See lithology lof of PC-141 for lithologic description

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–15			SP-SM		POORLY GRADED SAND WITH SILT AND GRAVEL(SP-SM); reddish brown (5YR 5/4), 70% very fine to medium grain with minor coarse grain sub rounded to sub angular sand, 20% angular to sub angular volcanic granules/pea gravel to 1", 10% silt, moderate calcareous ce
16–32			SM		SILTY SAND WITH GRAVEL (SM); light gray (10YR 7/2), 65% very fine to medium grain with minor very coarse grain sub angular to sub rounded sand, 15% angular to sub rounded volcanic granules/pea gravel to 1" (29-30' common cobbles to 4"), 20% silt, common c
25					▽
32					Bottom of borehole at 32.0 feet bgs.

WELL DIAGRAM



GENERAL NORTHGATE ENV _FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

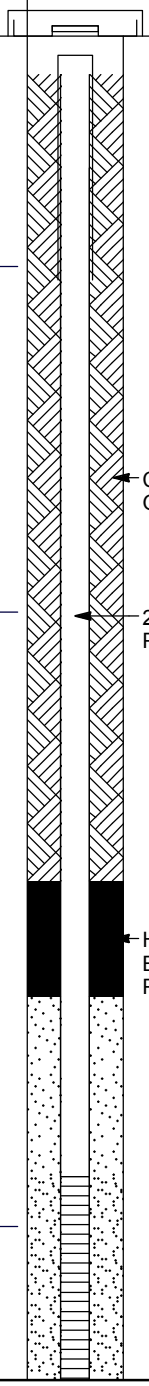
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-143

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/18/10 **COMPLETED** 6/18/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 31.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5			SP-SM		POORLY GRADED SAND WITH SILT AND GRAVEL FILL (SP-SM)
6–15			SW-SM		WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM); reddish brown (5YR 5/4), 70% very fine to medium grian with moderate coarse to very coarse grain angular to sub rounded sand, 20% angular to sub angular volcanic granules/pea gravel to 3/4", 10% silt, moderate calcareous cement/grain coatings throughout.
16–30			SM		SILTY SAND WITH GRAVEL (SM); light gray (10YR 7/2), reddish brown (5YR 5/4) from 22-25', 60% very fine to medium grain with common coarse to very coarse angular to sub rounded sand, 25% angular to sub rounded volcanic granules/pea gravel to 1-1/2", sp(?)-mod cobbles to 3-4" from 17-22, 15% silt, common calcareous cement/coating from 17-22' and 25-31'.
31–35			SM		∇ SILTY SAND WITH GRAVEL (SM); light brownish gray (10YR 6/2), 50% very fine to medium grain with common coarse to very coarse

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-143

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36, 37, 38, 39, 40			SM		SILTY SAND WITH GRAVEL (SM); light brownish gray (10YR 6/2), 50% very fine to medium grain with common coarse to very coarse *(continued)*	
41, 42			SP-SM		POORLY GRADED SAND WITH SILT (SP-SM); light brownish gray (10YR 6/2), 90% medium to coarse grain with minor very fine to fine grain and very coarse grain sub angular to sub rounded volcanic quartz and caliche sand, 1-2% sub angular to sub rounded volcanic granules to 1/4", 10% silt and clay.	
43, 44, 45			SM		SILTY SAND (SM); light brownish gray (10YR 6/2), 80% medium to coarse grain with fine and very coarse grain sub angular to sub rounded sand, 20% silt and clay, trace granules to 1/4".	
46, 47, 48					WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM); light brownish gray (10YR 6/2), 75% medium go coarse grain with minor fine and very coarse grain sub rounded to sub angular sand, 15% granules/pea gravel to 1", minor cobbles to 3", 10% silt, 25% silt locally. Reddish brown (5YR 5/4), 75% fine to medium grain sand, 25% silt from 47.5-48'.	10-20 Filter Pack Sand; 2" Schedule 40 PVC Slotted Well Screen
49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65			SW-SM		80% fine to coarse grain sand, 20% silt from 57-65'.	
66			ML		SILT (ML), light brownish gray (10YR 6/2).	2" Schedule 40 End Cap
67			SW-SM		WELL GRADED SAND WITH SILT (SW-SM); light gray (N&7), very fine grain quartz sand, 10% silt.	
68			CL		LEAN CLAY (CL); light greenish gray (5GY 7/1).	
69, 70			ML		SANDY SILT (ML); light brownish gray (10YR 6/2), 30% very fine grain sand, moderate very fine grain gypsum.	Native Fill
71, 72, 73, 74, 75			CL-ML		LEAN CLAY INTERBEDDED WITH SILT (CL-ML): light brownish gray (10YR 6/2), common very fine grain gypsum.	

Bottom of borehole at 75.0 feet bgs.

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

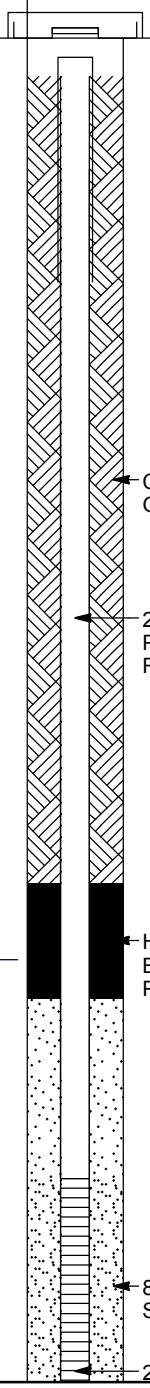
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-144

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 7/1/10 **COMPLETED** 7/1/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ▽ **AT TIME OF DRILLING** 35.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5			SM		SILTY SAND WITH GRAVEL (SM); Reddish brown (5YR 5/4), 60% poorly sorted fine to medium grain with common coarse to very coarse grain angular to sub rounded sand, 25% angular to sub angular volcanic and caliche granules/pea gravel to 3/4" (locally contains cobbles to 2-3"), 15% silt, moderate to common calcareous grain coatings and soft cement.
6–10			SM		
11–15			SM		Common-abu(?), soft calcareous cement.
16–20			SM		
21–25			SM		
26–30			SM		
31–35			SM		

WELL DIAGRAM



(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-144

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36			GM		SILTY GRAVEL WTH SAND (GM); Brown (10YR 5/4), 60% volcanic angular to sub rounded granules/pea gravel to 3/8", 35% fine to coarse grain with common very coarse grain sand, 15% silt, non-calcareous.	PVC 0.020" Slotted Well Screen
37						
38			CL		LEAN CLAY (CL); Light greenish gray (5GY 8/1), non-calcareous.	
39						
40						2" Schedule 40 PVC End Cap
41						
42						
43						Native Fill
44						
45						
					Bottom of borehole at 45.0 feet bgs.	

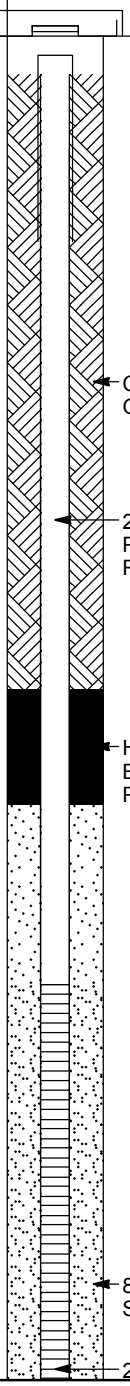
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-145

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/23/10 **COMPLETED** 6/23/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 26.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–15			SP		POORLY GRADED SAND WITH SILT AND GRAVEL (SP); Reddish brown (5YR 5/4), 75% very fine to medium grain with minor to common coarse to very coarse sub angular to sub rounded sand, 15% angular to sub rounded volcanic granules/pea gravel to 1" (with local to 2-3"), 10% silt, moderate calcareous coatings and soft cement throughout.
16–19			GM		SILTY GRAVEL WITH SAND (GM), Reddish brown (5YR 5/4), 50% angular to sub rounded volcanic pea gravel to 1" (local to 2-3"), 30% fine to coarse grain with very coarse grain sub angular to sub rounded sand, 20% silt, moderate calcareous cement.
20–35			SM		SILTY SAND WITH GRAVEL (SM); reddish brown (5YR 5/4), 70% fine to medium grain with common coarse to very coarse sub angular to sub rounded sand, 15% angular to sub rounded volcanic granules/pea gravel to 5/8" (with local to 1-2"), 15% silt, moderate calcareous cement.

WELL DIAGRAM



GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-145

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

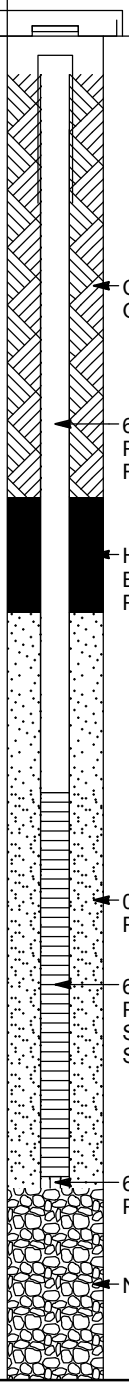
DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36			SM			PVC 0.020" Slotted Well Screen
37						
38			GP-GM		POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM); Brown (10YR 5/4), 60% angular to sub rounded volcanic granules/pea gravel to 5/8" (minor to 1"), 30% very fine to medium grain with common coarse to very coarse sub angular to sub rounded sand, 10% silt, common hard calichification in layers 2-3" thick.	
39						
40						
41			CL		LEAN CLAY (CL); Yellowish green (5Y 7/2).	
42						
43						
44						
45						2" Schedule 40 PVC End Cap
					Bottom of borehole at 45.0 feet bgs.	

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-146

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/20/10 **COMPLETED** 6/20/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS:
AT TIME OF DRILLING Dry
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5			SP-SM		POORLY GRADED SAND WITH SILT (SP-SM); Reddish brown (5YR 5/4), 80% very fine to medium grain with common coarse to very coarse grain sub angular to sub rounded sand, 10% volcanic angular to sub rounded granules to 1/4", 10% silt, moderately calcareous grain coatings and soft cement throughout.
6–10			SP-SM		
11–12			SP-SM		
13					Gravelly zone, gravels to 3" diameter.
14–15			SP-SM		POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM); Reddish brown (5YR 5/4), 75% very fine to coarse grain with minor very coarse grain sub angular to sub rounded sand, 15% angular to sub angular volcanic granules/pea gravel to 1", 10% silt, moderate calcareous cement and coatings.
16–19			SP-SM		
20–25			SP-SM		
26–27			SP-SM		
28–30			SP-SM		POORLY GRADED SAND WITH SILT (SP-SM); Brown (10YR 5/4), 85% very fine to medium grain with minor coarse to very coarse angular to sub rounded sand, 2-5% angular to sub angular volcanic granules to 1/4", 10% silt, moderately calcareous. Gravelly zone, gravels to 3" diameter.
31–35			CL		LEAN CLAY (CL); Yellowish gray (5Y7/2).



Bottom of borehole at 35.0 feet bgs.

GENERAL_NORTHGATE ENV_FORMATION_OS 2027.02_T_23_BORING_LOGS.GPJ 11/16/10

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-147

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/20/10 **COMPLETED** 6/20/10
TOC ELEVATION
HOLE SIZE 6"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS:
AT TIME OF DRILLING Dry
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5			SP-SM		POORLY GRADED SAND WITH SILT (SP-SM); Reddish brown (5YR 5/4), 80% very fine to medium grain with common coarse to very coarse grain sub angular to sub rounded sand, 10% volcanic angular to sub rounded granules to 1/4", 10% silt, moderate calcareous coatings and cement throughout.
6–13			SP-SM		
13–32			SP-SM		POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM); Reddish brown (5YR 5/4), 75% very fine to coarse grain with monor very coarse grain sub angular to sub rounded sand, 15% angular to sub rounded granules/pea gravel to 1", 10% silt, moderate calcareous cement/coatings throughout.
32–35			CL		LEAN CLAY (CL); Yellowish gray (10YR 7/2).

WELL DIAGRAM

Bottom of borehole at 35.0 feet bgs.

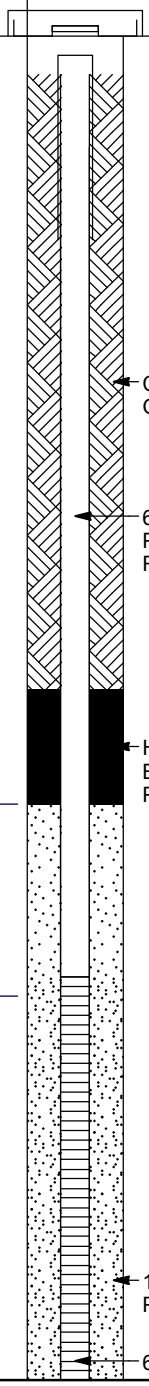
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-148

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/19/10 **COMPLETED** 6/19/10
TOC ELEVATION
HOLE SIZE 9"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 32.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–20			SM		SILTY SAND (SM); Reddish brown (5YR 5/4), 75% very fine to medium grain with common coarse to very coarse grain angular to sub rounded sand, 15% silt, 10% angular to sub rounded volcanic granules/pea gravel to 1/2" (trace 1-1/2-3" pebbles locally), moderate calcareous cement and grain coatings throughout. Common-abu(?) calcareous cement from 12.5-15', 15-17' contains 25-30% silt.
21–25			SM		SILTY SAND WITH GRAVEL (SM); yellowish brown (10YR 7/2), 65% very fine to medium grain with common coarse to very coarse grain angular to sub rounded sand, 20% volcanic and caliche granules/pea gravel to 1" (locally to 3"), 15% silt, moderate to common calichification (discontinuous) and grain coatings (semi-hard).
26–35			CL		LEAN CLAY INTERBEDDED WITH SILTY CLAY (CL); yellowish gray (5Y 7/2) to 32.5 then pale greenish yellow (10Y 8/2), 3" lense of sandy silt with 30% very fine grain sand at 32.2'.

WELL DIAGRAM



(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-148

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36			CL		LEAN CLAY INTERBEDDED WITH SILTY CLAY (CL); yellowish gray (5Y 7/2) to 32.5 then pale greenish yellow (10Y 8/2), 3" lense of sandy silt with 30% very fine grain sand at 32.2'. *(continued)*	PVC 0.010" Slotted Well Screen
37						
38						
39						
40						
41						
42						
43						
44						
45						6" Schedule 40 PVC End Cap
46					Common caliche nodules, semi-hard.	
47						
48						
49						
50						
					Bottom of borehole at 50.0 feet bgs.	

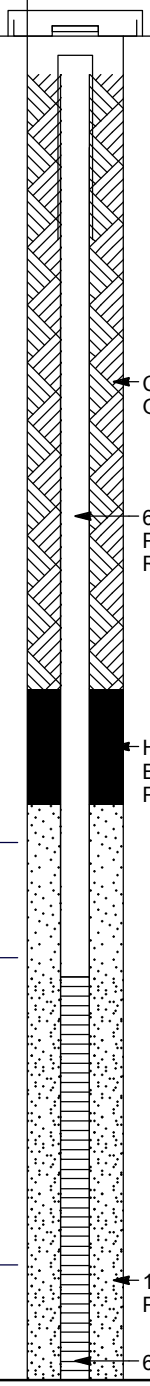
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-149

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/20/10 **COMPLETED** 6/23/10
TOC ELEVATION
HOLE SIZE 9"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 30.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–10			SM		SIILTY SAND (SM); Reddish brown (5YR 5/4), 75% very fine to medium grain with coarse to very coarse grain angular to sub rounded sand, 15% silt, 10% angular to sub rounded volcanic granules/pea gravel to 1/2", moderate calcareous cement and grain coatings throughout.
11–20			SM		
21–24			SM		SILTY SAND WITH GRAVEL (SM); Yellowish brown (10YR 7/2), 65% very fine to medium grain with common coarse to very coarse grain angular to sub rounded sand, 20% volcanic and caliche granules/pea gravel to 1", 15% silt, moderate to common calcareous cement and calichification.
25–32			SP		POORLY GRADED SAND WITH SILT (SP); Grayish orange (10YR 7/4), 90% very fine to fine with medium to very coarse grain sub angular to sub rounded sand, 10% silt to 40' then 20% silt to 32', 1-2% volcanic granules to 1/4", moderate to common soft caliche cement and coatings, hard discontinuous caliche from 31.5-32'.
33–35			CL		LEAN CLAY (CL); Moderate yellowish gray (5GY 6/2) to 39' then yellowish gray to 41', pale greenish yellow (10YR 8/2) to 50'. 6" caliche zone at 36'.

WELL DIAGRAM



(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-149

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36			CL		LEAN CLAY (CL); Moderate yellowish gray (5GY 6/2) to 39' then yellowish gray to 41', pale greenish yellow (10YR 8/2) to 50'. 6" caliche zone at 36'. *(continued)*	PVC 0.010" Slotted Well Screen
37						
38						
39						
40						
41						
42						
43						
44						
45						6" Schedule 40 PVC End Cap
46						
47						
48					Common caliche nodules to 1-1/2".	
49						
50						
					Bottom of borehole at 50.0 feet bgs.	

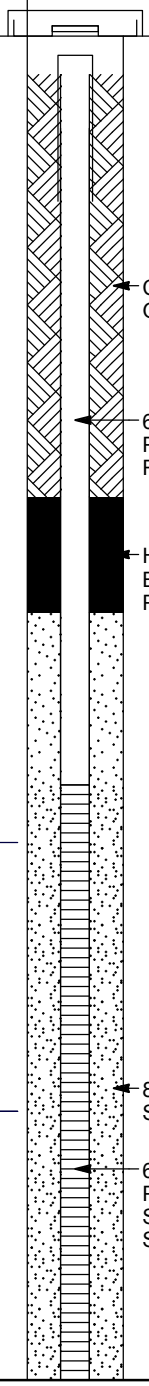
northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-150

PROJECT NAME Tronox
BORING LOCATION
PROJECT NUMBER 2027.02
PROJECT LOCATION Henderson, NV
DATE STARTED 6/29/10 **COMPLETED** 6/30/10
TOC ELEVATION
HOLE SIZE 9"
DRILLING CONTRACTOR WDC
GROUNDWATER LEVELS: ∇ **AT TIME OF DRILLING** 26.00 ft
DRILLING METHOD Sonic
AFTER DRILLING ---
AT END OF DRILLING ---
LOGGED BY EK **CHECKED BY** JWO
SURFACE CONDITIONS:
NOTES:

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
1–5			SM		SILTY SAND WITH GRAVEL (SM); Reddish brown (5YR 5/4), 65% fine to medium grain with common coarse to very coarse grain angular to sub angular sand, 20% angular to sub rounded volcanic and caliche granules/pea gravel to 3/4" with local 2-3" cobbles, 15% silt in matrix, moderate to common calcareous grain coatings and soft cement throughout.
6–10			SM		Common-abu(?) soft cement.
11–15			SM		
16–20			SM		
21–25			SM		
26–28			SM		∇ Decrease in silt to 5-10%, increase in pea gravel to 25-30%, 6" layer of 3-4" cobbles at 28'.
29–35			SM		SILTY SAND WITH GRAVEL (SM); Brown (10YR 5/4), 60-75% fine to medium grain with minor coarse to very caorse grain sand, 10-20% angular to sub rounded volcanic granules/pea gravel to 1/2", 5-25% silt, slightly calcareous except 34-39'. Clean sand (<10% silt) at 28-28.5', 29-30', 31.5-32', 34-39'. Silty sand (20-25% silt) 28.5-29', 30-31.5', 32-34'.

WELL DIAGRAM



(Continued Next Page)

northgate environmental management, inc.
300 Frank H. Ogawa Plaza, Suite 510
94612
Telephone: 510-839-0688

WELL NUMBER PC-150

PROJECT NAME Tronox **BORING LOCATION**

PROJECT NUMBER 2027.02 **PROJECT LOCATION** Henderson, NV

DEPTH (ft)	SAMPLE TYPE NUMBER	FORMATION	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
36			SM		SILTY SAND WITH GRAVEL (SM); Brown (10YR 5/4), 60-75% fine to medium grain with minor coarse to very caorse grain sand, 10-20% angular to sub rounded volcanic granules/pea gravel to 1/2", 5-25% silt, slightly calcareous except 34-39'. Clean sand (<10% silt) at 28-28.5', 29-30', 31.5-32', 34-39'. Silty sand (20-25% silt) 28.5-29', 30-31.5', 32-34'. *(continued)*	
37						
38						
39					Common 3-4" thick hard calichified sand and clean sand.	
					Common 3-4" thick hard calichified sand and clean sand. *(continued)*	
40			CL		LEAN CLAY (CL); Light greenish gray (5GY 8/1), non-calcareous.	6" Schedule 40 PVC End Cap
41						
42						
43						
44						
45						

Bottom of borehole at 45.0 feet bgs.

Appendix B
CZE Data Gaps Investigation Data

Introduction

In accordance with the scope of work outlined in the *Capture Zone Evaluation Work Plan* dated May 13, 2010 and approved by the Nevada Department of Environmental Protection (NDEP) in a letter dated May 24, 2010, Tronox performed the following groundwater well installation tasks in the area of the Tronox LLC facility (the Site) in Henderson, Nevada between April and July 2010:

- Drill and install 41 new monitoring and recovery wells at the Interceptor and Athens Road well fields;
- Drill and install eight replacement monitoring wells;
- Repair six damaged or buried monitoring wells; and
- Plug and abandon four monitoring wells.

Lithologic, geophysical, and chemical data from these new wells was used in preparation of the Capture Zone Evaluation report. Drilling and sampling methods used to collect this data are summarized below.

Drilling Methods

Table B-1 presents construction details and survey data for the newly installed and repaired wells, and logs of new wells are presented in Attachment B-1. Wells M-166-170 and M-172-177 were drilled and completed by Boart-Longyear of Peoria, Arizona (Boart) using a model 100C track-mounted Sonic rig. The rest of the wells were drilled and completed by WDC Exploration and Wells of Gilbert, Arizona (WDC) using a model 400RS truck-mounted Sonic rig. Well ART-7B, drilled by WDC, was initially drilled as a pilot hole using the 400RS Sonic rig and completed using a large-diameter hollow stem auger. With the exception of ART-7B, all wells were completed using blank PVC casing and PVC well screen. ART-7B was screened using Johnson stainless steel v-wire screen. Well screen openings and sand pack size used were determined by the local lithology of each well. A total of 2852 feet of drilling was completed during the investigation. Monitoring wells were developed by WDC following procedures described in Basic Remediation Company's (BRC) *SOP-3 – Groundwater Monitoring Well Development* (BRC, 2009a).

Sampling Methods

Table B-2 presents water level information and the results of chemical analyses. Several wells were sampled by Veolia Water North America (Veolia) during routine quarterly groundwater monitoring events at the Site. The sampling methods and field sampling sheets for those wells will be included in Tronox's remedial performance report for the period of July through December, 2010. Wells not sampled during compliance monitoring were sampled by Northgate in a standalone baseline monitoring event in September 2010. Wells were purged before sampling using low-flow or standard (3+ well volume) purge techniques and sampled according to *SOP-5 – Well Sampling and Field Measurements* (BRC, 2009b). Field sampling sheets are provided in Attachment B-2. At minimum, each sample was analyzed for perchlorate using EPA Method 314.0, total chromium using EPA Method 6020, and TDS using EPA Method 2540C. Perchlorate samples were filtered in the field using a 0.2-micron filter in accordance with NDEP guidance. Total chromium samples were filtered in the field using a 0.45-micron filter to remove suspended sediment. Field duplicates and blanks were collected in accordance with project quality assurance and quality control (QA/QC) procedures. Laboratory analysis of the baseline groundwater sampling was conducted by TestAmerica Denver of Arvada, Colorado. Laboratory analytical reports for the baseline sampling are provided in Attachment B-3.

Five soil samples were collected from borings advanced into the Upper Muddy Creek formation (UMCf) upgradient of the IWF, to measure aquifer properties and provide additional information to support groundwater modeling and capture evaluation calculations. These samples were collected by driving a split-spoon sampler equipped with brass liners beyond the bottom of the drill string. Sample cores thus collected were analyzed by PTS Laboratories, Inc of Santa Fe Springs, California for total organic carbon and fraction organic carbon using the Walkley-Black Method and hydraulic conductivity using ASTM D5084. In addition, two bulk soil samples were collected from the M-187 well boring at approximate depths of 117 and 161 feet below the ground surface and submitted for a grain size analysis using ASTM D422/D4464M. The laboratory analytical report is provided in Attachment B-4.

Deviations from Work Plan

Some of the proposed work has not been completed to date for various reasons. Deviations from the work plan are summarized below:

- Monitoring wells M-183 through M-185 have not been installed at the Site. Installation of these wells, proposed for monitoring the middle water-bearing zone (WBZ) along the eastern boundary of the Site adjacent to the Titanium Metals Corporation (TIMET)

property, has been delayed due to ongoing soil excavation and remediation of the Manganese tailings pile at the Site. Tronox intends to install these wells after the completion of remedial activities in this area.

- Monitoring wells PC-138 through PC-140 have not been installed at the Seep well field. These wells were proposed to provide additional information for evaluating capture at the well field. However, Tronox was unable to reach an agreement with Basic Management Incorporated (BMI) for access to drill and install monitoring wells at the proposed locations. There is currently no timetable for the installation of these wells.
- Plumbing and connection of new recovery wells I-AC and I-AD and existing recovery wells I-W, I-X, I-Y, I-AA, and I-AB in the Interceptor well field has not yet been completed. Unforeseen complexities regarding the electrical upgrades needed to connect the new extraction wells to the well field, increased costs, and conflicts with ongoing soil excavation work led to delays in the design and planning phase of the work. However, the construction phase of this work has been initiated, and is expected to be completed in January 2011.
- A study that included extracting groundwater from four wells downgradient of the wall and evaluating contaminant concentration and water levels in adjacent monitoring wells has not been completed. Additional details regarding this barrier wall evaluation are provided in Appendix D.

TABLES

B-1 Well Completion Summary for Wells Completed April – July 2010

B-2 Groundwater Elevation and Water Chemistry

ATTACHMENTS

B-1 Well Boring Logs

B-2 Groundwater Sampling Field Sheets

B-3 Laboratory Analytical Data

B-4 PTS Laboratory Report

APPENDIX C
SLUG TEST ANALYSIS

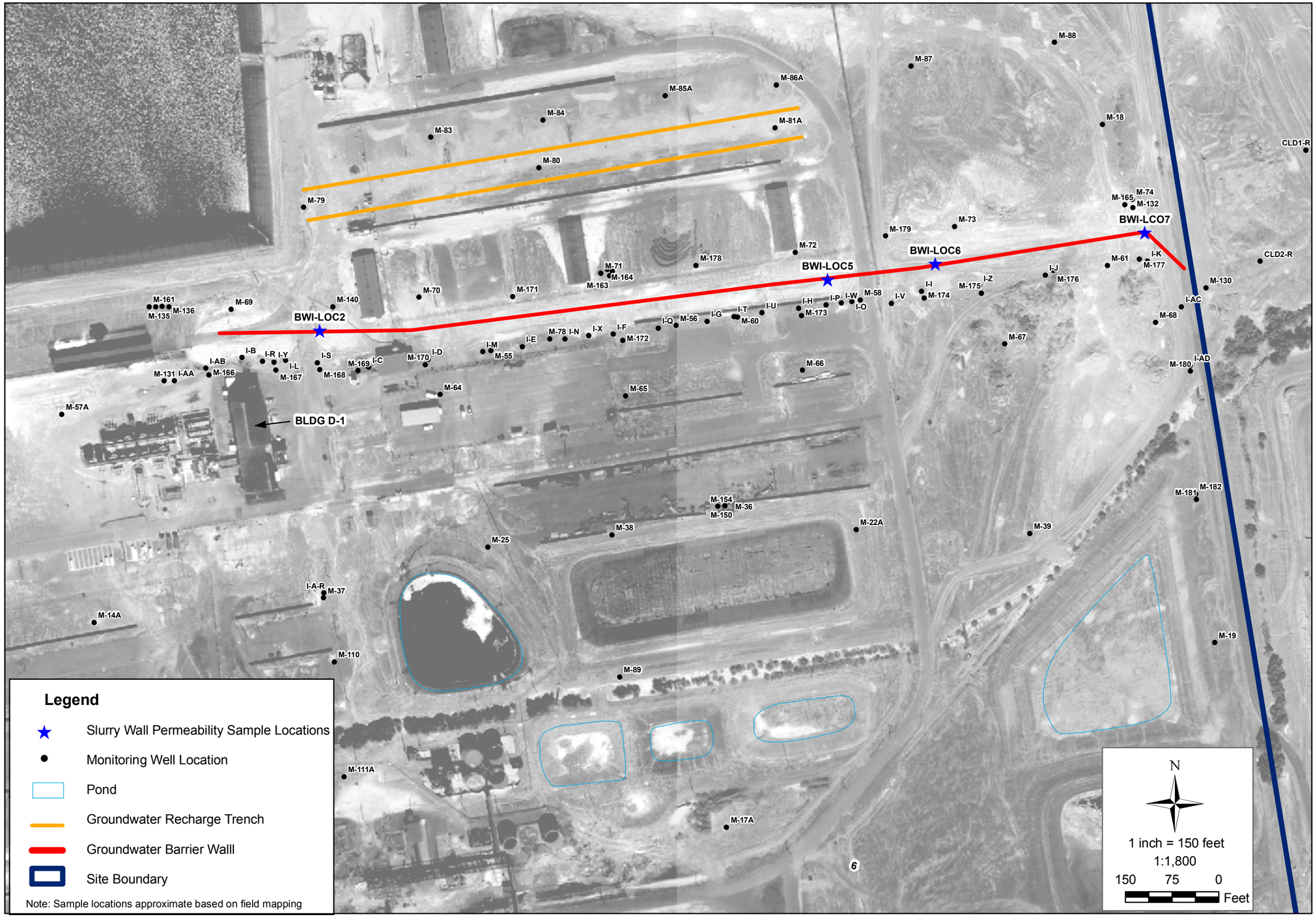
Appendix C
Slug Tests Conducted for the Capture Zone Evaluation

Northgate Environmental Management performed slug tests in five newly installed monitoring wells installed per the Capture Zone Evaluation Workplan (Northgate, 2010). An objective for these wells was to evaluate the hydraulic conductivity of the UMCf in the vicinity of the IWF and AWF. Slug tests were conducted between August 26, 2010 and September 2, 2010.

Slug test data were analyzed using the Aquifer Test Professional software from Waterloo Hydrologic Inc., utilizing the Hvorslev and Bouwer and Rice methodology. A straight line was fitted to the slug test data manually, and where appropriate based upon the shape of the data, a straight line was fitted to both the early time data and the overall data for both of these analytical methodologies. Calculated hydraulic conductivities for the multiple slug tests were averaged for each well, in order to develop one hydraulic conductivity value for each well.

Concurrent with the slug tests, a barologger was installed in one well, to measure barometric pressure changes during the slug tests. The data for one of the slug tests (M-162, Test 1 Slug In) was corrected for barometric changes, and the results of this analysis indicated almost no change in the hydraulic conductivity calculated for this well with and without the corrected data, indicating that barometer pressure changes did not have an impact on the results of the slug tests. This conclusion was confirmed by more detailed inspection of the barometric pressure data, which indicated that over the duration of each slug test (approximately 120 minutes to 300 minutes), the barometric pressure changes were on the order of 0.1 foot of pressure. Based upon this conclusion, the remaining slug test data were not corrected for barometric pressure changes before being analyzed.

APPENDIX D
BARRIER WALL INVESTIGATION STATUS REPORT



northgate environmental management, inc.
www.ngem.com
TRONOX

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	NGEM
DRAWN BY:	NGEM
CHECKED BY:	NGEM
APPROVED BY:	NGEM

SLURRY WALL PERMEABILITY SAMPLE LOCATIONS
Capture Zone Evaluation Report
Tronox LLC - Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 150 ft	12/10/2010	2027.02 T28

FIGURE NUMBER:
D-1

SHEET NUMBER:
1

\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_AppD_D1_Slurry_Sample_Locs_101210.mxd Last updated 12/9/2010 12:43:45 PM

DATE: September 10, 2010

TO: Josh Otis
Northgate Environmental Management, Inc.
300 Frank H. Ogawa Plaza, Suite 510,
Oakland, CA 94612

JOB NO: USVC00059
LAB LOG: 3068.0

RE: **Lab Report: Tronox Slurry Wall**

Enclosed are results for: Samples Received - August 5, 2010

Code	Item	Quantity
18572	Hydraulic Conductivity-Flex-wall, ASTM D-5084	4
99992	Sample Tubes	4

Thank you for consulting Vector Engineering for your material testing requirements. We look forward to working with you again. If you have any questions or require any additional information, please call us at 1-530-272-2448.

Sincerely,

Prepared By: Margaret Dell-Era
Laboratory Project Manager

Reviewed By: Kenneth R. Criley
Technical Director

This testing is based up on accepted industry practice as well as the test method listed. These results apply only to the samples supplied and tested for the above referenced job. The data and information are proprietary and can not be released without authorization of Vector Engineering Inc. By accepting the data and results represented on this page, client agrees to limit the liability of Vector Engineering, Inc. from Client and all other parties claims arising out of the use of this data to the cost for the respective test(s) represented here, and Client agrees to indemnify and hold harmless Vector from and against all liability in excess of the aforementioned limit.

143E Spring Hill Drive • Grass Valley, California 95945 • USA • Tel: +1-530-272-2448 • Fax: +1-530-272-8533
The Americas • Asia • Australia

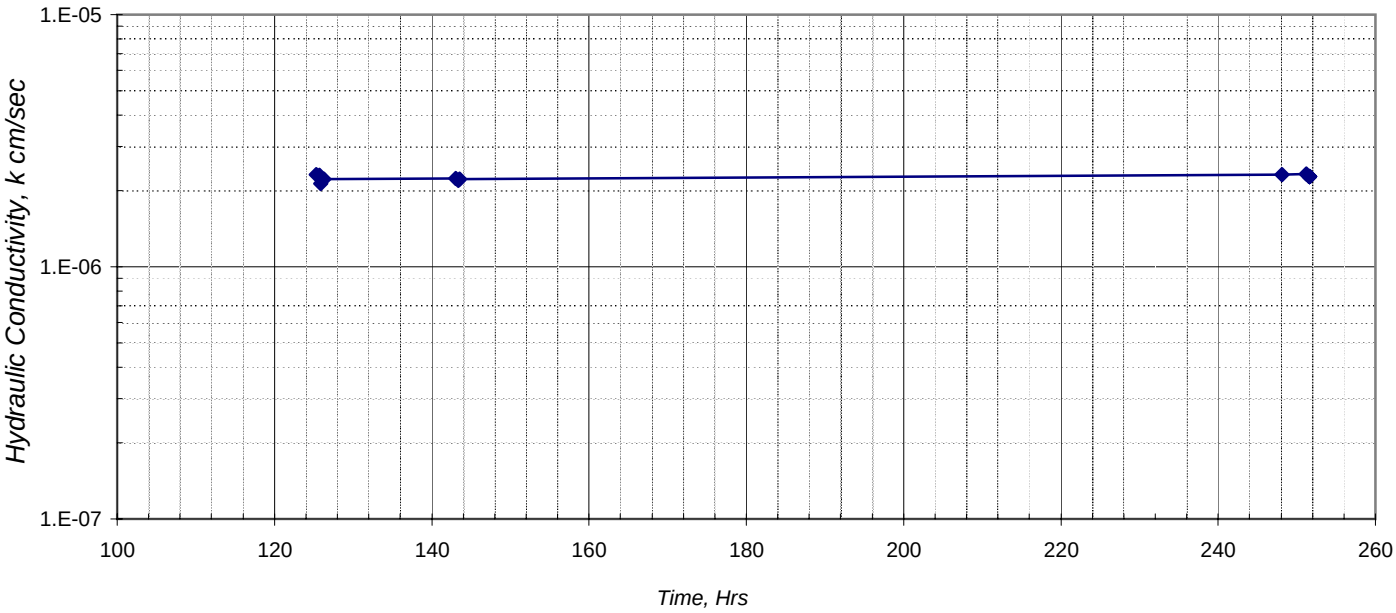
Ausenco Vector

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No:	Lab Sample Number:
Northgate Environmental Management, Inc. / Tronox Slurry Wall	USVC00059	3068A

Sample ID:	Report Date:
BWI-LOC 2	September 10, 2010

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID:	BWI-LOC 2	
DESCRIPTION:	Soil Bentonite	
	INITIAL	FINAL
HEIGHT, in.	2.4	2.4
DIAMETER, in.	2.9	2.8
WATER CONTENT, %	32.6	38.2
DRY DENSITY, pcf	79	81
SATURATION, %	77	95
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:

Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	10 psi
GRADIENT RANGE:	2 - 17
IN / OUT RATIO:	0.97
"B" PARAMETER:	0.98

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
4	126.3	2.2E-06
5	143.1	2.2E-06
6	143.4	2.2E-06
7	143.5	2.2E-06
8	248.2	2.3E-06
9	251.2	2.3E-06
10	251.7	2.3E-06

AVERAGE LAST 4 : **2.3E-06**

These results apply only to the above listed samples. The data and information are proprietary and can not be released without authorization of Vector Engineering Inc.
By accepting the data and results represented on this page, client agrees to limit the liability of Vector Engineering, Inc. from Client and all other parties claims arising out of the use of this data to the cost for the respective test(s) represented here, and Client agrees to indemnify and hold harmless Vector from and against all liability in excess of the aforementioned limit.

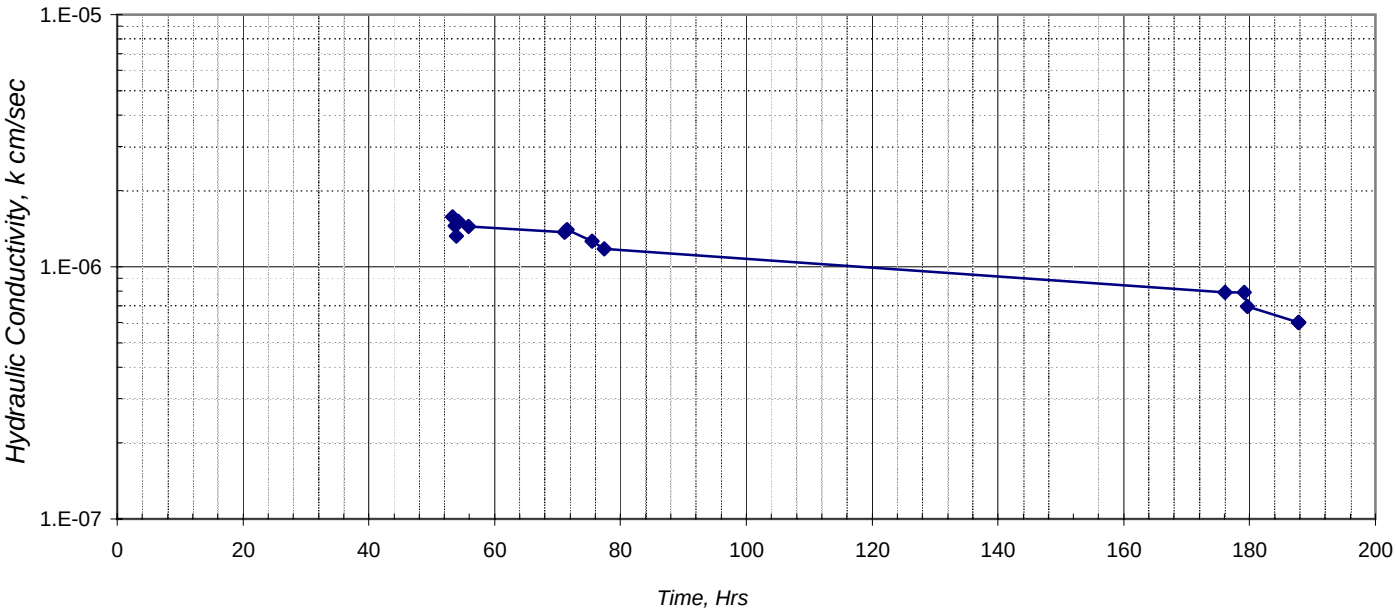
Ausenco Vector

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No:	Lab Sample Number:
Northgate Environmental Management, Inc. / Tronox Slurry Wall	USVC00059	3068B

Sample ID:	Report Date:
BWI-LOC 5	September 10, 2010

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID:	BWI-LOC 5	
DESCRIPTION:	Soil Bentonite	
	INITIAL	FINAL
HEIGHT, in.	3.6	3.6
DIAMETER, in.	2.9	2.8
WATER CONTENT, %	23.5	24.5
DRY DENSITY, pcf	98	100
SATURATION, %	88	96
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:

Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	10 psi
GRADIENT RANGE:	4 - 11
IN / OUT RATIO:	0.98
"B" PARAMETER:	0.96

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
8	71.5	1.4E-06
9	75.5	1.3E-06
10	77.5	1.2E-06
11	176.1	7.9E-07
12	179.2	7.9E-07
13	179.7	7.0E-07
14	187.8	6.0E-07
AVERAGE LAST 4 :		**7.2E-07**

These results apply only to the above listed samples. The data and information are proprietary and can not be released without authorization of Vector Engineering Inc.
By accepting the data and results represented on this page, client agrees to limit the liability of Vector Engineering, Inc. from Client and all other parties claims arising out of the use of this data to the cost for the respective test(s) represented here, and Client agrees to indemnify and hold harmless Vector from and against all liability in excess of the aforementioned limit.

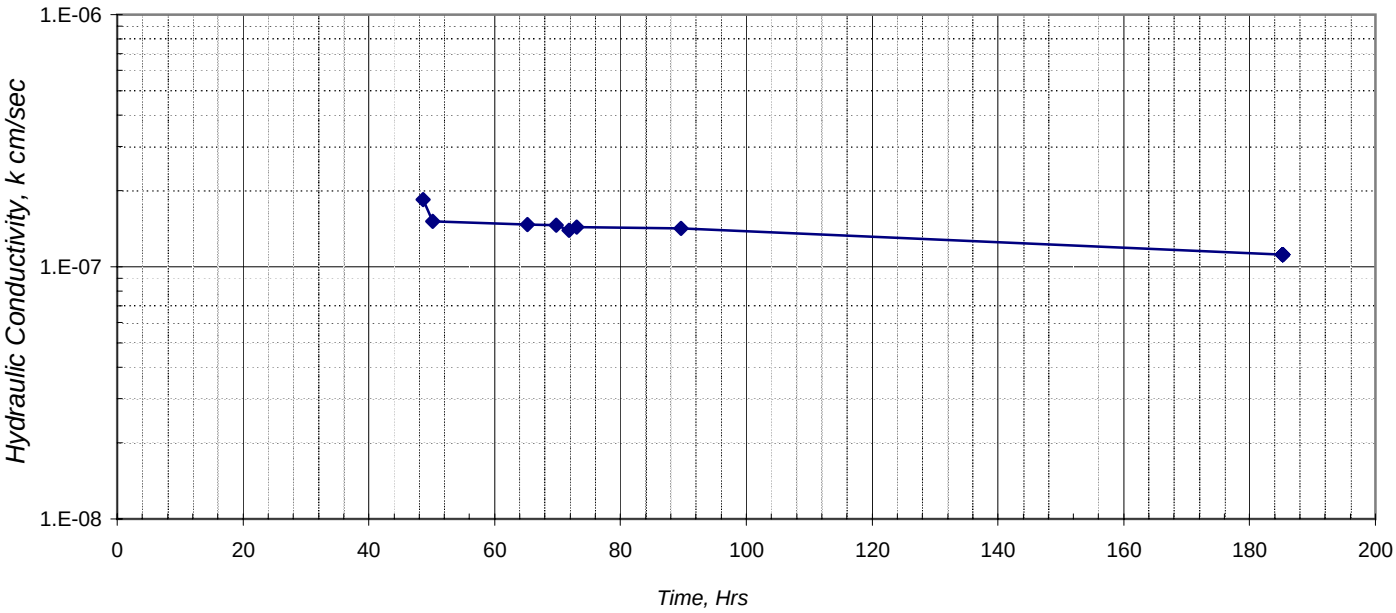
Ausenco Vector

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No:	Lab Sample Number:
Northgate Environmental Management, Inc. / Tronox Slurry Wall	USVC00059	3068C

Sample ID:	Report Date:
BWI-LOC 6	September 10, 2010

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID:	BWI-LOC 6	
DESCRIPTION:	Soil Bentonite	
	INITIAL	FINAL
HEIGHT, in.	3.5	3.5
DIAMETER, in.	2.9	2.9
WATER CONTENT, %	23.2	24.2
DRY DENSITY, pcf	98	100
SATURATION, %	88	95
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:

Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	10 psi
GRADIENT RANGE:	2 - 11
IN / OUT RATIO:	1.01
"B" PARAMETER:	1

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
2	50.2	1.5E-07
3	65.2	1.5E-07
4	69.8	1.5E-07
5	71.8	1.4E-07
6	73.0	1.4E-07
7	89.6	1.4E-07
8	185.3	1.1E-07
AVERAGE LAST 4 :		**1.3E-07**

These results apply only to the above listed samples. The data and information are proprietary and can not be released without authorization of Vector Engineering Inc.
By accepting the data and results represented on this page, client agrees to limit the liability of Vector Engineering, Inc. from Client and all other parties claims arising out of the use of this data to the cost for the respective test(s) represented here, and Client agrees to indemnify and hold harmless Vector from and against all liability in excess of the aforementioned limit.

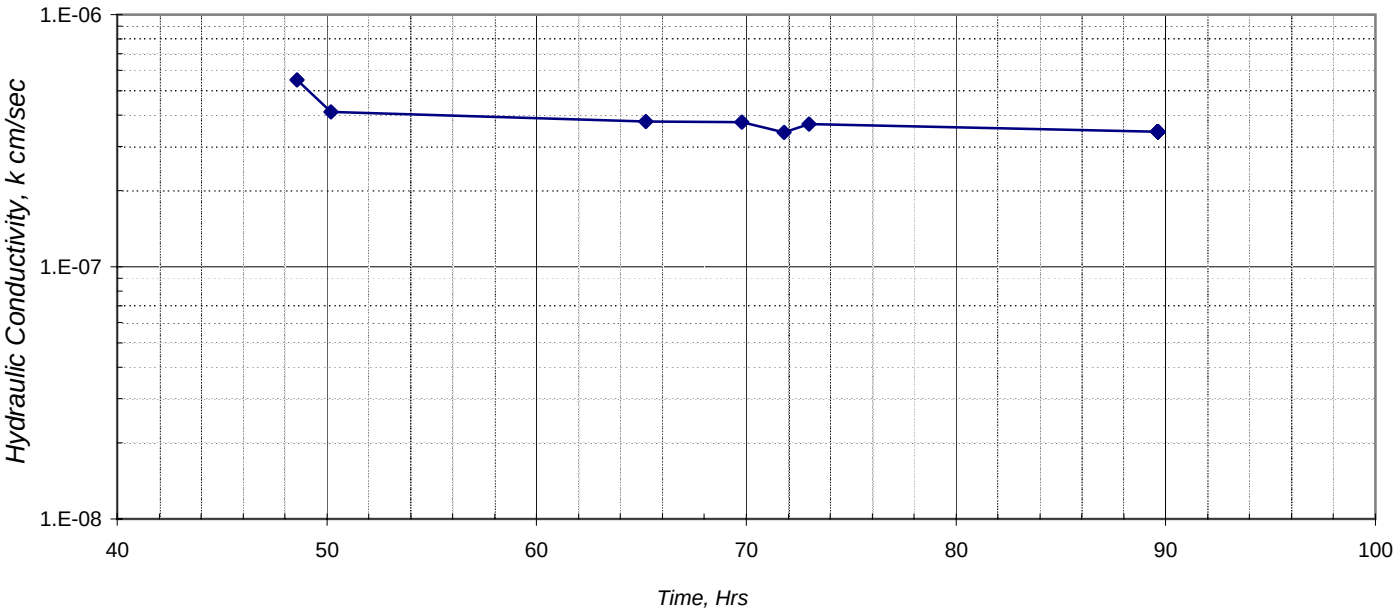
Ausenco Vector

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No:	Lab Sample Number:
Northgate Environmental Management, Inc. / Tronox Slurry Wall	USVC00059	3068D

Sample ID:	Report Date:
BWI-LOC 7	September 10, 2010

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID:	BWI-LOC 7	
DESCRIPTION:	Soil Bentonite	
	INITIAL	FINAL
HEIGHT, in.	3.9	3.9
DIAMETER, in.	2.9	2.9
WATER CONTENT, %	24.5	26.1
DRY DENSITY, pcf	96	97
SATURATION, %	87	95
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:

Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	10 psi
GRADIENT RANGE:	3 - 11
IN / OUT RATIO:	1.01
"B" PARAMETER:	0.96

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
1	48.6	5.5E-07
2	50.2	4.1E-07
3	65.2	3.8E-07
4	69.8	3.7E-07
5	71.8	3.4E-07
6	73.0	3.7E-07
7	89.6	3.4E-07
AVERAGE LAST 4 :		**3.6E-07**

These results apply only to the above listed samples. The data and information are proprietary and can not be released without authorization of Vector Engineering Inc.
By accepting the data and results represented on this page, client agrees to limit the liability of Vector Engineering, Inc. from Client and all other parties claims arising out of the use of this data to the cost for the respective test(s) represented here, and Client agrees to indemnify and hold harmless Vector from and against all liability in excess of the aforementioned limit.

APPENDIX D
BARRIER WALL INVESTIGATION STATUS REPORT

This Appendix summarizes the results of field activities to evaluate the effectiveness of the barrier wall immediately downgradient of the interceptor well field (IWF) at the Tronox facility in Henderson, Nevada (the Site). These activities were performed in accordance with the Capture Zone Evaluation Work Plan (Work Plan; Northgate, 2010d) to address one of the remaining data gaps identified in Section 2.2 of the Work Plan, which states:

> "Evaluate Barrier Wall Effectiveness (Addresses NDEP 1/26/10 comments 6.a.i, 6.a.ii, 6.a.iii, 6.a.iv, and 9): To confirm the effectiveness of the barrier wall, Northgate plans to install four new four-inch diameter wells in the "dead zone" between the barrier wall and the recharge trenches (Figure 5). Pumps will be installed in these new wells and they will be plumbed to the GWETS. It is planned that these wells will be pumped for three months while water quality and water levels are monitored in these wells and in nearby wells M-69 through M-72. Pumping may be extended for a longer period based on water quality and production rates. When pumping is stopped, water level recovery and water quality will be monitored and evaluated for evidence of barrier wall leakage.
>
> "In addition to pumping and monitoring these wells immediately downgradient of the barrier wall, Northgate proposes to pothole the area in the immediate vicinity of the barrier wall using a backhoe to expose the trench ends and barrier top at several locations along the length of the wall. The location of the wall will be mapped using GPS surveying techniques, and the barrier, where exposed by potholing, will be photographed. Physical markers will be installed at each end of the wall during this investigation.
>
> "Northgate also plans to collect samples of the barrier wall material, if possible, to be used for lab testing of its permeability. This testing will involve: 1) re-saturation of the material until it meets the original barrier wall slump test specifications; 2) re-molding of the re-saturated material; and, 3) laboratory permeability testing using ASTM Method D5084."

The following sections summarize the results of field work, laboratory tests, and data analysis to date, and recommended next steps for the barrier wall investigations.

Lithology and Well Construction

In accordance with the Work Plan, four new wells (M-140, M-171, M-178, and M-179) were installed in the area downgradient of the barrier wall and upgradient of the recharge trenches. Wells M-140 and M-171 are located near the western portion of the barrier wall, and wells M-178 and M-179 are located near the eastern portion of the barrier wall (see Figure 1-2 of the main report).

Appendix B summarizes the methods used to install and monitor wells M-140, M-171, M-178, and M-179. Boring logs are also presented in Appendix B and well construction details for these wells are summarized in Appendix B, Table B-1. The screen intervals for wells M-140, M-171, and M-179 extend across the lowermost portions of the Quaternary alluvium (Qal) and terminate in the UMCf. The screen interval for M-178 extends from the contact between the UMCf and Qal at 26 feet below ground surface (fbgs) to a depth of 46 fbgs in the UMCf. Because the sand pack for each well extends approximately five feet above the screened intervals, all of the newly installed pumping wells can extract water from the Qal, if it is saturated, as well as from the UMCf. The lithology of the Qal adjacent to the sand pack and screened intervals of the wells consists of well-graded sand, silty sand, and silty sand with gravel. The lithology of the UMCf within the screened intervals of the wells consists mostly of silt or silt interbedded with sandy silt, which is expected to have lower permeability than saturated portions of the Qal.

Baseline water-level measurements and groundwater chemical data were obtained from the newly installed wells in September 2010 (Table D-1A). The water elevation in wells M-140, M-171 and M-179 were one-to-three feet above the contact between the Qal and the UMCf before pumping began (discussed below). The water elevation in well M-178, near the central portion of the barrier wall, was below the contact with the UMCf before pumping started. Baseline perchlorate concentrations ranged from 16 milligrams per liter (mg/L) in the easternmost well (M-179) to 1,500 mg/L in the next well to the west (M-178).

Pumping Rates and Water Levels

Pumping of the “dead zone” wells commenced on October 18, 2010. Pumping rates and drawdown in the pumping wells and water levels in nearby monitoring wells are being evaluated for indications of the barrier wall’s integrity, as well as to remove higher concentration water from the stagnant zone.

Table D-2 presents a summary of flow rates and other observations during the startup and operation of the wells. Pumping of wells M-140, M-171, M-178, and M-179 began on October 18, and was intermittent during the first 24 hours of system testing. Each well pump was throttled to achieve an instantaneous flow rate of approximately 1.5 gallons per minute (gpm). Well pumps cycled on and off in response to water level sensors. With the exception of a planned total Groundwater Extraction and Treatment System (GWETS) shutdown on the morning of October 26 and brief shutdowns to allow water-level recovery and sampling, the pumps have been operational continuously since October 19, and have pumped whenever there was sufficient water entering the wells to activate the pumps.

Initially, the western wells (M-140 and M-171) produced significantly more water than the eastern wells (M-178 and M-179). M-140 and M-171 pumped at average rates of approximately 1.2 gpm and 0.3 gpm, respectively, until mid-November when pumping rates begin to decline. By the end of November, the water level in wells M-140 and M-171 had dropped below the upper level pump control, and neither well pumped from November 30 through last report (December 8, 2010). Average pumping rates at M-178 have also declined over time, starting at approximately 0.2 gpm and dropping to approximately 0.04 gpm by late November. Pumping rates in the easternmost well (M-179) have remained steady but very low at approximately 0.06 gpm. The pattern of pumping rates and drawdown observed in these wells is believed to reflect initial influx of Lake Mead water from the recently-discontinued trench recharge until it had dissipated or been extracted by mid-November, combined with the very low natural upward recharge from the UMCf. Prior to September 16, 2010, approximately 70 gpm of stabilized Lake Mead water were being injected into the one active recharge trench. On that date, injection ceased and the trenches were excavated during remediation of RZ-D. Therefore, no stabilized Lake Mead water has been injected into the area immediately downgradient of the barrier wall since September 16, 2010.

Based on the recent water level data, saturated alluvium is potentially present in only one of these four “dead zone” pumping wells (well M-179) under static conditions. Well M-179 is the easternmost of the pumping wells, and the alluvium was observed to extend to greater depths at this location (35 feet bgs compared with 25 to 27 feet bgs in the other three wells). The static water level elevation in M-179 prior to pumping was approximately 1,713 feet above mean sea level (amsl) and the UMCf contact is at approximately 1,712 feet amsl. Although this well was less affected by the trench recharge than the other “dead zone” wells, the static water level may be lower now that the recharge water has dispersed and little or no saturated alluvium may remain. The static water level in well M-178 prior to pumping was approximately 1,717 feet

amsl, already below the Qal/UMCf contact at approximately 1,721 feet amsl. Because the high level sensors in well M-140 (set at approximately 1,717 feet amsl) and in well M-171 (set at approximately 1,714 ft amsl) have not been triggered during more than a week of non-pumping, the static water level in each of these two wells appears to be below these elevations, putting it within the UMCf (contact elevation of approximately 1,720 feet amsl for both wells).

Chemical Analytical Results

Tables D-1A and D-1B present a summary of chemical analytical results for total chromium, perchlorate, and total dissolved solids (TDS) during baseline measurements in September 2010 and during pumping of the newly installed wells in November 2010. Data for the pumping wells is presented in Table D-1A and data for the nearby monitoring wells on the downgradient side of the barrier wall are presented in Table D-1B.[1]

Sampling of Barrier Wall Materials and Permeability Testing

The results of permeability testing of the material from the barrier wall were previously reported in a memorandum to NDEP dated September 29, 2010. Four samples of the barrier wall were collected at the locations shown in Figure D1 as described in the Work Plan(Northgate, 2010d), on July 29th and 30th, 2010. Locations BWI-LOC2 and BWI-LOC7 are located near the western and eastern ends of the barrier wall, respectively. Locations BWI-LOC5 and BWI-LOC6 are located east of the center of the barrier wall. Shallow trenches were excavated using a backhoe to expose the barrier wall material, and samples were collected using thin-walled Shelby Tube samplers. The top of the barrier wall was encountered at depths ranging from 1 foot below the ground surface (bgs) to 4.9 feet bgs. Each sample was analyzed for hydraulic conductivity by ASTM D-5084, Method C by Vector Engineering of Grass Valley, California. The laboratory report containing the test results is included in Appendix B.

The average hydraulic conductivity measured for the four samples is 8.8×10^{-7} cm/sec, meeting the design criteria for the barrier wall of a hydraulic conductivity less than 1×10^{-6} cm/sec. As shown in the laboratory report (Attachment D1), three of the four samples meet the design criteria, with the test result of the fourth sample (BWI-LOC 2) slightly below the criteria, at 2.3×10^{-6} cm/sec.

[1] Laboratory analytical results presented in Tables D-1A and D-1B are, in some cases, preliminary or partial, and have not yet been validated.

Conclusions and Next Steps

Since the trench recharge water dissipated in late November, recharge has been very slow and static water levels have dropped below or to the UMCf contact in the four "dead zone" wells. These results indicate that there are no significant leaks in the barrier wall in these areas. To further evaluate this conclusion, Tronox will continue to implement the pumping and monitoring proposed in the Work Plan (Northgate, 2010d). To better quantify the conclusion of no significant leakage, additional hydraulic analyses will be performed while the recharge trench is not operating. These may include: 1) using the groundwater model to simulate flow in this area to assess whether the observed flow rates are consistent with upflow from the UMCf; and, 2) conducting pumping and/or recovery tests using the "dead zone" wells and neighboring monitor wells to determine if observed pumping rates are consistent with UMCf transmissivity.

In addition to the data evaluation activities focused on evaluating barrier wall integrity, Tronox will also evaluate the need for reinstallation of the recharge trench. This will include using the groundwater flow model and particle tracking to evaluate the potential changes to chemical migration with and without trench recharge. A memorandum summarizing and evaluating all pumping, water level and chemical data, and providing recommendations regarding the need for reinstallation of the recharge trench and assessment of the effectiveness of the barrier wall will be prepared and submitted to NDEP.

Tables

D-1A Groundwater Elevation and Analytical Data for Pumping Wells Downgradient from the Barrier Wall, September – November 2010

D-1B Groundwater Elevation and Analytical Data for Monitoring Wells Downgradient from the Barrier Wall, September – November 2010

D-2 Pumping Wells Downgradient of the Barrier Wall – Flow Data

Figures

D-1 Slurry Wall Permeability Sample Locations

Attachment

D-1 Barrier Wall Geotechnical Data

APPENDIX E
HYDROGEOLOGIC MODEL REPORT

APPENDIX E
Hydrogeologic Model Report

1.0 INTRODUCTION

Northgate Environmental Management, Inc. (Northgate) has prepared this report of the hydrogeologic flow model on behalf of Tronox LLC (Tronox) for the Tronox facility located in Henderson, Nevada (the Site; Figure E-1). This document details the development and calibration of a three-dimensional, hydrogeological numerical model for the Site and surrounding areas (Figure E-2), which is referred to in this document as the "Tronox groundwater flow model" or "Tronox model." The model development effort follows the *Revised Hydrogeologic Modeling Work Plan* submitted by Tronox in June (Northgate, 2010c) and approved by the Nevada Department of Environmental Management (NDEP) in July 2010. This model is used as key tool for the revised Capture Zone Evaluation (CZE) conducted for the Site in accordance with United States Environmental Protection Agency (USEPA) guidance (USEPA, 2008).

2.0 DENSITY-DEPENDENT GROUNDWATER FLOW

As part of the numerical model selection process, Tronox analyzed the high total dissolved solids (TDS) plumes to determine if it is necessary to use a numerical model capable of simulating variable-density groundwater flow. Plumes with TDS concentrations higher than 5,000 mg/L over wide areas, and higher than 100,000 mg/L in smaller areas, are present within the area modeled. The higher fluid densities associated with increased TDS concentrations can lead to spatial gradients in fluid density, potentially creating upward or downward buoyancy forces which under certain conditions can have a significant effect on the flow regime. The relative magnitude of these buoyancy forces with respect to the vertical hydraulic head gradients determines whether or not the flow regime around the high TDS plumes is governed primarily by buoyancy forces or by the vertical hydraulic head gradients (Bear, 1972; Holzbecher, 1998).

A number of factors serve to minimize the relative impact that density gradients from the higher TDS plumes (i.e. higher density water) may have on the current flow and transport regime around the Tronox Well Field areas:

1. Hydraulic Controls:
    a. Strong upward vertical gradients due to artesian conditions at depth, serve to counteract small vertical density gradients;

b. Relatively low recharge infiltration rates (so does not contribute further downward migration); and

c. Pumping wells are screened in the shallow water bearing zone, so do not serve to draw the TDS plumes deeper as would be the case if there was extensive deeper pumping. The pumping wells are also generally situated in or just upgradient of the zones of highest TDS (highest density), and the strong horizontal and vertical gradients generated by active pumping also serve to minimize the effects of density gradients in the region where they would be expected to be greatest.

2. Geologic Controls:

   a. In the vertical direction the large contrast in hydraulic properties between the thin, high conductivity, Quaternary Alluvium (Qal), overlaying the much lower hydraulic conductivity Upper Muddy Creek formation (UMCF), serves to attenuate the effects of density gradients which would result in downward driving forces in the regions of high TDS; and

   b. Similarly, in the horizontal direction, the heterogeneity created by the presence of the high conductivity paleo-channels within the Qal and directly above the UMCf, results in a situation in which horizontal and vertical spreading due to hydrodynamic dispersion are likely much more significant than vertical spreading due to density gradients alone. As the TDS plumes advects horizontally, it becomes more dilute, thus diminishing density gradient effects.

Through these lines of analysis (Koch & Zhang, 1992; API, 2006) it was decided that for the purpose of the current CZE, based on the current plume configuration, it would not be necessary to explicitly account for variable density flow through the use of a specialized simulator, such as SEAWAT. Rather, fresh water head corrections were carried out for all water level measurements well pairs/triplets used for estimating the horizontal and vertical fluxes assigned along the southern and bottom boundaries of the model. Furthermore, all measured water levels chosen as calibration targets were also corrected for density differences based on measured TDS concentrations. At shallow depths, the corrections, even for high TDS values, are relatively minor, given the small water column. The correction however, can be large for deeper wells under artesian conditions, in which the well has a tall water column, over which the density difference can have a big effect on the corrected head. These effects were most pronounced towards the Las Vegas Wash in the region of very high TDS (upwards of 100,000 mg/l) brines that have been associated by BRC with deeper waters in contact with evaporitic deposits. Some of these wells had fresh water head corrections as large as 50 feet. For regions around the Tronox well fields, there were very few water levels in the shallow water bearing zone that had fresh water head corrections larger than a tenth of a foot.

3.0 NUMERICAL FLOW MODEL DEVELOPMENT

Numerical flow model development includes selecting the model domain extent; creating the model grid and designating the active grid cells; assigning appropriate boundary conditions along the top, bottom, and lateral faces of the model domain; assigning aquifer hydraulic parameters (e.g., hydraulic conductivity, porosity, storage coefficients) to adequately represent the known distribution of lithologic units at the Site; and assigning internal sinks and sources to account for infiltration, evapotranspiration, and pumping wells. The MODFLOW numerical flow model is developed using Groundwater Vistas Version 5. The three-dimensional geology model and the finite-difference numerical grid layers were developed using GMS 6.0 (Groundwater Modeling System).

3.1 Model Domain Extent

The extent of the model domain is shown in Figure E-2. The active area of the model domain is wedge-shaped, narrowing from south to north toward the Las Vegas Wash. From south to north, the model domain extends from south of Lake Mead Parkway to the Las Vegas Wash, approximately 20,000 feet (about 4 miles) in total length. Laterally (perpendicular to the regional groundwater flow direction), the model extends east and west of the Tronox Site to include the existing groundwater capture systems at the BMI and POSSM properties to the west and the proposed groundwater barrier trench and capture wells at the TIMET site to the east, in addition to the AMPAC extraction/injection and treatment systems to the northwest of the Tronox site. The extent of the model domain is sufficient to reflect the hydraulic features which may impact the evaluation of groundwater capture zones and future plume evolution, and to avoid having the lateral boundaries of the active domain intersect active sources and sinks. This regional domain is modeled using a relatively coarse grid size with the objective of describing the overall groundwater flow domain. This regional model is locally refined in the vicinity of the Tronox well fields for the purpose of CZE.

In the vertical direction, the model domain extends into the deep water bearing zone, as defined by NDEP (2009). The bottom depths were determined in the early stages of model development based on evaluation of the distribution of depths of monitoring well screen intervals, and of the depths of observed perchlorate concentrations.

In general, the orientation of the model layers follows the dip angle of alluvial fan sediments and the general Site topography. The model grid axes are aligned as best as possible with the general geologic and geomorphic structures of the valley to allow modeling of the hydraulic conductivity as diagonal tensors.

3.2 Qal-UMCf Lithologic Contact Surface

A regional scale contour map of the elevation of the Qal-UMCf contact was developed based on interpolation of contact elevations from almost twelve-hundred groundwater wells and soil borings (see Figure E-3). The two main sources of data for the elevation of the Qal-UMCf contact elevation were the "All Wells" spreadsheet database of well construction and lithology data that is maintained jointly by all the companies operating within the former BMI complex (th Companies), and the soil boring logs from the Tronox Phase A and B soil sampling events. Additional data were drawn from the 2003 hydrogeological database developed for the BMI complex region by the Desert Research Institute (DRI, 2003), soil boring logs from the 2008 BRC Deep Background Soil report (BRC, 2009), data from Plate 1 of the BRC Eastside Hydrogeologic Connectivity evaluation report (DBSA 2010a), as well as additional and or/updated data for BRC wells contained in Table 4 of the BMI Common Areas, 2009 Groundwater Monitoring Report (DBSA, 2010b).

As part of a quality assurance (QA) screening process, the recorded ground surface elevations of the wells were compared with ground surface elevations interpolated from a digital elevation model derived from the 5 foot contour interval topographic map of the BMI complex surveyed by PBS&J in 2006. If the differences between the recorded and interpolated ground elevation were greater than 15 feet then these well records were reviewed in greater detail to determine if errors existed in the recorded elevations and the resulting elevations of UMCf contact. For the small subset of wells for which surveyed ground surface elevations were missing, but a recorded depth to UMCf contact existed, the digital elevation model was used to generate an interpolated ground surface elevation, allowing for the calculation of the elevation of the UMCf contact.

As an additional QA check to flag wells with possible elevation errors, the recorded top-of-casing elevations were compared with the recorded or interpolated ground-surface elevations. This difference is equivalent to the well riser-height, which is generally between two to five feet.

In some instances, wells with the recorded top-of-casing elevations differed by more than 15 feet from the recorded or interpolated ground surface elevation; in these instances, the well construction logs were also reviewed to check for possible errors missed in other screenings. Depths to the UMCf contact were also compared with total hole depths to identify inconsistencies (such as a reported depth to the UMCf contact greater than the total hole depth). In these cases, the well logs were reviewed to identify corrected depths.

The method of ordinary kriging was then used to generate an initial interpolated grid (100 by 100 foot grid cell size) of the UMCf/Qal contact. Elevation contours of this initial map were then used to identify UMCf contact elevation data points that appeared anomalously high to low

compared to other surrounding data points. In these cases, the well lithology and construction logs were reviewed to identify and fix any possible errors in the data set.

A new interpolated contour map was then generated based on the corrected and reduced dataset using the ArcGIS Geostatistical Toolbox, also using a 100 feet by 100 feet cell size grid for interpolation. The method of ordinary kriging was used with a spatial correlation model that accounts for north-south trending anisotropy introduced by the paleo-channel network. The Qal-UMCf contact slopes northward towards the Wash, and both the ground surface topography and the regional potentiometric surface mirror this slope. The method of kriging assumes statistical stationarity (i.e., that the mean of the data set is the same everywhere), and the presence of this regional slope in elevation violates this assumption. For this reason a de-trending option was used to remove the regional slope of the contact elevation surface prior to generating the spatial correlation model used for kriging. The generated contour map of the elevation of the UMCf contact is shown in Figure E-3.

This new regional contour map was compared to an earlier contour map interpretation generated previously by Kerr-McGee (Plate 3 of Kerr-McGeee,1998). While the earlier map did not cover the entire model domain and was based on an older, more limited dataset, the two interpretations are in relatively good agreement.

The interpolated contour map was also compared with the recent contour map interpretation by BRC (Plate 1of DBSA 2010a). While many of the major topographic features are consistent between the two interpretations, there are also differences that appear to be due to the use of slightly different data sets and to differences in the methods of interpolation used to generate the contours.

The differences in the interpreted contours of the contact have an impact on the interpretations of paleo-channel locations as compared to the channel locations identified in the two previous studies. This is shown in Figure E-4, which will be discussed in more detail in the following Section 3.3.

3.3 Definition of Paleo-Channel Drainage Network

The paleo-channels are understood to represent a paleo-alluvial drainage network incised into the top of the UMCf. The paleo-drainage network was identified by analysis and interpretation of the topography of the Qal-UMCf contact surface. This analysis included the synthesis of multiple lines of evidence for determining the location of channels.

The lines of evidence used to delineate channel locations included the use of a GIS-based watershed drainage-network delineation algorithm, previous interpretations of the locations of

paleo-channels conducted by Tronox and the Companies, consistency with hydrogeologic interpretation of the regional potentiometric surface for the shallow water bearing zone, consistency with the observed spatial distribution of perchlorate movement in the alluvial sediments, consultation with geophysical survey section reconstructions, and professional judgment.

As a starting point, the interpolated Qal-UMCf contact surface was converted into a digital elevation model and then the automated hydrology drainage-network delineation algorithm of the ArcGIS Spatial Analyst Toolbox was used to extract the drainage network of this "paleo-basin" (see Figure E-4). It is recognized that automated network delineation tools based on interpolated surfaces have their own limitations. For this reason the algorithm-derived channel network map was used as a starting point on which to overlay the other lines of evidence. The auto-delineated network channels were compared with earlier interpretations of the paleo-channel networks by other investigators (Plate 3 of Kerr-McGee, 1998; Plate 1 of DBSA 2010a). Comparison with previous interpretations of channel locations is also shown in Figure E-4. Greater weight was placed on channel locations that were consistent with evidence of channelized flow visible in contoured potentiometric maps for the shallow water bearing zone, and with the known spatial distribution of the perchlorate plume.

3.4 Domain Discretization

3.4.1 Horizontal Discretization

A uniform horizontal grid cell size of 200 by 200 feet was initially used for the Tronox groundwater flow model (shown in three-dimensional view in Figure E-7). The model was calibrated using this 200 feet by 200 feet discretization and then subsequently locally refined near the three Tronox wells fields (Interceptor Well Field, Athens Road Well Field, and Seep Well Field; IWF, AWF and SWF) to a smaller grid cell size of 50 feet by 50 feet (see Figure E-2). Grid refinement was necessary to conduct the CZE by endpoint analysis for the different well fields (see Section 6 of CZE Report). Groundwater Vista's Telescopic Mesh Refinement (TMR) feature was originally going to be used to define sub-models of the different well fields for this evaluation. However, the percholorate plume was much longer and wider than originally envisioned, and the CZE had to be conducted on the model at the regional scale. TMR was still used to generate sub-models of the AWF and IWF with a grid spacing of 20 feet by 20 feet to visualize the three-dimensional (3-D) capture envelope near the wells (Section 6.2.7 of the CZE Report).

The horizontal grid dimension used in the Tronox model is thought to be sufficiently small to represent spatial heterogeneity in aquifer hydraulic properties at the smallest scale over which

differences in parameters can likely be defined with existing data. The smallest scale of heterogeneity that can likely be well-characterized within the model domain would be some fraction of the width of buried alluvial paleo-channels incised into the UMCf. The coarse 200 feet by 200 feet grid cell size is consistent with the grid cell size used in the current calibrated BMI Common Areas groundwater model (DBSA 2008a).

3.4.2 Vertical Discretization

The regional Site-wide model has been discretized vertically into six layers (see Figures E-7 though E-9). First a 3-D lithologic model of the site was developed based on the land surface topography and the interpolated Qal-UMCf contact (see Figures E-5 and E-6). The elevations for the tops of cells in the uppermost layer of the model were assigned based on the land surface elevations derived from a digital elevation model (DEM) generated from the 5-foot contour interval topographic map downloaded from the Clark County GIS web-site (note: this is different than the more detailed DEM used for well elevation QA/QC, but provided coverage over a larger regional area than the BMI complex topographic map by PBS&J, suitable for the regional land surface elevation).

The bottom elevation of the model grid was set by a surface 244 feet below the Qal-UMCf contact, maintaining the general regional slope of the contact surface. Lithologic data sets from across the Tronox Site and neighboring sites were combined and used in constructing a map of the Qal-UMCf contact across the entire model domain, as described above in Section 3.2.

The 3-D lithologic model was then mapped to the grid to define the layer elevations (Figures E-7 and E-8). One of the main goals of the flow model is to accurately model the potentiometric surface in the shallow Qal and near the Qal-UMCf contact. For this reason the model has a finer vertical discretization in the Qal and in the top most UMCf layer along the Qal-UMCf contact. The Qal has been divided into two layers, with the combined thickness of these layers ranging from 2 to 50 feet depending on the thickness of the alluvium (see Figures E-7 though E-9).

Another important goal is to adequately represent the upward vertical flow gradients that bring water from the UMCf into the Qal. For this reason, the UMCf has been divided into 4 layers. The top most UMCf layer (model Layer 3) was assigned a thickness closer to that of each of the two Qal layers (Layers 1 and 2). Layers 4 and 5 were each 61 feet in thickness, while the bottom Layer 6 is 122 feet thick. Generally speaking the layer thickness and layer depths were chosen in order to represent the best vertical discretization of the screened intervals of pumping in order to provide sufficient vertical resolution for representing the vertical gradients in hydraulic head, and to allow for sufficient vertical and horizontal coverage of hydraulic head calibration points (i.e., monitoring well screened intervals) in each layer.

3.4.3 Temporal Discretization

Site-wide hydrographs and pumping data from the period between 2006 through 2009 were examined to determine whether a steady-state period for the model could be identified. It was assumed that a difference in groundwater levels of less than 2 feet over a time period could be considered steady-state. Using this criterion, the period between August 2008 and March 2009 was selected as being representative of a steady-state condition.

3.5 Aquifer Hydraulic Parameters

Estimates for the hydraulic properties assigned to the model are based on field measurements (slug and pumping tests) of hydraulic parameters for locations within the model domain. Table E-1a summarizes the values of horizontal hydraulic conductivities obtained from field data for the alluvium, UMCf, paleo-channels, and the Las Vegas Wash alluvial deposits. The range of hydraulic conductivities for the alluvium and UMCf was bounded using the harmonic and the arithmetic means of the data. The values of hydraulic conductivities used to calculate these bounds are summarized in Tables E-2 and E-3 for the alluvium and UMCf, respectively. These bounds are used as the endpoints for the model calibration.

The hydraulic conductivities of model Layers 1 and 2, representing the alluvium, are divided into four zones (Figure E-10). The model was originally set up with two alluvium zones with different properties (Northgate, 2010d), but the initial calibration of the model indicated that only one zone was necessary, so a single zone represents the hydraulic conductivity of the alluvium. Two additional zones represent the paleo-channels on the east and west sides of the model domain. The locations of the paleo-channels were defined using the paleo-channel map developed as described in Section 3.3 (see Figure E-3). Most of the paleo-channels in the Tronox model were assigned a width of 400 feet, based largely on the paleo-channel widths defined by DBSA (DBSA, 2008a) in their model. Two of the paleo-channels that run through the IWF in the Tronox model have been assigned a width of close to 200 feet. The narrower width of these channels is based on the interpretation that these channels represent smaller, “lower order” tributaries of the larger, main Tronox channel with which they meet. The division of the paleo-channel zones into the eastern and western zones was based on differences in aquifer test data and on a previous groundwater model of the BMI Eastern Ponds area (DBSA, 2008a). A fourth zone represents the alluvial deposits near the Las Vegas Wash.

A single hydraulic conductivity zone was initially used for the UMCf (Layers 3 through 6). During the initial manual calibration of the model, it was evident that a higher conductivity zone in Layer 3 was needed upgradient of the IWF to sustain the observed pumping rates in that well field. This higher conductivity zone in Layer 3 is shown in Figure E-11 and was assigned a value

of 10 feet per day for the horizontal hydrolic conductivity (K) and 1 foot per day for the vertical K. A horizontal K value of 10 feet per day is close to the average K value for the transitional UMCf (see Table 3.3 of the CZE report). Based on observed water levels in monitoring wells and piezometers near the IWF, there is limited water in the alluvium, predominantly contained in small channels incised into the underlying UMCf. Although water levels in pumping wells are consistently below the Qal/UMCf contact, the water extracted by this well field appears to be a combination of flows entering the well from the UMCf and cascading into the wells from the thin layer of water located in the Qal above. For practical reasons, the detail necessary to simulate the limited water zones that occur in the Qal just above the contact with the UMCf has not been included in the model. The higher K value used near the IWF can therefore be considered an effective K value for the flow that occurs through both the UMCf and alluvium.

For the model auto-calibration runs, the ratio of horizontal to vertical hydraulic conductivities was bounded between 1 and 100 for the alluvium, paleo-channels, and wash deposits. For the UMCf, the ratio between horizontal to vertical hydraulic conductivities was bounded between 1 and 1000.

3.6 Boundary Conditions

Accurate modeling of the hydraulic head distribution and flow paths depends on appropriate definitions of boundary conditions, sources and sinks. The boundary conditions and sources/sinks fundamentally provide the driving forces for flow within the model and control the mass flux of water entering and leaving the model domain.

3.6.1 Top Boundary Conditions

3.6.1.1 Recharge

The water table is modeled as a flux boundary, based on the spatial distribution of recharge from precipitation, ponds, irrigation, and leaking utilities. Recharge is modeled using the MODFLOW Recharge package (Harbaugh et al., 2000). Six recharge zones were defined on the basis of land use as shown in Figure E-12 and the values of recharge used in the model are summarized in Table E-1b. The residential areas, industrial areas, and undeveloped regions are three of the six recharge zones. Recharge from the City of Henderson (COH) Birding Preserve is another zone as are recharge from irrigation water at the Tuscany Golf Course and the Tronox ponds. The TIMET ponds and the Northern Rapid Infiltration Basins (RIBs) are not active during the time period simulated. Recharge in those regions is therefore assigned the undeveloped recharge rate since those features are located in undeveloped areas.

The recharge rate for undeveloped areas is equal to the natural recharge rate of 1.83 x 10^{-5} feet per day (0.08 in per year) based on values from a 2007 USGS report (USGS, 2007). This value is consistent with the rate that NDEP has identified as the natural recharge rate and is the value used in the updated groundwater flow model by DBSA (DBSA, 2009). This value of recharge is equivalent to about 2 percent of the average annual precipitation. This value is held fixed during model calibration.

The recharge rates for the residential and industrial areas and the Tuscany Golf Course were adjusted as part of the model calibration process. The maximum and minimum recharge values used in the calibration for the residential and industrial areas are 5.0 x 10^{-5} feet per day and 4.3 x 10^{-4} feet per day (0.22 and 1.88 inches per year), respectively. The maximum value was based on the higher recharge value obtained by DBSA (DBSA, 2009) from calibration of their groundwater model. The maximum and minimum recharge values for the Tuscany Golf Course used in the calibration are based on the values used by DBSA (DBSA, 2009).

Records of recharge rates for the Birding Preserve were obtained from Brenda Pohlmann of the COH on August 19, 2010. For the time period used for the model calibration, August 2008 through March 2009, the average daily discharge was 1.15 x 10^{5} cubic feet day (0.86 million gallons per day). Using this discharge value and accounting the for evaporative loss using the pan evaporation rate of 8.2 feet per year estimated by Shevenell (Shevenell, 1996), a recharge rate of 2.43 x 10^{-3} feet per day was calculated for the Birding Preserve (footprint of the preserve is approximately 4.65 x 10^{6} $feet^{2}$).

The Tronox ponds are plastic lined ponds and the seepage rate used is comparable to the leakage rate for a high density polyethylene geomembrane (Peggs, 2009). Groundwater recharge from AMPAC re-injection systems and the Tronox and POSSM recharge trenches were modeled as internal sources as described later in Section 3.7.

3.6.1.2 Evapotranspiration

Evapotranspiration (ET) is simulated using the MODFLOW Evapotranspiration Package (Harbaugh et al., 2000). Estimates of ET_0 (0.011 foot per day) and the extinction depth (5 feet) are based on values from the calibrated BMI Upper and Lower Pond Area model (DBSA, 2008a). Locations where ET is simulated are based on a GIS map of the phreatophytes along the Las Vegas Wash that was obtained from Southern Nevada Water Authority (Figure E-13). Phreatophytes that were on the BMI site were removed at the end of 2007. Since the calibration period for the Tronox model occurs after they were removed, ET in those areas is not included.

3.6.2 Bottom Boundary Condition

The bottom boundary of the model represents the vertical inflow or outflow of water into or out of the deeper water bearing zone. Vertical flow for the different regions of the model domain was assessed by evaluating reports of neighboring sites and the vertical gradient data from the Tronox area (see Table E-4). These vertical gradients were calculated using head values from well pairs/triplets that had been corrected for density. Seventeen deep/middle well pairs exist within our model domain and all except for one indicate an upward vertical gradient. Data from fourteen middle/shallow well pairs within our model domain indicate that upward vertical flow occurs in all of those well pairs.

To simulate vertical into and out of the bottom of the model domain, the General Head Boundary (GHB) condition in MODFLOW was applied along this boundary. Because the bottom of the model is within the deep water bearing zone of the UMCf, the gradients from only the deep/middle well pair measurements were used to estimate the minimum and maximum GHB hydraulic conductances for the calibration. Flow from the bottom boundary was vertically upwards throughout most of the model domain except for the northeast region where downward vertical gradients were observed.

After evaluating the initial model calibration results, the locations of the seven GHB reaches/zones were changed somewhat from the zones presented in the Modeling Input Memo (Northgate, 2010d). The updated GHB zones are presented in Figure E-14 and consist of different zones encompassing each of the Tronox well fields, one zone on the western side of the domain, and three zones on the eastern side of the domain. A summary of the measured vertical gradients within each of these different reaches, if available, is included in Table E-1d. Minimum and maximum values of conductances corresponding to each zone were estimated using these gradients and the estimated range of vertical hydraulic conductivities for the UMCf. Reaches 2 and 3 did not have any measured vertical gradients corresponding to those areas, so the range of conductances for the calibration end points was based on the maximum ranges from the other reaches.

3.6.3 Lateral Boundary Conditions

3.6.3.1 Eastern and Western Edges

The eastern and western edges of active model domain have been chosen to coincide as closely as possible with observed streamlines. This allows the lateral boundaries to be treated as no-flow boundaries.

3.6.3.2 Mountain Block Recharge (Southern Edge)

Mountain block recharge to the basin sediments along the base of the McCullough Range, at the southern boundary of the model, was treated as a specified flux boundary condition. Estimates of this mountain block recharge flux were based on estimates calculated using a water budget approach (see Table E-1e). The MODFLOW Well package was used to simulate the flux across the southern boundary based on these recharge estimates.

3.6.3.3 Las Vegas Wash (Northern Edge)

The water surface elevation of the Las Vegas Wash was represented as constant head boundaries at the northern edge of the model. Information on the water surface elevation in the Wash was obtained from the Clark County Regional Flood District (CCRFD) and the Southern Nevada Water Authority (SNWA; see Table E-1f). Water surface elevation at Pabco Road was obtained from CCRFD and SNWA provided HEC-RAS cross-sections of the water surface elevation downstream of Pabco Road. A surface water elevation gradient was estimated based on this data. A linear gradient was assumed across the portion of the Wash within the model domain, although this is a simplification because of the weirs along the Wash. Therefore, some differences exist in the water elevations used in the model and the actual water surface elevations. Linear interpolation between these data was used to assign constant head values to all the cells along the northern edge of the model.

3.7 Internal Sources and Sinks

3.7.1 Groundwater Pumping Wells

Pumping wells (including both extraction and injection wells) are being modeled using the MODFLOW Well Package (Harbaugh et al., 2000) based on pumping records available from Tronox, AMPAC, and POSSM. Table E-1g gives a summary of the combined extraction/injection rates for each well field included in the model. Information on the top and bottom of the screened intervals of pumping wells was obtained from the “All_Wells” spreadsheet maintained by the Companies.

The pumping rates for the individual wells are summarized in Table E-5. The pumping rates for the Tronox wells are the average pumping rates over the period of the steady-state model calibration, 8/2008 – 3/2009. Pumping rates from October 2008 were used for the POSSM wells. AMPAC pumping rates during the steady-state period were not available so pumping rates available from the second half of 2009 were used.

3.7.2 Groundwater Infiltration trenches

The Tronox groundwater infiltration trenches are simulated using the MODFLOW Recharge package. Average recharge rates (Table E-1h) are based on the records for recharge pump flow rates during the identified steady-state period. The POSSM recharge trench is approximately 300 feet downgradient from the POSSM well field and is recharged with treated water at a rate approximately equal to the extraction rate (Table E-1h).

3.8 Tronox Groundwater Barrier Wall

The Tronox groundwater barrier wall in the IWF is being simulated with the MODFLOW Horizontal Flow Barrier (HFB) package (Harbaugh et al., 2000) applied to Layers 1-3, with an assigned hydraulic conductivity of $1x10^{-6}$ centimeters per second based on recent laboratory analysis of wall material.

3.9 Initial Conditions

A steady state model has been developed for the objectives stated in the Work Plan (Northgate, 2010c).

3.10 Model Calibration

The purpose of the calibration process is to ensure that all hydrologic input parameters are made to best describe the target (observed) hydraulic heads and/or fluxes in the model domain within an acceptable degree of accuracy. Model calibration was performed using 263 target calibration heads, based on a selection of observation well data distributed across the model domain and with screened intervals representative of all model layers. Hydraulic head observation points were chosen from a regional groundwater data set of the shallow, middle, and deep water bearing zones compiled from water level data available from the Site and the neighboring sites. An extensive QA/QC screening process was used to identify potential errors in recorded well coordinates and well construction data prior to assembling the final water elevation data set. The parameter estimation software, PEST (Doherty, 2004), was used to calibrate the Tronox model. The parameters estimated in the calibration are the horizontal and vertical hydraulic conductivities of the alluvium, UMCf, paleo-channels and the alluvial deposits, the recharge in the residential and industrial areas and the Tuscany Golf Course, the flux entering the southern boundary, and the GHB conductances along the bottom of the model domain.

3.10.1 Head targets

Several hundred groundwater heads measured between 2008 and 2009 were evaluated as potential calibration targets for the model. Whenever possible, groundwater heads measured during the time period used for model calibration (August 2008 to March 2009) were used. However, some data measured from the first half of 2008 and second half of 2009 were also used to provide sufficient spatial coverage of head targets throughout the model domain. Only groundwater heads with associated TDS data were used in the calibration so that a fresh water head correction for salinity could be uniformly applied to all the data using the equation in Post et al. (Post et al., 2007). Table E-6 summarizes the measured heads and corresponding corrected fresh water heads. The difference between the fresh water and measured head is less than 0.5 foot for all the wells except for MCF-05 and MCF-09A, which have fresh water heads 21 feet and 5 feet higher than the measured ones, respectively. These two wells are owned by BRC and located in the BMI Common Areas. Well MCF-05 is located in a high TDS region interpreted to contain a separate source of salts from paleo evaporite deposits (DBSA, 2010a).

The number of head targets varies with each layer, with the majority of the targets in Layers 2 and 3. The elevation of the targets corresponds to the center of the screen elevation from which the heads were measured. The head targets in the Layers 4, 5, and 6 were further evaluated because these layers are fairly thick and vertical flow occurs through them. The head values located away from the center of a model grid cell may not be appropriate to use as calibration targets, particularly when the layers are thick, because heads change in the z-direction during vertical flow while the head in a model grid cell is the same value throughout the layer thickness. Therefore, only a subset of targets near the center of the grid cell in Layers 4, 5, and 6 were selected for the final calibration. For Layers 4 and 5, which are 60 feet thick, head targets within ± 12 feet of the cell center were used and for layer 6, which is 120 feet thick, head targets within ± 20 feet of cell center were used. After selecting only the heads with elevations near the cell center, 263 head targets were used to calibrate the model (Table E-6).

3.10.2 Steady-State Calibration Results

Model calibration was performed on the regional model with the 200 feet by 200 feet grid discretization. Since the CZE analyses were performed using the regional model with the locally refined 50 by 50 grid, the calibration statistics for all the layers of both the coarse and refined model are presented in Table E-7. The refined model was not directly calibrated because of the long run times needed to solve the steady-state flow model. The differences are minor between the coarse and refined model, indicating that the grid refinement did not change the calibration results. Calibration metrics, including average error, average absolute error, and root mean square error (RMSE) indicate good agreement between the predicted and observed hydraulic

heads. The calibration indicated that the model predicted heads have a residual mean of 1.26 feet with a RMSE of about 6.2 feet for all six layers. In addition, the simulated mass balance error of the calibrated model is very low, less than 0.005% for both the coarse and refined models. Plots of the potentiometric surface from the calibrated model are shown in Figure E-15 for the six layers.

The calibration statistics of each layer from the refined model are also presented in Table E-7. The RMSE of Layers 1 – 4 ranges between 4.2 feet – 6.6 feet and is around 11 feet in both Layers 5 and 6. Therefore, the agreement between the simulated and observed heads is better in the upper portion of the model compared to the deeper portions. The majority of the perchlorate plume is located in Layers 2 – 4 (see Section 6 of the CZE report), so the calibrated model has good agreement between the simulated and observed heads in the layers critical for the CZE. A one-to-one plot of predicted versus observed hydraulic heads is shown in Figure E-16 and also shows the agreement between the predicted and observed heads over a large range of heads.

A good match was also found between the spatial distribution of dry model cells in Layers 1 - 3 and maps of unsaturated regions for the modeled steady-state period, as shown in Figure E-17. Most of Layer 1 is unsaturated except for the areas along the Wash and the western side of the domain. The model and observed results are consistent in this layer, except the model does not have a saturated region on the western side of the domain, which may be because of boundary effects. The match between the modeled and observed saturated areas in Layer 2 is also good, with the modeled results being slightly more saturated than observed. Layer 3 is almost entirely saturated. The model has some dry cells on the eastern boundary and the extent of the unsaturated region on this side is larger than the observed, which again may be due to boundary effects. The observed and modeled saturated regions along the center of the domain match well in the three layers, which is the region of interest for the CZE.

The parameter values estimated by the calibration are presented in Table E-8. As discussed below in Section 2, Sensitivity Analysis, the developed recharge rates (both residential and industrial) and the vertical conductances for the GHB's are the most sensitive parameters. The industrial recharge rate in the Tronox facility from the calibration was 4.3×10^{-4} feet per day (1.9 inches per year), while the calibrated value for recharge in the residential areas is lower with a value of 5.6×10^{-5} feet per day (0.25 inches per). Prior studies that have estimated recharge multipliers in areas that have transitioned from undeveloped to developed have generally only examined increases in recharge resulting from residential development. Literature on recharge multipliers for industrial areas is not readily available. A value of 3.8×10^{-4} feet per day (1.7 inches per year) for the industrial recharge rate was estimated for the Tronox facility based on literature values for residential recharge multipliers, the results from the DBSA (DBSA, 2009)

model calibration, and percentage of water deliveries to the Tronox plant (Northgate, 2010e, Attachment C). This value is consistent in magnitude with the industrial recharge rate of 4.3 x 10^{-4} feet per day from Tronox model.

The calibrated residential recharge rate of 5.6 x 10^{-5} feet per day is about 3 times higher than the undeveloped rate. A multiplier of 3 for developed (residential) areas falls in the range observed in studies by Garcia-Fresca (Garcia-Fresca, 2005) and Milczarek et al. (Milczarek et al, 2004), which estimated increases between 2 - 5 times in arid regions.

The calibrated values for the GHB conductances vary considerably throughout the model domain. The region below the Tronox IWF (Reach 4) has the highest conductance, followed by the zone along the western side of the model (Reach 7), indicating that the contribution of vertical upward flow from the deep water bearing zones is the highest in those regions. The conductances from Reaches 2 and 3 below the SWF and AWF are low, indicating minimal contribution from the deep water bearing zones in those areas. The conductances on the eastern side of the model are also relatively low (Reaches 5 and 7), but higher than the regions below the SWF and AWF. Reach 1 was the only region modeled to have downward vertical flow out of the bottom boundary.

3.10.3 Transient Runs with Calibrated Model

Two pump tests conducted on TIMET wells, CLD-3R and PC-67, were simulated using the calibrated model. Well CLD-3R is located just east of the IWF and Well PC-67 is located about midway between the IWF and AWF. Both wells are screened in the alluvium. To simulate the pump tests, sub-models of the region near the well were developed using the TMR feature of Groundwater Vista and a grid spacing of 10 feet by 10 feet. The grid in the sub-model was further refined to 1 foot in the well vicinity. Plots of the observed and simulated drawdown for the two pump tests are shown in Figure E-18. For Well PC-67, the model slightly over-predicts the measured drawdown while the model under-predicts the observed drawdown for Well CLD-3R. The model simulates a slightly slower recovery curve than observed after pumping ceases in both wells. Given the large extent of the model domain and that only a single K zone for the alluvium was used, the model adequately predicts the transient response of the two pump tests.

3.10.4 **Evaluation of Steady-State Calibration Results for Density Effects**

As discussed in Section 2, it was determined that accounting explicitly for variable density flow was not necessary. As further evidence that this was a valid assumption, the steady-state calibration results were examined for possible gravity-density driven flow bias. A comparison between TDS and the calibration residuals, well as between fresh water head correction (i.e. Observed Corrected Fresh Water Head – Observed Head) was carried out to identify if there

was any obvious correlation between errors in the modeled head values and locations with high TDS or large fresh water head corrections. Questions were asked, for example: Were high TDS locations systematically being under or over predicted by the model? If so, this could indicate some bias due to density differences. The results of these comparisons illustrated that no readily apparent correlation exists between the model prediction errors and either the TDS or fresh water head corrections. Residuals appear to be distributed between both high and low TDS values. While not diagnostic, this does add an additional line of evidence in support of the assessment variable density flow may not be significant for the purposes of the CZE.

That said, it should be noted that it is likely that density effects may have played a stronger role in the source areas (and immediately downgradient) during the initial historical release and migration of the TDS plumes; when the relative effects of horizontal hydrodynamic dispersion would have been smaller, vertical gradients may been reversed locally due to significant downward recharge of high TDS water, and when strong local gradients due to pumping had not yet begun. At the early stages, the initial TDS concentrations would also have been much higher and density effects would have added to the downward driving forces. In this regard future studies that simulate the historical releases and evolution of the plumes may need to incorporate variable density flow.

3.11 Sensitivity Analysis

A sensitivity analysis was conducted to identify which model input parameters (i.e., including aquifer hydraulic properties, boundary conditions) have the greatest effect on the predicted hydraulic heads and on any of the conclusions derived from the model. The sensitivity of the model parameters was investigated using PEST, which automatically calculates the sensitivity coefficient of each parameter during the calibration process. Figure E-19 summarizes the parameter sensitivity coefficients. These results indicate that the recharge rates and the conductances of the GHB's are the most sensitive parameters, followed by the vertical and horizontal hydraulic conductivities of the UMCf. The remaining parameters are insensitive, which includes the vertical and horizontal hydraulic conductivities of the alluvium, paleo-channels, and the alluvial deposits along the Wash. The Southern boundary flux is also insensitive.

The insensitive parameters were held fixed during the final model calibration. During the initial calibration of the model when sensitivities were examined, the horizontal hydraulic conductivity of the alluvium estimated by PEST was 35 feet per day, the maximum value in the calibration range. This parameter was held fixed at this value for the final model calibration. The alluvium in the model domain was originally divided into 2 zones, one on the eastern and another on the western side of the domain (Northgate, 2010d). However, the values estimated by PEST for both zones were the same, so only one alluvium zone was used in the final calibration. The hydraulic

conductivities for the paleo-channels are divided into an eastern zone and western zone. PEST estimated the K value of the paleo-channels in both of these zones as 265 feet per day, the maximum value allowed in the calibration. During the final model calibration, the western and eastern paleo-channels are fixed at values of 200 feet per day and 100 feet per day, respectively. A hydraulic conductivity of 200 feet per day is consistent with the paleo-channel K from the calibrated model developed for the AMPAC region (Geosyntec Consultants, 2010). The 100 feet per day value is consistent with the paleo-channel K used on the eastern side of the DBS&A model. The alluvial deposits near the Wash, another insensitive parameter, were fixed at the average value of 485 feet per day (McGinley and Associates, 2003) in the final calibration. The Southern boundary flux was also an insensitive parameter and set to a value about midway between the calibration endpoints for the final calibration. The vertical K's of the insensitive parameters were also held fixed for the final calibrations using the values summarized in Table E-8.

3.12 Transport Model

A mass transport model was developed using the MT3D code (Zheng 1993) to quantitatively evaluate the capture efficiency of the extraction well fields (see Section 6.2.8 of report) by calculating the mass fluxes of perchlorate captured and bypassed at the well fields for the current conditions. The transport model was not developed to predict future transport scenarios.

Perchlorate is a conservative tracer that does not suffer any degradation and adsorption; therefore, no sorption or decay is simulated. A longitudinal dispersivity of 66 feet was used, estimated using the equation developed by Xu and Eckstein (Xu and Eckstein, 1995) and a perchlorate plume length of 18,000 feet. The lateral dispersivity was 1/10 of the longitudinal dispersivity (6.6 feet) and the vertical dispersivity was 1/100 of the longitudinal dispersivity (0.66 foot).

The observed concentration points used to develop the 3-D plume model of perchlorate (Section 4 of CZE Report) were imported into Groundwater Vista to generate the initial concentration plume for the MT3D run. The imported concentrations were interpolated in Vista using the Nearest Neighbor approach. The interpolated concentrations in Vista were compared with the 3-D plume from Section 4 of the CZE Report and the concentration distribution was consistent.

After assigning the transport parameters and the initial concentrations, a transient transport run using MT3D was conducted. For the mass flux calculations, the MT3D concentration output from a time step of around one day were imported since the calculations performed are for the current conditions. Mass flux calculations (Q x C) were performed directly in Groundwater Vista since it has the option of multiplying the flux by the concentration when the mass balance is performed. The captured and bypassed perchlorate mass flux for the IWF and the AWF were calculated by

defining a thin zone along the plane of the extraction wells and extending the plane to (1) a local boundary and (2) the wider 1 ppm perchlorate plume boundary (see Figure 6.9 and Section 6.2.8 in the CZE Report for details and results).

4.0 PREDICTIVE SIMULATIONS

4.1 CZE with Current Conditions

After the model was calibrated and parameter sensitivity assessed, the model was used to delineate capture zones for the IWF, AWF, and SWF under the latest operational conditions. These results are presented in Section 6 of the CZE Report.

4.2 Optimization of Groundwater Systems to Achieve Target Capture or Improve Efficiency

Physical modifications were simulated in the Tronox model to improve the efficiency with which the target capture is achieved and the results are presented in Section 8 of the CZE Report.

5.0 LIMITATIONS OF THE TRONOX MODEL

The Tronox model is an appropriate tool for the purpose it was developed (e.g., CZEs). By the same token, it is also an appropriate tool for designing enhancements to the existing extraction system. However, the Tronox model does have limitations. The Tronox model is a steady-state model, and only capable of simulating average groundwater levels and stream flow conditions. Although the model was tested in a transient mode by simulating pump tests, more exhaustive tests should be performed before accepting it as a predictive tool for transient situations. For enhancing the model to be useful for transient situations, transient recharge and stream water elevations etc. have to be incorporated.

Constant head boundary conditions were used along the Wash as a simplification in the Tronox model since the capture zone analysis is mainly focused on the IWF and AWF, and the Wash is beyond these two regions of the interest. Using the constant head boundary conditions is a limitation since surface/groundwater interactions that occur along the Wash are not simulated. In addition, it was assumed that the water surface elevation gradient is linear along the Wash, and the impact of the weirs along this boundary was not accounted for. Surface/groundwater interactions along the Wash would likely impact the area around the SWF, but would not affect the IWF or AWF.

A vast majority of the model domain is covered by approximately 200 feet by approximately 200 feet grid blocks. In those areas of the domain, the model should not be expected to accurately predict head responses that propagate distances smaller than 200 feet. For example the model would severely under-predict draw down caused by a 5 gallons per minute well within a 200 feet cell. However, if such information is necessary, it is always possible to develop a sub-model using Vista's TMR feature.

As pointed out in the calibration section earlier, the model-predicted heads matched the observed heads better in the upper four layers of the model compared to the bottom two layers. Hence, some uncertainties should be attributed to model predicted heads for the deep water bearing zone of the UMCf unit.

6.0 REFERENCES

AMPAC, 2009. Quarterly Performance Report, July - September, 2009, Perchlorate In Situ Bioremediation System, American Pacific Corporation, Henderson, Nevada, October 29, 2009.

AMPAC, 2010. Quarterly Performance Report, October 1 – December 31, 2009, Perchlorate In Situ Bioremediation System, American Pacific Corporation, Henderson, Nevada, March 11, 2010.

American Petroleum Institute (API), 2006. Downward Solute Plume Migration: Assessment, Significance, and Implications for Characterization and Monitoring of "Diving Plumes", Regulatory Analysis and Scientific Affairs. API Soil and Groundwater Technical Task Force Bulletin 24. April 2006.

Bear, J., 1972. Dynamics of Fluids in Porous Media: New York, Dover Publications, Inc., 764 pp.1972.

Converse Consultants, 2009. Limited Hydrogeologic Investigation, BMI Common Areas, Nov 29, 2009.

Basic Remediation Company (BRC) 2009. BRC and ERM 2008 Deep Soil Background Report, BMI Common Areas (Eastside), Clark County, Nevada. October, 2009.

Daniel B. Stephens & Associates, Inc. (DBSA), 2006. Groundwater Modeling Work Plan for BMI Upper and Lower Ponds Area. Prepared for Basic Remediation Company, Henderson, Nevada. November, 2006.

DBSA, 2007. Memorandum: Revised interpretation of the structural contact between the Quaternary alluvium and the Tertiary Muddy Creek formation in borelog BRC-SB-27-A located near the southern border of the BRC eastside property in Henderson, Nevada. September 19, 2007.

DBSA, 2008a. Revised technical memorandum: Sources/sinks and input parameters for groundwater flow model BMI Common Areas Eastside Area, 2008.

DBSA, 2008b. Groundwater Flow Model Calibration: BMI Upper and Lower Ponds Area. Prepared for Basic Remediation Company, Henderson, Nevada. November 2008.

DBSA, 2009. Summary report for updated groundwater flow model calibration, BMI upper and lower ponds area, 2009.

DBSA, 2010a. Evaluation of Hydrogeologic Zone Connectivity through Tritium and Stable Isoptope Sampling and Analysis: BMI Common Areas (Eastside), Clark County, Nevada. Prepared for Basic Remediation Company, Henderson, Nevada. April 2010.

DBSA, 2010b. Groundwater Monitoring Report: BMI Common Areas (Eastside), Clark County, Nevada. Prepared for Basic Remediation Company, Henderson, Nevada. May 2010.

Devitt, D.A., 2006. Evapotranspiration estimates of saltcedar on Landwell property in Henderson, Nevada, University of Nevada Las Vegas. August 7, 2006.

Devitt, D.A., L.K. Fenstermaker, M. Young, B. Conrad and B. Bird, 2009. Evapotranspiration of Mixed Shrub Communities in Phreatophytic Zones of the Great Basin. American Geophysical Union, Fall Meeting 2009, abstract #H43D-105. December 2009.

Desert Research Institute (DRI), 2003. Pohlman, K., and G. Pohl, Documentation for the Hydrogeologic Database of the BMI Complex, Henderson, NV. Desert Research Institute, Division of Hydrologic Sciences, Publication No. 41190, June 2003.

Doherty, J., 2004. PEST Model-Independent Parameter Estimation, User Manual: 5th Edition, Watermark Numerical Computing.

ENSR International, 2005. Conceptual Site Model, Kerr-McGee Facility, Henderson, Nevada. Prepared for Kerr-McGee Chemical LLC, Henderson, Nevada. August 2005.

Errol L. Montgomery & Associates (ELM&A), 2000. Analysis of Rate of Groundwater Movement Based on Results of Tracer and Hydraulic Tests Conducted Between Pittman Lateral and the Seep Area, Henderson, Nevada. December 19, 2000.

Garcia-Fresca, B., 2005. Urban-enhanced groundwater recharge: review and case study of Austin, Texas. In: KWF Howard (ed) Groundwater management in urban areas. Proceedings of the 32nd International Geological Congress, Florence, August 20-28, 2004. International Association of Hydrogeologists.

Geosyntec, 2010. Groundwater Flow Model South of Warm Springs Study Area, Henderson, NV. Prepared for AMPAC. February 2010.

Harbaugh, A.W., 1992. A Generalized Finite-Difference Formulation for the U.S. Geological Survey Modular Three Dimensional Finite-Difference Ground-Water Flow Model: U.S. Geological Survey Open-File Report 91-494, 60 p. 1992.

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000. MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model—User Guide to Modularization Concepts and the Ground-Water Flow Process: U.S. Geological Survey Open-File Report 00-92, 121 pp. 2000.

Hargis and Associates, Inc., 2010. Vertical Delineation Investigation Data Submittal Report, Henderson, NV, February 8, 2010.

Holzbecher, E.O., 1998. Modeling density-driven flow in porous media: principles, numerics, software. Spring-Verlag, Heidelberg, 253 pp. 1998.

Kerr-McGee Chemical LLC (Kerr-McGee), 1985. Hydrogeological Investigation, July 1985.

KerrMcGee, 1998. Preliminary Report on a Hydrologic Investigation of Channel-Fill Alluvium at the Pittman Lateral, Henderson Nevada, prepared by Steven R. Lower, Hydrology Services Group. October 19, 1998.

Kerr-McGee, 2001. Seep Area Groundwater Characterization Report, Henderson, Nevada Facility. January 18, 2001.

Kleinfelder, 2007a. Slug test results, Implementation of revised aquifer testing work plan, BMI Common Area. Nov 16, 2007.

Kleinfelder, 2007b. Slug Test Results, BMI Common Area. Nov 29. 2007.

Kleinfelder, 2008. Slug test results, CAMU area. January 25, 2008.

Koch, M., & G. Zhang, 1992. "Numerical Simulation of the Effects of Variable Density in a Contaminant Plume", Groundwater, Vol. 30, No. 5, pp. 731-733, Sept.-Oct. 1992.

Langevin, C.D., Thorne, D.T., Jr., Dausman, A.M., Sukop, M.C., and Guo, Weixing, 2008. SEAWAT Version 4: A Computer Program for Simulation of Multi-Species Solute and Heat Transport: U.S. Geological Survey Techniques and Methods Book 6, Chapter A22, 39 pp. 2008.

McCutcheon, S.C., Martin, J.L, Barnwell, T.O. Jr. 1993. Water Quality in Maidment, D.R. (Editor). Handbood of Hydrology, McGraw-Hill, New York, NY (p. 11.3).

McGinley and Associates (McGinley), 2003. Las Vegas Wash Initial Perchlorate Modeling Report, Henderson, Nevada: McGinley and Associates, 2003.

McGinley, 2007. Athens Road Well Field Modeling Report – Near BMI Industrial Complex, Henderson, Nevada: McGinley and Associates, Reno, Nevada. June 30, 2007.

Milczarek, M., T. Yao, J. Harding, D. Goodrich, and L. Levick., 2004. Predicting Recharge Rates in Small Urbanized Watersheds, Southwest Hydrology, pg. 6-7.

Northgate Environmental Management, Inc. (Northgate), 2010a. Interim Groundwater Capture Evaluation and Vertical Delineation Report, Tronox LLC, Henderson, Nevada. Prepared by Northgate Environmental Management, Inc. March 23, 2010.

Northgate, 2010b. Capture Zone Evaluation Work Plan, Tronox LLC, Henderson, Nevada. Prepared by Northgate Environmental Management, Inc., Oakland, California. March 25, 2010.

Northgate, 2010c. REVISED Hydrogeologic Modeling Work Plan, Tronox LLC, Henderson, Nevada. Prepared by Northgate Environmental Management, Inc., Oakland, California. June 7, 2010.

Northgate, 2010d, Technical Memorandum: Hydrogeologic Groundwater Model Inputs, Tronox Facility, Henderson, Nevada. Prepared by Northgate Environmental Management, Inc., Oakland, California. October 29, 2010.

Northgate, 2010e, Revised Technical Memorandum: Calculation of Leaching-Based, Site-Specific Levels (LSSLs) for the Soil-to-Groundwater Pathway Using NDEP Guidance, Tronox LLC, Henderson, Nevada, Prepared by Northgate Environmental Management, Inc., Oakland, California. November 18, 2010.

Peggs, I.D., 2009. Geomembrane Liner Action Leakage Rates: What is Practical and What is Not? Land and Water. July/August 2009.

Post, V., Looi, H., and Simmons, C., "Using Hydraulic Head Measurments in Variable-Density Ground Water Flow Analyses", Groundwater Volume 45, No. 6, November-December 2007.

Seller, K., W. Aslop, S. Clough, M. Hoyt, B. Pugh, J. Robb and K Weeks, 2006. Perchlorate: Environmental Problems and Solutions, Taylor & Francis. 2006.

Shevenell, L., 1996. Statewide Potential Evapotranspiration Maps for Nevada. Report 48, Nevada Bureau of Mines and Geology. 1996.

Stauffer Chemical Company, 1983. Hydrogeologic Investigation report, March 14, 1983.

TIMET, 2007. Conceptual Site Model, Titanium Metals Corp Facility, Henderson, NV. April 25, 2007.

TIMET, 2009a. Design Data Gap Investigation. June 12, 2009.

TIMET, 2009b. Revised Remedial Design for the First Water Bearing Zone, Technical Addendum: Capture zone modeling, Oct 2009.

TIMET, 2009c. Revised Remedial Design for the First Water Bearing Zone, Titanium Metals Corporation Facility, Henderson, Nevada. October 14, 2009.

U.S. Environmental Protection Agency (USEPA), 2008, A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems: U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/003. 2008.

U.S. Geological Survey (USGS), 2007. Ground-Water Recharge in the Arid and Semiarid Southwestern United States, Professional Paper 1703. Ground-Water Resources Program. July 2007.

Wilson, J.L., Guan, H., 2004. Mountain-block hydrology and mountain-front recharge. In: Hogan, J.F., Phillips, F.M., Scanlon, B.R. (Eds.), Groundwater Recharge in a Desert Environment: The Southwestern United States, Water Science and Application 9. American Geophysical Union, Washington DC, pp. 113-137. 2004.

Xu, M. and Y. Eckstein, 1995, Use of Weighted Least-Square Method in Evaluation of the Relationship Between Dispersivity and Scale", J. Ground Water, Vol 33, No. 6, pp 905-908.

Zheng, Chunmiao, and Wang, P.P., 1999. MT3DMS—A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion and Chemical Reactions of Contaminants in Ground-Water Systems: Documentation and User's Guide: U.S. Army Corps of Engineers Contract Report SERDP-99-1. 1999.

ATTACHMENTS

TABLES

1 Inputs for Regional Groundwater Model
   a. Hydraulic Conductivities
   b. Recharge
   c. Evapotranspiration
   d. Vertical Flow through Deep UMCf
   e. Southern Boundary Condition
   f. Northern Boundary Condition
   g. Injection/Extraction Wells
   h. Recharge Trench
2 Alluvium Hydraulic Conductivities
3 Muddy Creek Hydraulic Conductivities
4 Vertical Gradients
5 Injection and Extraction Rates
6 Head Targets and Calibration Results
7 Calibration Statistics
8 Parameter Values for Calibrated Regional Model

FIGURES

1 Location Map
2 Numerical Model Domain
3 Contour Map of Qal-UMCf Contact Elevation and Paleo-Channels
4 Previous Paleo-Channel Network Interpretations
5 3-D Lithological Layer Block Model
6 3-D Fence Diagram of Lithologic Layer
7 3-D View of Numerical Model Grid
8 3-D Fence Diagram Cut-away View of Grid Layers in Active Model Domain
9 Representative Cross-sections of Model Layers
10 Hydraulic Conductivity Zones for Tronox Goundwater Model, Layers 1 and 2
11 Hydraulic Conductivity Zones for Tronox Goundwater Model, Layer 3
12 Recharge Zones for Tronox Groundwater Model
13 Evapotranspiration Zones for Tronox Groundwater Model
14 General Head Boundary Reaches for Bottom Layer of Model
15 Potentiometric Surface – All Layers
16 Comparison of Simulated to Measured Heads
17 Dry Cells Comparison: Observed versus Computed
18 Comparison of Simulated to Measured Transient Pumping Tests
19 Parameter Sensitivity Results

TABLE E-8
Parameter Values for Calibrated Regional Groundwater Model

Hydraulic Conductivities	
Alluvium	
	K (ft/d)
Horizonal K	35.0
Vertical K	8.7
Muddy Creek	
	K (ft/d)
Horizonal K	0.72
Vertical K	0.0048
Paleochannels	
	K (ft/d)
Horizonal K, west side of model	200
Vertical K, west side of model	15.2
Horizonal K, east side of model	100
Vertical K, east side of model	1
Alluvial Deposits Near Las Vegas Wash	
	K (ft/d)
Horizonal K	485
Vertical K	5

Recharge	
Region	**Recharge (ft/d)**
Residential areas	5.6×10^{-5}
Industrial areas	4.3×10^{-4}
Tuscany Golf Course	1.8×10^{-3}
Undeveloped Areas (fixed value)	1.83×10^{-5}
COH Birding Preserve (fixed value)	2.43×10^{-3}
Northern RIBs (fixed value)	1.83×10^{-5}
TIMET ponds (fixed value)	1.83×10^{-5}
Tronox ponds (fixed value)	2.57×10^{-5}
Vertical Flow through Deep UMCf	
Reach	**Conductance for GHB (ft^2/d)**
1	2.8×10^{-4}
2	8.0×10^{-6}
3	8.0×10^{-6}
4	8.3×10^{-3}
5	1.5×10^{-5}
6	2.4×10^{-5}
7	6.8×10^{-3}
Southern Boundary Flux	
	Flux (ft/d)
Southern Boundary	0.008

TABLE E-7
Calibration Statistics

	COARSE MODEL	REFINED MODEL						
	All Layers	All Layers	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6
Number of Targets	263	263	7	132	102	9	8	5
Range in Observed Values	285.84	285.84	16.83	276.53	255.12	224.87	170.50	210.09
Minimum Residual	-19.68	-19.75	-2.31	-10.55	-19.75	-10.29	-19.36	-9.74
Maximum Residual	21.03	21.25	6.16	21.25	16.66	7.29	10.04	15.58
Sum of Squared Residuals	10,100.00	10,267.45	121.29	3,860.34	4,431.27	292.18	984.39	577.98
RMS Error	6.21	6.25	4.16	5.41	6.59	5.70	11.09	10.75
Residual Mean	0.97	1.26	2.65	1.60	1.31	-2.09	-4.18	3.93
Absolute Residual Mean	4.77	4.86	3.76	4.36	4.98	4.62	10.01	9.30
Standard Deviation	6.13	6.12	3.21	5.17	6.46	5.30	10.27	10.01

TABLE E-6
Head Targets and Calibration Results

WELL	Owner	Center of Screen Elevation (ft msl)	Lithology	Average TDS 2006-09 (ppm)	Average Measured Head 2008-09 (ft msl)	Fresh Water Head (ft msl)[1]	Simulated Head (ft msl)	Fresh Water - Measured Head (ft)	Fresh Water - Simulated Head (ft)	Model Layer
PC-76	Kerr-McGee	1547.01	Qal	6340.00	1549.94	1549.95	1552.27	0.01	-2.31	1
PC-80	Kerr-McGee	1539.99	Qal	2102.50	1553.77	1553.80	1548.99	0.02	4.81	1
PC-81	Kerr-McGee	1551.73	Qal	3130.00	1553.70	1553.70	1548.89	0.00	4.81	1
PC-86	Kerr-McGee	1531.58	Qal	2752.68	1548.05	1548.08	1541.92	0.03	6.16	1
PC-90	Kerr-McGee	1539.74	Qal	4690.77	1543.45	1543.46	1538.23	0.01	5.23	1
PC-92	Kerr-McGee	1535.62	Qal	5462.50	1540.66	1540.68	1539.26	0.02	1.42	1
PC-94	Kerr-McGee	1533.15	Qal	4472.50	1536.95	1536.96	1538.53	0.01	-1.56	1
AA-01	BRC	1707.77	Qal	3709.17	1709.61	1709.62	1712.60	0.01	-2.98	2
AA-08	BRC	1554.61	Qal	4443.44	1565.77	1565.80	1561.21	0.04	4.60	2
AA-09	BRC	1643.49	Qal	6537.74	1657.87	1657.94	1651.46	0.07	6.49	2
AA-10	BRC	1584.13	Qal	4505.25	1595.72	1595.76	1588.56	0.04	7.20	2
AA-20	BRC	1597.61	Qal	5996.67	1599.15	1599.15	1603.89	0.01	-4.74	2
AA-21	BRC	1558.29	Qal	5754.17	1572.45	1572.51	1563.94	0.06	8.57	2
AA-22	BRC	1551.29	Qal	2564.67	1553.70	1553.70	1545.55	0.00	8.15	2
AA-27	BRC	1713.44	Qal	4098.93	1721.53	1721.55	1715.53	0.02	6.03	2
AA-BW-04A	BRC	1685.42	Qal	15580.00	1693.38	1693.47	1696.24	0.09	-2.77	2
AA-BW-05A	BRC	1680.21	Qal	21633.33	1697.70	1697.98	1697.79	0.28	0.19	2
AA-BW-06A	BRC	1692.44	Qal	4590.00	1698.60	1698.62	1699.27	0.02	-0.65	2
AA-BW-07A	BRC	1695.14	Qal	11630.00	1702.38	1702.44	1706.37	0.06	-3.93	2
AA-BW-08A	BRC	1707.98	Qal	18175.00	1712.18	1712.23	1717.93	0.06	-5.70	2
AA-BW-08B	BRC	1705.25	Qal	37000.00	1712.03	1712.21	1717.94	0.19	-5.73	2
AAX-15	AMPAC	1620.66	Qal/xMCf/UMCf	4615.00	1627.01	1627.03	1621.34	0.02	5.69	2
ACY-15	AMPAC	1679.70	Qal/xMCf/UMCf	4890.00	1691.64	1691.68	1685.88	0.04	5.80	2
APX-2-P1O1	AMPAC	1594.50	Qal/xMCf	4510.00	1605.48	1605.52	1594.67	0.04	10.85	2
APX-5-7	AMPAC	1605.55	Qal/xMCf	5470.00	1606.49	1606.49	1602.60	0.00	3.90	2
APX-7-14	AMPAC	1597.04	Qal	4520.00	1608.37	1608.41	1598.81	0.04	9.60	2
ARP-1	Kerr-McGee	1579.36	Qal	6236.63	1589.38	1589.43	1591.77	0.05	-2.34	2
ARP-2	Kerr-McGee	1575.32	Qal	6557.50	1588.60	1588.67	1591.33	0.07	-2.67	2

TABLE E-6
Head Targets and Calibration Results

WELL	Owner	Center of Screen Elevation (ft msl)	Lithology	Average TDS 2006-09 (ppm)	Average Measured Head 2008-09 (ft msl)	Fresh Water Head (ft msl)[1]	Simulated Head (ft msl)	Fresh Water - Measured Head (ft)	Fresh Water - Simulated Head (ft)	Model Layer
ARP-3	Kerr-McGee	1577.99	Qal	8798.33	1587.60	1587.66	1590.98	0.06	-3.32	2
ARP-4A	Tronox	1584.80	Qal	4544.00	1586.59	1586.59	1589.72	0.01	-3.13	2
ARP-5A	Tronox	1581.19	Qal	6322.50	1583.59	1583.60	1588.64	0.01	-5.03	2
ARP-6B	Tronox	1578.29	Qal	9420.71	1583.57	1583.61	1588.09	0.04	-4.48	2
ARP-7	Kerr-McGee	1578.98	Qal	6050.43	1583.56	1583.59	1587.94	0.02	-4.35	2
BEC-4	BRC	1646.65	Qal	2860.00	1651.95	1651.96	1648.38	0.01	3.58	2
CLD3-R	TIMET	1712.84	Qal	14237.50	1716.67	1716.71	1719.07	0.04	-2.35	2
CLD4-R	TIMET	1737.32	Qal	7418.75	1744.64	1744.68	1734.45	0.04	10.22	2
DBMW-19	BRC	1548.05	Qal	4780.00	1548.48	1548.48	1559.03	0.00	-10.55	2
H-21R	Stauffer	1691.05	Qal	8600.00	1697.46	1697.50	1698.55	0.04	-1.05	2
H-58A	Stauffer	1643.98	Qal	11800.00	1663.99	1664.17	1671.05	0.18	-6.89	2
J2D4	TIMET	1730.59	Qal	11595.83	1736.17	1736.22	1731.73	0.05	4.49	2
KX-18	AMPAC	1626.90	Qal/xMCf	3320.00	1634.40	1634.42	1635.93	0.02	-1.51	2
KY-23	AMPAC	1618.36	Qal/xMCf	3460.00	1626.12	1626.14	1629.03	0.02	-2.89	2
M-23	Kerr-McGee	1685.79	Qal	4520.83	1691.45	1691.46	1691.51	0.02	-0.05	2
M-48	Kerr-McGee	1687.36	Qal/xMCf/UMCf	3190.00	1692.40	1692.41	1693.37	0.01	-0.97	2
M-94	Kerr-McGee	1676.93	Qal	7338.33	1680.59	1680.61	1680.63	0.02	-0.02	2
M-95	Kerr-McGee	1677.08	Qal	7352.29	1681.64	1681.66	1680.84	0.03	0.83	2
M-96	Kerr-McGee	1677.16	Qal	6701.63	1681.03	1681.05	1680.86	0.02	0.19	2
M-99	Kerr-McGee	1697.96	Qal	4800.33	1698.63	1698.63	1702.90	0.00	-4.26	2
MW-J	AMPAC	1649.41	Qal/xMCf/UMCf	5010.00	1658.31	1658.34	1658.21	0.03	0.13	2
MW-K	AMPAC	1644.76	Qal/xMCf	4620.00	1650.91	1650.93	1650.32	0.02	0.61	2
MW-K1	AMPAC	1618.05	xMCf	8213.33	1625.29	1625.33	1621.56	0.04	3.77	2
MW-K4	AMPAC	1576.84	xMCf	6877.34	1587.98	1588.04	1590.39	0.06	-2.35	2
MW-R	AMPAC	1641.90	Qal/xMCf	5390.00	1655.74	1655.80	1658.07	0.06	-2.27	2
MW-S	AMPAC	1571.19	Qal/xMCf/UMCf	7266.11	1581.17	1581.22	1578.67	0.05	2.56	2
MW-T	AMPAC	1561.22	Qal/xMCf/UMCf	5000.00	1575.23	1575.28	1566.39	0.05	8.89	2
MW-U	AMPAC	1561.36	Qal/xMCf/UMCf	4336.67	1574.21	1574.25	1564.28	0.04	9.98	2

TABLE E-6
Head Targets and Calibration Results

WELL	Owner	Center of Screen Elevation (ft msl)	Lithology	Average TDS 2006-09 (ppm)	Average Measured Head 2008-09 (ft msl)	Fresh Water Head (ft msl)[1]	Simulated Head (ft msl)	Fresh Water - Measured Head (ft)	Fresh Water - Simulated Head (ft)	Model Layer
NX-17	AMPAC	1622.10	Qal/xMCf	4880.00	1627.39	1627.41	1621.60	0.02	5.81	2
NY-15	AMPAC	1622.95	Qal/xMCf	4910.00	1628.99	1629.01	1627.68	0.02	1.33	2
OX-16	AMPAC	1617.21	Qal/xMCf	4690.00	1622.01	1622.03	1612.07	0.02	9.96	2
OY-8	AMPAC	1612.92	Qal/xMCf	4940.00	1619.74	1619.77	1610.64	0.03	9.12	2
PC-101R	Kerr-McGee	1578.81	Qal	9595.63	1589.51	1589.59	1591.79	0.08	-2.20	2
PC-103	Kerr-McGee	1571.94	Qal	4917.92	1575.86	1575.87	1578.36	0.01	-2.49	2
PC-104	Kerr-McGee	1563.91	Qal	3115.00	1566.14	1566.14	1570.93	0.01	-4.78	2
PC-108	Kerr-McGee	1556.04	Qal	2663.13	1571.82	1571.85	1562.67	0.03	9.17	2
PC-110	Kerr-McGee	1566.79	Qal	4625.00	1578.48	1578.52	1568.56	0.04	9.96	2
PC-112	Kerr-McGee	1544.47	Qal	2372.50	1560.71	1560.73	1555.52	0.03	5.21	2
PC-12	Kerr-McGee	1587.28	Qal	7366.00	1587.41	1587.41	1588.87	0.00	-1.46	2
PC-123	Kerr-McGee	1597.62	Qal/xMCf/UMCf	7438.54	1603.53	1603.57	1601.96	0.03	1.60	2
PC-124	Kerr-McGee	1605.89	Qal/xMCf/UMCf	6036.25	1610.77	1610.79	1613.77	0.02	-2.97	2
PC-125	Kerr-McGee	1605.29	Qal/xMCf/UMCf	5825.33	1611.86	1611.89	1613.24	0.03	-1.35	2
PC-126	Kerr-McGee	1606.08	Qal	10524.58	1612.00	1612.04	1612.83	0.05	-0.79	2
PC-127	Kerr-McGee	1605.64	Qal/xMCf/UMCf	7642.71	1613.35	1613.40	1611.99	0.04	1.41	2
PC-128	Kerr-McGee	1606.52	Qal/xMCf/UMCf	5206.29	1614.23	1614.26	1612.93	0.03	1.32	2
PC-130	Kerr-McGee	1598.91	Qal/xMCf/UMCf	6675.00	1614.12	1614.20	1614.72	0.08	-0.52	2
PC-131	Kerr-McGee	1608.39	Qal/xMCf/UMCf	9056.25	1622.30	1622.39	1618.07	0.09	4.32	2
PC-132	Kerr-McGee	1610.18	Qal/xMCf/UMCf	8734.17	1624.94	1625.04	1620.84	0.10	4.21	2
PC-135	Tronox	1578.31	Qal	8183.33	1588.81	1588.87	1591.91	0.06	-3.03	2
PC-136	Tronox	1582.62	Qal	5213.33	1587.17	1587.19	1588.15	0.02	-0.96	2
PC-17	Kerr-McGee	1578.16	Qal/xMCf/UMCf	9211.96	1588.92	1588.99	1592.02	0.07	-3.02	2
PC-18	Kerr-McGee	1578.59	Qal	9320.96	1590.13	1590.21	1592.13	0.08	-1.91	2
PC-2	Kerr-McGee	1567.15	Qal	5525.25	1569.51	1569.52	1575.69	0.01	-6.17	2
PC-21A	Kerr-McGee	1691.34	Qal/xMCf/UMCf	14475.00	1694.48	1694.51	1697.44	0.03	-2.93	2
PC-24	Kerr-McGee	1608.23	Qal	11391.67	1612.51	1612.55	1612.28	0.04	0.26	2
PC-28	Kerr-McGee	1635.13	Qal	7095.00	1638.60	1638.61	1636.56	0.02	2.05	2

TABLE E-6
Head Targets and Calibration Results

WELL	Owner	Center of Screen Elevation (ft msl)	Lithology	Average TDS 2006-09 (ppm)	Average Measured Head 2008-09 (ft msl)	Fresh Water Head (ft msl)[1]	Simulated Head (ft msl)	Fresh Water - Measured Head (ft)	Fresh Water - Simulated Head (ft)	Model Layer
PC-31	Kerr-McGee	1626.13	Qal	5822.50	1646.97	1647.06	1652.02	0.09	-4.96	2
PC-37	Kerr-McGee	1673.12	Qal	6897.92	1681.39	1681.44	1681.95	0.04	-0.51	2
PC-4	Kerr-McGee	1561.34	Qal	7031.67	1568.26	1568.29	1572.20	0.04	-3.91	2
PC-50	Kerr-McGee	1606.53	Qal/xMCf/UMCf	10112.50	1621.38	1621.49	1616.30	0.11	5.19	2
PC-53	Kerr-McGee	1565.26	Qal	4363.96	1569.88	1569.89	1576.66	0.02	-6.76	2
PC-54	Kerr-McGee	1677.85	Qal	6355.38	1685.80	1685.84	1686.16	0.04	-0.32	2
PC-55	Kerr-McGee	1577.24	Qal/xMCf/UMCf	7634.58	1591.09	1591.17	1594.11	0.08	-2.94	2
PC-56	Kerr-McGee	1534.71	Qal/xMCf/UMCf	3950.46	1555.22	1555.28	1550.78	0.06	4.50	2
PC-58	Kerr-McGee	1545.32	Qal	6193.92	1555.21	1555.26	1551.32	0.05	3.94	2
PC-59	Kerr-McGee	1544.36	Qal/xMCf/UMCf	4562.58	1555.17	1555.21	1551.62	0.04	3.59	2
PC-60	Kerr-McGee	1542.53	Qal	4152.50	1555.76	1555.80	1551.16	0.04	4.63	2
PC-62	Kerr-McGee	1543.10	Qal/xMCf/UMCf	3270.06	1555.34	1555.37	1551.86	0.03	3.52	2
PC-64	Kerr-McGee	1661.60	Qal	8870.00	1666.70	1666.73	1665.32	0.03	1.41	2
PC-65	Kerr-McGee	1662.54	Qal	7752.50	1667.70	1667.73	1663.39	0.03	4.34	2
PC-66	Kerr-McGee	1654.63	Qal/xMCf/UMCf	8102.50	1662.12	1662.16	1652.67	0.05	9.49	2
PC-67	Kerr-McGee	1650.18	Qal	11035.83	1661.59	1661.68	1647.59	0.09	14.09	2
PC-68	Kerr-McGee	1534.21	Qal/xMCf/UMCf	2168.19	1555.67	1555.70	1551.90	0.04	3.80	2
PC-73	Kerr-McGee	1660.94	Qal	6708.00	1669.31	1669.36	1677.23	0.04	-7.87	2
PC-74	Kerr-McGee	1520.04	Qal	2862.50	1547.18	1547.24	1552.18	0.06	-4.94	2
PC-77	Kerr-McGee	1532.13	Qal	4870.00	1558.31	1558.40	1552.61	0.10	5.79	2
PC-79	Kerr-McGee	1525.03	Qal	2685.00	1553.89	1553.95	1549.08	0.06	4.87	2
PC-88	Kerr-McGee	1505.91	Qal	4180.00	1543.20	1543.31	1538.87	0.12	4.45	2
PC-91	Kerr-McGee	1520.92	Qal	7161.46	1541.03	1541.14	1539.29	0.11	1.85	2
PC-93	Kerr-McGee	1516.36	Qal	4833.33	1536.75	1536.82	1538.58	0.07	-1.75	2
PC-96	Kerr-McGee	1518.69	Qal	2890.00	1545.64	1545.69	1542.08	0.06	3.61	2
PC-97	Kerr-McGee	1520.78	Qal	2650.29	1542.87	1542.91	1539.28	0.04	3.63	2
PY-14	AMPAC	1614.61	Qal/xMCf	3890.00	1618.31	1618.32	1611.30	0.01	7.02	2
SB-29-3	AMPAC	1586.66	Qal/xMCf	4210.00	1588.22	1588.22	1584.81	0.00	3.41	2

TABLE E-6
Head Targets and Calibration Results

WELL	Owner	Center of Screen Elevation (ft msl)	Lithology	Average TDS 2006-09 (ppm)	Average Measured Head 2008-09 (ft msl)	Fresh Water Head (ft msl)[1]	Simulated Head (ft msl)	Fresh Water - Measured Head (ft)	Fresh Water - Simulated Head (ft)	Model Layer
SB-5-5	AMPAC	1604.76	Qal/xMCf	4860.00	1608.91	1608.93	1602.09	0.02	6.83	2
SBMW-11-11	AMPAC	1588.96	Qal/xMCf	8930.00	1591.41	1591.43	1587.19	0.02	4.23	2
SBMW-18-5	AMPAC	1594.27	Qal/xMCf	5850.00	1597.43	1597.44	1592.50	0.01	4.95	2
TIMETMW-5	TIMET	1757.42	Qal	4162.50	1761.84	1761.85	1763.15	0.01	-1.31	2
TMMW-103	TIMET	1803.73	Qal	2405.00	1811.77	1811.79	1804.96	0.01	6.82	2
TWA-20	AMPAC	1645.61	xMCf	2870.00	1650.31	1650.32	1652.72	0.01	-2.40	2
TWBY-21	AMPAC	1629.60	xMCf/UMCf	3030.00	1640.68	1640.71	1641.95	0.03	-1.24	2
TWD1-17	AMPAC	1641.85	Qal/xMCf	3400.00	1649.10	1649.12	1650.67	0.02	-1.55	2
TWD4-15	AMPAC	1642.61	Qal/xMCf	3450.00	1649.01	1649.03	1650.40	0.02	-1.37	2
TWE-15	AMPAC	1616.90	xMCf	4035.00	1624.17	1624.19	1623.90	0.02	0.29	2
UC-3	AMPAC	1559.41	Qal	4700.00	1569.22	1569.25	1562.92	0.03	6.33	2
UC-4	AMPAC	1554.14	Qal	4830.00	1567.57	1567.62	1562.30	0.05	5.32	2
UD-2	AMPAC	1567.86	Qal	6540.00	1572.01	1572.03	1563.78	0.02	8.25	2
UWO-16	AMPAC	1555.42	Qal/xMCf	4350.00	1569.94	1569.99	1563.68	0.05	6.31	2
UXO-16	AMPAC	1553.50	Qal/xMCf	3920.00	1570.07	1570.12	1563.26	0.05	6.86	2
UYO-16	AMPAC	1551.60	Qal/xMCf	4420.00	1569.25	1569.31	1562.71	0.06	6.60	2
UZO-17	AMPAC	1551.50	Qal/xMCf	4570.00	1568.49	1568.55	1562.11	0.06	6.43	2
ZX-11	AMPAC	1717.20	Qal	4590.00	1730.35	1730.40	1709.15	0.05	21.25	2
ACX-16	AMPAC	1659.10	Qal/xMCf/UMCf	3800.00	1670.51	1670.54	1669.53	0.03	1.01	2
DBMW-2	BRC	1584.48	Qal	6500.00	1593.76	1593.80	1596.67	0.05	-2.87	2
H-55	Stauffer	1706.58	Qal	2800.00	1709.09	1709.10	1714.28	0.01	-5.18	2
PC-71	Kerr-McGee	1671.34	Qal/xMCf/UMCf	8040.88	1674.98	1675.00	1679.00	0.02	-4.00	2
PC-72	Kerr-McGee	1666.70	Qal	7046.25	1671.51	1671.53	1678.01	0.03	-6.48	2
SB-1-8	AMPAC	1586.23	Qal/xMCf	4670.00	1587.76	1587.77	1586.46	0.01	1.31	2
SBMW-6-12	AMPAC	1588.90	Qal/xMCf	4200.00	1596.26	1596.28	1590.12	0.02	6.16	2
TMMW-102	TIMET	1801.62	Qal	1487.50	1810.05	1810.06	1805.56	0.01	4.50	2
TMMW-104	TIMET	1804.99	Qal	1866.67	1813.34	1813.35	1804.67	0.01	8.69	2
J2D1-R2	TIMET	1726.95	Qal	6098.33	1729.91	1729.92	1730.16	0.01	-0.24	3

TABLE E-6
Head Targets and Calibration Results

WELL	Owner	Center of Screen Elevation (ft msl)	Lithology	Average TDS 2006-09 (ppm)	Average Measured Head 2008-09 (ft msl)	Fresh Water Head (ft msl)[1]	Simulated Head (ft msl)	Fresh Water - Measured Head (ft)	Fresh Water - Simulated Head (ft)	Model Layer
M-34	Kerr-McGee	1736.92	Qal/xMCf/UMCf	9319.38	1739.80	1739.82	1738.19	0.02	1.63	3
M-35	Kerr-McGee	1736.96	UMCf	6187.50	1740.87	1740.89	1737.98	0.02	2.90	3
AA-13	BRC	1663.26	Qal	2658.89	1662.15	1662.15	1668.16	0.00	-6.01	3
AA-18	BRC	1605.22	Qal	1199.33	1609.34	1609.34	1606.41	0.00	2.93	3
AA-BW-02A	BRC	1700.50	Qal	9333.33	1707.23	1707.27	1712.98	0.05	-5.71	3
AA-BW-03A	BRC	1694.24	Qal	6086.67	1702.00	1702.04	1708.36	0.04	-6.33	3
AA-MW-07	Montrose	1708.44	xMCf	19866.67	1725.47	1725.72	1725.86	0.25	-0.14	3
AA-UW1	BRC	1712.13	Qal	4310.00	1722.29	1722.32	1725.48	0.03	-3.16	3
AA-UW2	BRC	1749.02	Qal	4460.00	1754.37	1754.38	1751.77	0.02	2.62	3
AA-UW4	BRC	1749.64	Qal	6495.00	1757.10	1757.14	1745.32	0.04	11.82	3
AA-UW5	BRC	1714.38	Qal	1615.00	1719.85	1719.85	1703.20	0.01	16.66	3
AEX-35	AMPAC	1736.58	xMCf/UMCf	3080.00	1745.46	1745.48	1751.11	0.02	-5.63	3
AGX-50	AMPAC	1696.30	UMCf	790.00	1713.05	1713.06	1719.85	0.01	-6.80	3
AMX-40	AMPAC	1711.20	UMCf	5750.00	1730.06	1730.14	1734.04	0.08	-3.89	3
APX-1-45	AMPAC	1573.70	Qal/xMCf/UMCf	2590.00	1609.09	1609.16	1600.56	0.07	8.60	3
APX-2-45	AMPAC	1571.10	UMCf	2090.00	1605.32	1605.37	1598.01	0.05	7.37	3
APX-4-20	AMPAC	1595.70	UMCf	3630.00	1607.30	1607.33	1602.57	0.03	4.76	3
APX-5-16	AMPAC	1595.40	UMCf	3520.00	1606.38	1606.41	1601.75	0.03	4.66	3
BEC-9	BRC	1592.92	UMCf	5700.42	1597.28	1597.29	1615.59	0.02	-18.30	3
BRW-R1	TIMET	1790.39	Qal	3833.75	1796.78	1796.80	1787.94	0.02	8.86	3
DBMW-14	BRC	1626.49	Qal	5680.00	1636.53	1636.57	1625.53	0.04	11.05	3
DBMW-3	BRC	1582.27	Qal	6590.00	1596.83	1596.90	1599.53	0.07	-2.63	3
DBMW-5	BRC	1573.66	Qal	8000.00	1584.64	1584.71	1580.23	0.07	4.48	3
DBMW-8	BRC	1568.55	Qal	5860.00	1575.21	1575.24	1582.91	0.03	-7.67	3
DX-30	AMPAC	1790.20	UMCf	1870.00	1805.39	1805.41	1807.43	0.02	-2.02	3
DY-26	AMPAC	1764.60	xMCf/UMCf	6190.00	1779.03	1779.10	1777.94	0.07	1.15	3
FX-25	AMPAC	1719.49	Qal/xMCf/UMCf	2240.00	1727.67	1727.68	1726.88	0.01	0.81	3
H-28	Stauffer	1685.86	Qal	5916.67	1691.41	1691.43	1700.01	0.02	-8.58	3

TABLE E-6
Head Targets and Calibration Results

WELL	Owner	Center of Screen Elevation (ft msl)	Lithology	Average TDS 2006-09 (ppm)	Average Measured Head 2008-09 (ft msl)	Fresh Water Head (ft msl)[1]	Simulated Head (ft msl)	Fresh Water - Measured Head (ft)	Fresh Water - Simulated Head (ft)	Model Layer
J2D2-R2	TIMET	1722.71	Qal	6557.50	1726.92	1726.94	1729.54	0.02	-2.60	3
M-11	Kerr-McGee	1766.69	Qal/xMCf/UMCf	3313.75	1772.93	1772.94	1762.76	0.02	10.18	3
M-111A	Tronox	1730.19	UMCf	4050.00	1733.83	1733.84	1731.35	0.01	2.49	3
M-115	Kerr-McGee	1743.91	Qal/xMCf/UMCf	2822.21	1745.19	1745.19	1742.93	0.00	2.26	3
M-126	Tronox	1720.08	UMCf	15483.33	1723.45	1723.49	1726.25	0.04	-2.76	3
M-12A	Kerr-McGee	1767.48	UMCf	7621.88	1772.24	1772.27	1764.97	0.03	7.29	3
M-13	Kerr-McGee	1767.52	UMCf	3140.00	1769.55	1769.55	1767.85	0.00	1.70	3
M-131	Tronox	1716.51	UMCf	3106.00	1720.66	1720.67	1718.33	0.01	2.34	3
M-135	Tronox	1714.53	UMCf	3759.50	1718.60	1718.61	1717.30	0.01	1.31	3
M-14A	Kerr-McGee	1723.12	UMCf	3340.58	1727.86	1727.88	1727.30	0.01	0.58	3
M-17A	Kerr-McGee	1728.95	Qal/xMCf/UMCf	13520.42	1735.92	1735.99	1733.06	0.07	2.94	3
M-19	Kerr-McGee	1731.15	UMCf	3851.25	1732.40	1732.40	1727.33	0.00	5.07	3
M-22A	Kerr-McGee	1725.93	Qal/xMCf/UMCf	15223.33	1728.96	1729.00	1720.46	0.03	8.54	3
M-25	Kerr-McGee	1722.09	Qal/xMCf/UMCf	8961.67	1726.29	1726.32	1721.30	0.03	5.02	3
M-31A	Kerr-McGee	1746.94	UMCf	8479.17	1751.94	1751.98	1748.74	0.03	3.24	3
M-36	Kerr-McGee	1724.64	UMCf	16578.75	1727.40	1727.43	1719.66	0.03	7.77	3
M-37	Kerr-McGee	1725.90	UMCf	5766.88	1728.68	1728.69	1724.81	0.01	3.88	3
M-38	Kerr-McGee	1725.42	UMCf	13645.83	1728.01	1728.04	1720.24	0.03	7.79	3
M-39	Kerr-McGee	1723.94	Qal/xMCf/UMCf	6870.25	1729.18	1729.20	1721.17	0.03	8.04	3
M-44	Kerr-McGee	1669.33	Qal/xMCf/UMCf	8023.75	1677.93	1677.98	1680.50	0.05	-2.52	3
M-50	Kerr-McGee	1741.40	UMCf	14310.42	1749.31	1749.40	1748.20	0.09	1.20	3
M-52	Kerr-McGee	1758.38	UMCf	7300.42	1761.92	1761.94	1755.48	0.02	6.46	3
M-57A	Kerr-McGee	1717.32	UMCf	3050.75	1723.41	1723.43	1721.11	0.01	2.32	3
M-61	Kerr-McGee	1714.18	Qal/xMCf/UMCf	5364.63	1722.64	1722.68	1708.73	0.03	13.95	3
M-64	Kerr-McGee	1715.78	Qal/xMCf/UMCf	7922.08	1720.07	1720.09	1710.27	0.03	9.82	3
M-65	Kerr-McGee	1716.96	Qal/xMCf/UMCf	15282.29	1721.09	1721.14	1709.25	0.05	11.88	3
M-66	Kerr-McGee	1716.07	Qal/xMCf/UMCf	14905.42	1722.74	1722.81	1709.59	0.07	13.22	3
M-67	Kerr-McGee	1714.77	Qal/xMCf/UMCf	7387.50	1723.70	1723.75	1707.91	0.05	15.84	3

TABLE E-6
Head Targets and Calibration Results

WELL	Owner	Center of Screen Elevation (ft msl)	Lithology	Average TDS 2006-09 (ppm)	Average Measured Head 2008-09 (ft msl)	Fresh Water Head (ft msl)[1]	Simulated Head (ft msl)	Fresh Water - Measured Head (ft)	Fresh Water - Simulated Head (ft)	Model Layer
M-68	Kerr-McGee	1715.42	Qal/xMCf/UMCf	5721.46	1723.48	1723.52	1712.90	0.03	10.62	3
M-69	Kerr-McGee	1713.66	Qal/xMCf/UMCf	4350.50	1718.82	1718.83	1716.54	0.02	2.29	3
M-70	Kerr-McGee	1713.43	Qal/xMCf/UMCf	6051.04	1720.87	1720.90	1718.66	0.03	2.24	3
M-71	Kerr-McGee	1709.14	Qal/xMCf/UMCf	7064.58	1715.40	1715.44	1718.45	0.03	-3.01	3
M-72	Kerr-McGee	1712.39	Qal/xMCf/UMCf	8502.71	1714.97	1714.99	1716.37	0.02	-1.39	3
M-73	Kerr-McGee	1707.48	Qal/xMCf/UMCf	4035.17	1711.90	1711.91	1713.22	0.01	-1.30	3
M-74	Kerr-McGee	1709.35	UMCf	5816.04	1714.99	1715.02	1712.67	0.02	2.35	3
M-75	Kerr-McGee	1737.20	Qal/xMCf/UMCf	4913.75	1741.78	1741.79	1740.43	0.02	1.36	3
M-76	Kerr-McGee	1739.08	UMCf	4290.00	1745.78	1745.80	1741.48	0.02	4.32	3
M-77	Kerr-McGee	1757.96	Qal/xMCf/UMCf	2866.67	1761.63	1761.63	1754.56	0.01	7.08	3
M-79	Kerr-McGee	1711.71	Qal/xMCf/UMCf	2378.17	1716.26	1716.27	1718.05	0.01	-1.79	3
M-83	Kerr-McGee	1708.98	Qal/xMCf/UMCf	1767.86	1718.38	1718.39	1717.70	0.01	0.69	3
M-84	Kerr-McGee	1710.16	Qal/xMCf/UMCf	1160.92	1715.94	1715.94	1717.45	0.01	-1.51	3
M-85	Kerr-McGee	1708.46	Qal/xMCf/UMCf	1053.39	1711.86	1711.86	1716.98	0.00	-5.12	3
M-86	Kerr-McGee	1705.65	UMCf	3789.44	1710.61	1710.62	1714.91	0.01	-4.29	3
M-87	Kerr-McGee	1704.86	UMCf	3162.24	1707.02	1707.02	1711.68	0.01	-4.66	3
M-88	Kerr-McGee	1703.69	Qal/xMCf/UMCf	6194.38	1707.25	1707.27	1711.14	0.02	-3.87	3
M-89	Kerr-McGee	1729.11	Qal/xMCf/UMCf	12804.38	1732.73	1732.76	1727.53	0.03	5.23	3
M-93	Kerr-McGee	1756.89	UMCf	2883.33	1761.38	1761.39	1762.78	0.01	-1.40	3
M-97	Kerr-McGee	1756.95	UMCf	3444.25	1760.54	1760.55	1761.31	0.01	-0.76	3
MCF-01B	BRC	1683.95	UMCf	1940.68	1709.59	1709.63	1713.43	0.04	-3.81	3
MCF-06C	BRC	1574.17	Qal	9949.17	1576.92	1576.94	1585.65	0.02	-8.71	3
MCF-16C	BRC	1621.11	Qal	10087.78	1625.34	1625.37	1627.88	0.03	-2.51	3
MW-K5	AMPAC	1552.89	xMCf/UMCf	6740.48	1560.48	1560.52	1577.56	0.04	-17.04	3
MW-V	AMPAC	1573.43	Qal/UMCf	8820.00	1579.16	1579.20	1579.02	0.04	0.17	3
PC-134	Tronox	1552.73	UMCf	1767.50	1590.07	1590.12	1594.64	0.05	-4.52	3
PC-82	Kerr-McGee	1507.40	Qal	2847.00	1550.20	1550.29	1546.65	0.09	3.64	3
POD8	TIMET	1620.27	Qal	3873.33	1621.89	1621.89	1641.64	0.00	-19.75	3

TABLE E-6
Head Targets and Calibration Results

WELL	Owner	Center of Screen Elevation (ft msl)	Lithology	Average TDS 2006-09 (ppm)	Average Measured Head 2008-09 (ft msl)	Fresh Water Head (ft msl)[1]	Simulated Head (ft msl)	Fresh Water - Measured Head (ft)	Fresh Water - Simulated Head (ft)	Model Layer
POU3	TIMET	1676.15	Qal	8923.33	1689.29	1689.38	1688.28	0.09	1.10	3
PX-40	AMPAC	1590.60	UMCf	2260.00	1618.32	1618.37	1606.60	0.05	11.77	3
SB-2-7	AMPAC	1589.10	Qal/xMCf	5030.00	1591.50	1591.51	1590.51	0.01	1.00	3
SB-3-13	AMPAC	1594.70	Qal/xMCf	14570.00	1598.99	1599.04	1595.57	0.05	3.47	3
TIMETMW-4	TIMET	1744.54	Qal	4072.92	1748.73	1748.75	1750.12	0.01	-1.37	3
TIMETMW-6R	TIMET	1759.85	Qal	3162.50	1768.95	1768.97	1759.82	0.02	9.15	3
TWB-21	AMPAC	1628.60	xMCf/UMCf	3210.00	1641.32	1641.35	1643.49	0.03	-2.14	3
TWBX-21	AMPAC	1630.40	UMCf	4310.00	1641.78	1641.82	1645.01	0.04	-3.19	3
TWBX-36	AMPAC	1615.10	UMCf	3760.00	1641.84	1641.92	1644.93	0.08	-3.01	3
TWBY-36	AMPAC	1614.80	UMCf	5090.00	1640.44	1640.54	1642.44	0.10	-1.90	3
TWC-15	AMPAC	1630.00	xMCf/UMCf	3080.00	1637.82	1637.84	1640.05	0.02	-2.21	3
TWC-27	AMPAC	1620.70	UMCf	3560.00	1637.55	1637.60	1640.23	0.05	-2.64	3
TWE-18	AMPAC	1610.70	xMCf	4120.00	1624.21	1624.25	1624.39	0.04	-0.14	3
TWE-33	AMPAC	1594.20	UMCf	1260.00	1624.49	1624.52	1624.51	0.03	0.00	3
TWH-14	AMPAC	1624.63	UMCf	6650.00	1629.56	1629.58	1628.15	0.02	1.44	3
UC-1	AMPAC	1556.20	UMCf	5630.00	1575.04	1575.12	1569.98	0.08	5.14	3
WS1-14	AMPAC	1694.00	xMCf	4120.00	1704.74	1704.77	1702.11	0.03	2.67	3
DX-75	AMPAC	1745.10	UMCf	910.00	1819.37	1819.42	1812.13	0.05	7.29	4
M-120	Tronox	1785.81	UMCf	1907.50	1801.99	1802.01	1812.30	0.02	-10.29	4
M-133	Tronox	1676.23	UMCf	5026.00	1715.65	1715.80	1719.31	0.15	-3.52	4
M-136	Tronox	1664.39	UMCf	2376.00	1722.62	1722.73	1723.62	0.10	-0.89	4
MCF-09B	BRC	1578.00	UMCf	3515.68	1658.53	1658.74	1659.61	0.21	-0.87	4
MCF-10B	BRC	1518.38	UMCf	2118.33	1597.68	1597.80	1598.48	0.13	-0.68	4
MW-D2D	AMPAC	1772.30	UMCf	5770.00	1822.45	1822.67	1818.58	0.22	4.09	4
TR-10	Kerr-McGee	1761.72	UMCf	1773.33	1794.54	1794.58	1803.15	0.04	-8.57	4
TWC-48	AMPAC	1592.50	UMCf	1250.00	1637.44	1637.48	1642.82	0.04	-5.33	4
ADX-135	AMPAC	1665.15	UMCf	1530.00	1807.90	1808.06	1798.84	0.16	9.23	5
AGX-160	AMPAC	1585.90	UMCf	810.00	1738.79	1738.89	1742.35	0.09	-3.47	5

TABLE E-6
Head Targets and Calibration Results

WELL	Owner	Center of Screen Elevation (ft msl)	Lithology	Average TDS 2006-09 (ppm)	Average Measured Head 2008-09 (ft msl)	Fresh Water Head (ft msl)[1]	Simulated Head (ft msl)	Fresh Water - Measured Head (ft)	Fresh Water - Simulated Head (ft)	Model Layer
M-152	Tronox	1560.79	UMCf	850.00	1673.26	1673.33	1692.69	0.07	-19.36	5
M-153	Tronox	1637.15	UMCf	585.00	1763.78	1763.83	1759.79	0.06	4.04	5
MCF-32B		1578.31	UMCf	2900.00	1663.40	1663.59	1653.54	0.19	10.04	5
TR-2	Kerr-McGee	1589.95	UMCf	566.67	1724.51	1724.57	1733.48	0.06	-8.92	5
TR-4	Kerr-McGee	1635.54	UMCf	878.67	1735.87	1735.93	1749.50	0.07	-13.57	5
TWC-126	AMPAC	1514.60	UMCf	1130.00	1637.46	1637.56	1649.02	0.10	-11.46	5
MCF-05	BRC	1399.03	UMCf	149511.11	1580.31	1601.51	1598.84	21.20	2.67	6
MCF-09A	BRC	1414.26	UMCf	26200.00	1656.85	1661.63	1671.38	4.78	-9.74	6
TR-3	Kerr-McGee	1535.58	UMCf	662.60	1778.27	1778.39	1763.57	0.12	14.82	6
TR-5	Kerr-McGee	1561.45	UMCf	770.79	1801.59	1801.72	1786.14	0.14	15.58	6
TR-9	Kerr-McGee	1611.75	UMCf	809.33	1811.48	1811.60	1815.27	0.12	-3.67	6

Notes and Abbreviations:

[1]Corrected fresh water heads are used as targets in calibration

[1]Measured groundwater elevation corrected for density following McCutcheon (1993) and using the total dissolved solids (TDS) concentration and an average water temperature of 25°C. The equivalent fresh water head was calculated after Post et al. (2007).

Qal = Alluvium

UMCf = Upper Muddy Creek Formation

xMCf = Transitional Muddy Creek Formation

TDS = Total dissolved solids

TABLE E-5
Injection and Extraction Rates

Well	Owner	Screen top elevation (ft)	Screen bottom elevation (ft)	Q (gpm)†	Q (cfd)†	Source
APEW-1	AMPAC	1603.5	1583.5	0.00	0.00	(1)
APEW-2	AMPAC	1601	1591	-46.00	-8,855.61	(1)
APEW-3	AMPAC	1604.8	1584.5	-6.00	-1,155.08	(1)
AREW-1	AMPAC	1624.49	1614.49	-35.00	-6,737.97	(1)
AREW-2	AMPAC	1619.2	1604.2	-70.01	-13,475.94	(1)
AREW-3	AMPAC	1617.97	1607.97	-20.00	-3,850.27	(1)
AREW-4	AMPAC	1617.48	1607.48	-50.01	-9,625.67	(1)
AREW-5	AMPAC	1610.74	1595.74	-120.01	-23,101.60	(1)
AREW-6	AMPAC	1613.86	1598.86	-15.00	-2,887.70	(1)
RIW-2	AMPAC	1571	1561	0.50	96.26	(2)
RIW-3	AMPAC	1570	1540	23.40	4,504.81	(2)
RIW-4	AMPAC	1569	1549	3.90	750.80	(2)
RIW-5	AMPAC	1568	1543	0.30	57.75	(2)
RIW-5A	AMPAC	1592	1592	2.90	558.29	(2)
RIW-6	AMPAC	1586	1586	0.00	0.00	(2)
RIW-7	AMPAC	1570	1550	13.30	2,560.43	(2)
RIW-8	AMPAC	1570	1540	5.30	1,020.32	(2)
A	OSM Companies	1690.54	1680.54	-13.00	-2,502.67	(4)
B	OSM Companies	1683.04	1668.04	-20.00	-3,850.27	(4)
C	OSM Companies	1686.94	1676.94	-16.00	-3,080.21	(4)
D2	OSM Companies	1680.92	1676.92	-10.00	-1,925.13	(4)
E3	OSM Companies	1689.18	1679.18	-33.00	-6,352.94	(4)
F	OSM Companies	1693.87	1673.87	-11.00	-2,117.65	(4)
G	OSM Companies	1691.98	1671.98	-7.00	-1,347.59	(4)
H	OSM Companies	1690.76	1675.76	0.00	0.00	(4)
H2	OSM Companies	1682.76	1672.76	-9.00	-1,732.62	(4)
I	OSM Companies	1692.6	1682.6	-10.00	-1,925.13	(4)
J	OSM Companies	1715.8	1715.8	-9.00	-1,732.62	(4)
K2	OSM Companies	1723.5	1723.5	-9.00	-1,732.62	(4)
L	OSM Companies	1720	1720	-9.00	-1,732.62	(4)
M	OSM Companies	1723.9	1723.9	-10.00	-1,925.13	(4)
M2	OSM Companies	1699.58	1679.58	0.00	0.00	(4)
ART-1	Tronox	1601.57	1561.57	-2.22	-427.63	(3)
ART-2	Tronox	1598.42	1563.42	-73.91	-14,227.84	(3)
ART-3	Tronox	1602.61	1572.61	-42.20	-8,122.64	(3)
ART-4	Tronox	1598.91	1573.91	-9.73	-1,873.06	(3)
ART-5	Tronox	1599.18	1589.18	0.00	0.00	(3)
ART-6	Tronox	1602.25	1582.25	-45.45	-8,749.10	(3)
ART-7	Tronox	1599.42	1579.42	-31.06	-5,979.75	(3)
ART-8	Tronox	1600.54	1570.54	-67.81	-13,053.04	(3)
I-AB*	Tronox	1728.891	1708.891	-1.08	-207.84	(3)
I-A-R*	Tronox	1733.35	1713.35	0.00	0.00	(3)
I-B	Tronox	1732.2	1707.5	-1.48	-284.38	(3)
I-C	Tronox	1738.8	1709.5	-3.51	-675.45	(3)
I-D	Tronox	1734	1705.5	-1.39	-266.92	(3)
I-E	Tronox	1728.5	1706.5	-1.26	-243.03	(3)
I-F	Tronox	1735.9	1704.4	-6.21	-1,194.69	(3)

TABLE E-5
Injection and Extraction Rates

Well	Owner	Screen top elevation (ft)	Screen bottom elevation (ft)	Q (gpm)†	Q (cfd)†	Source
I-G	Tronox	1739.7	1710.4	-0.19	-35.98	(3)
I-H	Tronox	1736.7	1707.2	-0.83	-158.98	(3)
I-I	Tronox	1731	1701.8	-5.18	-996.67	(3)
I-J	Tronox	1735.3	1706	-8.51	-1,637.91	(3)
I-K	Tronox	1743.08	1714.88	-4.23	-814.70	(3)
I-L	Tronox	1739.3	1709.3	-1.85	-355.37	(3)
I-M	Tronox	1740.2	1710.2	-2.75	-530.24	(3)
I-N	Tronox	1740.8	1710.8	-3.59	-690.86	(3)
I-O	Tronox	1740	1710	-1.82	-350.04	(3)
I-P	Tronox	1735.2	1705.2	-2.83	-543.85	(3)
I-Q	Tronox	1739.8	1709.8	-0.29	-54.89	(3)
I-R	Tronox	1739.26	1709.26	-1.96	-376.37	(3)
I-S	Tronox	1735.57	1705.57	-4.19	-806.47	(3)
I-T	Tronox	1737.03	1707.03	-0.28	-53.27	(3)
I-U	Tronox	1737.54	1707.54	-0.83	-159.63	(3)
I-V	Tronox	1737.46	1707.46	-4.75	-913.76	(3)
I-Z	Tronox	1727.19	1707.19	-6.84	-1,316.97	(3)
PC-115R	Tronox	1544.79	1504.79	-86.61	-16,672.13	(3)
PC-116R	Tronox	1542.04	1502.04	-175.05	-33,695.36	(3)
PC-117	Tronox	1540.23	1500.23	-83.00	-15,977.03	(3)
PC-118	Tronox	1544.65	1504.65	-57.16	-11,003.24	(3)
PC-119	Tronox	1539.34	1509.34	-53.92	-10,379.94	(3)
PC-120	Tronox	1539.41	1509.41	-1.39	-267.47	(3)
PC-121	Tronox	1548.2	1518.2	0.00	0.00	(3)
PC-133	Tronox	1546.8366	1511.8366	-6.80	-1,308.14	(3)
PC-99R	Tronox	1543.67	1503.67	-110.44	-21,258.53	(3)

Notes and Abbreviations:

(1) AMPAC (2010)

(2) AMPAC (2009)

(3) Tronox spreadsheet with pumping rate data; values are average rates between Aug 2008 - March 2009

(4) October 2008 data provided by Paul Sundberg

* Pumping rate for I-A-R was mistakenly assigned to I-AB

†Positive Q values indicate injection; negative values are extraction

cfd = cubic feet per day

Q = pumping rate

TABLE E-4
Vertical Gradients

Screened Formation	Well	Site	Hydraulic gradient (with respect to shallow zone)*	Hydraulic gradient (with respect to middle zone)*	Source
Shallow	AA-01	BMI Common Area			(1)
Middle	MCF-01B	BMI Common Area	0.06		(1)
Deep	MCF-01A	BMI Common Area		0.03	(1)
Shallow					(1)
Middle	MCF-02B	BMI Common Area			(1)
Deep	MCF-02A	BMI Common Area		0.16	(1)
Shallow					
Middle	MCF-03B	BMI Common Area			(1)
Deep	MCF-03A	BMI Common Area		0.001	(1)
Shallow	MCF-06C	BMI Common Area			(1)
Middle	MCF-06B	BMI Common Area	0.05		(1)
Deep	MCF-06A	BMI Common Area		-0.05	(1)
Shallow	AA-08	BMI Common Area			(1)
Middle	MCF-08B	BMI Common Area	0.12		(1)
Deep	MCF-08A	BMI Common Area		up (artesian)	(1)
Shallow	AA-10	BMI Common Area			(1)
Middle	MCF-10B	BMI Common Area	0.03		(1)
Deep	MCF-10A	BMI Common Area			(1)
Shallow	MCF-16C	BMI Common Area			(1)
Middle	MCF-16B	BMI Common Area	0.06		(1)
Deep	MCF-16A	BMI Common Area		0.31	(1)
Shallow	AA-27	BMI Common Area			(1)
Middle					(1)
Deep	MCF-27	BMI Common Area	0.19		(1)
Shallow	AA-07	BMI Common Area			(1)
Middle					(1)
Deep	MCF-07	BMI Common Area			(1)
Shallow	AA-09	BMI Common Area			(1)
Middle	MCF-09B	BMI Common Area	0.02		(1)
Deep	MCF-09A	BMI Common Area		0.01	(1)
Shallow	B-01	POSSM			(2)
Middle	DPT-01	POSSM	0.061		(2)
Deep	DMC-MW-26	POSSM		0.224	(2)
Shallow	PW-01	POSSM			(2)
Middle	CP-01	POSSM			(2)
Deep	DMC-MW-27	POSSM		0.182	(2)

TABLE E-4
Vertical Gradients

Screened Formation	Well	Site	Hydraulic gradient (with respect to shallow zone)*	Hydraulic gradient (with respect to middle zone)*	Source
Shallow	MC-09R	POSSM			(2)
Middle	MC-MW-29	POSSM	0.005		(2)
Deep	TR-11	POSSM		0.253	(2)
Shallow	AA-BW-09A	POSSM			(2)
Middle	MCF-BW-09B	POSSM	0.09		(2)
Deep	DMC-MW-28	POSSM		0.223	(2)
Shallow	M-74	Tronox Industrial area			(3)
Middle	M-133	Tronox Industrial area	0.0178		(3)
Deep	M-132	Tronox Industrial area		0.067	(3)
Shallow	M-135	Tronox Industrial area			(3)
Middle	M-134	Tronox Industrial area	0.0208		(3)
Deep	M-136	Tronox Industrial area		0.207	(3)
Shallow	M-31A	Tronox Industrial area			(3)
Middle	M-153	Tronox Industrial area	0.1438		(3)
Deep	M-149	Tronox Industrial area		0.3116	(3)
Shallow	M-36	Tronox Industrial area			(3)
Middle	M-154	Tronox Industrial area	0.0992		(3)
Deep	M-150	Tronox Industrial area		0.1788	(3)
Shallow	M-100	Tronox Industrial area			(3)
Middle	M-155	Tronox Industrial area	0.1583		(3)
Deep	M-151	Tronox Industrial area		0.2321	(3)
Shallow	M-44	Tronox Industrial area			(3)
Middle	M-156	Tronox Industrial area	0.04526		(3)
Deep	M-152	Tronox Industrial area		0.11232	(3)
Shallow	PC-135	Tronox Industrial area			(3)
Shallow	PC-134	Tronox Industrial area	0.0754		(3)
Shallow	PC-136	Tronox Industrial area			(3)
Shallow	PC-137	Tronox Industrial area	0.0651		(3)

Notes:

*Positive gradients indicate upward vertical flow. Measured heads were corrected for density before vertical gradients were calculated.

(1) DBS&A (2010a)

(2) Hargis and Associated, Inc (2010)

(3) Northgate (2010a)

TABLE E-3
Hydraulic Conductivities for Muddy Creek Formation

Wells	Site	K (ft/d)	Lithology	Test type	Analysis	Report Source
ADX-112	AMPAC	0.001	UMCf	Slug	Bouwer-Rice	(6)
TWA-180	AMPAC	0.027	UMCf	Slug	Bouwer-Rice	(6)
TWE-51	AMPAC	0.160	UMCf	Slug	Bouwer-Rice	(6)
TWE-33	AMPAC	0.410	UMCf	Slug	Bouwer-Rice	(6)
MW-D2D	AMPAC	2.630	UMCf	Slug	Bouwer-Rice	(6)
MW-C	AMPAC	3.600	UMCf	Slug	Bouwer-Rice	(6)
MW-AL	AMPAC	3.750	UMCf	Slug	Bouwer-Rice	(6)
AMX-40	AMPAC	4.230	UMCf	Slug	Bouwer-Rice	(6)
AMX-98	AMPAC	4.400	UMCf	Slug	Bouwer-Rice	(6)
TWE-18	AMPAC	6.100	xMCf	Slug	Bouwer-Rice	(6)
MCF-28A	BMI Common Area	0.004	MCf	Slug	Hvorslev	(3)
MCF-31A	BMI Common Area	0.005	MCf	Slug	Hvorslev	(3)
MCF-24B	BMI Common Area	0.006	MCf	Slug	Hvorslev	(3)
MCF-31B	BMI Common Area	0.008	MCf	Slug	Hvorslev	(3)
MCF-29B	BMI Common Area	0.021	MCf	Slug	Hvorslev	(3)
MCF-30B	BMI Common Area	0.030	MCf	Slug	Hvorslev	(3)
MCF-30A	BMI Common Area	0.033	MCf	Slug	Hvorslev	(3)
MCF-28B	BMI Common Area	0.044	MCf	Slug	Hvorslev	(3)
MCF-29A	BMI Common Area	0.072	MCf	Slug	Hvorslev	(3)
MCF-32B	BMI Common Area	0.077	MCf	Slug	Hvorslev	(3)
MCF-03B	BMI Common Area	0.180	UMCf	Slug	Bouwer-Rice	(4)
EC-1	CAMU	0.650	Qal/UMCf	Slug	Bouwer-Rice	(5)
MCF-BW-11A	CAMU	1.040	UMCf	Slug	Bouwer-Rice	(5)
H-10	Stauffer Chemical	2.607	Qal	drawdown		(2)
TMPZ-202	TIMET	0.146	xMCF		Cooper & Jacob, recovery	(7)
TMPZ-203	TIMET	0.243	xMCF		Cooper & Jacob, recovery	(7)
TMPZ-201	TIMET	1.290	xMCF	pumping test	Cooper & Jacob, recovery	(7)
TMPZ-204	TIMET	5.350	xMCF	pumping test	Cooper & Jacob, recovery	(7)
M-11	Tronox Industrial area	1.000	Qal/xMCf/UMCf	Slug	Bouwer and Rice, 1976	(1)
M-12	Tronox Industrial area	2.600	UMCf	Slug	Bouwer and Rice, 1976	(1)
M-13	Tronox Industrial area	4.826	UMCf	Slug	Bouwer and Rice, 1976	(1)
M-17	Tronox Industrial area	24.332	UMCf	slug test	Bouwer and Rice, 1976	(1)
M-162	Tronox Industrial area	0.021		Slug	avg of Hvorslev & Bouwer Rice	(8)
M-163	Tronox Industrial area	0.005		Slug	avg of Hvorslev & Bouwer Rice	(8)
M-164	Tronox Industrial area	0.077		Slug	avg of Hvorslev & Bouwer Rice	(8)
M-187	Tronox Industrial area	0.010		Slug	avg of Hvorslev & Bouwer Rice	(8)
M-188	Tronox Industrial area	0.062		Slug	avg of Hvorslev & Bouwer Rice	(8)
	Arithmetic Mean of Hydraulic Conductivities=	1.89				
	Geometric Mean of Hydraulic Conductivities=	0.19				
	Harmonic Mean of Hydraulic Conductivities=	0.013				

Notes:

(1) Kerr-McGee, Hydrogeological Investigation, July 1985
(2) Stauffer Chemical Company, Hydrogeologic Investigation Report, March 14, 1983
(3) Converse Consultants, Limited Hydrogeologic Investigation, BMI Common Areas, Nov. 25, 2009
(4) Kleinfelder, Slug test Results, Implementation of Revised Aquifer Testing Work Plan, BMI Common Area, Nov. 16, 2007
(5) Klenifelder, Slug Test Results, CAMU Area, Jan. 25, 2008
(6) Geosyntec/AMPAC, Groundwater Flow Model South of Warm Springs Study Area, Henderson, NV., Feb. 2010
(7) Timet, Design Data Gap Investigation, June 12, 2009
(8) Tronox, Capture Zone Evaluation Work Plan, Henderson, NV., March 25, 2010

TABLE E-2
Hydraulic Conductivities for Alluvium

Wells	Site	K (ft/d)	Lithology	Test type	Analysis	Report Source
DBMW-19	BMI Common Area	1.96	Qal	Slug	Bouwer and Rice, 1976	(5)
DBMW-4	BMI Common Area	2	Qal	Slug	Bouwer and Rice, 1976	(5)
AA-26	BMI Common Area	2.45	Qal	Slug	Bouwer and Rice, 1976	(5)
AA-23R	BMI Common Area	9.99	Qal	Slug	Bouwer and Rice, 1976	(5)
AA-30	BMI Common Area	26.83	Qal	Slug	Hvorslev	(6)
AA-22	BMI Common Area	0.5	Qal	Slug	Bouwer-Rice	(7)
MCF-06C	BMI Common Area	1.5	Qal	Slug	Bouwer-Rice	(7)
AA-07	BMI Common Area	6.88	Qal	Slug	Bouwer-Rice	(7)
AA-13	BMI Common Area	12.53	Qal	Slug	Bouwer-Rice	(7)
AA-20	BMI Common Area	35.17	Qal	Slug	Bouwer-Rice	(7)
AA-08	BMI Common Area	55.55	Qal	Step test		(7)
AA-09	BMI Common Area	60.2	Qal	Slug	Bouwer-Rice	(7)
B-18	CAMU	2.18	Qal	Slug	Bouwer and Rice, 1976	(8)
AA-BW-01	CAMU	4.75		Slug	Bouwer and Rice, 1976	(8)
AA-BW-07A	CAMU	4.92	Qal	Slug	Bouwer-Rice	(8)
B-17	CAMU	7.74	Qal	Slug	Bouwer-Rice	(8)
AA-BW-08A	CAMU	28.02	Qal	Slug	Bouwer-Rice	(8)
B-14R	CAMU	69	Qal	Slug	Bouwer-Rice	(8)
MC32	Stauffer Chemical	4.28	Qal	Slug	Bouwer and Rice, 1976	(3)
MC25	Stauffer Chemical	6.15	Qal/UMCf	Slug	Bouwer and Rice, 1976	(3)
H-52	Stauffer Chemical	12.3	Qal	Slug	Bouwer and Rice, 1976	(3)
MC21	Stauffer Chemical	50.8	Qal/UMCf	slug	Bouwer and Rice, 1976	(3)
H-51	Stauffer Chemical	81	Qal	drawdown		(3)
H-49A	Stauffer Chemical	83.82	Qal	drawdown		(3)
H-14	Stauffer Chemical	77.54	Qal/UMCf	drawdown		(4)
H-21R	Stauffer Chemical	129.41	Qal	pumping		(4)
TMMW-104	TIMET Facility	1.3	Qal	pumping test	Cooper & Jacob, recovery	(1)
TMMW-103	TIMET Facility	1.4	Qal	pumping test	Cooper & Jacob, recovery	(1)
TMMW-101	TIMET Facility	2	Qal	pumping test	Cooper & Jacob, recovery	(1)
TMPZ-110	TIMET Facility	5	Qal	pumping test	Cooper & Jacob, recovery	(1)
CLD3-R	TIMET Facility	12	Qal	pumping test	Cooper & Jacob, recovery	(1)
PC-65	TIMET Facility	19	Qal	pumping test	Cooper & Jacob, recovery	(1)
PC-67	TIMET Facility	22	Qal	pumping test	Cooper & Jacob, recovery	(1)
CLD1-R	TIMET Facility	70	Qal	pumping test	Cooper & Jacob, recovery	(1)
PC-54	TIMET Facility	118	Qal	pumping test	Cooper & Jacob, recovery	(1)
J2D2-R2	TIMET Facility	125	Qal	pumping test	Cooper & Jacob, recovery	(1)
M-11	Tronox Industrial area	1	Qal/xMCf/UMCf	Slug	Bouwer and Rice, 1976	(2)
M-4	Tronox Industrial area	6.71	Qal	Slug	Bouwer and Rice, 1976	(2)
M-9	Tronox Industrial area	7.3	Qal	Slug	Bouwer and Rice, 1976	(2)
M-2	Tronox Industrial area	51.2	Qal	Slug	Bouwer and Rice, 1976	(2)
M-8	Tronox Industrial area	111.5	Qal/xMCf/UMCf	slug test	Bouwer and Rice, 1976	(2)
M-3	Tronox Industrial area	131.42	Qal	Slug	Bouwer and Rice, 1976	(2)
	Arithmetic Mean of Hydraulic Conductivities=	34.82				
	Geometric Mean of Hydraulic Conductivities=	12.98				
	Harmonic Mean of Hydraulic Conductivities=	4.28				

Notes:

(1) Titanium Metals Corp., Conceptual Site Model, Titanium Metals Corp. Facility, Henderson, Nevada, April 25, 2007

(2) Kerr-McGee, Hydrogeological Investigation, July 1985

(3) Stauffer Chemical Company, Hydrogeologic Investigation Report, March 14, 1983

(4) Gerharty & Miller (1980) referenced in the Stauffer Chemical Company Hydrogeologic Investigation Report, March 14, 1983

(5) Kleinfelder, Slug Test Results for the BMI Common Area, Nov. 29, 2007

(6) Converse Consultants, Limited Hydrogeologic Investigation, BMI Common Areas, Nov. 25, 2009

(7) Kleinfelder, Slug test Results, Implementation of Revised Aquifer Testing Work Plan, BMI Common Area, Nov. 16, 2007

(8) Klenifelder, Slug Test Results, CAMU Area, Jan. 25, 2008

TABLE E-1
Inputs for Regional Groundwater Model

a. Horizontal Hydraulic Conductivities

Alluvium and Muddy Creek

Alluvium - Qal	K (ft/d)
arithmetic mean	34.8
geometric mean	13.0
harmonic mean	4.3

Muddy Creek - UMCf	K (ft/d)
arithmetic mean	1.9
geometric mean	0.19
harmonic mean	0.013

Sources

- Stauffer Chemical Company, Hydrogeologic Investigation report, March 14, 1983
- Kerr-McGee, Hydrogeological Investigation, July 1985
- Kerr-McGee Chemical: Preliminary report on a hydrogeologic investigation of channel-fill alluvium at Pittmann Lateral, Oct 19, 1998
- Errol Mongomery & Assoc: Analysis of rate of GW movement based on results of tracer and hydraulic tests, Dec 19, 2000
- Conceptual Site Model, Titanium Metals Corp Facility, Henderson, NV, April 25, 2007
- Kleinfelder, Slug test results, BMI Common Area, Nov 29, 2007
- Kleinfelder, Slug test results, Implementation of revised aquifer testing work plan, BMI Common Area, Nov 16, 2007
- Kleinfelder, Slug test results, CAMU area, January 25, 2008
- TIMET, Design Data Gap Investigation, June 12, 2009
- TIMET, Revised Remedial Design for the First Water Bearing Zone, Technical Addendum: Capture zone modeling, Oct 2009
- Converse Consultants, Limited Hydrogeologic Investigation, BMI Common Areas, Nov 29, 2009
- Geosyntec/AMPAC, Groundwater Flow Model South of Warm Springs Study Area Henderson, NV, Feb 2010
- Tronox 2010 Slug Tests for CZE Evaluation (CZE Report, Appendix C)

Paleochannels

	K (ft/d)	Sources
Range of K values	60 - 265	• Kerr-McGee Chemical: Preliminary report on a hydrogeologic investigation of channel-fill alluvium at Pittmann Lateral, Oct 19, 1998 • Kerr-McGee, Hydrogeological Investigation, July 1985 • Stauffer Chemical Company, Hydrogeologic Investigation report, March 14, • Lower value of range inferred from viewing in ArcGIS the K measurement locations relative to paleochannel

Alluvial Deposits Near Las Vegas Wash

	K (ft/d)	Source
Range of K values	457 - 526	McGinley and Associates, Las Vegas Wash Initial Perchlorate Modeling Report, 2003
Extent of alluvial deposits		Based on geologic map and presentation from Joe Leising of SNWA.

b. Recharge

Region	Recharge (ft/d)	Source
Residential areas	5.0×10^{-5} - 4.3×10^{-4}	DBSA, Summary report for updated groundwater flow model calibration BMI upper and lower ponds area, 2009 (max value)
Industrial areas	5.0×10^{-5} - 4.3×10^{-4}	DBSA, Summary report for updated groundwater flow model calibration BMI upper and lower ponds area, 2009 (max value)
Tuscany Golf Course	8.33×10^{-4} - 5.21×10^{-3}	DBSA, Revised technical memorandum: Sources/sinks and input parameters for groundwater flow model BMI Common Areas Eastside Area, 2008
Undeveloped Areas	1.83×10^{-5}	Natural recharge rate - NDEP value based on USGS (2007) report
COH Birding Preserve	2.43×10^{-3}	COH data sent from Brenda Pholmann on 8/19/10
Northern RIBs	1.83×10^{-5}	COH data, no longer active, used natural recharge rate
TIMET ponds	1.83×10^{-5}	No longer active - used natural recharge rate
Tronox ponds	2.57×10^{-5}	Plastic lined ponds, leakage rate from Peggs (2009)

TABLE E-1
Inputs for Regional Groundwater Model

c. Evapotranspiration

Region	ET (ft/d)	Source
Phreatophytes south of Las Vegas Wash; North end of model	0.011	ET rate obtained from DBSA (2008) based on estimates by Devitt (2006). Areas of phreatophytes based on GIS map obtained from Nick Rice of SNWA.

d. Vertical Flow through Deep UMCf

Reach	Vertical gradient(s)	Source
1	-0.05	DBSA, Tritium and Stable Isotope Sampling & Analysis, and Evaluation of Hydrogeologic Zone Connectivity, BMI Common Areas (Eastside), Clark County, Nevada, 2010
2	NA	
3	NA	
4	0.113 - 0.312	• Tronox, LLC, Interim Groundwater Capture Evaluation and Vertical Delineation Report, March 2010 • Hargis and Assoc, Vertical Delineation Investigation, 2010
5	0.01 - 0.06	DBSA, Tritium and Stable Isotope Sampling & Analysis, and Evaluation of Hydrogeologic Zone Connectivity, BMI Common Areas (Eastside), Clark County, Nevada, 2010
6	0.001 - 0.33	DBSA, Tritium and Stable Isotope Sampling & Analysis, and Evaluation of Hydrogeologic Zone Connectivity, BMI Common Areas (Eastside), Clark County, Nevada, 2010
7	0.04 - artesian	DBSA, Tritium and Stable Isotope Sampling & Analysis, and Evaluation of Hydrogeologic Zone Connectivity, BMI Common Areas (Eastside), Clark County, Nevada, 2010

Reach	Range of conductances for GHB (ft^2/d)	
1	1.0×10^{-4} - 1.0×10^{-2}	Based on vertical gradients and estimated range of vertical K values for MCf
2*	8.0×10^{-6} - 4.0×10^{-2}	
3*	8.0×10^{-6} - 4.0×10^{-2}	
4	1.0×10^{-4} - 4.0×10^{-2}	
5	1.0×10^{-5} - 1.0×10^{-3}	
6	8.0×10^{-6} - 4.0×10^{-2}	
7	3.0×10^{-5} - 4.0×10^{-2}	

*No vertical gradients available

e. Southern Boundary Condition

Specified flux boundary based on an estimate of horizontal flux in the UMCf using hydraulic gradients from wells.
flux = Kh, ave (UMCf) * gradient

Parameter	Value	Source
gradient	0.03	Horizontal gradient calculated based on head measurements in Tronox region
gradient	0.01	Horizontal gradient between Wells EW-2 and DX-161A near Southern boundary of model domain
Kh (UMCf), ft/d	0.01 - 2	
min flux, ft/d	0.0001	
max flux, ft/d	0.06	

TABLE E-1
Inputs for Regional Groundwater Model

f. Northern Boundary Condition		
Constant head boundaries used based on LV Wash water surface elevation (WSE)		
Location	**WSE (ft)**	**Source**
Pabco Road	1535	Based on Pabco Weir construction design drawing from CCRFD
East edge of model	1492	Water surface elevation based on HEC-RAS cross sections of LV Wash from SNWA
West edge of model	1572	Water surface elevation based on HEC-RAS cross sections of LV Wash from SNWA

g. Injection/Extraction Wells		
Wells/Owner	**Combined Rate (cfd)***	**Source**
APEW/AMPAC	-10011	AMPAC, Quarterly Performance Report, Oct 1- Dec 31, 2009
AREW/AMPAC	-59679	AMPAC, Quarterly Performance Report, Oct 1- Dec 31, 2009
RIW/AMPAC	9549	AMPAC, Quarterly Performance Report, July-Sept, 2009
ART/Tronox	-52433	Tronox spreadsheet with pumping/injection rates
Interceptor wells/Tronox	-12668	Tronox spreadsheet with pumping/injection rates
Seep well field/Tronox	-110562	Tronox spreadsheet with pumping/injection rates
POSSM wells /POSSM	-31957	Data sent from Paul Sundberg, contractor for POSSM; Used October 2008 data
*Positive rate = injection, negative = extraction		

h. Recharge Trench		
	Recharge (ft/d)	**Source**
Tronox infiltration trench	0.098	Tronox spreadsheet with pumping/injection rates
POSSM infiltration trench	0.06	Paul Sundberg, contractor for POSSM

i. Formation Porosities		
	Porosity	**Source**
Alluvium - Qal	0.4	Analysis of Tronox core samples, 2010
Muddy Creek - UMCf	0.54	Analysis of Tronox core samples, 2010

FIGURE E-19
Parameter Sensitivity Results

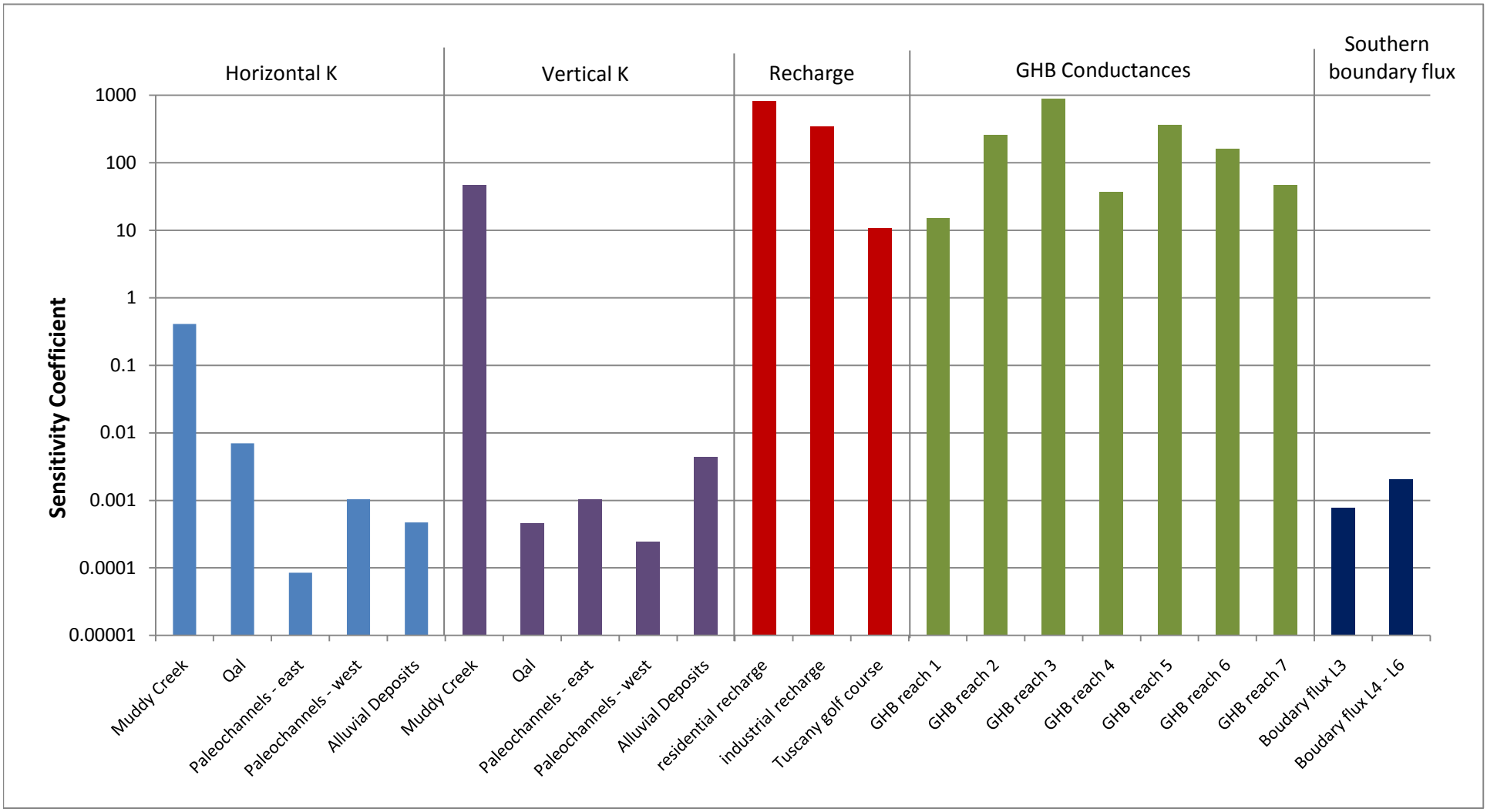
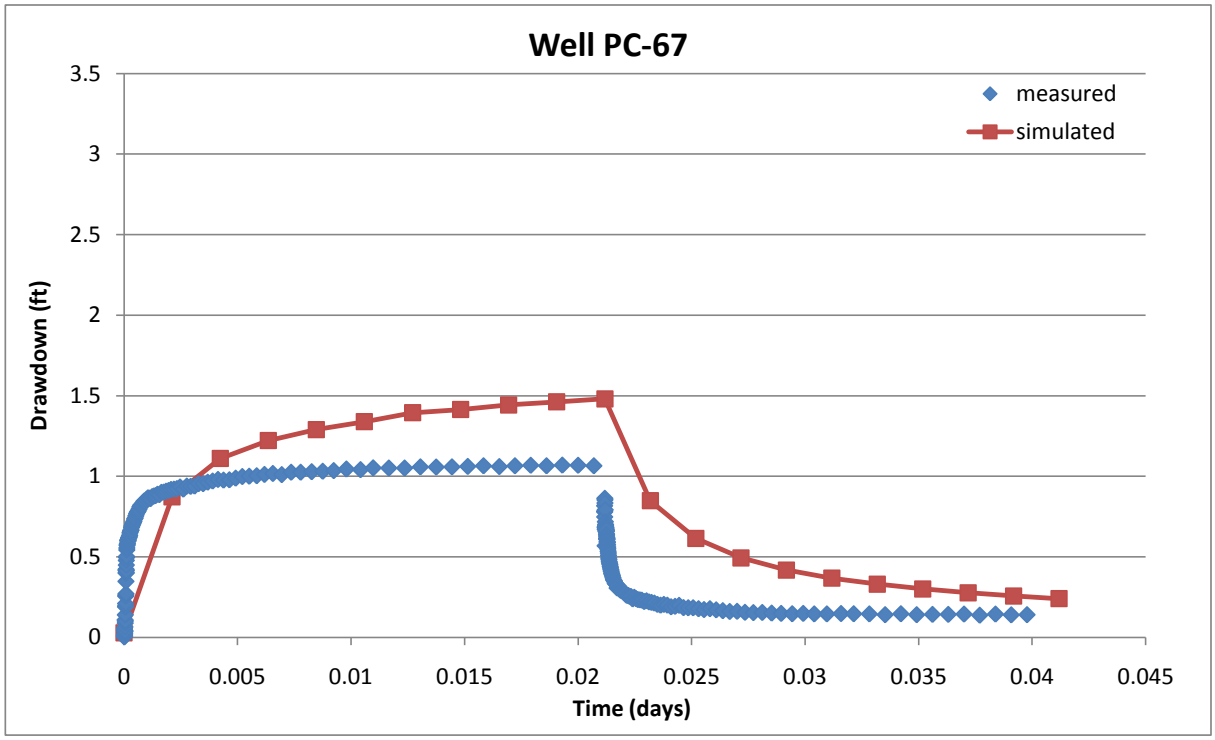
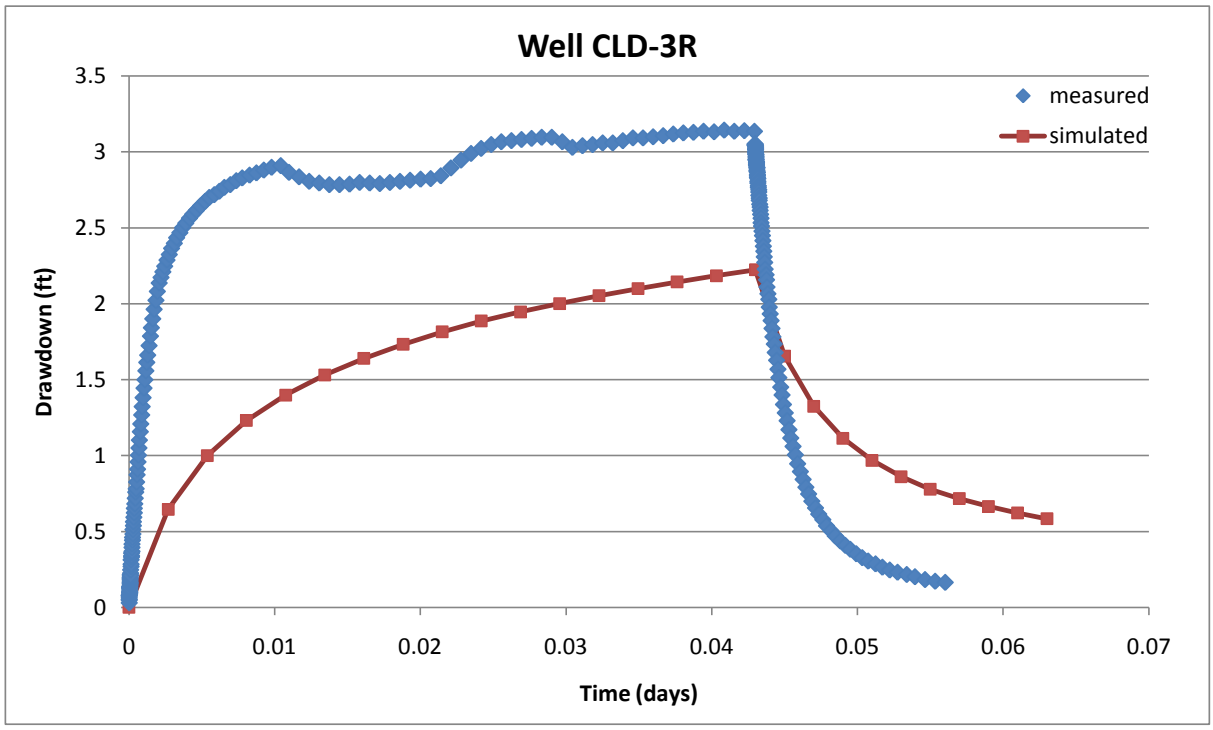
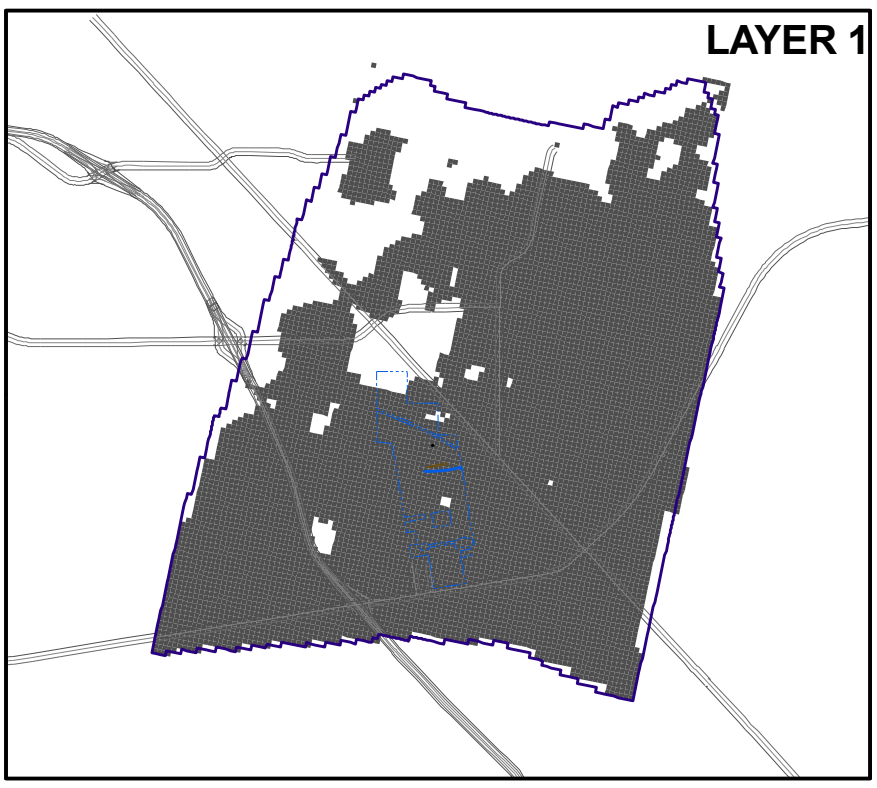
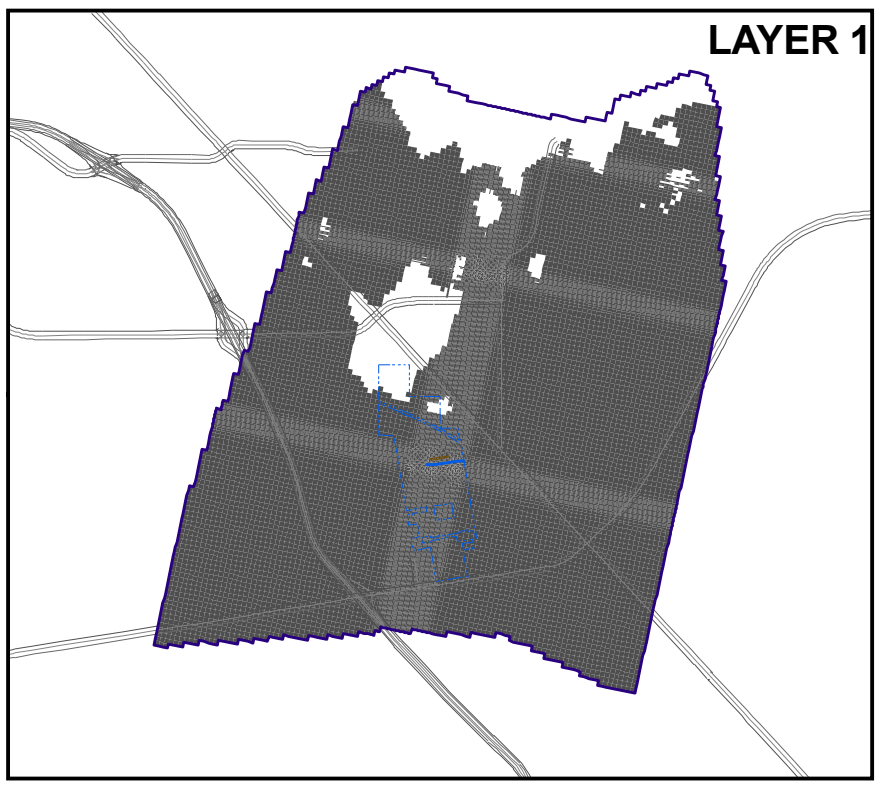


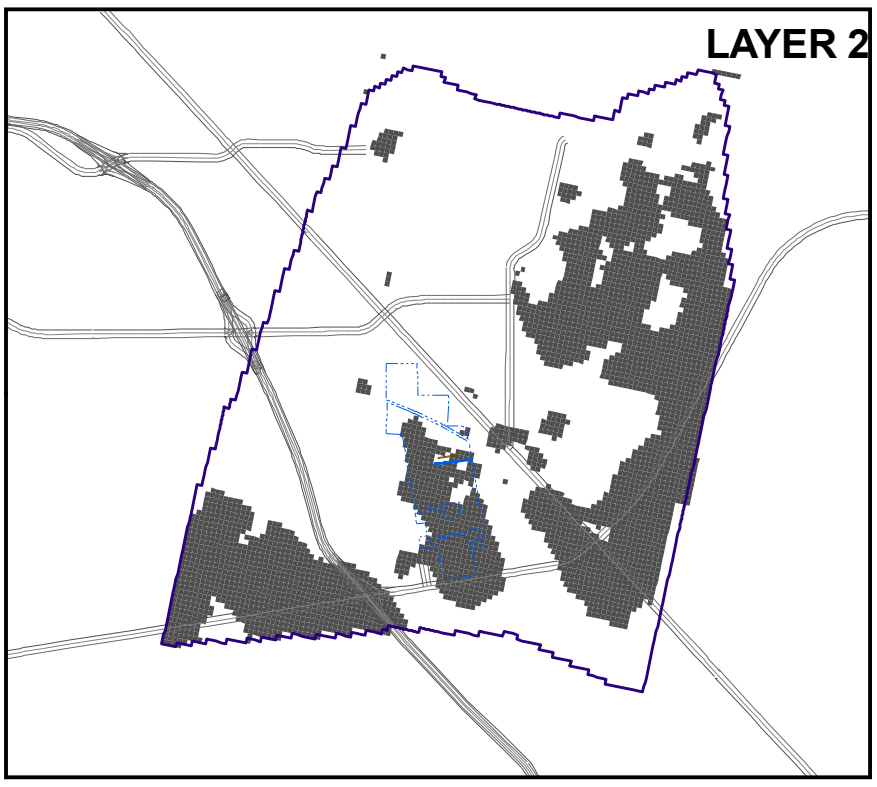
FIGURE E-18
Comparison of Simulated to Measured Transient Pumping Tests

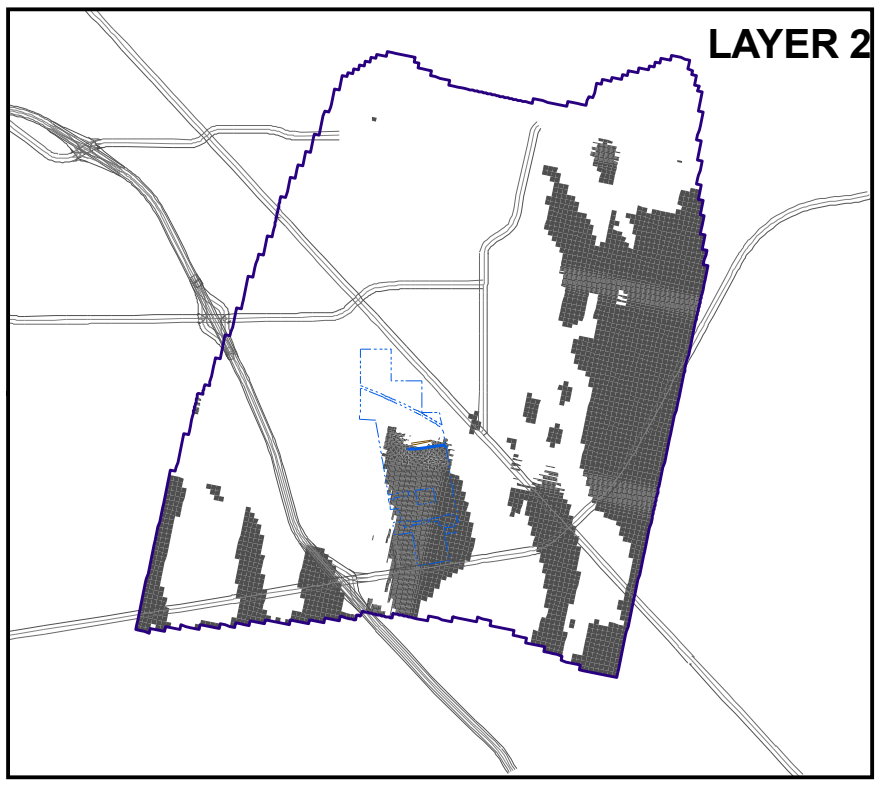


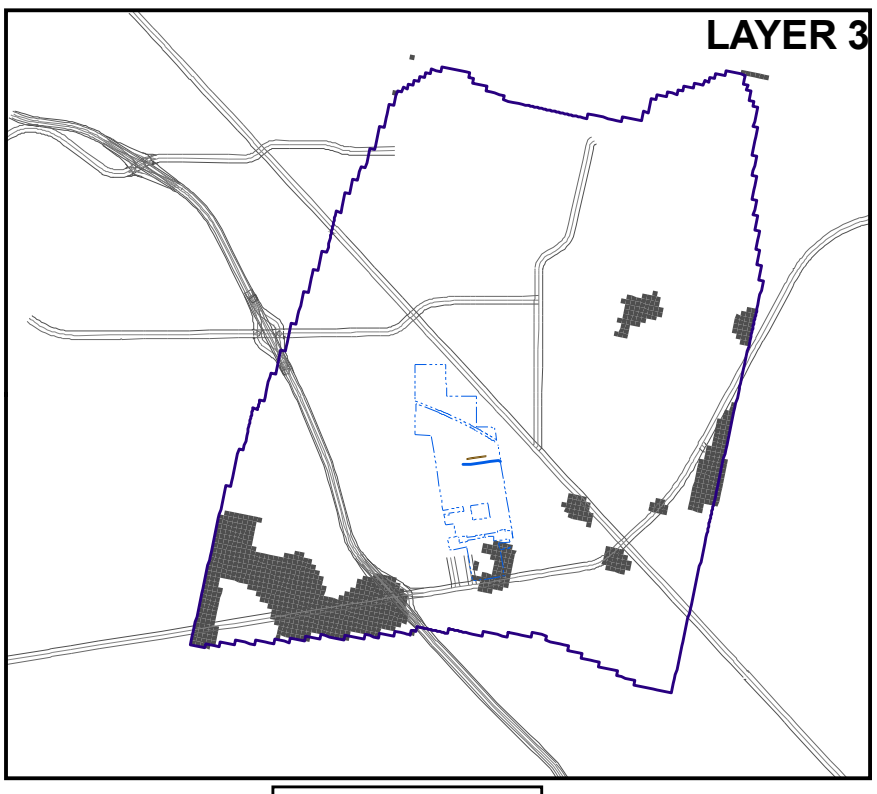


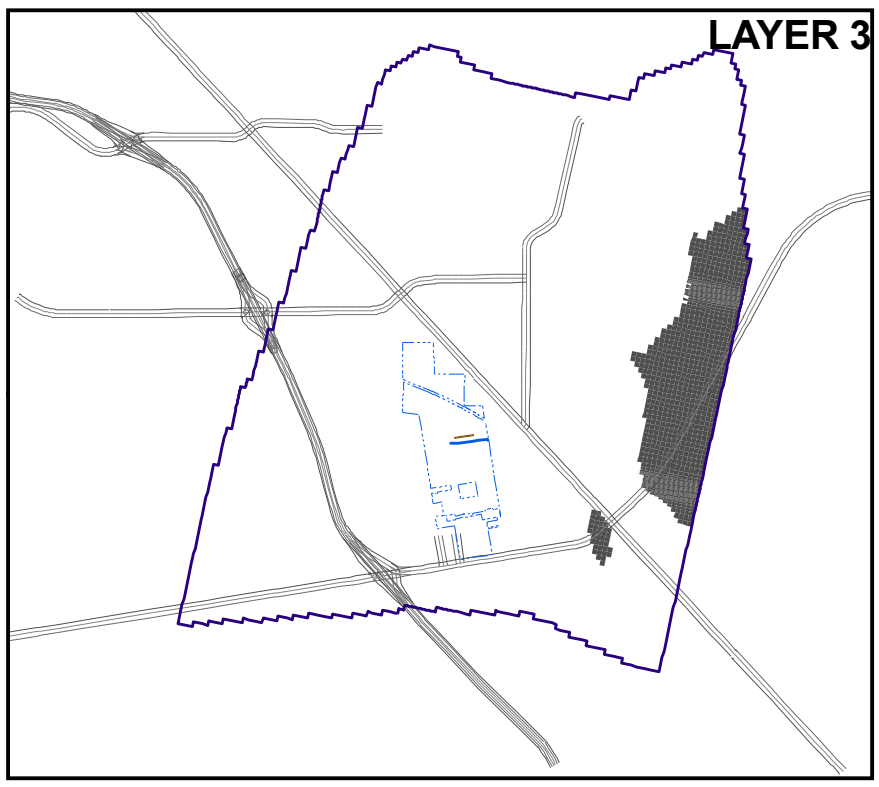


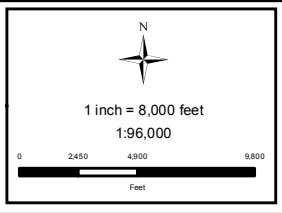












Active Model Boundary
Roads
Dry Cells
Groundwater Trench
Groundwater Barrier Wall
Tronox Property Boundary

*Title indicating that this is based on regional water table map based on natural-neighbor interpolation of the observed water levels from the 2008-2009 period.

FIGURE NUMBER: E-17

SHEET NUMBER: 1

DRY CELLS COMPARISON
OBSERVED VERSUS COMPUTED

Hydrogeologic Model
Tronox LLC - Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 inch = 8,000 feet	12/10/2010	2027.02

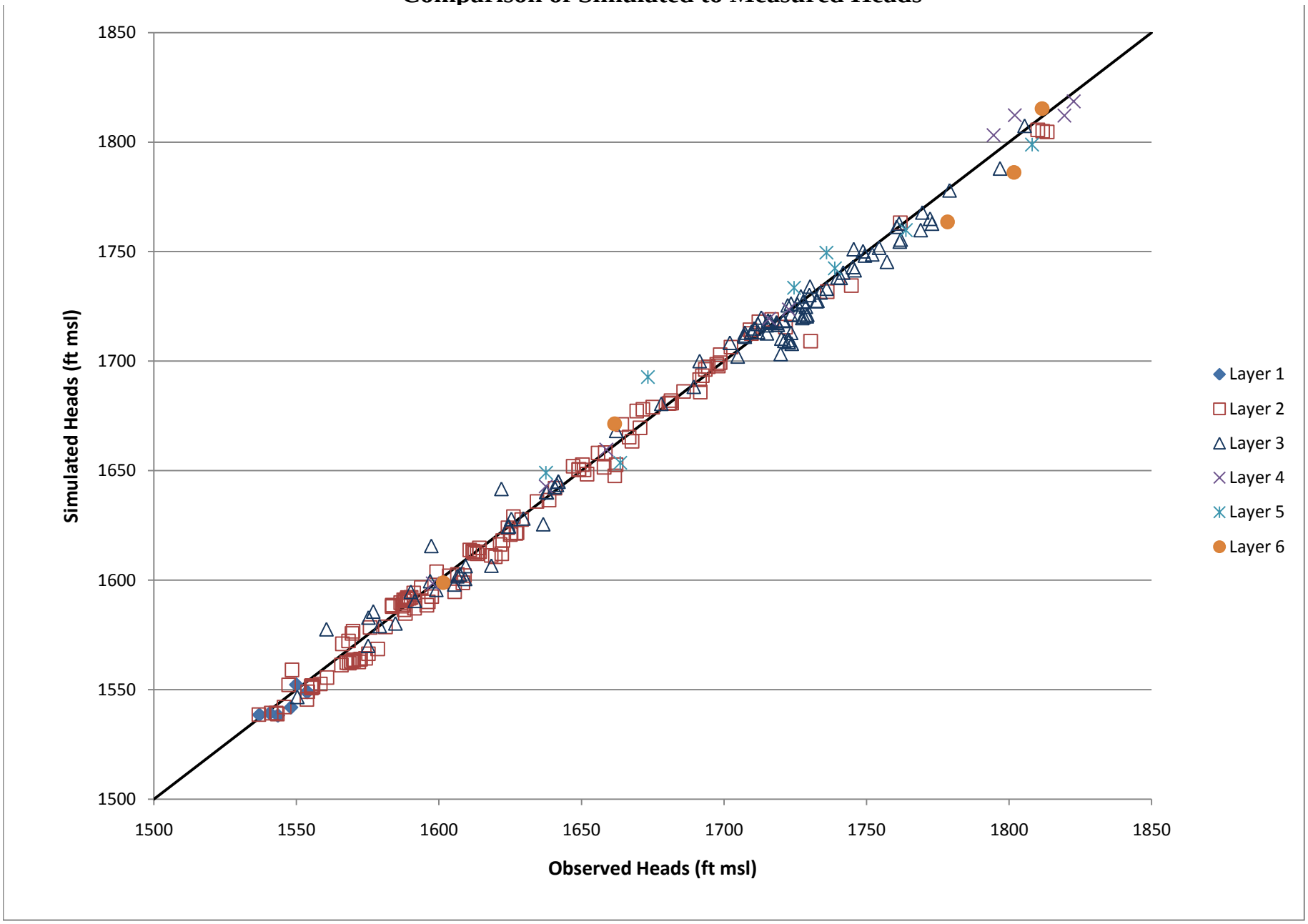
DESIGNED BY:	REVISIONS:			
AS	NO:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
SC				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

northgate environmental management, inc.

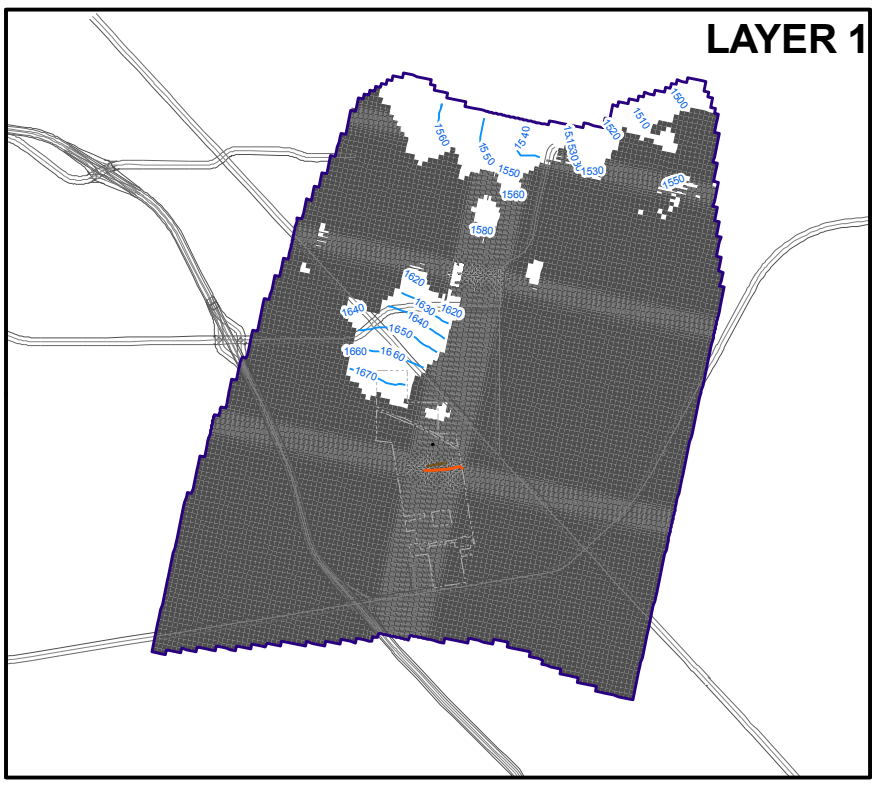
TRONOX

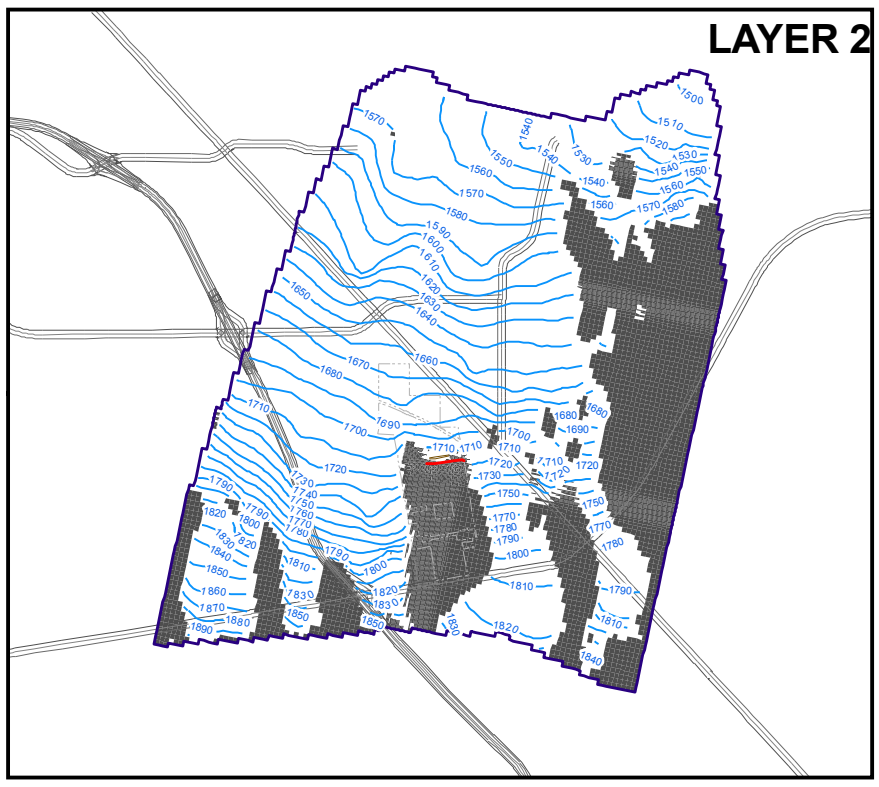
www.ngem.com

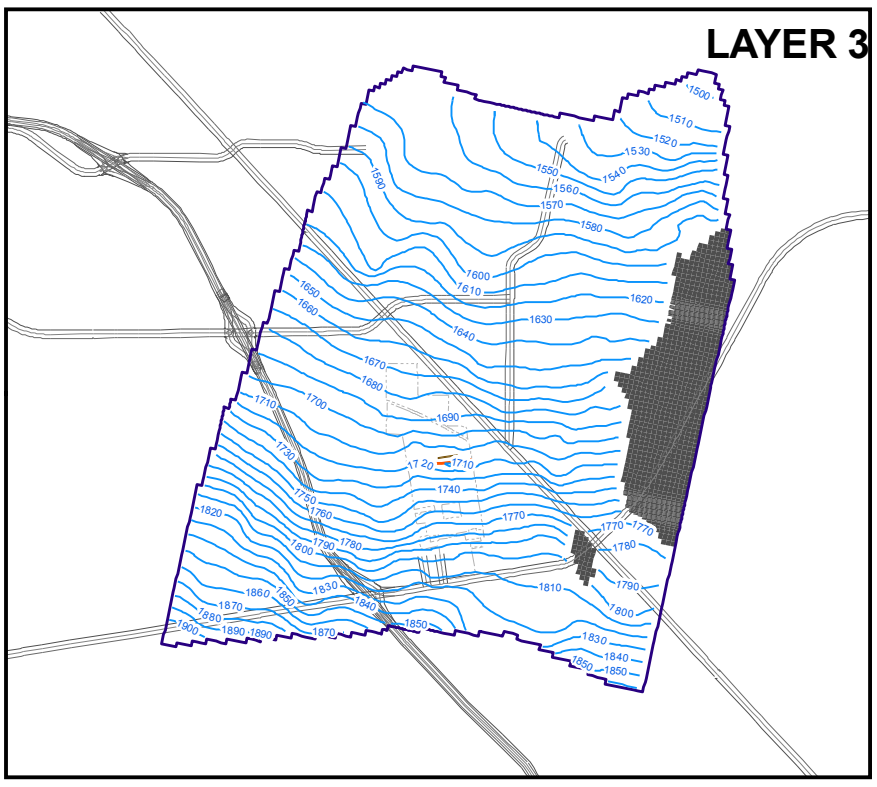
FIGURE E-16
Comparison of Simulated to Measured Heads

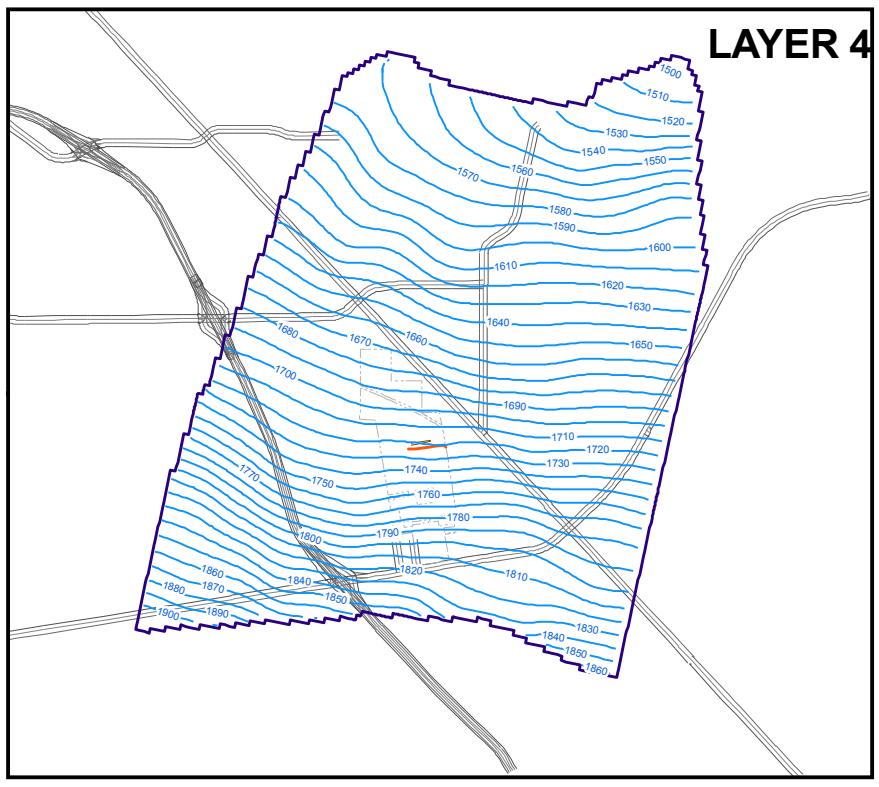


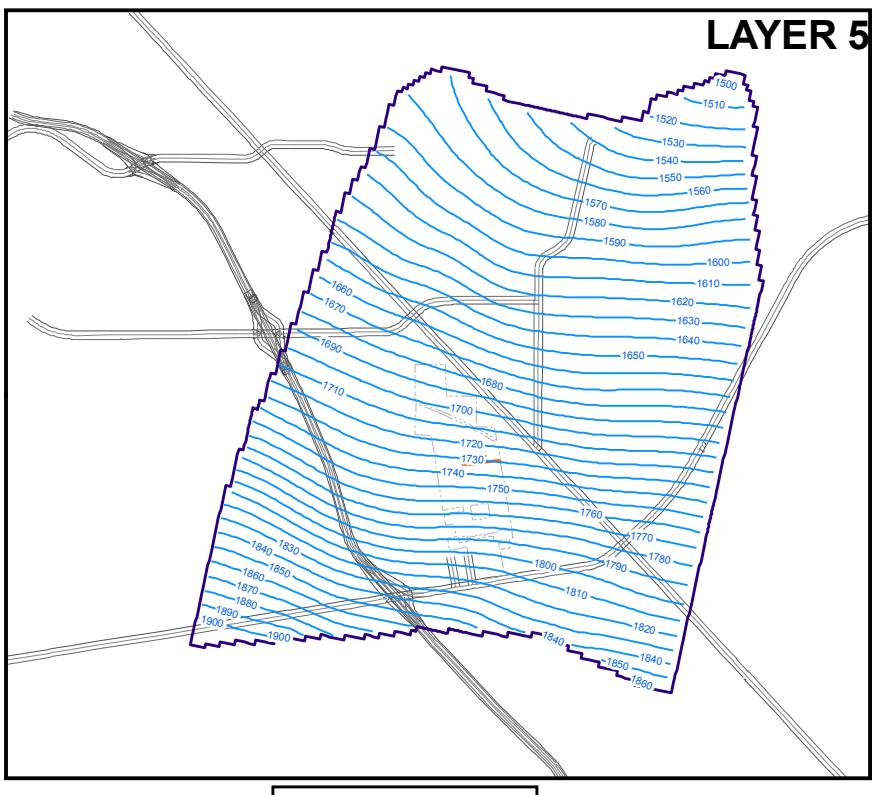
\\ng-oak1\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_Fig_APPENDIX-E_potentiometric_all_layers_101209.mxd Last updated 12/9/2010

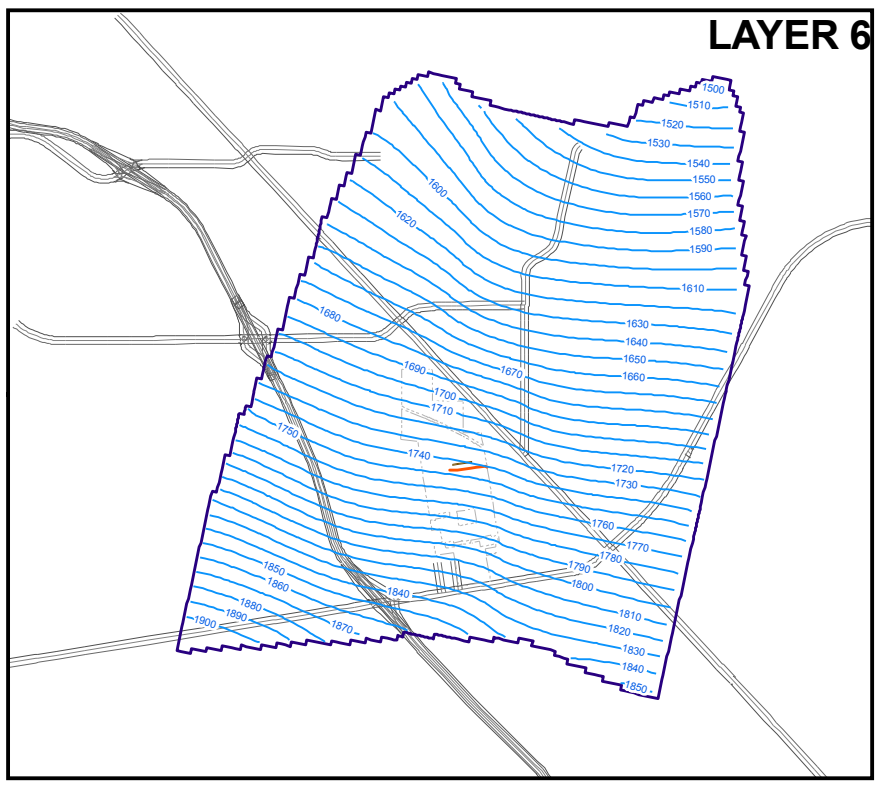


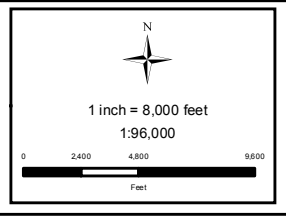












Active Model Boundary
Roads
Dry Cells
Groundwater Contours (feet amsl)
Groundwater Recharge Trench
Groundwater Barrier Wall
Tronox Property Boundary

FIGURE NUMBER: E- 15

SHEET NUMBER: 1

POTENTIOMETRIC SURFACE - ALL LAYERS
REGIONAL GROUNDWATER MODEL

Hydrogeologic Model
Tronox LLC - Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 inch = 8,000 feet	12/10/2010	2027.02

DESIGNED BY:	REVISIONS:			
AS	NO:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
AS				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

northgate environmental management, inc.

TRONOX

www.ngem.com

GHB Reaches along Bottom Layer of Model

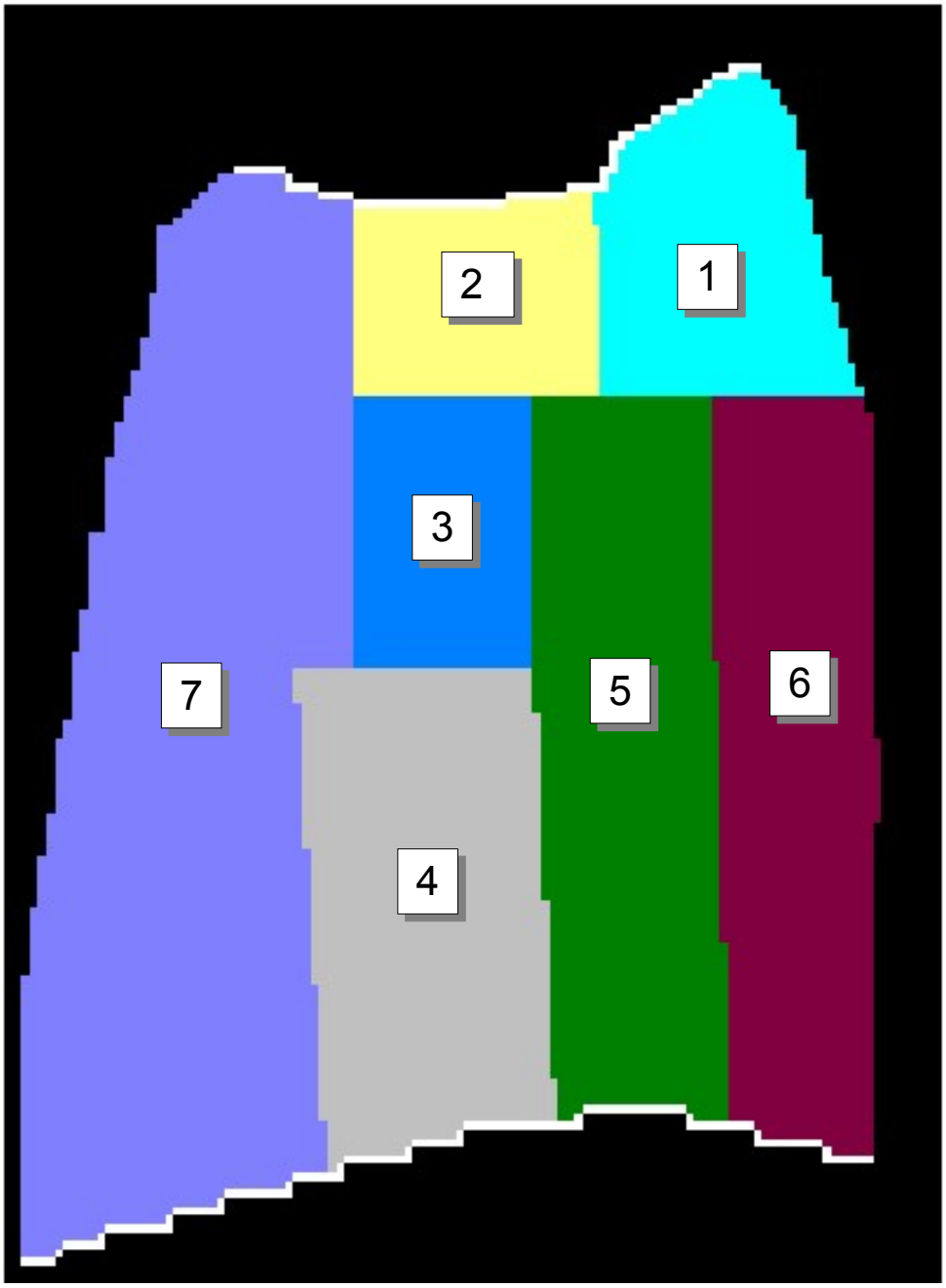


Figure E-14	
General Head Boundary Reaches along Bottom of Tronox Groundwater Model	
5000 feet	northgate environmental management, inc.

Evapotranspiration Zones Near the Las Vegas Wash

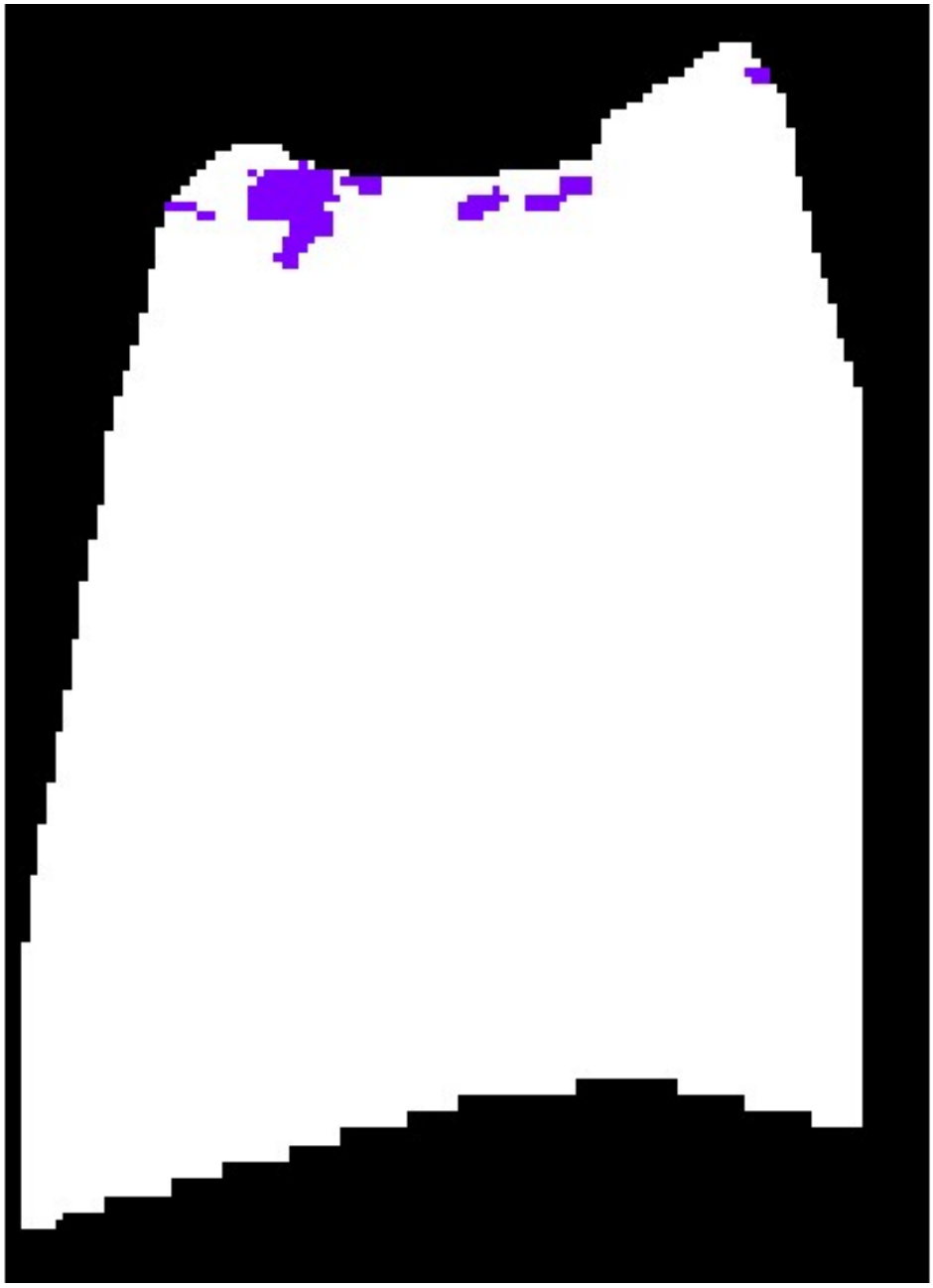


Figure E-13	
Evapotranspiration Zones for Tronox Groundwater Model	
5000 feet	northgate environmental management, inc.

Recharge Zones

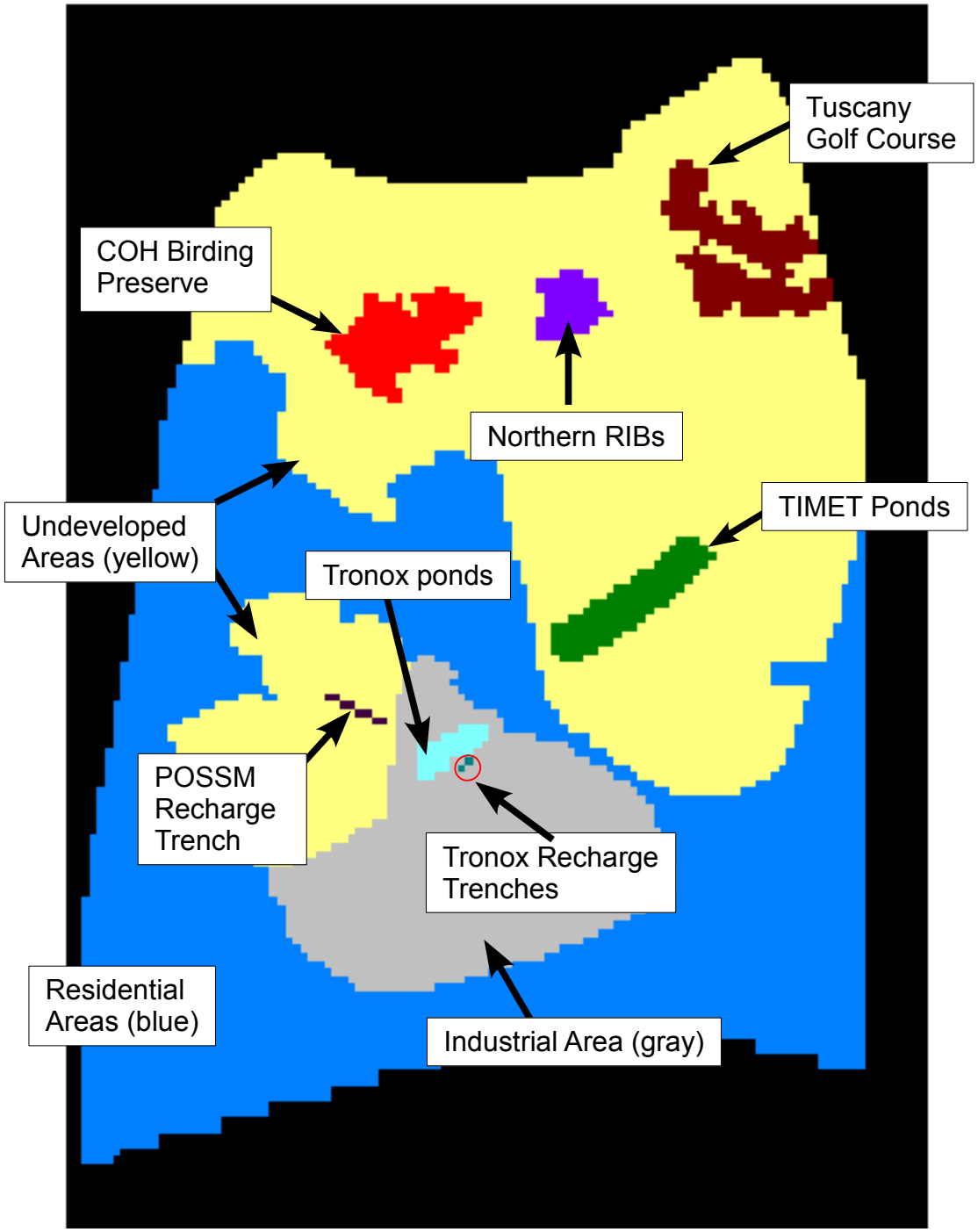


Figure E-12	
Recharge Zones for Tronox Groundwater Model	
5000 feet	northgate environmental management, inc.

Hydraulic Conductivity Zones in Layer 3 (UMCf)

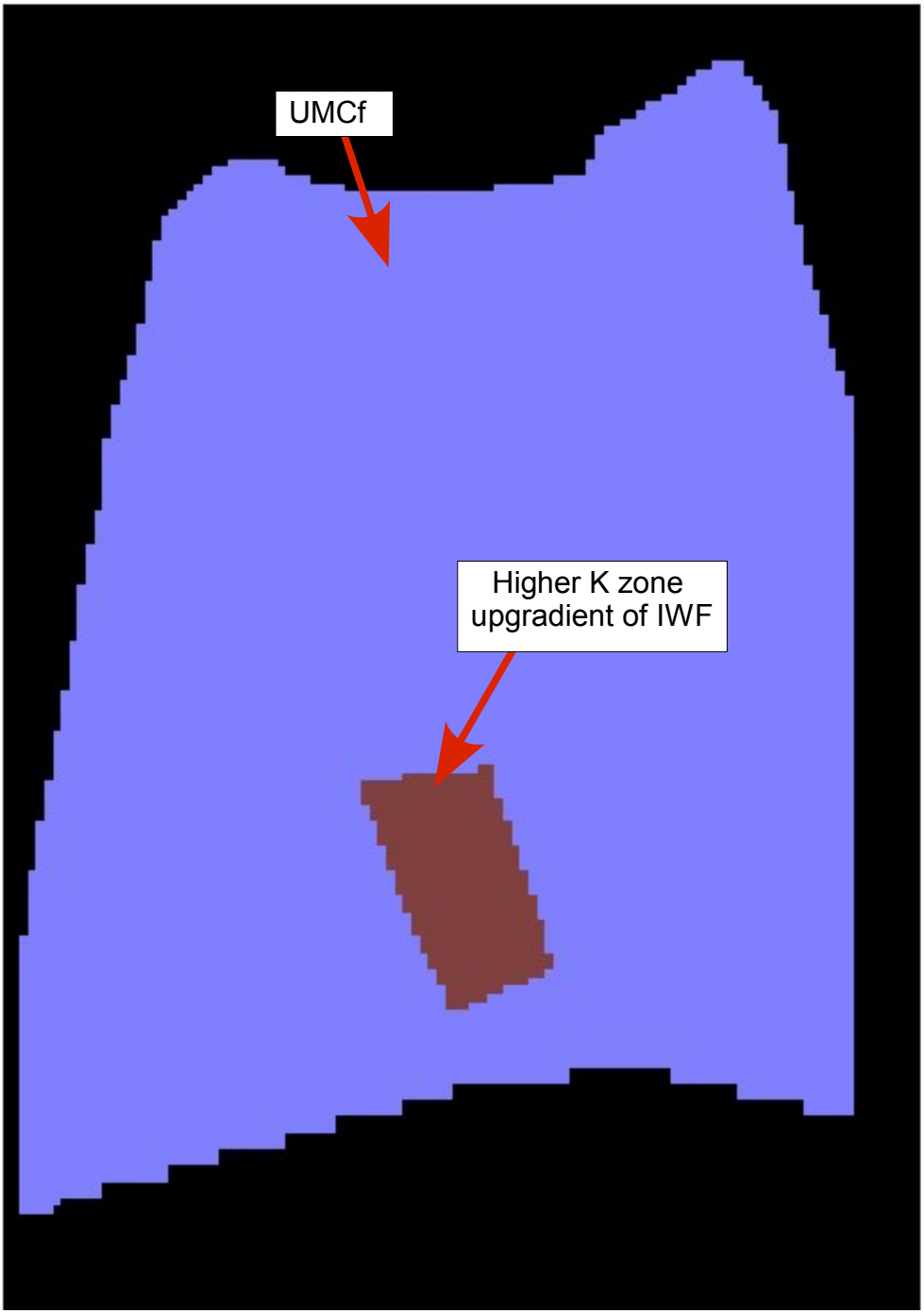


Figure E-11	
Hydraulic Conductivity Zones in Layer 3 (UMCf)	
5000 feet	northgate environmental management, inc.

Hydraulic Conductivity Zones in Alluvium – Layers 1 and 2

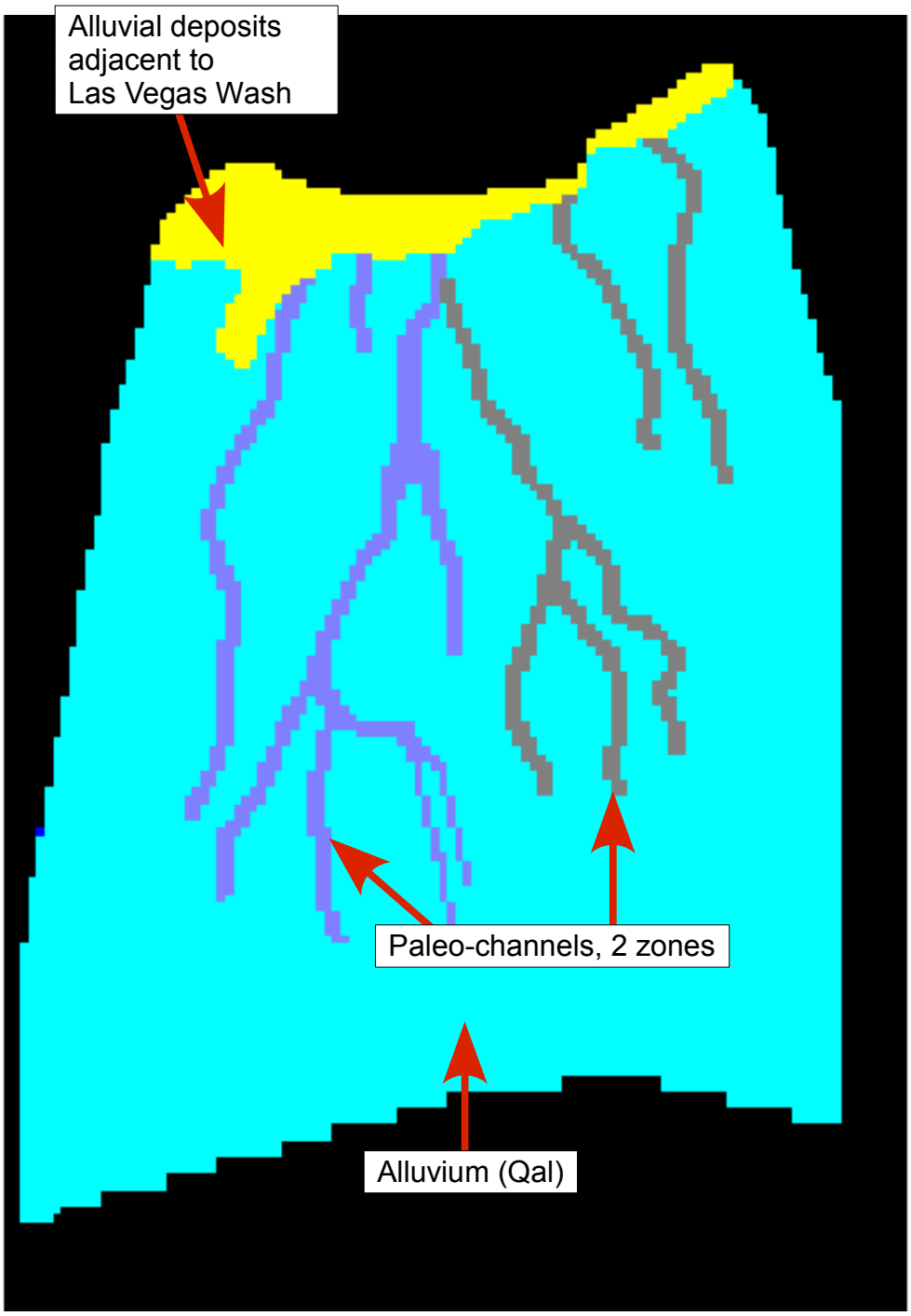


Figure E-10	
Hydraulic Conductivity Zones for Tronox Groundwater Model Layers 1 and 2	
5000 feet	northgate environmental management, inc.

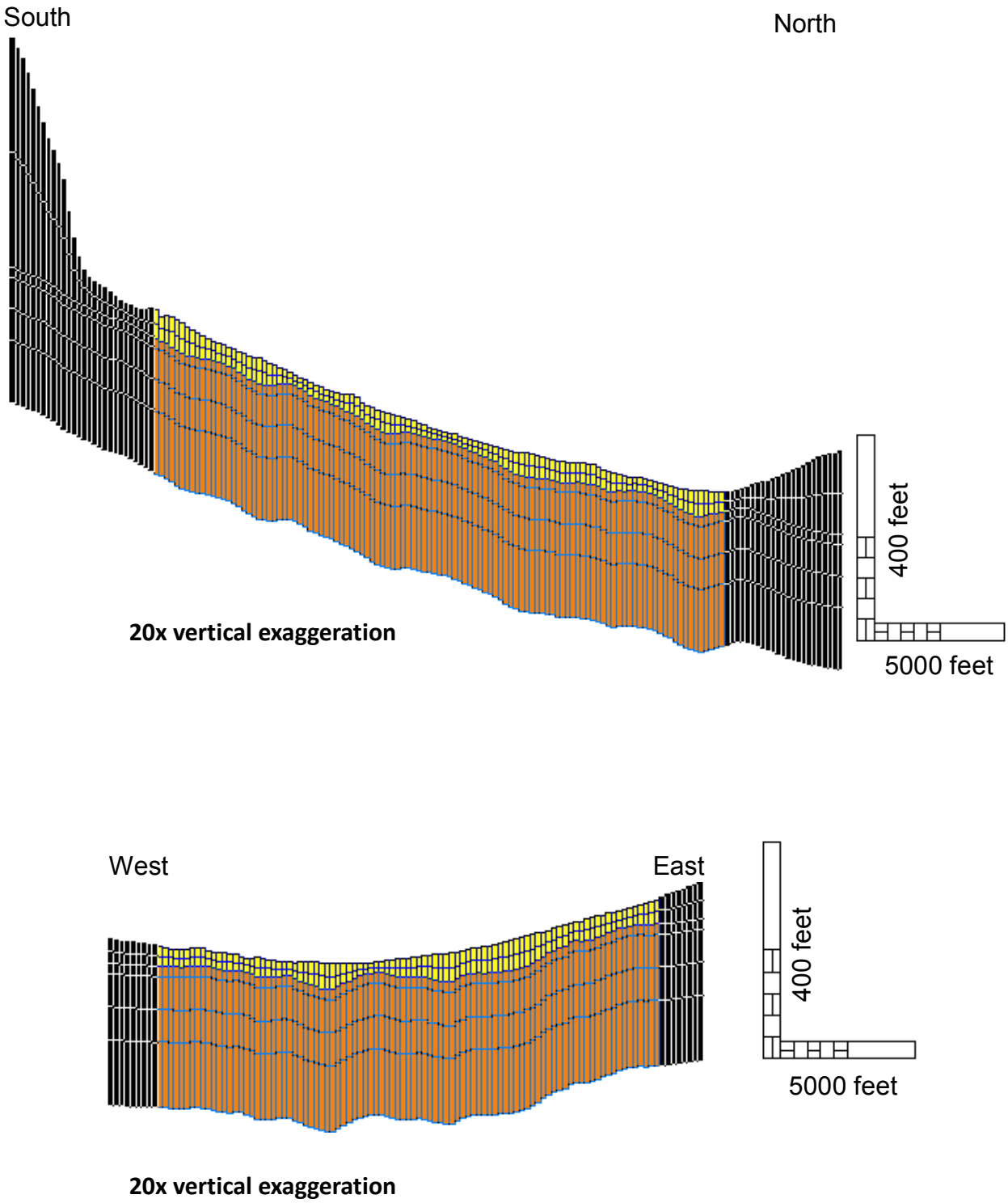


Figure E-9. Representative cross-sections of numerical grid layers across the center of the active model domain. Top: South-North Section; Bottom: West-East. Qal = Yellow, UMCf = Orange

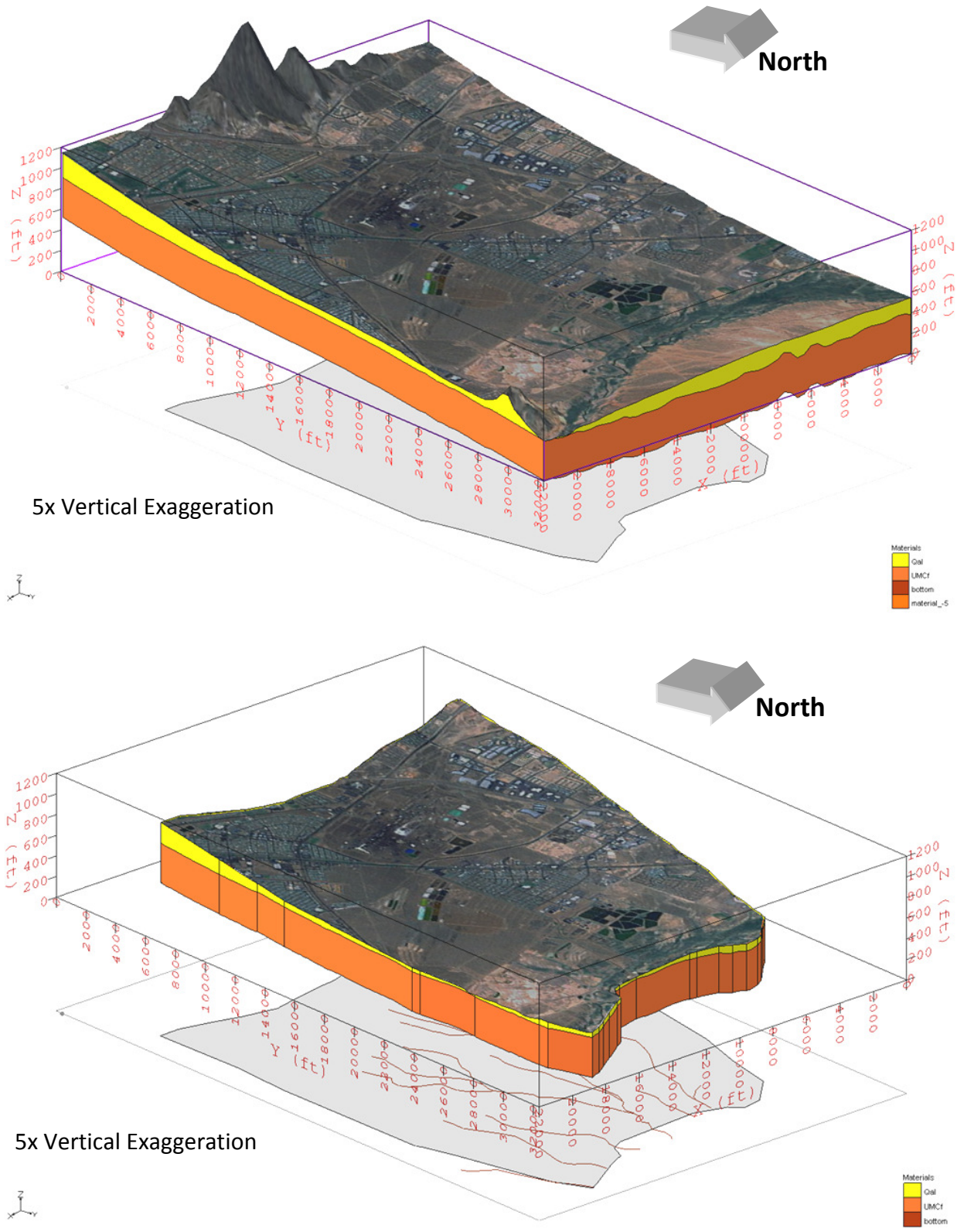
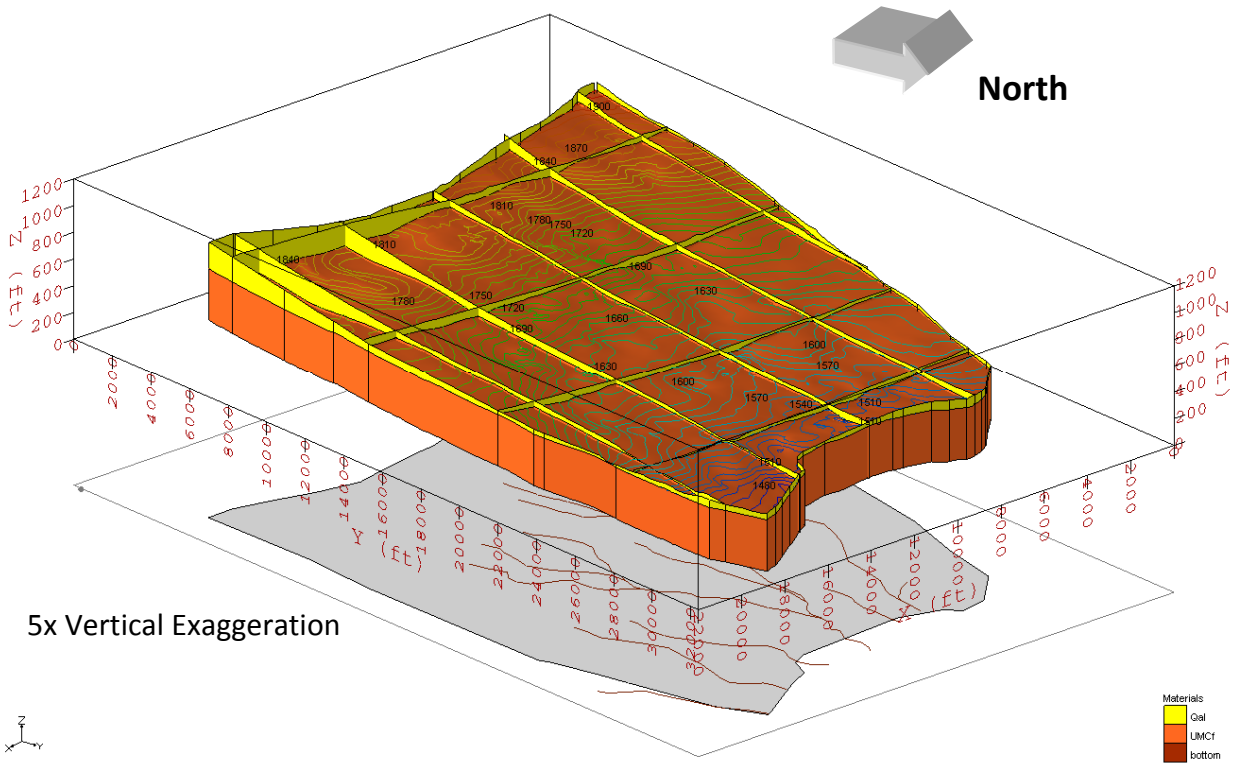


Figure E- 5. 3D block model of lithological layers (Qal = Yellow, UMCf=Orange) , ground surface topography, and aerial imagery. Top: full extent of study area; Bottom: cut- away showing only active model domain.



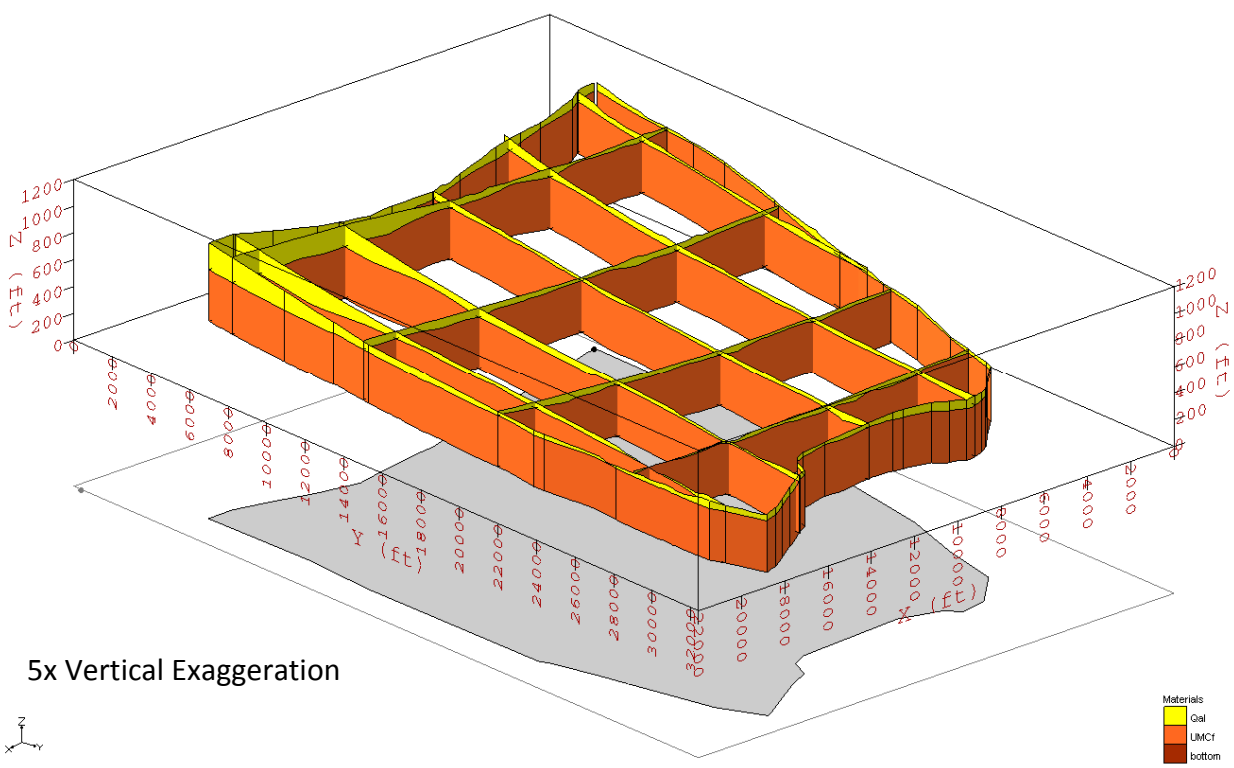


Figure E-6. 3D fence diagram cut-away of Qal layer thickness and Qal-UMCf contact surface (top image) in active area of model (grey footprint). Qal = Yellow, UMCf=Orange

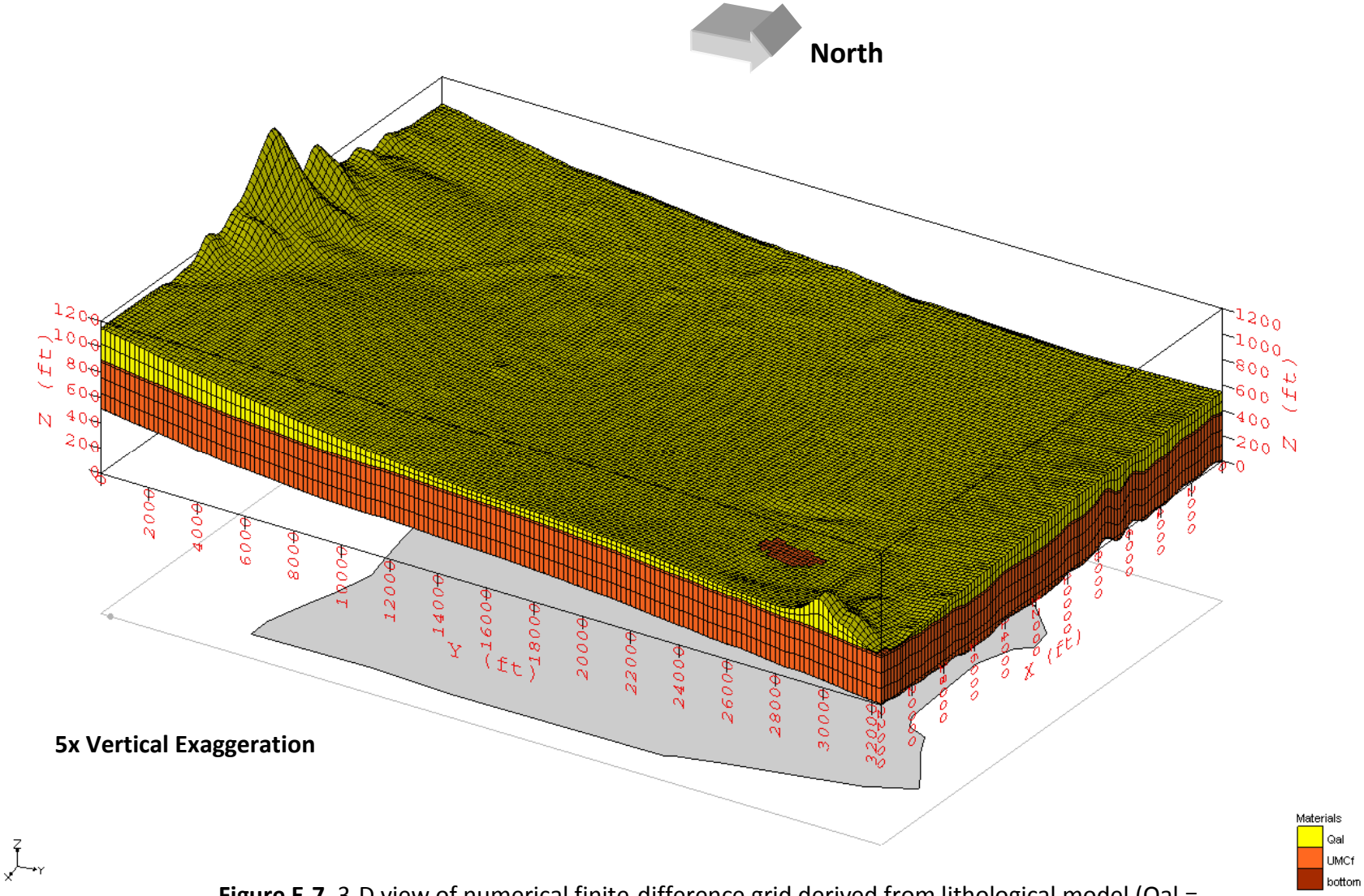
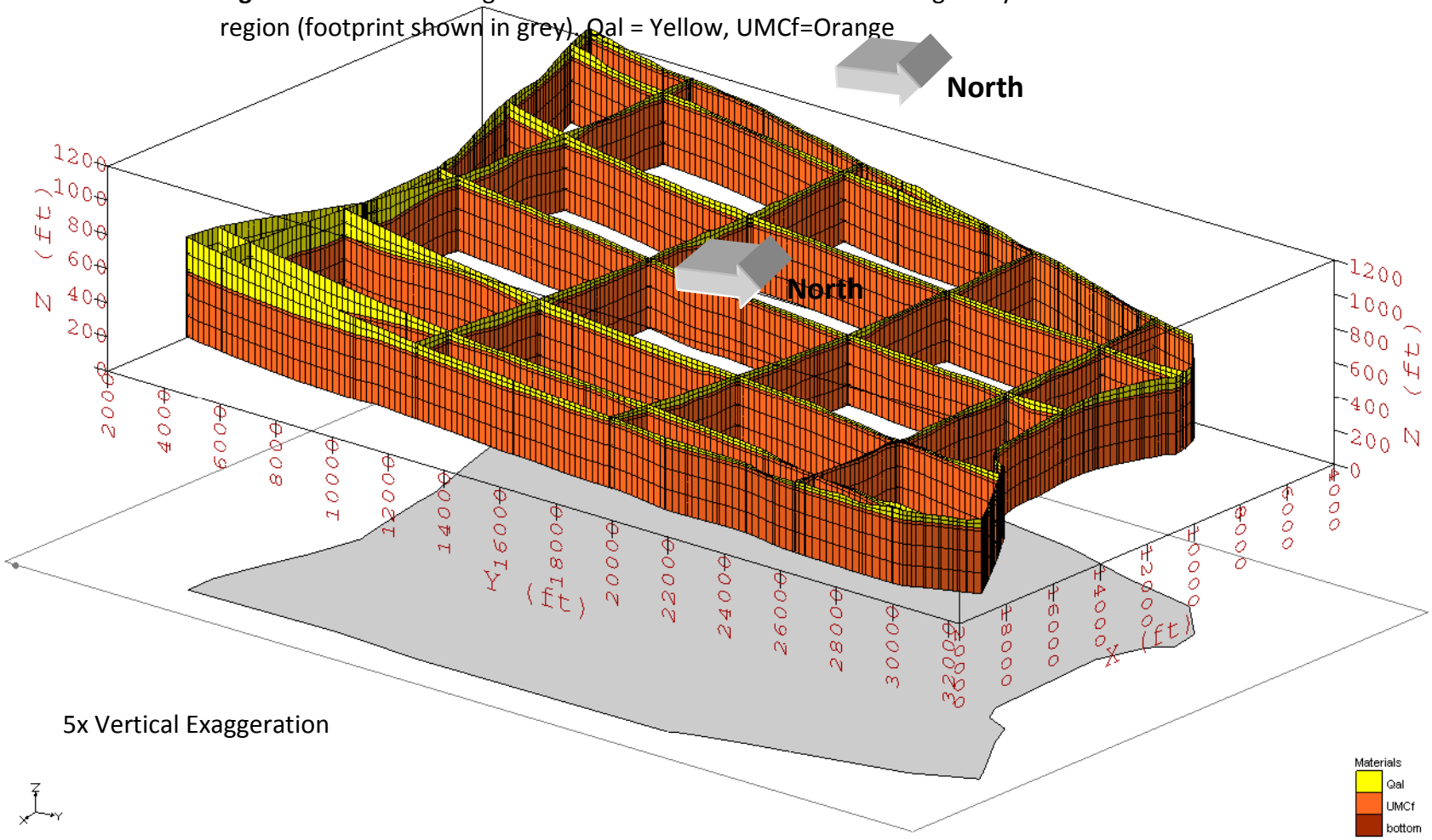
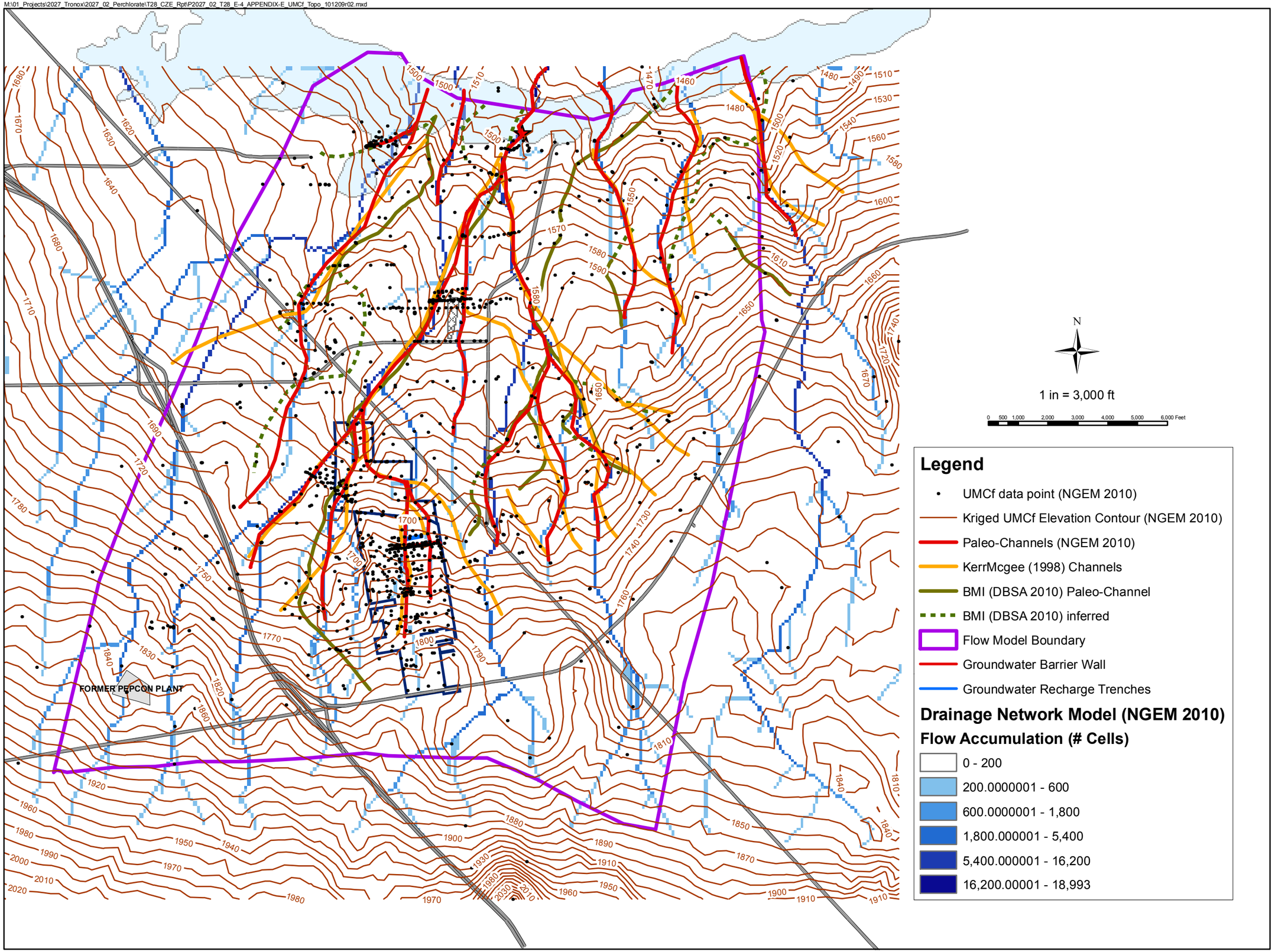


Figure E-7. 3-D view of numerical finite-difference grid derived from lithological model (Qal = Yellow, UMCf=Orange). Footprint of active model region shown in grey.

Figure E-8. 3D fence diagram view of numerical finite difference grid layers for active model region (footprint shown in grey). Qal = Yellow, UMCf=Orange



M:\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_E-4_APPENDIX-E_UMCf_Topo_101209r02.mxd



northgate environmental management, inc.
www.ngem.com
TRONOX

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	AS
DRAWN BY:	SC
CHECKED BY:	LMS
APPROVED BY:	KR

PALEOCHANNEL INTERPRETATION

Hydrogeologic Model
Tronox LLC - Henderson, Nevada

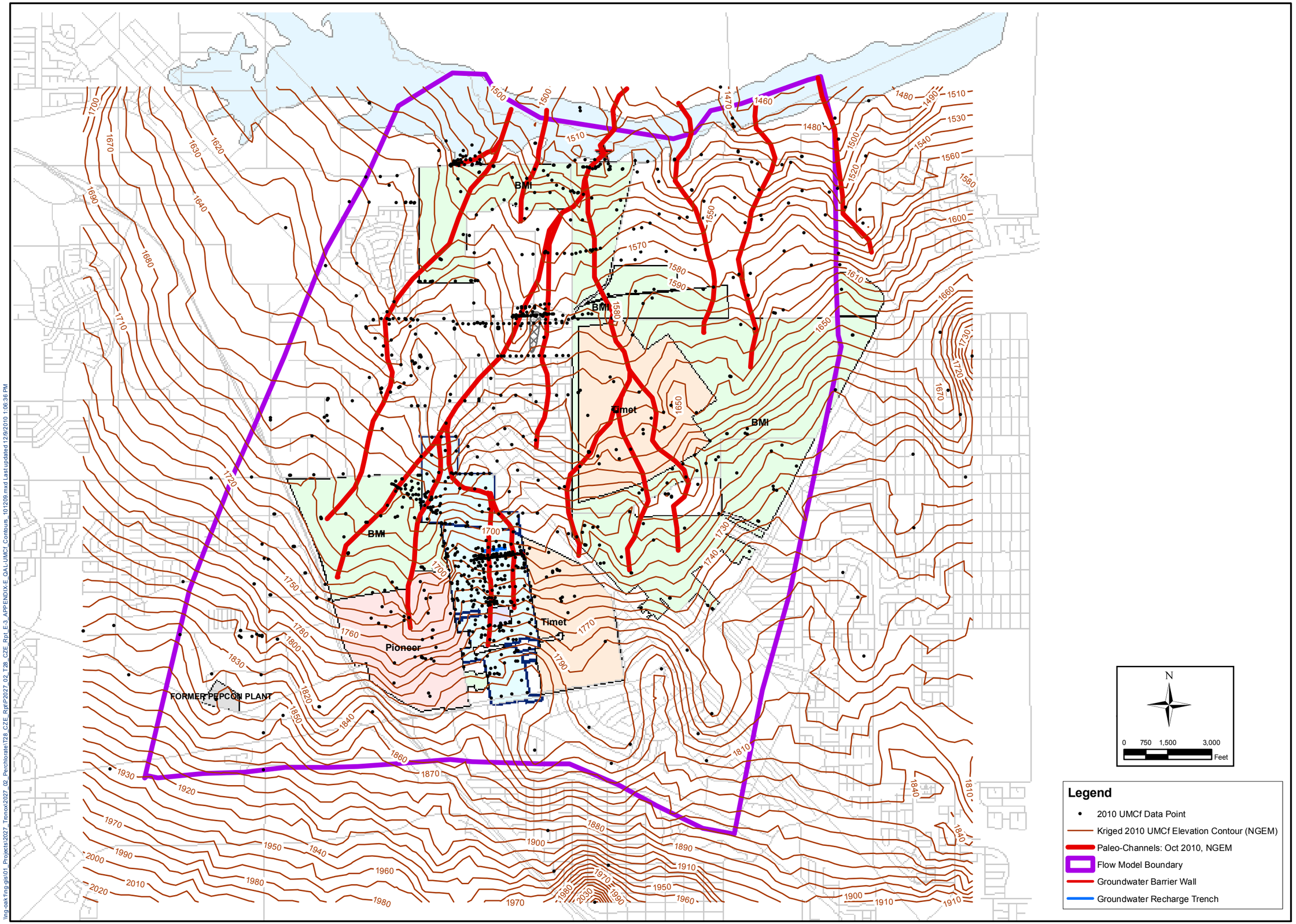
SCALE:	DATE:	PROJECT NUMBER:
1:2,400	12/10/2010	2027.02 T28

FIGURE NUMBER:

E- 4

SHEET NUMBER:

1



northgate environmental management, inc.
TRONOX
www.ngem.com

REVISIONS:			
NO:	DESCRIPTION:	DATE:	BY:

DESIGNED BY:	DRAWN BY:	CHECKED BY:	APPROVED BY:
AS	OS	KR	KR

QAL-UMCf CONTOURS AND PALEO-CHANNEL NETWORK

Hydrogeologic Model
Tronox LLC
Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 3,000 ft	12/10/2010	2027.02 T28

FIGURE NUMBER:

E-3

SHEET NUMBER:

1

\\ng-oak\ng-gis\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_E-3_APPENDIX-E_QAL-UMCf_Contours_101209.mxd Last updated 12/9/2010 1:06:36 PM

\\Ng-oak1\NG-GIS\01_Projects\2027_Tronox\2027_02_Perchlorate\T28_CZE_Rpt\P2027_02_T28_CZE_Rpt_E-2_APPENDIX-E_General_model_domian _101209.mxd Last updated 12/10/2010 3:55:10 AM

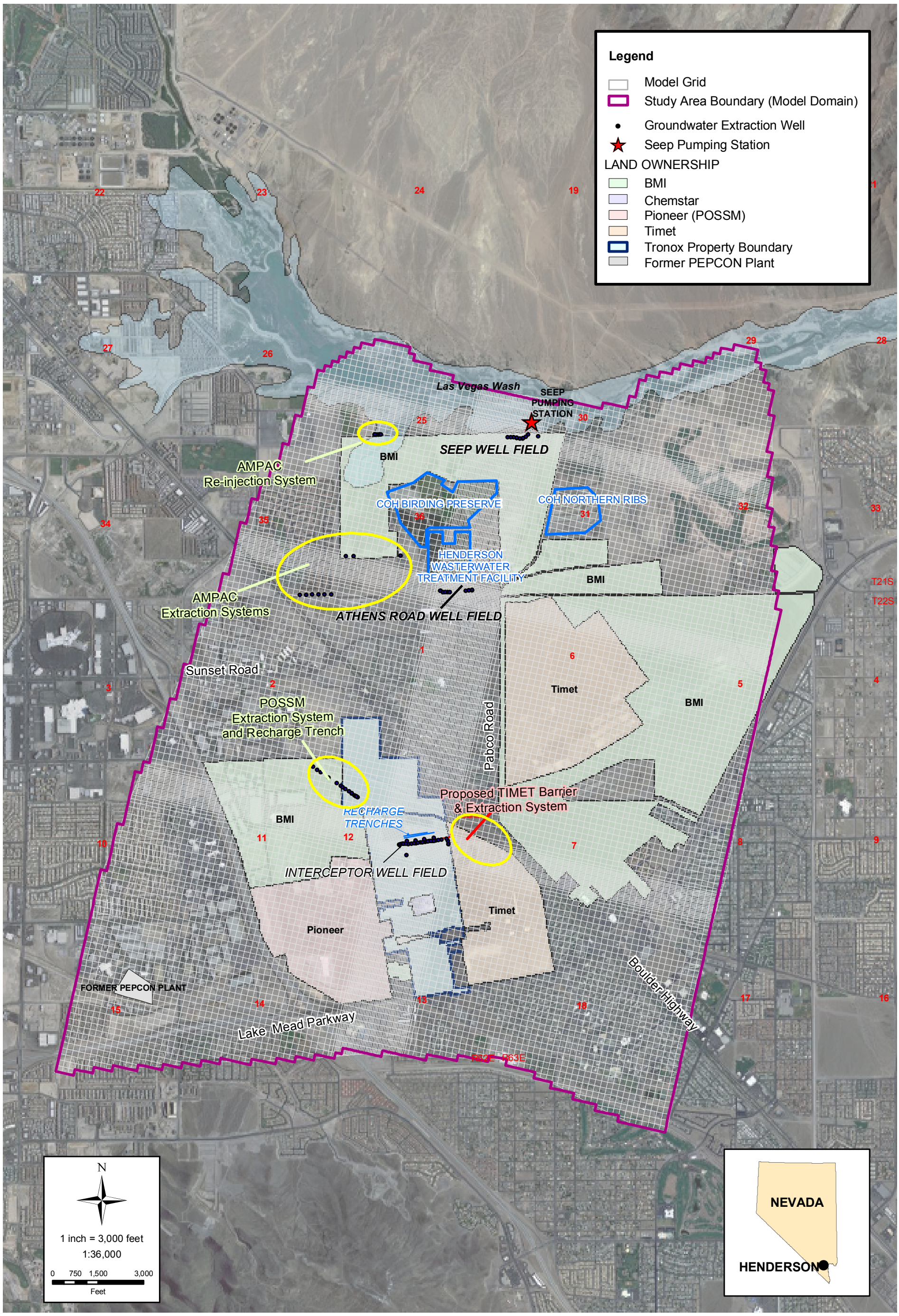


FIGURE NUMBER:	SHEET NUMBER:
E- 2	1

GENERAL MODEL DOMAIN

Hydrogeologic Model
Tronox LLC - Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1 in = 3,000 ft	12/10/2010	2027.02 T28

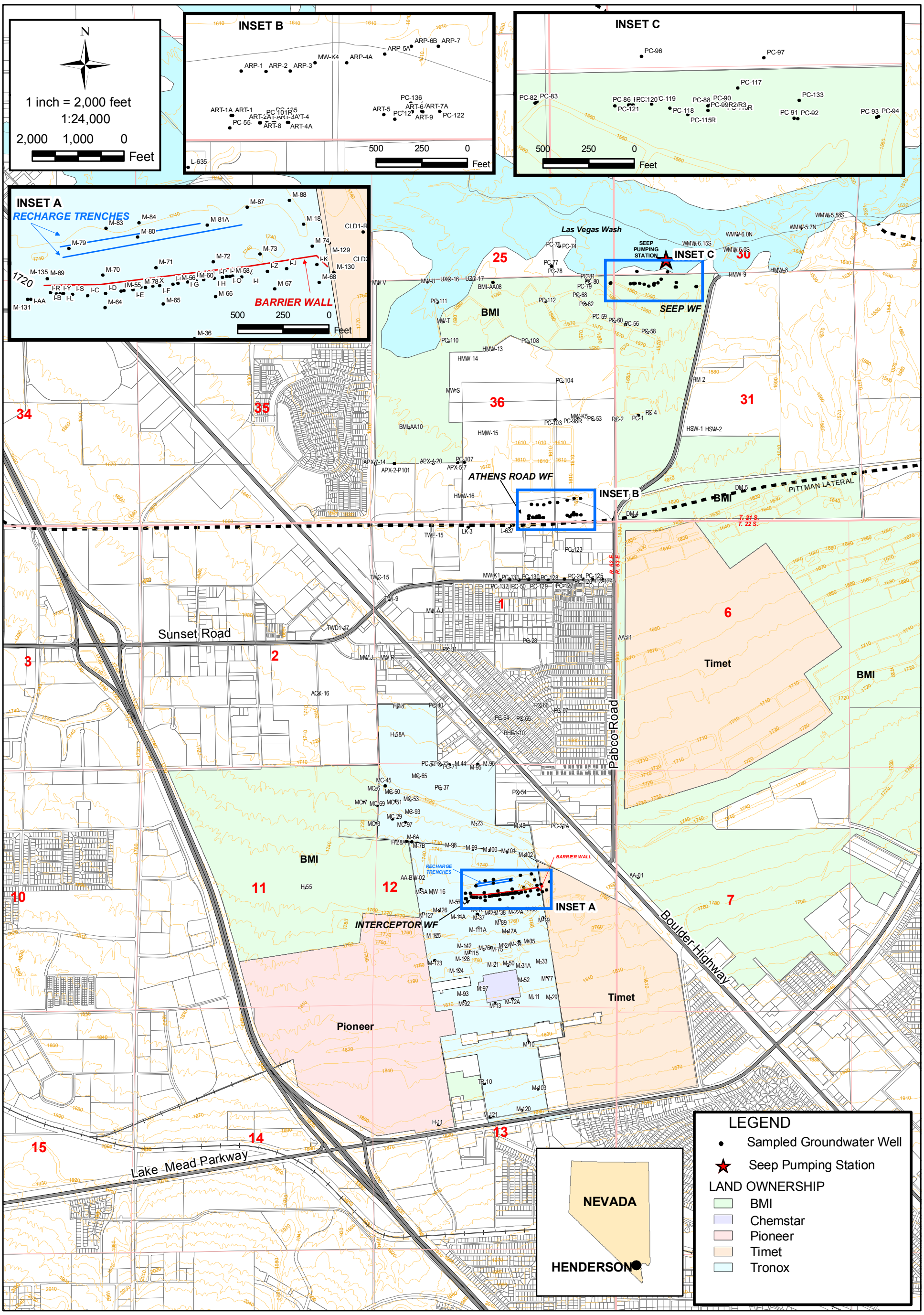
DESIGNED BY:	REVISIONS			
AS	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
AS				
CHECKED BY:				
GS				
APPROVED BY:				
PB				

northgate environmental management, inc.

TRONOX

http://www.ngem.com

\\Ng-oak1\NG-GIS\01_Projects\2027_Tronox\2027_02_T26_Hydrogeo_Model\2027_02_T26_Figure_1_Location_Map_082010.mxd Last updated 12/10/2010 2:18:54 AM



SHEET NUMBER:	FIGURE NUMBER:
1	E-1

LOCATION MAP

Hydrogeologic Model
Tronox LLC - Henderson, Nevada

SCALE:	DATE:	PROJECT NUMBER:
1:24,000	04/29/10	2027

DESIGNED BY:	REVISIONS			
NGEM	NO.:	DESCRIPTION:	DATE:	BY:
DRAWN BY:				
NGEM				
CHECKED BY:				
NGEM				
APPROVED BY:				
NGEM				

northgate environmental management, inc.

TRONOX

http://www.ngem.com

APPENDIX F
PERCHLORATE AND CHROMIUM DATA USED FOR 3-D PLUMES

TABLE F-2
Chromium Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppb)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type	Chemical
AA-01	08/07/09	830921.12	26720238.47	9.2	29.0	49.0	39.0	1754.93	1715.93	Shallow	Qal	Monitoring	Chromium
AA-07	08/10/09	837100.42	26729559.52	10.8	30.0	50.0	40.0	1610.12	1570.12	Shallow	Qal	Monitoring	Chromium
AA-08	08/14/09	827756.55	26733208.24	10.0	5.0	35.0	20.0	1578.46	1558.46	Shallow	Qal	Monitoring	Chromium
AA-09	08/12/09	831041.59	26723441.40	90.1	30.0	65.0	47.5	1694.11	1646.61	Shallow	Qal	Monitoring	Chromium
AA-10	08/11/09	825935.16	26730040.80	18.4	10.0	40.0	25.0	1612.54	1587.54	Shallow	Qal	Monitoring	Chromium
AA-11	04/20/10	830672.66	26725458.78	18.0	9.0	29.0	19.0	1658.00	1639.00	Shallow	Qal	Monitoring	Chromium
AA-13	08/13/09	833889.39	26722860.98	7.7	38.0	58.0	48.0	1722.37	1674.37	Shallow	Qal	Monitoring	Chromium
AA-18	08/11/09	836690.87	26727656.38	6.2	44.5	64.5	54.5	1665.60	1611.10	Shallow	Qal	Monitoring	Chromium
AA-20	09/11/09	831811.84	26728007.71	91.9	10.0	30.0	20.0	1626.07	1606.07	Shallow	Qal	Monitoring	Chromium
AA-21	08/12/09	826148.08	26734078.78	2.9	9.0	39.0	24.0	1583.13	1559.13	Shallow	Qal	Monitoring	Chromium
AA-22	09/23/09	833425.59	26731586.01	10.7	11.0	31.0	21.0	1579.88	1558.88	Shallow	Qal	Monitoring	Chromium
AA-23R	09/10/09	833898.96	26732042.31	8.9	20.0	45.0	32.5	1545.04	1512.54	Shallow	Qal	Monitoring	Chromium
AA-26	09/11/09	840176.49	26733349.15	29.3	32.0	52.0	42.0	1563.56	1521.56	Shallow	Qal	Monitoring	Chromium
AA-27	08/26/09	832471.34	26719301.66	32.3	61.5	81.5	71.5	1786.85	1715.35	Shallow	Qal/xMCF/UMCf	Monitoring	Chromium
AA-30	09/09/09	836125.91	26733691.70	28.2	11.7	31.7	21.7	1529.84	1508.14	Shallow	Qal	Unknown	Chromium
AA-BW-04A	10/21/09	825492.25	26721142.81	5.0	32.0	52.0	42.0	1729.47	1687.47	Shallow	Qal	Monitoring	Chromium [VI]
AA-BW-05A	10/20/09	825065.41	26721183.83	4.0	34.0	64.0	49.0	1729.21	1680.21	Shallow	Qal	Monitoring	Chromium [VI]
AA-BW-06A	10/23/09	824476.16	26721238.26	1.0	23.0	43.0	33.0	1729.28	1696.28	Shallow	Qal	Monitoring	Chromium [VI]
AA-BW-07A	10/28/09	823979.46	26720637.98	0.7	32.0	52.0	42.0	1739.89	1697.89	Shallow	Qal	Monitoring	Chromium [VI]
AA-BW-12A	10/13/09	824440.21	26718772.36	4.5	49.0	69.0	59.0	1776.54	1717.54	Shallow	Qal	Monitoring	Chromium
AA-MW-05	10/20/09	824351.37	26715530.83	9.0	30.5	60.5	45.5	1843.11	1797.61	Shallow	xMCf	Monitoring	Chromium
AA-MW-07	10/22/09	826126.54	26719344.40	5.0	30.5	70.5	50.5	1761.91	1711.41	Shallow	xMCf	Monitoring	Chromium [VI]
AA-MW-13	11/02/09	825332.59	26717020.38	40.0	31.5	61.5	46.5	1809.83	1763.33	Shallow	xMCf/UMCf	Monitoring	Chromium
AA-MW-14	11/02/09	825660.68	26717082.46	7.4	33.0	53.0	43.0	1808.85	1765.85	Shallow	xMCf	Monitoring	Chromium
AA-MW-16	02/05/08	826447.64	26719904.41	20.0	24.7	39.7	32.2	1751.99	1719.79	Shallow	UMCf	Monitoring	Chromium
AA-MW-20	11/16/09	824824.86	26716566.62	10.0	46.0	66.0	56.0	1813.63	1757.63	Shallow	xMCf/UMCf	Monitoring	Chromium
AA-MW-24	10/30/09	825495.60	26715178.08	5.4	55.0	75.0	65.0	1851.03	1786.03	Shallow	xMCf/UMCf	Monitoring	Chromium
AA-MW-25	11/10/09	825508.33	26717917.91	8.2	55.0	65.0	60.0	1772.13	1712.13	Shallow	Qal	Monitoring	Chromium
AA-UW1	08/24/09	831427.20	26719624.99	16.4	55.0	65.0	60.0	1818.68	1758.68	Shallow	Qal	Monitoring	Chromium
AA-UW2	08/11/09	832819.54	26718117.11	19.8	55.0	75.0	65.0	1829.00	1764.00	Shallow	Qal	Monitoring	Chromium
AA-UW3	08/25/09	835097.86	26718183.94	43.6	60.0	80.0	70.0	1797.18	1727.18	Shallow	Qal	Monitoring	Chromium
AA-UW4	08/26/09	836517.02	26720029.40	16.0	35.0	55.0	45.0	1765.91	1720.91	Shallow	Qal	Monitoring	Chromium
AA-UW5	09/15/09	838134.66	26722958.50	13.3	37.0	57.0	47.0	1743.23	1696.23	Shallow	Qal	Monitoring	Chromium
AA-UW6	08/27/09	839469.22	26725552.51	7.0	37.0	57.0	47.0	1613.33	1566.33	Shallow	Qal	Monitoring	Chromium
ARP-1	08/11/10	828593.16	26728365.51	0.4	14.0	44.0	29.0	1613.03	1584.03	Shallow	Qal	Monitoring	Chromium
ARP-2A	08/11/10	828856.20	26728402.86	0.4	23.7	53.7	38.7	1614.75	1576.05	Shallow	Qal	Monitoring	Chromium
ARP-3A	08/11/10	828722.80	26728404.34	0.4	20.7	40.7	30.7	1614.51	1583.81	Shallow	Qal	Monitoring	Chromium
ARP-4A	08/11/10	829167.89	26728411.81	0.4	17.7	32.7	25.2	1615.72	1590.52	Shallow	Qal	Monitoring	Chromium
ARP-5A	08/11/10	829375.01	26728458.43	81.0	12.7	37.7	25.2	1616.50	1591.30	Shallow	Qal	Monitoring	Chromium
ARP-6B	08/11/10	829520.52	26728499.92	230.0	27.7	42.7	35.2	1615.70	1580.50	Shallow	Qal	Monitoring	Chromium

TABLE F-2
Chromium Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppb)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type	Chemical
ARP-7	08/11/10	829668.22	26728501.08	26.0	14.0	39.0	26.5	1613.39	1586.89	Shallow	Qal	Monitoring	Chromium
ART-1	08/04/10	828543.96	26728122.71	0.4	14.0	54.0	34.0	1615.57	1581.57	Shallow	Qal	Recovery	Chromium
ART-2	08/04/10	828625.03	26728084.71	27.0	19.0	54.0	36.5	1617.42	1580.92	Shallow	Qal	Recovery	Chromium
ART-3	08/04/10	828775.42	26728085.17	310.0	15.0	45.0	30.0	1617.61	1587.61	Shallow	Qal	Recovery	Chromium
ART-4	08/04/10	828850.69	26728085.26	410.0	19.0	44.0	31.5	1617.91	1586.41	Shallow	Qal	Recovery	Chromium
ART-5	02/11/08	829369.98	26728128.79	20.0	15.0	25.0	20.0	1614.18	1594.18	Shallow	Qal	Recovery	Chromium
ART-6	08/04/10	829472.91	26728140.60	1500.0	14.0	34.0	24.0	1616.25	1592.25	Shallow	Qal	Recovery	Chromium
ART-7B	08/12/10	829576.25	26728151.94	3800.0	29.5	44.5	37.0	1618.06	1581.06	Shallow	Qal	Extraction	Chromium
ART-8	08/04/10	828697.72	26728084.10	190.0	18.0	48.0	33.0	1618.54	1585.54	Shallow	Qal	Recovery	Chromium
ART-9	08/04/10	829525.57	26728143.32	1500.0	20.5	40.5	30.5	1616.16	1585.66	Shallow	Qal	Recovery	Chromium
B-01	11/02/09	825676.63	26717341.36	2.8	44.5	54.5	49.5	1807.89	1758.39	Shallow	xMCF	Monitoring	Chromium
B-16	11/10/09	823953.15	26718137.87	1.9	47.0	57.0	52.0	1787.96	1735.96	Shallow	xMCF	Monitoring	Chromium
BEC-6	09/28/09	835779.00	26724128.00	180.0	65.0	80.0	72.5	1725.26	1652.76	Shallow	UMCf	Monitoring	Chromium [VI]
BEC-9	08/18/09	833044.00	26727209.00	9.9	44.0	59.0	51.5	1647.56	1596.06	Shallow	UMCf	Monitoring	Chromium
BRW-R1	01/20/09	831591.74	26716952.35	43.0	40.0	60.0	50.0	1844.00	1794.00	Shallow	Qal	Monitoring	Chromium
CLD-1R	05/17/10	828992.45	26720140.80	390.0	16.0	39.0	27.5	1741.00	1713.50	Shallow		Monitoring	Chromium
CLD-2R	05/09/08	828919.18	26719962.61	920.0	10.5	30.5	20.5	1750.00	1729.50	Shallow	Qal	Monitoring	Chromium
CLD3-R	04/21/09	829651.41	26720010.74	240.0	20.0	39.0	29.5	1748.00	1718.50	Shallow	Qal	Monitoring	Chromium
CLD4-R	07/22/09	829031.76	26718855.46	305.0	27.0	47.0	37.0	1777.00	1740.00	Shallow	Qal	Monitoring	Chromium [VI]
CMT-101	04/29/10	829635.17	26719980.31	120.0	48.0	48.5	48.3	1749.00	1700.75	Shallow	xMCf	Monitoring	Chromium [VI]
COH-1	09/28/09	832590.00	26734998.02	10.0	157.9	167.9	162.9	1550.11	1387.21	Middle	UMCf	Monitoring	Chromium [VI]
COH-2	08/13/09	832572.52	26733634.08	6.6	159.0	169.0	164.0	1544.29	1380.29	Middle	UMCf	Monitoring	Chromium
COH-2A	09/11/09	832549.34	26733644.43	4.8	40.0	50.0	45.0	1544.30	1499.30	Shallow	Qal	Unknown	Chromium
CP-1	10/22/09	825287.67	26716403.47	16.0	115.0	125.0	120.0	1824.00	1704.00	Middle	UMCf	Monitoring	Chromium
DBMW-1	08/31/09	830462.90	26728009.64	59.5	19.0	49.0	34.0	1623.99	1589.99	Shallow	Qal/UMCf	Monitoring	Chromium
DBMW-10	09/29/09	836936.46	26727919.92	12.0	54.5	74.5	64.5	1660.83	1596.33	Shallow	Qal/UMCf	Monitoring	Chromium [VI]
DBMW-11	10/01/09	837574.55	26727982.28	63.0	45.0	75.0	60.0	1664.89	1604.89	Shallow	Qal	Monitoring	Chromium [VI]
DBMW-12	09/24/09	837992.38	26727975.89	50.0	45.0	75.0	60.0	1666.36	1606.36	Shallow	UMCf	Monitoring	Chromium [VI]
DBMW-13	09/29/09	838573.32	26727948.66	39.0	45.0	75.0	60.0	1675.93	1615.93	Shallow	UMCf	Monitoring	Chromium [VI]
DBMW-14	09/29/09	838969.37	26727963.68	41.0	35.0	65.0	50.0	1681.89	1631.89	Shallow	UMCf	Monitoring	Chromium [VI]
DBMW-15	09/30/09	839454.28	26727966.16	9.4	40.0	65.0	52.5	1690.25	1637.75	Shallow	UMCf	Monitoring	Chromium [VI]
DBMW-16	10/02/09	840513.96	26728557.52	23.0	85.0	110.0	97.5	1691.08	1593.58	Middle	Qal/UMCf	Monitoring	Chromium [VI]
DBMW-17	10/02/09	840749.71	26728093.57	1.7	52.0	72.0	62.0	1709.57	1647.57	Shallow	Qal/UMCf	Monitoring	Chromium [VI]
DBMW-19	09/24/09	831488.74	26731383.23	55.0	15.0	40.0	27.5	1580.74	1553.24	Shallow	Qal/UMCf	Monitoring	Chromium [VI]
DBMW-2	09/04/09	830518.23	26728063.40	49.4	20.0	40.0	30.0	1625.01	1595.01	Shallow	Qal	Monitoring	Chromium
DBMW-20	09/30/09	838723.25	26734838.71	21.0	20.0	70.0	45.0	1519.81	1474.81	Shallow	Qal/UMCf	Monitoring	Chromium [VI]
DBMW-22	09/28/09	839140.74	26733030.52	2.9	35.0	55.0	45.0	1532.58	1487.58	Shallow	UMCf	Monitoring	Chromium [VI]
DBMW-3	09/04/09	831004.79	26728157.00	61.9	19.0	39.0	29.0	1623.40	1594.40	Shallow	Qal/UMCf	Monitoring	Chromium
DBMW-4	09/22/09	832282.93	26729895.86	59.0	10.0	30.0	20.0	1603.42	1583.42	Shallow	Qal/UMCf	Monitoring	Chromium [VI]
DBMW-5	09/23/09	833395.04	26729807.16	53.0	15.0	35.0	25.0	1607.19	1582.19	Shallow	UMCf	Monitoring	Chromium [VI]

TABLE F-2
Chromium Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppb)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type	Chemical
DBMW-7	09/25/09	835296.00	26729079.57	62.0	50.0	70.0	60.0	1629.15	1569.15	Shallow	UMCf	Monitoring	Chromium [VI]
DBMW-8	09/23/09	835396.26	26729034.51	66.0	47.5	67.5	57.5	1629.46	1571.96	Shallow	UMCf	Monitoring	Chromium [VI]
DBMW-9	09/29/09	836220.90	26727794.49	35.0	54.0	74.0	64.0	1656.76	1592.76	Shallow	UMCf	Monitoring	Chromium [VI]
DM-1	10/01/09	832745.01	26722024.65	27.0	30.0	55.0	42.5	1729.11	1686.61	Shallow		Monitoring	Chromium [VI]
DPT-1	11/05/09	825680.22	26717349.85	4.1	114.0	129.0	121.5	1807.95	1686.45	Middle	UMCf	Monitoring	Chromium
EC-10	10/21/09	823570.10	26717752.81	12.0	38.5	53.5	46.0	1789.93	1743.93	Shallow	Qal-xUMCf	Monitoring	Chromium
EC-7	11/04/09	824698.70	26717808.89	1.8	47.0	62.0	54.5	1795.78	1741.28	Shallow	Qal/xUMCf	Monitoring	Chromium
H-21R	10/21/09	824914.54	26721148.51	5.0	30.0	45.0	37.5	1729.64	1692.14	Shallow		Monitoring	Chromium [VI]
H-28R	01/26/09	824914.54	26721024.80	10.0	37.4	50.5	44.0	1729.33	1685.38	Shallow		Monitoring	Chromium [VI]
H-48	05/11/10	825658.27	26723952.95	10.0	32.5	42.5	37.5	1680.34	1642.84	Shallow		Monitoring	Chromium
H49A	06/24/08	826110.29	26723485.40	3.1	28.0	48.0	38.0	1685.64	1647.64	Shallow	Qal	Monitoring	Chromium [VI]
H-55	10/26/09	823645.49	26720010.20	1.5	26.0	47.0	36.5	1751.06	1714.56	Shallow	Qal	Monitoring	Chromium
H-56A	07/28/10	825665.28	26723934.55	5.0	28.0	58.0	43.0	1681.68	1638.68	Shallow	Qal	Monitoring	Chromium
H-58A	05/13/10	825642.55	26723331.88	10.0	37.0	57.0	47.0	1690.98	1643.98	Shallow	Qal	Monitoring	Chromium
HMW-09	09/28/09	833045.87	26733362.32	37.0	67.0	87.0	77.0	1543.66	1466.66	Shallow	Qal	Monitoring	Chromium [VI]
HMWWT-6	09/04/09	837455.79	26722112.82	10.0	36.0	51.0	43.5	1774.31	1730.81	Shallow		Monitoring	Chromium [VI]
I-AA	05/04/10	827174.40	26719770.85	53.0	23.7	43.7	33.7	1751.08	1717.38	Shallow	UMCf	Recovery	Chromium
I-AB	05/04/10	827225.04	26719790.40	63.0	25.0	45.0	35.0	1753.89	1718.89	Shallow	Qal/UMCf	Recovery	Chromium
I-AR	05/03/10	827414.35	26719429.52	510.0	25.0	45.0	35.0	1758.02	1723.02	Shallow	UMCf	Recovery	Chromium
I-B	05/03/10	827282.89	26719808.09	250.0	17.8	42.5	30.2	1750.00	1719.85	Shallow		Monitoring	Chromium
I-C	05/03/10	827486.47	26719791.90	3200.0	13.2	42.5	27.9	1752.00	1724.15	Shallow	UMCf	Recovery	Chromium
I-D	05/03/10	827582.21	26719805.21	8100.0	16.0	44.5	30.3	1750.00	1719.75	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-E	05/03/10	827733.37	26719825.39	12000.0	21.5	43.5	32.5	1750.00	1717.50	Shallow	UMCf	Recovery	Chromium
I-F	05/03/10	827879.70	26719845.58	23000.0	11.8	43.3	27.6	1747.70	1720.15	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-G	05/03/10	828030.70	26719866.33	29000.0	9.5	38.8	24.2	1749.20	1725.05	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-H	05/03/10	828177.55	26719887.13	30000.0	13.6	43.1	28.4	1750.30	1721.95	Shallow	UMCf	Recovery	Chromium
I-I	08/04/10	828375.04	26719914.40	17000.0	11.3	40.5	25.9	1742.30	1716.40	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-J	08/04/10	828573.94	26719940.33	3000.0	11.2	40.5	25.9	1746.50	1720.65	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-K	08/04/10	828738.09	26719962.87	1400.0	7.0	35.2	21.1	1750.08	1728.98	Shallow	UMCf	Recovery	Chromium
I-L	05/03/10	827352.86	26719803.23	950.0	9.0	39.0	24.0	1748.30	1724.30	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-M	05/03/10	827669.83	26719817.42	11000.0	9.0	39.0	24.0	1749.20	1725.20	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-N	05/03/10	827802.25	26719837.85	14000.0	7.0	37.0	22.0	1747.80	1725.80	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-O	05/03/10	828263.13	26719898.00	22000.0	9.0	39.0	24.0	1749.00	1725.00	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-P	05/03/10	828221.66	26719892.08	27000.0	14.0	44.0	29.0	1749.20	1720.20	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-Q	05/03/10	827952.15	26719855.17	29000.0	9.6	39.6	24.6	1749.40	1724.80	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-R	05/03/10	827316.06	26719801.85	430.0	9.8	39.8	24.8	1749.06	1724.26	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-S	05/03/10	827404.20	26719799.87	1200.0	12.0	42.0	27.0	1747.57	1720.57	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-T	05/03/10	828073.50	26719873.66	30000.0	12.0	42.0	27.0	1749.03	1722.03	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-U	05/03/10	828118.60	26719879.67	16000.0	12.0	42.0	27.0	1749.54	1722.54	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
I-V	08/04/10	828326.28	26719894.97	17000.0	12.0	42.0	27.0	1749.46	1722.46	Shallow	Qal/xMCf/UMCf	Recovery	Chromium

TABLE F-2
Chromium Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppb)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type	Chemical
I-Z	08/04/10	828467.92	26719923.37	9200.0	15.0	35.0	25.0	1742.19	1717.19	Shallow		Monitoring	Chromium
J2D1-R2	01/22/09	829885.78	26719274.00	60.0	19.0	44.0	31.5	1768.00	1736.50	Shallow	Qal	Monitoring	Chromium
J2D2-R2	01/19/09	830098.48	26719406.73	50.0	23.5	48.5	36.0	1767.00	1731.00	Shallow		Monitoring	Chromium
J2D3	01/27/09	830356.31	26719443.26	34.0	34.0	39.0	36.5	1764.00	1727.50	Shallow		Monitoring	Chromium
J2D4	04/22/09	829582.57	26719171.05	290.0	15.0	45.0	30.0	1770.00	1740.00	Shallow		Monitoring	Chromium
J2U2	04/22/09	830063.17	26718456.02	62.0	33.5	68.5	51.0	1800.00	1749.00	Shallow		Monitoring	Chromium
L-635	05/20/10	828302.28	26727839.46	10.0	0.0	45.0	22.5	1621.27	1598.77	Shallow	Qal	Monitoring	Chromium
L-637	02/12/09	828110.00	26727839.47	10.0	14.0	29.0	21.5	1621.85	1600.35	Shallow	Qal	Monitoring	Chromium
M-10	08/06/10	828536.18	26716636.63	0.4	43.0	63.0	53.0	1834.11	1781.11	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-100	05/06/10	827659.99	26720820.26	98.0	19.0	29.0	24.0	1728.63	1704.63	Shallow	Qal	Monitoring	Chromium
M-102	06/25/08	828437.98	26720705.96	1900.0	19.4	39.4	29.4	1738.18	1708.78	Shallow	Qal	Monitoring	Chromium
M-103	06/09/10	828728.34	26715622.48	10.0	69.5	89.5	79.5	1864.53	1785.03	Shallow	UMCf	Monitoring	Chromium
M-11	07/27/10	828617.03	26717608.56	2360.0	33.3	53.0	43.2	1813.45	1770.30	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-111A	05/12/10	827447.19	26719134.86	64.0	29.7	39.7	34.7	1766.25	1731.55	Shallow	UMCf	Monitoring	Chromium
M-115	08/03/10	827243.65	26718612.90	33.0	35.0	45.0	40.0	1787.64	1747.64	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-117	06/09/10	828917.06	26715198.29	10.0	130.0	150.0	140.0	1877.98	1737.98	Middle	UMCf	Monitoring	Chromium
M-118	06/09/10	828036.40	26715068.01	23.0	138.0	158.0	148.0	1874.53	1726.53	Middle	UMCf	Monitoring	Chromium
M-120	07/27/10	828387.79	26715162.90	2.8	80.0	100.0	90.0	1875.81	1785.81	Middle	UMCf	Monitoring	Chromium
M-121	06/09/10	827694.57	26715011.24	25.0	77.0	97.0	87.0	1872.90	1785.90	Shallow	UMCf	Monitoring	Chromium
M-126	05/12/10	826569.37	26719505.57	10.0	19.7	39.7	29.7	1756.40	1726.70	Shallow		Monitoring	Chromium
M-12A	07/28/10	828178.52	26717575.29	10600.0	40.0	50.0	45.0	1812.72	1767.72	Shallow	UMCf	Monitoring	Chromium
M-13	05/05/10	827806.03	26717477.66	900.0	28.0	48.0	38.0	1813.49	1775.49	Shallow	UMCf	Monitoring	Chromium
M-131	05/04/10	827158.08	26719770.57	79.0	28.7	38.7	33.7	1751.05	1717.35	Shallow	UMCf	Monitoring	Chromium
M-132	05/13/10	828714.61	26720048.49	36.0	79.7	89.7	84.7	1741.41	1656.71	Shallow	UMCf	Monitoring	Chromium
M-133	05/13/10	828698.61	26720067.29	660.0	59.7	69.7	64.7	1740.93	1676.23	Shallow	UMCf	Monitoring	Chromium
M-134	05/12/10	827144.35	26719889.14	130.0	59.7	69.7	64.7	1749.39	1684.69	Shallow	UMCf	Monitoring	Chromium
M-135	05/04/10	827154.48	26719890.17	72.0	28.7	38.7	33.7	1749.17	1715.47	Shallow	UMCf	Monitoring	Chromium
M-136	05/12/10	827165.34	26719889.77	80.0	79.7	89.7	84.7	1749.09	1664.39	Shallow	UMCf	Monitoring	Chromium
M-137	05/12/10	827666.01	26716034.02	110.0	52.0	72.0	62.0	1845.02	1783.02	Shallow	UMCf	Monitoring	Chromium
M-138	05/12/10	827816.34	26716058.31	60.0	50.5	65.5	58.0	1844.06	1786.06	Shallow	UMCf	Monitoring	Chromium
M-139	05/13/10	829044.25	26717213.06	92.0	45.0	60.0	52.5	1813.71	1761.21	Shallow	UMCf	Monitoring	Chromium
M-140	09/11/10	827428.84	26719889.51	2400.0	23.0	43.0	33.0	1745.67	1712.67	Shallow	Qal/UMCf	Recovery	Chromium
M-141	05/13/10	828465.43	26718195.34	12000.0	37.5	47.5	42.5	1797.52	1755.02	Shallow	UMCf	Monitoring	Chromium
M-144	05/13/10	827644.50	26717026.00	57.0	35.0	45.0	40.0	1813.20	1773.20	Shallow	UMCf	Monitoring	Chromium
M-145	05/13/10	829205.27	26717451.15	110.0	45.0	60.0	52.5	1812.70	1760.20	Shallow	UMCf	Monitoring	Chromium
M-146	05/13/10	827774.94	26716991.91	77.0	40.0	50.0	45.0	1812.97	1767.97	Shallow	UMCf	Monitoring	Chromium
M-147	05/13/10	828824.17	26718857.89	150.0	25.0	40.0	32.5	1778.57	1746.07	Shallow	UMCf	Monitoring	Chromium
M-148A	09/15/10	829030.35	26718357.14	91.0	40.0	50.0	45.0	1797.74	1752.74	Shallow	Qal/UMCf	Monitoring	Chromium
M-149	07/28/10	828373.15	26718285.78	4100.0	100.0	120.0	110.0	1797.14	1687.14	Middle	UMCf	Monitoring	Chromium
M-14A	08/03/10	827045.36	26719382.67	45.0	20.0	40.0	30.0	1758.38	1728.38	Shallow	UMCf	Monitoring	Chromium

TABLE F-2
Chromium Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppb)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type	Chemical
M-150	06/09/10	828059.15	26719569.83	10.0	125.0	145.0	135.0	1756.50	1621.50	Middle	UMCf	Monitoring	Chromium
M-151	06/09/10	827643.03	26720826.75	26.0	125.0	145.0	135.0	1728.31	1593.31	Middle	UMCf	Monitoring	Chromium
M-152	06/09/10	826973.49	26722690.63	30.0	125.0	145.0	135.0	1695.79	1560.79	Middle	UMCf	Monitoring	Chromium
M-153	07/28/10	828385.61	26718287.91	15.0	150.0	170.0	160.0	1797.15	1637.15	Middle	UMCf	Monitoring	Chromium
M-154	06/09/10	828047.74	26719568.61	13.0	175.0	195.0	185.0	1756.51	1571.51	Middle	UMCf	Monitoring	Chromium
M-155	06/09/10	827636.10	26720827.40	10.0	200.0	220.0	210.0	1728.30	1518.30	Middle	UMCf	Monitoring	Chromium
M-156	06/09/10	826964.22	26722690.74	10.0	175.0	195.0	185.0	1695.84	1510.84	Middle	UMCf	Monitoring	Chromium
M-159	09/09/10	826758.00	26719824.06	99.0	65.0	75.0	70.0	1752.41	1682.41	Shallow	UMCf	Monitoring	Chromium
M-160	09/09/10	826769.05	26719826.22	70.0	40.0	50.0	45.0	1752.14	1707.14	Shallow	UMCf	Monitoring	Chromium
M-161	09/11/10	827134.13	26719889.85	8.8	100.0	110.0	105.0	1749.95	1644.95	Middle	UMCf	Monitoring	Chromium
M-163	09/11/10	827873.42	26719939.04	22.0	80.0	90.0	85.0	1745.63	1660.63	Shallow	UMCf	Monitoring	Chromium
M-164	09/11/10	827870.17	26719949.61	1600.0	60.0	70.0	65.0	1745.19	1680.19	Shallow	UMCf	Monitoring	Chromium
M-165	09/15/10	828701.37	26720053.24	6.7	110.0	120.0	115.0	1741.25	1626.25	Middle	UMCf	Monitoring	Chromium
M-171	09/11/10	827718.15	26719905.85	2400.0	24.7	44.7	34.7	1746.87	1712.17	Shallow	Qal/UMCf	Recovery	Chromium
M-178	09/11/10	828012.64	26719955.96	6600.0	26.0	46.0	36.0	1747.10	1711.10	Shallow	Qal/UMCf	Recovery	Chromium
M-179	09/11/10	828317.19	26720002.95	150.0	33.0	53.0	43.0	1747.28	1704.28	Shallow	Qal/UMCf	Recovery	Chromium
M-17A	08/03/10	828061.72	26719053.74	26000.0	35.0	45.0	40.0	1768.95	1728.95	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-181	09/08/10	828816.30	26719579.72	36.0	105.0	115.0	110.0	1759.26	1649.26	Middle	UMCf	Monitoring	Chromium
M-182	09/07/10	828815.50	26719588.73	1400.0	80.0	90.0	85.0	1759.40	1674.40	Shallow	UMCf	Monitoring	Chromium
M-186	09/09/10	829022.55	26718356.19	5100.0	105.0	115.0	110.0	1797.99	1687.99	Middle	UMCf	Monitoring	Chromium
M-187	09/11/10	827375.01	26718180.84	37.0	160.0	170.0	165.0	1797.33	1632.33	Middle	UMCf	Monitoring	Chromium
M-188	09/11/10	827377.14	26718171.32	21.0	110.0	120.0	115.0	1797.38	1682.38	Middle	UMCf	Monitoring	Chromium
M-19	08/04/10	828846.19	26719350.03	320.0	14.5	34.5	24.5	1764.41	1739.91	Shallow	UMCf	Monitoring	Chromium
M-21	05/05/10	827792.86	26718359.30	1000.0	18.0	38.0	28.0	1790.37	1762.37	Shallow	UMCf	Monitoring	Chromium
M-22A	05/06/10	828270.11	26719531.63	25000.0	16.0	36.0	26.0	1758.90	1732.90	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-23	05/03/10	827373.96	26721391.25	560.0	9.4	37.4	23.4	1717.54	1694.14	Shallow	Qal	Monitoring	Chromium
M-25	08/03/10	827677.80	26719503.57	11000.0	24.0	39.0	31.5	1756.89	1725.39	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-29	05/17/10	828999.00	26717598.00	37.0	22.0	42.0	32.0	1816.60	1784.60	Shallow	UMCf	Monitoring	Chromium
M-2A	05/06/10	827984.75	26718769.56	19000.0	30.0	40.0	35.0	1780.23	1745.23	Shallow	Qal	Monitoring	Chromium
M-31A	05/05/10	828368.37	26718289.58	10000.0	35.0	55.0	45.0	1796.94	1751.94	Shallow	UMCf	Monitoring	Chromium
M-33	05/05/10	828784.12	26718382.73	140.0	30.0	45.0	37.5	1797.03	1759.53	Shallow	UMCf	Monitoring	Chromium
M-34	08/03/10	828318.25	26718833.45	15000.0	25.0	40.0	32.5	1774.04	1741.54	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-35	08/03/10	828509.37	26718840.13	5100.0	25.0	40.0	32.5	1773.05	1740.55	Shallow	UMCf	Monitoring	Chromium
M-36	05/06/10	828069.09	26719556.63	30000.0	20.0	35.0	27.5	1756.89	1729.39	Shallow	UMCf	Monitoring	Chromium
M-37	05/04/10	827414.22	26719422.01	29.0	20.0	35.0	27.5	1758.13	1730.63	Shallow	UMCf	Monitoring	Chromium
M-38	05/06/10	827877.66	26719523.27	23000.0	20.0	35.0	27.5	1757.82	1730.32	Shallow	UMCf	Monitoring	Chromium
M-39	08/04/10	828548.82	26719525.34	4500.0	24.9	39.9	32.4	1758.61	1726.21	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-44	05/03/10	827005.61	26722699.15	660.0	5.0	35.0	20.0	1695.74	1675.74	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-48	02/02/09	828303.85	26721337.52	1200.0	6.1	36.1	21.1	1718.43	1697.33	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-50	05/05/10	828083.47	26718315.58	39000.0	39.6	59.6	49.6	1793.08	1743.48	Shallow	UMCf	Monitoring	Chromium

TABLE F-2
Chromium Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppb)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type	Chemical
M-52	05/05/10	828394.48	26717985.39	4300.0	34.5	44.5	39.5	1799.34	1759.84	Shallow	UMCf	Monitoring	Chromium
M-55	07/01/08	827683.04	26719819.36	11700.0	14.6	44.6	29.6	1749.43	1719.83	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium [VI]
M-57A	05/04/10	826993.31	26719716.74	57.0	20.0	40.0	30.0	1751.23	1721.23	Shallow	UMCf	Monitoring	Chromium
M-5A	07/27/10	826179.29	26719961.12	2.8	40.0	50.0	45.0	1749.69	1704.69	Shallow	UMCf	Monitoring	Chromium
M-61	05/12/10	828673.67	26719955.76	1300.0	9.3	38.8	24.1	1744.51	1720.46	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-64	05/12/10	827601.30	26719748.40	8300.0	12.7	37.3	25.0	1748.80	1723.80	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-65	05/12/10	827899.72	26719746.36	27000.0	14.4	39.0	26.7	1751.84	1725.14	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-66	05/12/10	828183.64	26719787.47	29000.0	17.5	42.3	29.9	1751.70	1721.80	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-67	05/12/10	828508.52	26719829.72	5100.0	7.8	37.8	22.8	1743.64	1720.84	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-68	08/04/10	828751.00	26719864.47	960.0	11.2	39.8	25.5	1747.16	1721.66	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-69	05/04/10	827265.73	26719885.28	530.0	19.9	39.3	29.6	1747.80	1718.20	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-6A	05/04/10	825984.54	26721013.69	30.0	26.8	41.5	34.2	1730.84	1696.69	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-70	05/06/10	827567.35	26719904.69	250.0	15.3	40.0	27.7	1746.00	1718.35	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-71	05/06/10	827859.71	26719943.63	3100.0	17.5	42.0	29.8	1744.87	1715.12	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-72	05/06/10	828172.13	26719977.14	4100.0	10.1	34.8	22.5	1744.62	1722.17	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-73	08/04/10	828427.82	26720018.47	7400.0	11.0	35.8	23.4	1738.87	1715.47	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-74	08/04/10	828713.65	26720062.18	960.0	9.2	38.8	24.0	1742.51	1718.51	Shallow	UMCf	Monitoring	Chromium
M-75	05/06/10	827718.82	26718702.64	3300.0	34.6	49.3	42.0	1781.92	1739.97	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-76	05/06/10	827550.73	26718659.92	2500.0	34.6	49.3	42.0	1781.68	1739.73	Shallow	UMCf	Monitoring	Chromium
M-77	05/05/10	828933.94	26718047.69	570.0	29.0	43.8	36.4	1798.09	1761.69	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-78	06/17/09	827777.45	26719838.17	12000.0	21.5	41.5	31.5	1749.54	1718.04	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium [VI]
M-79	05/04/10	827382.10	26720048.92	46.0	10.8	35.4	23.1	1742.57	1719.47	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-7B	05/04/10	826106.50	26720979.66	10.0	25.5	50.5	38.0	1730.35	1692.35	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-83	08/11/10	827586.44	26720161.50	0.4	10.8	40.3	25.6	1739.89	1714.34	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-84	05/06/10	827766.70	26720189.13	10.0	11.8	34.1	23.0	1738.48	1715.53	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-85	05/08/08	827962.63	26720219.88	65.0	10.4	35.0	22.7	1740.07	1717.37	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-86	05/08/08	828141.82	26720238.99	2700.0	11.3	40.9	26.1	1741.60	1715.50	Shallow	UMCf	Monitoring	Chromium
M-87	08/11/10	828358.13	26720276.13	3000.0	9.3	38.8	24.1	1741.51	1717.46	Shallow	UMCf	Monitoring	Chromium
M-88	08/04/10	828588.75	26720313.96	770.0	7.3	36.8	22.1	1736.93	1714.88	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-89	05/06/10	827890.08	26719294.84	23000.0	18.0	38.2	28.1	1763.69	1735.59	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
M-92	08/03/10	827138.09	26717531.94	0.4	34.9	44.9	39.9	1797.99	1758.09	Shallow	UMCf	Monitoring	Chromium
M-94	02/04/08	827222.85	26722695.81	590.0	12.0	22.0	17.0	1695.27	1678.27	Shallow	Qal	Monitoring	Chromium
M-95	05/03/10	827426.74	26722701.69	900.0	12.0	22.0	17.0	1694.52	1677.52	Shallow	Qal	Monitoring	Chromium
M-96	05/03/10	827626.08	26722700.30	760.0	10.5	20.5	15.5	1693.80	1678.30	Shallow	Qal	Monitoring	Chromium
M-97	08/03/10	827492.47	26717795.18	49.0	35.0	45.0	40.0	1798.35	1758.35	Shallow	UMCf	Monitoring	Chromium
M-99	08/03/10	827309.69	26720851.72	930.0	16.0	31.0	23.5	1728.29	1704.79	Shallow		Monitoring	Chromium
MC-53	06/15/09	825942.24	26721920.01	41.0	19.0	38.0	28.5	1713.34	1684.84	Shallow	Qal/UMCf	Monitoring	Chromium
MC-62	06/23/08	825880.75	26722727.62	3.1	25.0	50.0	37.5	1699.00	1661.50	Shallow	Qal/UMCf	Monitoring	Chromium [VI]
MC-65	05/11/10	826119.27	26722421.15	120.0	20.0	41.0	30.5	1703.62	1673.12	Shallow	Qal/UMCf	Monitoring	Chromium
MC-66	06/20/08	826221.37	26722558.03	634.0	27.0	47.0	37.0	1700.80	1663.80	Shallow	Qal/UMCf	Monitoring	Chromium [VI]

TABLE F-2
Chromium Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppb)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type	Chemical
MC-94	10/07/09	825912.02	26721595.27	11.0	30.0	40.0	35.0	1718.86	1683.86	Shallow		Monitoring	Chromium [VI]
MC-97	06/25/08	825838.35	26721425.66	3.1	31.0	41.0	36.0	1723.10	1687.10	Shallow	Qal/UMCf	Monitoring	Chromium [VI]
MCF-01A	08/10/09	830905.30	26720244.86	10.0	335.0	355.0	345.0	1754.44	1409.44	Deep	UMCf	Monitoring	Chromium
MCF-01B	08/07/09	830888.59	26720256.83	7.4	55.0	85.0	70.0	1753.95	1683.95	Shallow	UMCf	Monitoring	Chromium
MCF-02A	08/21/09	833801.41	26718435.24	10.7	360.0	380.0	370.0	1816.44	1446.44	Deep	UMCf	Monitoring	Chromium
MCF-02B	08/21/09	833785.68	26718432.16	7.9	215.0	235.0	225.0	1816.36	1591.36	Middle	UMCf	Monitoring	Chromium
MCF-03A	08/13/09	836835.26	26721058.78	38.0	364.0	384.0	374.0	1783.23	1409.23	Deep	UMCf	Monitoring	Chromium [VI]
MCF-03B	08/17/09	836813.17	26721066.60	7.7	57.0	77.0	67.0	1783.46	1716.46	Shallow	UMCf	Monitoring	Chromium
MCF-04	08/28/09	837630.23	26723668.56	10.0	379.0	399.0	389.0	1748.35	1359.35	Deep	UMCf	Monitoring	Chromium [VI]
MCF-05	08/28/09	832871.21	26728512.84	10.0	221.0	231.0	226.0	1625.03	1399.03	Middle	UMCf	Monitoring	Chromium [VI]
MCF-06A-R	09/21/09	834925.18	26729029.99	10.0	333.0	373.0	353.0	1630.32	1277.32	Deep	UMCf	Monitoring	Chromium [VI]
MCF-06B	08/28/09	834930.92	26729012.42	46.8	67.0	82.0	74.5	1630.40	1555.90	Shallow	UMCf	Monitoring	Chromium
MCF-06C	09/09/09	834945.84	26729004.59	70.0	44.0	59.0	51.5	1630.42	1578.92	Shallow	Qal	Monitoring	Chromium
MCF-07	09/11/09	837113.60	26729569.85	21.8	350.0	370.0	360.0	1576.33	1216.33	Deep	UMCf	Monitoring	Chromium
MCF-08A	08/31/09	827753.96	26733221.86	10.3	350.0	370.0	360.0	1579.02	1219.02	Deep	UMCf	Monitoring	Chromium
MCF-12B	08/19/09	840046.01	26727441.77	26.0	64.0	84.0	74.0	1712.74	1638.74	Shallow	Qal	Monitoring	Chromium
MCF-12C	08/19/09	840042.06	26727428.91	8.2	155.0	175.0	165.0	1713.03	1548.03	Middle	UMCf	Monitoring	Chromium
MCF-16A	10/05/09	835886.90	26726023.31	5.0	364.5	384.5	374.5	1689.67	1315.17	Deep	UMCf	Monitoring	Chromium [VI]
MCF-16B	09/30/09	835867.57	26726026.53	5.0	283.7	313.7	298.7	1689.75	1391.05	Middle	UMCf	Monitoring	Chromium [VI]
MCF-16C	09/30/09	835846.38	26726030.18	93.0	53.0	73.0	63.0	1689.88	1626.88	Shallow	Qal	Monitoring	Chromium [VI]
MCF-17A	09/29/09	825853.00	26732675.00	10.0	347.0	387.0	367.0	1597.65	1230.65	Deep	UMCf	Monitoring	Chromium [VI]
MCF-18A	09/21/09	831874.00	26731588.00	10.0	360.0	400.0	380.0	1574.16	1194.16	Deep	UMCf	Monitoring	Chromium [VI]
MCF-20A	09/03/09	833377.00	26728861.00	7.8	340.0	380.0	360.0	1623.53	1263.53	Deep	UMCf	Monitoring	Chromium
MCF-21A	08/25/09	838100.00	26727963.00	6.7	330.0	370.0	350.0	1663.63	1313.63	Deep	UMCf	Monitoring	Chromium
MCF-22A	10/09/09	840735.00	26729054.00	20.0	341.5	381.5	361.5	1680.62	1319.12	Deep	UMCf	Monitoring	Chromium
MCF-23A	10/05/09	830403.00	26726167.00	10.0	342.0	382.0	362.0	1543.86	1181.86	Deep	UMCf	Monitoring	Chromium [VI]
MCF-24A	08/28/09	833902.00	26725666.00	6.0	335.0	375.0	355.0	1674.07	1319.07	Deep	UMCf	Monitoring	Chromium
MCF-27	09/14/09	832488.11	26719293.06	34.0	361.5	381.5	371.5	1787.03	1415.53	Deep	UMCf	Monitoring	Chromium [VI]
MCF-28A	09/29/09	830679.60	26732313.65	10.0	370.0	390.0	380.0	1564.73	1184.73	Deep	UMCf	Monitoring	Chromium [VI]
MCF-28B	10/01/09	830661.57	26732313.02	10.0	168.0	188.0	178.0	1565.24	1387.24	Middle	UMCf	Monitoring	Chromium [VI]
MCF-29A	09/29/09	833957.87	26733436.56	10.0	359.5	379.5	369.5	1543.48	1173.98	Deep	UMCf	Monitoring	Chromium [VI]
MCF-29B	10/09/09	833954.70	26733444.92	35.5	155.0	175.0	165.0	1543.52	1378.52	Middle	UMCf	Monitoring	Chromium
MCF-30A	10/05/09	836135.15	26733724.11	10.0	350.0	370.0	360.0	1527.60	1167.60	Deep	UMCf	Monitoring	Chromium [VI]
MCF-30B	10/05/09	836130.63	26733707.02	10.0	144.0	164.0	154.0	1528.84	1374.84	Middle	UMCf	Monitoring	Chromium [VI]
MCF-31A	09/29/09	838327.15	26733550.26	10.0	361.0	381.0	371.0	1523.82	1152.82	Deep	UMCf	Monitoring	Chromium [VI]
MCF-31B	10/09/09	838313.96	26733552.24	33.6	210.0	230.0	220.0	1523.95	1303.95	Middle	UMCf	Monitoring	Chromium
MCF-32B	10/02/09	835753.14	26724074.91	0.4	140.0	160.0	150.0	1728.31	1578.31	Middle	UMCf	Monitoring	Chromium [VI]
MCF-BW-11A	10/13/09	824044.54	26718693.95	11.4	57.0	72.0	64.5	1776.18	1711.68	Shallow	UMCf	Monitoring	Chromium
MCF-MW-12	11/17/09	826293.89	26717903.04	5.0	100.0	120.0	110.0	1797.38	1687.38	Middle	UMCf	Monitoring	Chromium [VI]
MC-MW-09	11/12/09	825794.59	26716752.37	3.6	90.0	120.0	105.0	1812.62	1707.62	Middle	UMCf	Monitoring	Chromium

TABLE F-2
Chromium Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppb)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type	Chemical
MC-MW-10	11/13/09	825523.88	26717919.06	10.0	85.0	115.0	100.0	1801.21	1701.21	Middle	UMCf	Monitoring	Chromium
MC-MW-11	11/12/09	824860.15	26717766.00	2.0	100.0	120.0	110.0	1801.94	1691.94	Middle	UMCf	Monitoring	Chromium
MC-MW-17	11/16/09	826576.82	26717707.84	6.7	70.5	90.5	80.5	1797.67	1717.17	Shallow	UMCf	Monitoring	Chromium
MC-MW-18	11/17/09	826495.85	26718439.15	10.0	96.5	116.5	106.5	1784.50	1678.00	Middle	UMCf	Monitoring	Chromium
MW-13	09/02/09	838307.02	26734741.23	24.0	38.0	48.0	43.0	1528.36	1485.36	Shallow	Qal	Monitoring	Chromium
MW-K1	07/28/10	827777.00	26726810.00	10.0	8.5	24.0	16.3	1634.80	1618.55	Shallow	xMCf	Monitoring	Chromium
MW-K4	08/11/10	828994.00	26728410.00	200.0	9.5	50.0	29.8	1615.70	1585.95	Shallow	xMCf	Monitoring	Chromium
MW-K5	08/12/10	829617.00	26730252.00	48.0	28.5	44.0	36.3	1589.30	1553.05	Shallow	xMCf/UMCf	Monitoring	Chromium
PC-1	05/08/08	830925.11	26730308.65	78.0	14.7	29.7	22.2	1596.68	1574.48	Shallow		Monitoring	Chromium
PC-101R	08/11/10	828711.72	26728107.74	88.0	20.0	50.0	35.0	1618.12	1583.12	Shallow	Qal	Monitoring	Chromium
PC-103	05/19/10	829110.87	26730205.73	10.0	9.0	29.0	19.0	1597.02	1578.02	Shallow	Qal	Monitoring	Chromium
PC-104	05/08/09	829277.08	26731049.70	10.0	10.0	35.0	22.5	1596.68	1574.18	Shallow	Qal	Monitoring	Chromium
PC-108	09/16/09	828526.96	26731913.05	5.8	9.7	44.7	27.2	1584.96	1557.76	Shallow	Qal	Monitoring	Chromium
PC-115R	08/04/10	831148.64	26733131.33	0.4	10.0	50.0	30.0	1554.79	1524.79	Shallow	Qal	Recovery	Chromium
PC-116R	08/04/10	831348.43	26733203.15	0.4	10.0	50.0	30.0	1552.04	1522.04	Shallow	Qal	Recovery	Chromium
PC-117	08/04/10	831422.37	26733275.94	0.4	11.0	51.0	31.0	1551.23	1520.23	Shallow	Qal	Recovery	Chromium
PC-118	08/04/10	831051.99	26733167.39	0.4	9.0	49.0	29.0	1553.65	1524.65	Shallow	Qal	Recovery	Chromium
PC-119	08/04/10	830951.29	26733188.50	0.4	15.0	45.0	30.0	1554.34	1524.34	Shallow	Qal	Recovery	Chromium
PC-120	08/04/10	830851.47	26733185.77	0.4	15.0	45.0	30.0	1554.41	1524.41	Shallow	Qal	Recovery	Chromium
PC-121	08/04/10	830751.31	26733180.39	0.4	6.5	36.5	21.5	1554.70	1533.20	Shallow	Qal	Recovery	Chromium
PC-122	08/12/10	829675.17	26728145.17	110.0	22.5	37.5	30.0	1617.55	1587.55	Shallow	Qal	Monitoring	Chromium
PC-123	05/03/10	829485.04	26727358.44	1700.0	20.0	35.0	27.5	1626.70	1599.20	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-124	05/03/10	830132.95	26726741.58	47.0	20.3	35.3	27.8	1636.30	1608.50	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-125	05/03/10	829925.95	26726739.82	10.0	18.7	33.7	26.2	1632.41	1606.21	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-126	05/03/10	829724.72	26726737.84	130.0	19.5	34.5	27.0	1634.66	1607.66	Shallow	Qal	Monitoring	Chromium
PC-127	05/03/10	829316.65	26726735.62	1600.0	15.0	35.0	25.0	1632.92	1607.92	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-128	05/03/10	828953.97	26726732.39	190.0	14.8	34.8	24.8	1633.62	1608.82	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-129	05/03/10	828747.28	26726730.81	830.0	12.8	37.8	25.3	1634.36	1609.06	Shallow	Qal	Monitoring	Chromium
PC-130	05/03/10	828538.19	26726729.31	880.0	14.8	49.8	32.3	1633.50	1601.20	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-131	05/03/10	828123.28	26726725.41	10.0	9.8	39.8	24.8	1634.28	1609.48	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-132	05/03/10	827913.94	26726723.10	10.0	9.8	39.8	24.8	1635.21	1610.41	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-133	08/04/10	831758.00	26733209.00	0.4	5.0	40.0	22.5	1551.84	1529.34	Shallow	Qal/xMCf/UMCf	Recovery	Chromium
PC-134A	09/13/10	828775.80	26728143.15	5.3	59.7	69.7	64.7	1618.84	1554.14	Shallow	UMCf	Monitoring	Chromium
PC-135A	09/14/10	828767.49	26728143.03	5.0	30.7	50.7	40.7	1618.77	1578.07	Shallow	Qal	Monitoring	Chromium
PC-136	05/14/08	829517.91	26728191.38	4000.0	20.7	40.7	30.7	1618.78	1588.08	Shallow	Qal	Monitoring	Chromium
PC-137	05/11/08	829517.61	26728199.10	20.0	63.7	73.7	68.7	1618.77	1550.07	Shallow	UMCf	Monitoring	Chromium
PC-141	09/14/10	828446.31	26728106.63	2.3	44.7	54.7	49.7	1617.12	1567.42	Shallow	Qal	Monitoring	Chromium
PC-142	09/14/10	828436.04	26728106.76	0.9	21.7	31.7	26.7	1617.14	1590.44	Shallow	Qal	Monitoring	Chromium
PC-143	09/14/10	828698.71	26728238.64	32.0	29.7	39.7	34.7	1619.25	1584.55	Shallow	Qal	Monitoring	Chromium
PC-144	09/14/10	828903.75	26728223.86	330.0	29.7	39.7	34.7	1618.93	1584.23	Shallow	Qal	Monitoring	Chromium

TABLE F-2
Chromium Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppb)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type	Chemical
PC-145	09/13/10	829536.07	26728324.97	160.0	24.7	39.7	32.2	1618.10	1585.90	Shallow	Qal	Monitoring	Chromium
PC-148	09/14/10	829249.33	26728124.42	22.0	24.5	44.5	34.5	1617.79	1583.29	Shallow	Qal	Monitoring	Chromium
PC-149	09/14/10	829117.97	26728122.90	4.2	24.5	44.5	34.5	1618.93	1584.43	Shallow	Qal	Monitoring	Chromium
PC-150	09/13/10	828915.29	26728104.18	170.0	19.5	39.5	29.5	1618.36	1588.86	Shallow	Qal	Monitoring	Chromium
PC-17	08/13/08	828732.63	26728089.23	83.0	11.5	51.5	31.5	1618.55	1587.05	Shallow	Qal	Monitoring	Chromium
PC-18	08/10/10	828636.25	26728079.97	140.0	11.5	51.5	31.5	1618.55	1587.05	Shallow	Qal	Monitoring	Chromium
PC-2	05/11/10	830443.45	26730209.58	10.0	14.0	29.0	21.5	1593.79	1572.29	Shallow	Qal	Monitoring	Chromium
PC-21A	05/17/10	829269.53	26721332.72	210.0	14.0	34.0	24.0	1722.20	1698.20	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-24	05/10/10	829524.18	26726729.82	150.0	15.0	30.0	22.5	1633.95	1611.45	Shallow	Qal	Monitoring	Chromium
PC-28	08/20/09	828530.65	26725375.67	1400.0	10.0	19.5	14.8	1651.17	1636.42	Shallow	Qal	Monitoring	Chromium [VI]
PC-31	05/10/10	826781.65	26725195.83	10.0	14.5	49.5	32.0	1658.13	1626.13	Shallow	Qal	Monitoring	Chromium
PC-37	05/03/10	826612.10	26722172.24	230.0	16.8	41.8	29.3	1706.64	1677.34	Shallow	Qal	Monitoring	Chromium
PC-4	05/11/10	831171.80	26730353.42	83.0	17.7	42.7	30.2	1597.13	1566.93	Shallow	Qal	Monitoring	Chromium
PC-40	05/10/10	826476.78	26723971.04	10.0	15.0	55.0	35.0	1677.05	1642.05	Shallow	Qal	Monitoring	Chromium
PC-50	05/10/10	828326.94	26726722.30	78.0	11.8	41.8	26.8	1633.49	1606.69	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-53	08/11/10	829941.58	26730225.29	32.0	13.0	32.5	22.8	1593.14	1570.39	Shallow	Qal	Monitoring	Chromium
PC-54	05/03/10	828296.34	26722067.79	1800.0	9.5	34.5	22.0	1704.40	1682.40	Shallow	Qal	Monitoring	Chromium
PC-55	08/12/10	828530.49	26728056.66	0.4	4.0	54.0	29.0	1617.39	1588.39	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-56	08/09/10	830645.29	26732289.43	23.0	4.8	54.8	29.8	1568.99	1539.19	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-58	08/09/10	831123.78	26732118.20	36.0	7.8	32.8	20.3	1568.24	1547.94	Shallow	Qal	Monitoring	Chromium
PC-59	08/09/10	830150.30	26732452.69	0.4	4.8	34.8	19.8	1568.34	1548.54	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-60	08/09/10	830405.14	26732358.75	36.0	4.5	39.5	22.0	1568.80	1546.80	Shallow	Qal	Monitoring	Chromium
PC-62	08/09/10	829764.28	26732733.52	0.4	7.6	37.6	22.6	1568.45	1545.85	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-64	05/10/10	827916.52	26723702.44	2000.0	4.0	19.0	11.5	1675.51	1664.01	Shallow	Qal	Monitoring	Chromium
PC-65	05/10/10	828386.90	26723682.74	1200.0	4.1	18.7	11.4	1676.07	1664.67	Shallow	Qal	Monitoring	Chromium
PC-66	05/10/10	828779.40	26723966.95	2200.0	6.9	26.9	16.9	1674.05	1657.15	Shallow		Monitoring	Chromium
PC-67	07/28/10	829207.80	26723846.87	880.0	11.0	35.6	23.3	1674.38	1651.08	Shallow	Qal	Monitoring	Chromium
PC-68	08/09/10	829616.96	26732906.82	51.0	9.9	54.9	32.4	1567.66	1535.26	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-71	05/03/10	826805.90	26722687.72	390.0	13.4	28.4	20.9	1696.11	1675.21	Shallow	Qal/xMCf/UMCf	Monitoring	Chromium
PC-72	05/03/10	826604.72	26722688.82	210.0	15.0	35.0	25.0	1696.89	1671.89	Shallow	Qal	Monitoring	Chromium
PC-73	05/03/10	826404.90	26722694.93	380.0	20.0	45.0	32.5	1697.56	1665.06	Shallow	Qal	Monitoring	Chromium
PC-76	09/21/09	829183.79	26734006.74	1.0	39.5	49.5	44.5	1564.54	1520.04	Shallow	Qal	Monitoring	Chromium [VI]
PC-79	05/10/10	829815.15	26733246.70	10.0	34.5	44.5	39.5	1564.53	1525.03	Shallow		Monitoring	Chromium
PC-80	08/27/09	829823.82	26733250.46	10.0	19.5	29.5	24.5	1564.49	1539.99	Shallow	Qal	Monitoring	Chromium [VI]
PC-81	09/01/09	829833.40	26733254.77	10.0	9.5	14.5	12.0	1564.27	1552.27	Shallow	Qal	Monitoring	Chromium [VI]
PC-86	08/10/10	830826.99	26733185.76	0.4	17.5	27.5	22.5	1554.08	1531.58	Shallow	Qal	Monitoring	Chromium
PC-88	12/16/09	831259.41	26733178.42	10.0	40.0	50.0	45.0	1550.91	1505.91	Shallow	Qal	Monitoring	Chromium
PC-90	08/10/10	831271.92	26733192.63	0.4	4.5	14.5	9.5	1550.53	1541.03	Shallow	Qal	Monitoring	Chromium
PC-91	08/10/10	831729.99	26733110.85	10.0	26.5	36.5	31.5	1552.42	1520.92	Shallow	Qal	Monitoring	Chromium
PC-92	08/10/10	831749.30	26733109.85	0.4	11.5	21.5	16.5	1552.12	1535.62	Shallow	Qal	Monitoring	Chromium

TABLE F-2
Chromium Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppb)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type	Chemical
PC-93	12/16/09	832179.60	26733117.81	42.0	27.5	37.5	32.5	1548.86	1516.36	Shallow	Qal	Monitoring	Chromium
PC-94	08/10/10	832189.05	26733122.48	53.0	9.5	19.5	14.5	1548.84	1534.34	Shallow	Qal	Monitoring	Chromium
PC-97	08/10/10	831565.69	26733441.54	0.4	23.0	33.0	28.0	1548.78	1520.78	Shallow	Qal	Monitoring	Chromium
PC-98R	05/19/10	829522.58	26730260.53	35.0	20.0	35.0	27.5	1593.46	1565.96	Shallow	Qal	Monitoring	Chromium
PC-99R2/R3	08/04/10	831258.73	26733155.42	0.4	10.0	50.0	30.0	1552.18	1522.18	Shallow	Qal	Recovery	Chromium
POD2R	09/14/09	831955.50	26724825.40	150.0	45.0	65.0	55.0	1673.80	1618.80	Shallow	Qal	Monitoring	Chromium [VI]
POD8	09/03/09	833586.10	26724789.80	10.1	42.5	72.5	57.5	1691.16	1633.66	Shallow	Qal	Monitoring	Chromium
POU3	09/22/09	831329.98	26721664.71	420.0	35.0	65.0	50.0	1728.00	1678.00	Shallow	Qal	Monitoring	Chromium [VI]
TIMETMW-3R	02/02/09	829483.25	26716571.73	31.0	41.0	66.0	53.5	1840.39	1786.89	Shallow	xMCf	Monitoring	Chromium
TIMETMW-5	01/26/09	830319.58	26717935.92	21.0	40.0	60.0	50.0	1813.00	1763.00	Shallow	Qal	Monitoring	Chromium
TIMETMW-6R	04/22/09	829221.18	26717836.95	80.0	39.7	59.7	49.7	1810.43	1760.76	Shallow	Qal	Monitoring	Chromium
TMMW-101	02/05/09	829462.76	26715285.26	10.0	65.0	95.0	80.0	1876.00	1796.00	Shallow	Qal	Monitoring	Chromium [VI]
TMMW-102	02/04/09	830371.18	26715433.08	10.0	47.0	87.0	67.0	1880.00	1813.00	Shallow	Qal/xMCf	Monitoring	Chromium [VI]
TMMW-103	02/03/09	831325.82	26715583.05	10.0	57.0	87.0	72.0	1880.00	1808.00	Shallow	xMCf	Monitoring	Chromium [VI]
TMMW-104	02/04/09	832104.88	26715722.71	10.0	57.0	87.0	72.0	1884.00	1812.00	Shallow	xMCf	Monitoring	Chromium [VI]
TMPZ-105	05/06/10	828703.77	26720557.27	910.0	19.0	39.0	29.0	1736.00	1707.00	Shallow	Qal/xMCf	Monitoring	Chromium [VI]
TMPZ-106	05/06/10	829102.42	26720359.15	460.0	19.0	39.0	29.0	1742.00	1713.00	Shallow	Qal	Monitoring	Chromium [VI]
TMPZ-107	05/11/10	829386.70	26720209.59	330.0	19.0	39.0	29.0	1745.00	1716.00	Shallow	Qal/xMCf	Monitoring	Chromium [VI]
TMPZ-108	05/11/10	829756.76	26720032.09	420.0	26.0	46.0	36.0	1750.00	1714.00	Shallow	Qal/xMCf	Monitoring	Chromium [VI]
TMPZ-109	05/05/10	830082.66	26719874.25	43.0	26.0	46.0	36.0	1756.00	1720.00	Shallow	Qal/xMCf	Monitoring	Chromium [VI]
TMPZ-110	05/05/10	830531.86	26719668.76	12.0	25.0	45.0	35.0	1763.00	1728.00	Shallow	Qal/xMCf	Monitoring	Chromium [VI]
TR-1	06/10/10	826168.04	26719957.91	10.0	281.5	311.5	296.5	1749.41	1452.91	Middle	UMCf	Monitoring	Chromium
TR-10	06/10/10	827562.53	26715739.77	90.0	80.0	100.0	90.0	1851.72	1761.72	Middle	UMCf	Monitoring	Chromium
TR-11	06/09/10	825422.57	26721918.29	10.0	210.0	230.0	220.0	1714.80	1494.80	Middle	UMCf	Monitoring	Chromium
TR-12	06/11/10	825286.37	26723271.82	45.0	272.0	292.0	282.0	1693.44	1411.44	Middle	UMCf	Monitoring	Chromium
TR-2	06/10/10	826156.85	26719954.57	10.0	144.5	174.5	159.5	1749.45	1589.95	Middle	UMCf	Monitoring	Chromium
TR-3	06/11/10	826342.89	26718941.61	10.0	219.5	249.5	234.5	1770.08	1535.58	Middle	UMCf	Monitoring	Chromium
TR-4	06/09/10	826342.53	26718951.58	24.0	124.5	144.5	134.5	1770.04	1635.54	Middle	UMCf	Monitoring	Chromium
TR-5	07/27/10	826595.86	26717592.13	17.0	221.0	251.0	236.0	1797.45	1561.45	Middle	UMCf	Monitoring	Chromium
TR-6	07/27/10	826594.34	26717608.38	17.0	60.0	80.0	70.0	1797.53	1727.53	Shallow	UMCf	Monitoring	Chromium
TR-7	06/10/10	826724.99	26716525.47	10.0	260.0	290.0	275.0	1826.56	1551.56	Middle	UMCf	Monitoring	Chromium
TR-8	06/10/10	826722.81	26716512.15	10.0	63.0	93.0	78.0	1826.54	1748.54	Shallow	UMCf	Monitoring	Chromium
TR-9	06/10/10	827560.22	26715752.71	10.0	230.0	250.0	240.0	1851.75	1611.75	Middle	UMCf	Monitoring	Chromium
WMW5.58SD	09/09/09	835091.50	26734645.80	7.7	60.0	80.0	70.0	1433.76	1363.76	Shallow	UMCf	Monitoring	Chromium

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
AA-01	5/17/10	830921.12	26720238.47	2.0	29.0	49.0	39.0	1754.93	1715.93	Shallow	Qal	Monitoring
AA-07	8/10/09	837100.42	26729559.52	0.5	30.0	50.0	40.0	1578.99	1538.99	Shallow	Qal	Monitoring
AA-09	8/14/09	831041.59	26723441.40	7.2	30.0	65.0	47.5	1694.11	1646.61	Shallow	Qal	Monitoring
AA-11	5/17/10	830672.66	26725458.78	4.2	9.0	29.0	19.0	1658.00	1639.00	Shallow	Qal	Monitoring
AA-13	8/13/09	833889.39	26722860.98	0.1	38.0	58.0	48.0	1722.37	1674.37	Shallow	Qal	Monitoring
AA-18	8/11/09	836690.87	26727656.38	0.1	44.5	64.5	54.5	1665.60	1611.10	Shallow	Qal	Monitoring
AA-20	9/11/09	831811.84	26728007.71	5.4	10.0	30.0	20.0	1626.07	1606.07	Shallow	Qal	Monitoring
AA-21	8/12/09	826148.08	26734078.78	0.1	9.0	39.0	24.0	1583.13	1559.13	Shallow	Qal	Monitoring
AA-22	5/14/08	833425.59	26731586.01	0.1	11.0	31.0	21.0	1579.88	1558.88	Shallow	Qal	Monitoring
AA-23R	5/19/08	833898.96	26732042.31	0.7	20.0	45.0	32.5	1545.04	1512.54	Shallow	Qal	Monitoring
AA-26	5/19/08	840176.49	26733349.15	0.0	32.0	52.0	42.0	1563.56	1521.56	Shallow	Qal	Monitoring
AA-27	8/26/09	832471.34	26719301.66	0.2	61.5	81.5	71.5	1786.85	1715.35	Shallow	Qal/xMCF/UMCf	Monitoring
AA-30	9/9/09	836125.91	26733691.70	2.5	11.7	31.7	21.7	1529.84	1508.14	Shallow	Qal	Unknown
AA-BW-01A	10/26/09	826112.39	26719802.79	0.1	33.0	53.0	43.0	1752.84	1709.84	Shallow	Qal	Monitoring
AA-BW-04A	7/21/09	825492.25	26721142.81	0.0	32.0	52.0	42.0	1729.47	1687.47	Shallow	Qal	Monitoring
AA-BW-05A	7/21/09	825065.41	26721183.83	0.0	34.0	64.0	49.0	1729.21	1680.21	Shallow	Qal	Monitoring
AA-BW-06A	10/23/09	824476.16	26721238.26	0.0	23.0	43.0	33.0	1729.28	1696.28	Shallow	Qal	Monitoring
AA-BW-07A	7/22/09	823979.46	26720637.98	0.0	32.0	52.0	42.0	1739.89	1697.89	Shallow	Qal	Monitoring
AA-BW-08A	10/29/09	825332.70	26719492.77	0.0	37.5	57.5	47.5	1761.28	1713.78	Shallow	Qal	Monitoring
AA-BW-09A	10/29/09	825703.31	26719455.90	0.1	33.0	53.0	43.0	1761.59	1718.59	Shallow	Qal	Monitoring
AA-BW-12A	10/13/09	824440.21	26718772.36	0.0	49.0	69.0	59.0	1776.54	1717.54	Shallow	Qal	Monitoring
AA-MW-05	10/20/09	824351.37	26715530.83	0.2	30.5	60.5	45.5	1843.11	1797.61	Shallow	xMCf	Monitoring
AA-MW-07	10/22/09	826126.54	26719344.40	0.1	30.5	70.5	50.5	1761.91	1711.41	Shallow	xMCf	Monitoring
AA-MW-13	11/2/09	825332.59	26717020.38	0.4	31.5	61.5	46.5	1809.83	1763.33	Shallow	xMCf/UMCf	Monitoring
AA-MW-14	11/2/09	825660.68	26717082.46	0.2	33.0	53.0	43.0	1808.85	1765.85	Shallow	xMCf	Monitoring
AA-MW-20	11/16/09	824824.86	26716566.62	0.0	46.0	66.0	56.0	1813.63	1757.63	Shallow	xMCf/UMCf	Monitoring
AA-MW-21	7/16/08	825815.69	26716593.28	0.2	54.0	74.0	64.0	1820.24	1756.24	Shallow	xMCf/UMCf	Monitoring
AA-MW-22	7/16/08	826019.53	26716508.86	0.0	45.0	65.0	55.0	1822.02	1767.02	Shallow	xMCf/UMCf	Monitoring
AA-MW-23	7/16/08	826663.57	26716921.14	0.1	45.0	65.0	55.0	1812.64	1757.64	Shallow	xMCf/UMCf	Monitoring
AA-MW-24	10/30/09	825495.60	26715178.08	0.0	55.0	75.0	65.0	1851.03	1786.03	Shallow	xMCf/UMCf	Monitoring
AA-UW1	8/24/09	831427.20	26719624.99	0.7	55.0	65.0	60.0	1772.13	1712.13	Shallow	Qal	Monitoring
AA-UW2	8/11/09	832819.54	26718117.11	0.1	55.0	75.0	65.0	1818.68	1753.68	Shallow	Qal	Monitoring
AA-UW3	8/25/09	835097.86	26718183.94	0.1	60.0	80.0	70.0	1829.00	1759.00	Shallow	Qal	Monitoring
AA-UW4	8/26/09	836517.02	26720029.40	0.1	35.0	55.0	45.0	1797.18	1752.18	Shallow	Qal	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
AA-UW5	9/15/09	838134.66	26722958.50	0.1	37.0	57.0	47.0	1765.91	1718.91	Shallow	Qal	Monitoring
ARP-2	5/14/08	828726.35	26728363.61	0.4	16.0	51.0	33.5	1613.03	1579.53	Shallow	Qal	Monitoring
ARP-2A	9/16/10	828856.20	26728402.86	3.1	23.7	53.7	38.7	1614.75	1576.05	Shallow	Qal	Monitoring
ARP-3	4/17/08	828860.77	26728364.89	9.5	14.0	44.0	29.0	1612.38	1583.38	Shallow	Qal	Monitoring
ARP-3A	9/16/10	828722.80	26728404.34	3.6	20.7	40.7	30.7	1614.51	1583.81	Shallow	Qal	Monitoring
ARP-4	2/10/10	829171.79	26728363.72	23.0	15.0	45.0	30.0	1613.13	1583.13	Shallow	Qal	Monitoring
ARP-4A	9/16/10	829167.89	26728411.81	25.0	17.7	32.7	25.2	1615.72	1590.52	Shallow	Qal	Monitoring
ARP-5A	9/16/10	829375.01	26728458.43	20.0	12.7	37.7	25.2	1616.50	1591.30	Shallow	Qal	Monitoring
ARP-6B	9/16/10	829520.52	26728499.92	28.0	27.7	42.7	35.2	1615.70	1580.50	Shallow	Qal	Monitoring
ARP-7	9/16/10	829668.22	26728501.08	4.7	14.0	39.0	26.5	1613.39	1586.89	Shallow	Qal	Monitoring
ART-1	9/8/10	828543.96	26728122.71	1.7	14.0	54.0	34.0	1615.57	1581.57	Shallow	Qal	Recovery
ART-2	9/8/10	828625.03	26728084.71	77.0	19.0	54.0	36.5	1617.42	1580.92	Shallow	Qal	Recovery
ART-3	9/8/10	828775.42	26728085.17	340.0	15.0	45.0	30.0	1617.61	1587.61	Shallow	Qal	Recovery
ART-4	9/8/10	828850.69	26728085.26	400.0	19.0	44.0	31.5	1617.91	1586.41	Shallow	Qal	Recovery
ART-6	9/8/10	829472.91	26728140.60	350.0	14.0	34.0	24.0	1616.25	1592.25	Shallow	Qal	Recovery
ART-7	9/8/10	829576.52	26728145.71	160.0	16.9	36.9	26.9	1616.32	1589.42	Shallow	Qal	Recovery
ART-7B	8/12/10	829576.25	26728151.94	160.0	29.5	44.5	37.0	1618.06	1581.06	Shallow	Qal	Extraction
ART-8	9/8/10	828697.72	26728084.10	260.0	18.0	48.0	33.0	1618.54	1585.54	Shallow	Qal	Recovery
ART-9	9/8/10	829525.57	26728143.32	320.0	20.5	40.5	30.5	1616.16	1585.66	Shallow	Qal	Recovery
B01	11/2/09	825676.63	26717341.36	0.2	44.5	54.5	49.5	1807.89	1758.39	Shallow	xMCF	Monitoring
BEC-6	9/28/09	835779.00	26724128.00	15.0	65.0	80.0	72.5	1725.26	1652.76	Shallow	UMCf	Monitoring
BEC-9	8/18/09	833044.00	26727209.00	0.3	44.0	59.0	51.5	1647.56	1596.06	Shallow	UMCf	Monitoring
BRW-R1	1/20/09	831591.74	26716952.35	0.3	40.0	60.0	50.0	1844.00	1794.00	Shallow	Qal	Monitoring
C	10/24/08	824604.78	26722157.41	0.5	28.0	38.0	33.0	1714.94	1681.94	Shallow	Qal	Extraction
CLD2-R	5/20/09	828919.18	26719962.61	9.7	10.5	30.5	20.5	1750.00	1729.50	Shallow	Qal	Monitoring
CLD3-R	7/10/08	829654.21	26720009.48	3.0	20.0	39.0	29.5	1748.00	1718.50	Shallow	Qal	Monitoring
CLD4-R	4/21/09	829031.76	26718855.46	3.0	27.0	47.0	37.0	1777.00	1740.00	Shallow	Qal	Monitoring
CMT-101	4/3/08	829635.17	26719980.31	2.7	48.0	48.5	48.3	1749.40	1701.15	Shallow	xMCf	Monitoring
CMT-102	4/2/08	829635.17	26719980.31	3.8	64.0	64.5	64.3	1749.40	1685.15	Shallow	xMCf	Monitoring
CMT-103	4/2/08	829635.17	26719980.31	0.0	85.0	85.5	85.3	1749.40	1664.15	Shallow	UMCf	Monitoring
CMT-104	4/1/08	829635.17	26719980.31	0.0	115.0	115.5	115.3	1749.40	1634.15	Middle	UMCf	Monitoring
CMT-105	4/1/08	829635.17	26719980.31	0.0	126.0	126.5	126.3	1749.40	1623.15	Middle	UMCf	Monitoring
CMT-106	3/31/08	829635.17	26719980.31	0.0	142.0	142.5	142.3	1749.40	1607.15	Middle	UMCf	Monitoring
CMT-107	3/31/08	829635.17	26719980.31	2.4	157.0	157.5	157.3	1749.40	1592.15	Middle	UMCf	Monitoring
CMT-201	4/22/08	829165.09	26719005.54	14.0	48.0	48.5	48.3	1780.70	1732.45	Shallow	xMCf	Monitoring
CMT-202	3/19/08	829165.09	26719005.54	9.6	75.0	75.5	75.3	1780.70	1705.45	Shallow	xMCf	Monitoring
CMT-203	3/20/08	829165.09	26719005.54	1.5	92.0	92.5	92.3	1780.70	1688.45	Middle	UMCf	Monitoring
CMT-204	3/20/08	829165.09	26719005.54	160.0	119.5	120.0	119.8	1780.70	1660.95	Middle	UMCf	Monitoring
CMT-205	4/22/08	829165.09	26719005.54	0.0	137.0	137.5	137.3	1780.70	1643.45	Middle	UMCf	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
CMT-206	3/19/08	829165.09	26719005.54	0.1	160.0	160.5	160.3	1780.70	1620.45	Middle	UMCf	Monitoring
CMT-207	3/18/08	829165.09	26719005.54	0.0	177.5	178.0	177.8	1780.70	1602.95	Middle	UMCf	Monitoring
CMT-302	4/10/08	829945.55	26719002.96	0.5	46.0	46.5	46.3	1775.20	1728.95	Shallow	xMCf	Monitoring
CMT-303	4/9/08	829945.55	26719002.96	0.0	76.0	76.5	76.3	1775.20	1698.95	Shallow	xMCf	Monitoring
CMT-304	4/8/08	829945.55	26719002.96	8.0	105.5	106.0	105.8	1775.20	1669.45	Middle	xMCf	Monitoring
CMT-305	4/8/08	829945.55	26719002.96	0.1	131.5	132.0	131.8	1775.20	1643.45	Middle	xMCf	Monitoring
CMT-306	4/7/08	829945.55	26719002.96	0.0	147.0	147.5	147.3	1775.20	1627.95	Middle	xMCf	Monitoring
CMT-307	4/7/08	829945.55	26719002.96	0.0	167.5	168.0	167.8	1775.20	1607.45	Middle	UMCf	Monitoring
CMT-501	4/14/08	828934.81	26720431.12	17.0	40.0	40.5	40.3	1740.30	1700.05	Shallow	xMCf	Monitoring
CMT-502	3/27/08	828934.81	26720431.12	20.0	49.5	50.0	49.8	1740.30	1690.55	Shallow	xMCf	Monitoring
CMT-503	3/27/08	828934.81	26720431.12	0.2	58.5	59.0	58.8	1740.30	1681.55	Shallow	xMCf	Monitoring
CMT-504	3/26/08	828934.81	26720431.12	0.6	94.0	94.5	94.3	1740.30	1646.05	Middle	xMCf	Monitoring
CMT-505	4/10/08	828934.81	26720431.12	0.0	113.0	113.5	113.3	1740.30	1627.05	Middle	UMCf	Monitoring
CMT-506	3/25/08	828934.81	26720431.12	0.0	128.0	128.5	128.3	1740.30	1612.05	Middle	UMCf	Monitoring
CMT-507	3/24/08	828934.81	26720431.12	0.1	157.5	158.0	157.8	1740.30	1582.55	Middle	UMCf	Monitoring
COH-1	9/28/09	832590.00	26734998.02	0.0	157.9	167.9	162.9	1550.11	1387.21	Middle	UMCf	Monitoring
COH-2	8/13/09	832572.52	26733634.08	0.0	159.0	169.0	164.0	1544.29	1380.29	Middle	UMCf	Monitoring
COH-2A	9/11/09	832549.34	26733644.43	5.4	40.0	50.0	45.0	1544.30	1499.30	Shallow	Qal	Unknown
CP-1	10/22/09	825287.67	26716403.47	0.0	115.0	125.0	120.0	1824.00	1704.00	Middle	UMCf	Monitoring
CTRL_1	-	825418.65	26724445.93	1.0	10.0	30.0	20.0	1675.85	1655.85	Shallow		
CTRL_2	-	825523.07	26724689.56	1.0	10.0	30.0	20.0	1674.26	1654.26	Shallow		
CTRL_3	-	828255.26	26730223.55	1.0	10.0	30.0	20.0	1603.20	1583.20	Shallow		
CTRL_4	-	830066.81	26727781.97	5.0	0.0	26.0	13.0	1620.36	1607.36	Shallow		
CTRL_5	-	829887.43	26722384.15	5.0	0.0	35.0	17.5	1704.70	1687.20	Shallow		
CTRL_6	-	830081.76	26723683.72	5.0	0.0	42.0	21.0	1684.33	1663.33	Shallow		
D2	-	825124.05	26721802.52	0.3	37.0	41.0	39.0	1717.92	1678.92	Shallow		
DBMW-1	8/31/09	830462.90	26728009.64	7.1	19.0	49.0	34.0	1623.99	1589.99	Shallow	Qal/UMCf	Monitoring
DBMW-10	9/29/09	836936.46	26727919.92	0.5	54.5	74.5	64.5	1660.83	1596.33	Shallow	Qal/UMCf	Monitoring
DBMW-12	9/24/09	837992.38	26727975.89	12.0	45.0	75.0	60.0	1666.36	1606.36	Shallow	UMCf	Monitoring
DBMW-13	9/29/09	838573.32	26727948.66	9.8	45.0	75.0	60.0	1675.93	1615.93	Shallow	UMCf	Monitoring
DBMW-14	9/29/09	838969.37	26727963.68	14.0	35.0	65.0	50.0	1681.89	1631.89	Shallow	UMCf	Monitoring
DBMW-15	9/30/09	839454.28	26727966.16	1.4	40.0	65.0	52.5	1690.25	1637.75	Shallow	UMCf	Monitoring
DBMW-16	10/2/09	840513.96	26728557.52	0.0	85.0	110.0	97.5	1691.08	1593.58	Middle	Qal/UMCf	Monitoring
DBMW-17	10/2/09	840749.71	26728093.57	0.0	52.0	72.0	62.0	1709.57	1647.57	Shallow	Qal/UMCf	Monitoring
DBMW-19	9/24/09	831463.83	26731381.50	6.5	15.0	40.0	27.5	1580.74	1553.24	Shallow	Qal/UMCf	Monitoring
DBMW-2	9/4/09	830518.23	26728063.40	7.5	20.0	40.0	30.0	1625.01	1595.01	Shallow	Qal	Monitoring
DBMW-20	9/30/09	838723.25	26734838.71	3.2	20.0	70.0	45.0	1519.81	1474.81	Shallow	Qal/UMCf	Monitoring
DBMW-22	5/30/08	839121.84	26733024.47	0.2	35.0	55.0	45.0	1532.58	1487.58	Shallow	UMCf	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
DBMW-3	9/4/09	831004.79	26728157.00	7.6	19.0	39.0	29.0	1623.40	1594.40	Shallow	Qal/UMCf	Monitoring
DBMW-4	9/22/09	832282.93	26729895.86	4.3	10.0	30.0	20.0	1603.42	1583.42	Shallow	Qal/UMCf	Monitoring
DBMW-5	9/23/09	833395.04	26729807.16	3.0	15.0	35.0	25.0	1607.19	1582.19	Shallow	UMCf	Monitoring
DBMW-6	5/27/08	834366.86	26728951.38	2.0	30.0	50.0	40.0	1629.97	1589.97	Shallow	Qal/UMCf	Monitoring
DBMW-7	9/25/09	835296.00	26729079.57	3.3	50.0	70.0	60.0	1629.15	1569.15	Shallow	UMCf	Monitoring
DBMW-8	9/23/09	835396.26	26729034.51	3.6	47.5	67.5	57.5	1629.46	1571.96	Shallow	UMCf	Monitoring
DBMW-9	9/29/09	836220.90	26727794.49	2.7	54.0	74.0	64.0	1656.76	1592.76	Shallow	UMCf	Monitoring
DM1	10/1/09	832745.01	26722024.65	0.3	30.0	55.0	42.5	1729.11	1686.61	Shallow		Monitoring
E3	10/24/08	825263.64	26721705.66	0.4	30.0	40.0	35.0	1719.18	1684.18	Shallow	Qal	Extraction
EC-2	10/22/09	825069.70	26719453.56	0.0	50.0	70.0	60.0	1770.00	1710.00	Shallow	Qal/UMCf	Monitoring
EC-3	11/3/09	824697.79	26717247.43	0.2	50.0	70.0	60.0	1805.00	1745.00	Shallow	UMCf	Monitoring
EC-4	10/26/09	824135.84	26717035.31	0.1	50.0	70.0	60.0	1811.95	1751.95	Shallow	UMCf	Monitoring
F	10/24/08	825407.50	26721607.40	0.2	27.0	47.0	37.0	1720.87	1683.87	Shallow	Qal	Extraction
G	10/24/08	825525.13	26721526.56	0.1	30.0	50.0	40.0	1721.98	1681.98	Shallow	Qal	Extraction
H-11	7/13/09	826574.18	26714839.94	0.0	94.0	103.0	98.5	1867.10	1768.60	Middle	Qal/UMCf	Monitoring
H2	10/24/08	825614.58	26721467.01	0.0	40.0	50.0	45.0	1722.76	1677.76	Shallow	Qal	Extraction
H-28A	5/6/10	825864.67	26721023.60	2.3	38.0	51.0	44.5	1730.57	1686.07	Shallow		
H-28R	1/26/09	825845.21	26721024.80	0.0	37.4	50.5	44.0	1729.33	1685.38	Shallow		Monitoring
H-38	6/18/09	826103.08	26718901.83	0.0	16.0	55.0	35.5	1772.14	1736.64	Shallow	Qal/UMCf	Monitoring
H-49A	6/24/08	826110.29	26723485.40	210.0	28.0	48.0	38.0	1685.64	1647.64	Shallow	Qal	Monitoring
H-55	10/26/09	823645.49	26720010.20	0.0	26.0	47.0	36.5	1751.06	1714.56	Shallow	Qal	Monitoring
H-58A	5/13/10	825642.55	26723331.88	1.7	37.0	57.0	47.0	1690.98	1643.98	Shallow	Qal	Monitoring
HMWWT6	9/4/09	837455.79	26722112.82	0.1	36.0	51.0	43.5	1774.31	1730.81	Shallow	UMCf	Monitoring
I-AA	5/4/10	827174.40	26719770.85	140.0	23.7	43.7	33.7	1751.08	1717.38	Shallow	UMCf	Recovery
I-AB	5/4/10	827225.04	26719790.40	460.0	25.0	45.0	35.0	1753.89	1718.89	Shallow	Qal/UMCf	Recovery
I-AC	9/15/10	828792.61	26719889.66	66.0	24.5	44.5	34.5	1750.12	1715.62	Shallow		Recovery
I-AD	9/15/10	828806.68	26719794.82	45.0	24.5	44.5	34.5	1752.94	1718.44	Shallow		Recovery
I-A-R	5/3/10	827414.35	26719429.52	2400.0	25.0	45.0	35.0	1758.02	1723.02	Shallow	UMCf	Recovery
I-B	5/3/10	827282.89	26719808.09	990.0	17.8	42.5	30.2	1750.00	1719.85	Shallow		Monitoring
I-C	5/3/10	827486.47	26719791.90	860.0	13.2	42.5	27.9	1752.00	1724.15	Shallow	UMCf	Recovery
I-D	5/3/10	827582.21	26719805.21	850.0	16.0	44.5	30.3	1750.00	1719.75	Shallow	Qal/xMCf/UMCf	Recovery
I-E	5/3/10	827733.37	26719825.39	860.0	21.5	43.5	32.5	1750.00	1717.50	Shallow	UMCf	Recovery
I-F	5/3/10	827879.70	26719845.58	1300.0	11.8	43.3	27.6	1747.70	1720.15	Shallow	Qal/xMCf/UMCf	Recovery
I-G	5/3/10	828030.70	26719866.33	1700.0	9.5	38.8	24.2	1749.20	1725.05	Shallow	Qal/xMCf/UMCf	Recovery
I-H	5/3/10	828177.55	26719887.13	1600.0	13.6	43.1	28.4	1750.30	1721.95	Shallow	UMCf	Recovery
I-I	8/4/10	828375.04	26719914.40	880.0	11.3	40.5	25.9	1742.30	1716.40	Shallow	Qal/xMCf/UMCf	Recovery
I-J	8/4/10	828573.94	26719940.33	250.0	11.2	40.5	25.9	1746.50	1720.65	Shallow	Qal/xMCf/UMCf	Recovery
I-K	8/4/10	828738.09	26719962.87	120.0	7.0	35.2	21.1	1750.08	1728.98	Shallow	UMCf	Recovery
I-L	5/3/10	827352.86	26719803.23	1300.0	9.0	39.0	24.0	1748.30	1724.30	Shallow	Qal/xMCf/UMCf	Recovery
I-M	5/3/10	827669.83	26719817.42	850.0	9.0	39.0	24.0	1749.20	1725.20	Shallow	Qal/xMCf/UMCf	Recovery
I-N	5/3/10	827802.25	26719837.85	2200.0	7.0	37.0	22.0	1747.80	1725.80	Shallow	Qal/xMCf/UMCf	Recovery
I-O	5/3/10	828263.13	26719898.00	1900.0	9.0	39.0	24.0	1749.00	1725.00	Shallow	Qal/xMCf/UMCf	Recovery
I-P	5/3/10	828221.66	26719892.08	1700.0	14.0	44.0	29.0	1749.20	1720.20	Shallow	Qal/xMCf/UMCf	Recovery
I-Q	5/3/10	827952.15	26719855.17	1600.0	9.6	39.6	24.6	1749.40	1724.80	Shallow	Qal/xMCf/UMCf	Recovery
I-R	5/3/10	827316.06	26719801.85	2300.0	9.8	39.8	24.8	1749.06	1724.26	Shallow	Qal/xMCf/UMCf	Recovery
I-S	5/3/10	827404.20	26719799.87	810.0	12.0	42.0	27.0	1747.57	1720.57	Shallow	Qal/xMCf/UMCf	Recovery
I-T	5/3/10	828073.50	26719873.66	2000.0	12.0	42.0	27.0	1749.03	1722.03	Shallow	Qal/xMCf/UMCf	Recovery
I-U	5/3/10	828118.60	26719879.67	1200.0	12.0	42.0	27.0	1749.54	1722.54	Shallow	Qal/xMCf/UMCf	Recovery
I-V	8/4/10	828326.28	26719894.97	1600.0	12.0	42.0	27.0	1749.46	1722.46	Shallow	Qal/xMCf/UMCf	Recovery

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
I-Z	8/4/10	828467.92	26719923.37	410.0	15.0	35.0	25.0	1742.19	1717.19	Shallow		Monitoring
J	10/24/08	824858.75	26721983.00	0.0	32.0	37.0	34.5	1715.80	1681.30	Shallow	Qal	Recovery
J2D1-R2	1/22/09	829782.80	26719355.60	2.3	19.0	44.0	31.5	1768.00	1736.50	Shallow	Qal	Monitoring
J2D2-R2	1/19/09	829944.60	26719411.80	0.8	23.5	48.5	36.0	1767.00	1731.00	Shallow		Monitoring
J2D3	1/27/09	830031.73	26719368.62	1.4	34.0	39.0	36.5	1764.00	1727.50	Shallow		Monitoring
J2D4	4/22/09	829572.60	26719151.60	3.4	15.0	45.0	30.0	1770.00	1740.00	Shallow	Qal	Monitoring
J2U2	4/22/09	830112.30	26718472.90	0.7	33.5	68.5	51.0	1800.00	1749.00	Shallow	Qal	Monitoring
K2	10/24/08	825712.26	26721397.17	0.0	25.8	44.8	35.3	1723.50	1688.25	Shallow	Qal	Extraction
L	10/24/08	825323.49	26721664.22	0.1	40.0	45.0	42.5	1720.00	1677.50	Shallow	Qal	Extraction
L637	2/12/09	828110.00	26727839.47	0.0	14.0	29.0	21.5	1621.85	1600.35	Shallow	Qal	Monitoring
M-10	5/5/10	828536.18	26716636.63	19.0	43.0	63.0	53.0	1834.11	1781.11	Shallow	Qal/xMCf/UMCf	Monitoring
M-100	5/6/10	827659.99	26720820.26	23.0	19.0	29.0	24.0	1728.63	1704.63	Shallow	Qal	Monitoring
M-102	6/25/08	828437.98	26720705.96	173.0	19.4	39.4	29.4	1738.18	1708.78	Shallow	Qal	Monitoring
M-103	7/8/09	828728.34	26715622.48	0.3	69.5	89.5	79.5	1864.53	1785.03	Shallow	UMCf	Monitoring
M-11	7/27/10	828617.03	26717608.56	32.5	33.3	53.0	43.2	1813.45	1770.30	Shallow	Qal/xMCf/UMCf	Monitoring
M-110	7/1/09	827431.42	26719319.32	1350.0	30.0	40.0	35.0	1760.78	1725.78	Shallow	Qal/xMCf/UMCf	Monitoring
M-111A	5/12/10	827447.19	26719134.86	550.0	29.7	39.7	34.7	1766.25	1731.55	Shallow	UMCf	Monitoring
M-115	8/3/10	827243.65	26718612.90	14.0	35.0	45.0	40.0	1787.64	1747.64	Shallow	Qal/xMCf/UMCf	Monitoring
M-117	7/6/09	828917.06	26715198.29	0.0	130.0	150.0	140.0	1877.98	1737.98	Middle	UMCf	Monitoring
M-118	7/9/09	828036.40	26715068.01	0.0	138.0	158.0	148.0	1874.53	1726.53	Middle	UMCf	Monitoring
M-120	7/27/10	828387.79	26715162.90	0.5	80.0	100.0	90.0	1875.81	1785.81	Middle	UMCf	Monitoring
M-121	7/10/09	827694.57	26715011.24	1.9	77.0	97.0	87.0	1872.90	1785.90	Shallow	UMCf	Monitoring
M-123	5/12/10	826516.40	26718416.92	0.1	36.0	51.0	43.5	1782.26	1738.76	Shallow		Monitoring
M-124	5/13/10	827092.23	26718226.14	2.2	34.0	49.0	41.5	1784.84	1743.34	Shallow		Monitoring
M-125	5/13/10	826531.82	26718993.90	0.6	35.0	50.0	42.5	1768.51	1726.01	Shallow		Monitoring
M-126	5/12/10	826569.37	26719505.57	0.0	19.7	39.7	29.7	1756.40	1726.70	Shallow		Monitoring
M-127	5/28/09	826225.22	26719386.79	0.0	35.0	50.0	42.5	1760.67	1718.17	Shallow		Monitoring
M-128	5/13/10	827171.63	26718501.70	10.0	40.0	55.0	47.5	1780.94	1733.44	Shallow		Unknown
M-12A	7/28/10	828178.52	26717575.29	323.0	40.0	50.0	45.0	1812.72	1767.72	Shallow	UMCf	Monitoring
M-13	5/5/10	827806.03	26717477.66	22.0	28.0	48.0	38.0	1813.49	1775.49	Shallow	UMCf	Monitoring
M-130	6/15/09	828832.01	26719919.70	52.4	20.0	40.0	30.0	1746.55	1716.55	Shallow	Qal/UMCf	Monitoring
M-131	5/4/10	827158.08	26719770.57	63.0	28.7	38.7	33.7	1751.05	1717.35	Shallow	UMCf	Monitoring
M-132	5/13/10	828714.61	26720048.49	6.0	79.7	89.7	84.7	1741.41	1656.71	Shallow	UMCf	Monitoring
M-133	5/13/10	828698.61	26720067.29	16.0	59.7	69.7	64.7	1740.93	1676.23	Shallow	UMCf	Monitoring
M-134	5/12/10	827144.35	26719889.14	120.0	59.7	69.7	64.7	1749.39	1684.69	Shallow	UMCf	Monitoring
M-135	5/4/10	827154.48	26719890.17	59.0	28.7	38.7	33.7	1749.17	1715.47	Shallow	UMCf	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
M-136	5/12/10	827165.34	26719889.77	140.0	79.7	89.7	84.7	1749.09	1664.39	Shallow	UMCf	Monitoring
M-137	5/12/10	827666.01	26716034.02	1.9	52.0	72.0	62.0	1845.02	1783.02	Shallow	UMCf	Monitoring
M-138	5/12/10	827816.34	26716058.31	2.7	50.5	65.5	58.0	1844.06	1786.06	Shallow	UMCf	Monitoring
M-139	5/13/10	829044.25	26717213.06	2.0	45.0	60.0	52.5	1813.71	1761.21	Shallow	UMCf	Monitoring
M-140	9/11/10	827428.84	26719889.51	380.0	23.0	43.0	33.0	1745.67	1712.67	Shallow	Qal/UMCf	Recovery
M-141	5/13/10	828465.43	26718195.34	770.0	37.5	47.5	42.5	1797.52	1755.02	Shallow	UMCf	Monitoring
M-142	5/13/10	827191.75	26718713.09	22.0	30.0	45.0	37.5	1774.04	1736.54	Shallow		Monitoring
M-144	5/13/10	827644.50	26717026.00	3.6	35.0	45.0	40.0	1813.20	1773.20	Shallow	UMCf	Monitoring
M-145	10/26/09	829205.27	26717451.15	0.5	45.0	60.0	52.5	1812.70	1760.20	Shallow	UMCf	Monitoring
M-146	5/13/10	827774.94	26716991.91	3.8	40.0	50.0	45.0	1812.97	1767.97	Shallow	UMCf	Monitoring
M-147	5/13/10	828824.17	26718857.89	6.3	25.0	40.0	32.5	1778.57	1746.07	Shallow	UMCf	Monitoring
M-148	5/13/10	828951.29	26718469.21	2.6	35.0	50.0	42.5	1797.86	1755.36	Shallow	UMCf	Monitoring
M-148A	9/15/10	829030.35	26718357.14	3.9	40.0	50.0	45.0	1797.74	1752.74	Shallow	Qal/UMCf	Monitoring
M-149	11/4/09	828373.15	26718285.78	413.0	100.0	120.0	110.0	1797.14	1687.14	Middle	UMCf	Monitoring
M-14A	8/3/10	827045.36	26719382.67	32.0	20.0	40.0	30.0	1758.38	1728.38	Shallow	UMCf	Monitoring
M-150	11/6/09	828059.15	26719569.83	15.0	125.0	145.0	135.0	1756.50	1621.50	Middle	UMCf	Monitoring
M-151	11/12/09	827643.03	26720826.75	0.0	125.0	145.0	135.0	1728.31	1593.31	Middle	UMCf	Monitoring
M-152	11/9/09	826973.49	26722690.63	3.1	125.0	145.0	135.0	1695.79	1560.79	Middle	UMCf	Monitoring
M-153	11/5/09	828385.61	26718287.91	0.3	150.0	170.0	160.0	1797.15	1637.15	Middle	UMCf	Monitoring
M-154	11/6/09	828047.74	26719568.61	0.1	175.0	195.0	185.0	1756.51	1571.51	Middle	UMCf	Monitoring
M-155	11/13/09	827636.10	26720827.40	0.0	200.0	220.0	210.0	1728.30	1518.30	Middle	UMCf	Monitoring
M-156	11/11/09	826964.22	26722690.74	0.1	175.0	195.0	185.0	1695.84	1510.84	Middle	UMCf	Monitoring
M-159	9/9/10	826758.00	26719824.06	4.5	65.0	75.0	70.0	1752.41	1682.41	Shallow	UMCf	Monitoring
M-160	9/9/10	826769.05	26719826.22	9.1	40.0	50.0	45.0	1752.14	1707.14	Shallow	UMCf	Monitoring
M-161	9/11/10	827134.13	26719889.85	0.3	100.0	110.0	105.0	1749.95	1644.95	Middle	UMCf	Monitoring
M-163	9/11/10	827873.42	26719939.04	0.7	80.0	90.0	85.0	1745.63	1660.63	Shallow	UMCf	Monitoring
M-164	9/11/10	827870.17	26719949.61	260.0	60.0	70.0	65.0	1745.19	1680.19	Shallow	UMCf	Monitoring
M-165	9/15/10	828701.37	26720053.24	0.7	110.0	120.0	115.0	1741.25	1626.25	Middle	UMCf	Monitoring
M-171	9/11/10	827718.15	26719905.85	240.0	24.7	44.7	34.7	1746.87	1712.17	Shallow	Qal/UMCf	Recovery
M-178	9/11/10	828012.64	26719955.96	1500.0	26.0	46.0	36.0	1747.10	1711.10	Shallow	Qal/UMCf	Recovery
M-179	9/11/10	828317.19	26720002.95	16.0	33.0	53.0	43.0	1747.28	1704.28	Shallow	Qal/UMCf	Recovery
M-17A	8/3/10	828061.72	26719053.74	810.0	35.0	45.0	40.0	1768.95	1728.95	Shallow	Qal/xMCf/UMCf	Monitoring
M-180	9/15/10	828806.85	26719785.94	48.0	24.0	39.0	31.5	1753.23	1721.73	Shallow	Qal/UMCf	Monitoring
M-181	9/8/10	828816.30	26719579.72	0.0	105.0	115.0	110.0	1759.26	1649.26	Middle	UMCf	Monitoring
M-182	9/7/10	828815.50	26719588.73	6.5	80.0	90.0	85.0	1759.40	1674.40	Shallow	UMCf	Monitoring
M-186	9/9/10	829022.55	26718356.19	330.0	105.0	115.0	110.0	1797.99	1687.99	Middle	UMCf	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
M-187	9/11/10	827375.01	26718180.84	0.1	160.0	170.0	165.0	1797.33	1632.33	Middle	UMCf	Monitoring
M-188	9/11/10	827377.14	26718171.32	0.5	110.0	120.0	115.0	1797.38	1682.38	Middle	UMCf	Monitoring
M-19	8/4/10	828846.19	26719350.03	1.6	14.5	34.5	24.5	1764.41	1739.91	Shallow	UMCf	Monitoring
M2	10/24/08	825769.77	26721359.10	0.1	24.0	44.0	34.0	1723.58	1689.58	Shallow	Qal	Extraction
M-21	5/5/10	827792.86	26718359.30	25.0	18.0	38.0	28.0	1790.37	1762.37	Shallow	UMCf	Monitoring
M-22A	5/6/10	828270.11	26719531.63	1800.0	16.0	36.0	26.0	1758.90	1732.90	Shallow	Qal/xMCf/UMCf	Monitoring
M-23	5/3/10	827373.96	26721391.25	370.0	9.4	37.4	23.4	1717.54	1694.14	Shallow	Qal	Monitoring
M-25	8/3/10	827677.80	26719503.57	960.0	24.0	39.0	31.5	1756.89	1725.39	Shallow	Qal/xMCf/UMCf	Monitoring
M-29	5/17/10	828999.00	26717598.00	4.0	22.0	42.0	32.0	1816.60	1784.60	Shallow	UMCf	Monitoring
M-2A	5/6/10	827984.75	26718769.56	570.0	30.0	40.0	35.0	1780.23	1745.23	Shallow	Qal	Monitoring
M-31A	5/5/10	828368.37	26718289.58	1300.0	35.0	55.0	45.0	1796.94	1751.94	Shallow	UMCf	Monitoring
M-33	5/5/10	828784.12	26718382.73	200.0	30.0	45.0	37.5	1797.03	1759.53	Shallow	UMCf	Monitoring
M-34	8/3/10	828318.25	26718833.45	1000.0	25.0	40.0	32.5	1774.04	1741.54	Shallow	Qal/xMCf/UMCf	Monitoring
M-35	8/3/10	828509.37	26718840.13	190.0	25.0	40.0	32.5	1773.05	1740.55	Shallow	UMCf	Monitoring
M-36	5/6/10	828069.09	26719556.63	1500.0	20.0	35.0	27.5	1756.89	1729.39	Shallow	UMCf	Monitoring
M-37	5/4/10	827414.22	26719422.01	1900.0	20.0	35.0	27.5	1758.13	1730.63	Shallow	UMCf	Monitoring
M-38	5/6/10	827877.66	26719523.27	1400.0	20.0	35.0	27.5	1757.82	1730.32	Shallow	UMCf	Monitoring
M-39	8/4/10	828548.82	26719525.34	360.0	24.9	39.9	32.4	1758.61	1726.21	Shallow	Qal/xMCf/UMCf	Monitoring
M-44	5/3/10	827005.61	26722699.15	630.0	5.0	35.0	20.0	1695.74	1675.74	Shallow	Qal/xMCf/UMCf	Monitoring
M-48	2/2/09	828303.85	26721337.52	194.0	6.1	36.1	21.1	1718.43	1697.33	Shallow	Qal/xMCf/UMCf	Monitoring
M-50	5/5/10	828083.47	26718315.58	1400.0	39.6	59.6	49.6	1793.08	1743.48	Shallow	UMCf	Monitoring
M-52	5/5/10	828394.48	26717985.39	890.0	34.5	44.5	39.5	1799.34	1759.84	Shallow	UMCf	Monitoring
M-55	7/1/08	827683.04	26719819.36	610.0	14.6	44.6	29.6	1749.43	1719.83	Shallow	Qal/xMCf/UMCf	Monitoring
M-57A	5/4/10	826993.31	26719716.74	25.0	20.0	40.0	30.0	1751.23	1721.23	Shallow	UMCf	Monitoring
M-5A	5/4/10	826179.29	26719961.12	25.0	40.0	50.0	45.0	1749.69	1704.69	Shallow	UMCf	Monitoring
M-61	5/12/10	828673.67	26719955.76	140.0	9.3	38.8	24.1	1744.51	1720.46	Shallow	Qal/xMCf/UMCf	Monitoring
M-64	5/12/10	827601.30	26719748.40	770.0	12.7	37.3	25.0	1748.80	1723.80	Shallow	Qal/xMCf/UMCf	Monitoring
M-65	5/12/10	827899.72	26719746.36	1400.0	14.4	39.0	26.7	1751.84	1725.14	Shallow	Qal/xMCf/UMCf	Monitoring
M-66	5/12/10	828183.64	26719787.47	1600.0	17.5	42.3	29.9	1751.70	1721.80	Shallow	Qal/xMCf/UMCf	Monitoring
M-67	5/12/10	828508.52	26719829.72	390.0	7.8	37.8	22.8	1743.64	1720.84	Shallow	Qal/xMCf/UMCf	Monitoring
M-68	8/4/10	828751.00	26719864.47	82.0	11.2	39.8	25.5	1747.16	1721.66	Shallow	Qal/xMCf/UMCf	Monitoring
M-69	5/4/10	827265.73	26719885.28	1100.0	19.9	39.3	29.6	1747.80	1718.20	Shallow	Qal/xMCf/UMCf	Monitoring
M-6A	5/4/10	825984.54	26721013.69	20.0	26.8	41.5	34.2	1730.84	1696.69	Shallow	Qal/xMCf/UMCf	Monitoring
M-70	5/6/10	827567.35	26719904.69	27.0	15.3	40.0	27.7	1746.00	1718.35	Shallow	Qal/xMCf/UMCf	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
M-71	5/6/10	827859.71	26719943.63	430.0	17.5	42.0	29.8	1744.87	1715.12	Shallow	Qal/xMCf/UMCf	Monitoring
M-72	5/6/10	828172.13	26719977.14	1000.0	10.1	34.8	22.5	1744.62	1722.17	Shallow	Qal/xMCf/UMCf	Monitoring
M-73	8/4/10	828427.82	26720018.47	400.0	11.0	35.8	23.4	1738.87	1715.47	Shallow	Qal/xMCf/UMCf	Monitoring
M-74	8/4/10	828713.65	26720062.18	77.0	9.2	38.8	24.0	1742.51	1718.51	Shallow	UMCf	Monitoring
M-75	5/6/10	827718.82	26718702.64	69.0	34.6	49.3	42.0	1781.92	1739.97	Shallow	Qal/xMCf/UMCf	Monitoring
M-76	5/6/10	827550.73	26718659.92	140.0	34.6	49.3	42.0	1781.68	1739.73	Shallow	UMCf	Monitoring
M-77	5/5/10	828933.94	26718047.69	340.0	29.0	43.8	36.4	1798.09	1761.69	Shallow	Qal/xMCf/UMCf	Monitoring
M-78	6/17/09	827777.45	26719838.17	973.0	21.5	41.5	31.5	1749.54	1718.04	Shallow	Qal/xMCf/UMCf	Monitoring
M-79	5/4/10	827382.10	26720048.92	13.0	10.8	35.4	23.1	1742.57	1719.47	Shallow	Qal/xMCf/UMCf	Monitoring
M-7B	5/4/10	826106.50	26720979.66	54.0	25.5	50.5	38.0	1730.35	1692.35	Shallow	Qal/xMCf/UMCf	Monitoring
M-83	9/15/10	827586.44	26720161.50	0.1	10.8	40.3	25.6	1739.89	1714.34	Shallow	Qal/xMCf/UMCf	Monitoring
M-84	5/6/10	827766.70	26720189.13	1.0	11.8	34.1	23.0	1738.48	1715.53	Shallow	Qal/xMCf/UMCf	Monitoring
M-85	5/8/08	827962.63	26720219.88	19.7	10.4	35.0	22.7	1740.07	1717.37	Shallow	Qal/xMCf/UMCf	Monitoring
M-86	5/8/08	828141.82	26720238.99	649.0	11.3	40.9	26.1	1741.60	1715.50	Shallow	UMCf	Monitoring
M-87	9/15/10	828358.13	26720276.13	330.0	9.3	38.8	24.1	1741.51	1717.46	Shallow	UMCf	Monitoring
M-88	8/4/10	828588.75	26720313.96	43.0	7.3	36.8	22.1	1736.93	1714.88	Shallow	Qal/xMCf/UMCf	Monitoring
M-89	5/6/10	827890.08	26719294.84	1000.0	18.0	38.2	28.1	1763.69	1735.59	Shallow	Qal/xMCf/UMCf	Monitoring
M-92	8/3/10	827138.09	26717531.94	1.1	34.9	44.9	39.9	1797.99	1758.09	Shallow	UMCf	Monitoring
M-94	6/23/08	827222.85	26722695.81	892.0	12.0	22.0	17.0	1695.27	1678.27	Shallow	Qal	Monitoring
M-95	5/3/10	827426.74	26722701.69	490.0	12.0	22.0	17.0	1694.52	1677.52	Shallow	Qal	Monitoring
M-96	5/3/10	827626.08	26722700.30	280.0	10.5	20.5	15.5	1693.80	1678.30	Shallow	Qal	Monitoring
M-97	8/3/10	827492.47	26717795.18	65.0	35.0	45.0	40.0	1798.35	1758.35	Shallow	UMCf	Monitoring
M-99	8/3/10	827309.69	26720851.72	930.0	16.0	31.0	23.5	1728.29	1704.79	Shallow	Qal	Monitoring
MC29	5/11/10	825566.39	26721514.56	0.4	37.5	50.0	43.8	1721.95	1678.20	Shallow	Qal/UMCf	Monitoring
MC45	5/11/10	825400.42	26722230.35	2.1	30.0	34.0	32.0	1707.86	1675.86	Shallow	Qal	Monitoring
MC50	5/11/10	825534.87	26722076.15	1.0	26.0	49.0	37.5	1711.99	1674.49	Shallow	UMCf	Monitoring
MC51	5/11/10	825647.67	26721900.05	1.4	23.0	44.0	33.5	1714.12	1680.62	Shallow	Qal	Monitoring
MC53	5/11/10	825942.24	26721920.01	2.8	19.0	38.0	28.5	1713.34	1684.84	Shallow	Qal/UMCf	Monitoring
MC62	6/23/08	825880.75	26722727.62	0.0	25.0	50.0	37.5	1699.00	1661.50	Shallow	Qal/UMCf	Monitoring
MC65	5/11/10	826119.27	26722421.15	86.0	20.0	41.0	30.5	1703.62	1673.12	Shallow	Qal/UMCf	Monitoring
MC66	6/20/08	826221.37	26722558.03	406.0	27.0	47.0	37.0	1700.80	1663.80	Shallow	Qal/UMCf	Monitoring
MC69	5/11/10	825235.63	26721806.92	2.3	29.0	44.0	36.5	1716.98	1680.48	Shallow	Qal/xMCf/UMCf	Monitoring
MC93	5/11/10	825948.78	26721673.15	11.0	32.0	42.0	37.0	1717.92	1680.92	Shallow	Qal/UMCf	Monitoring
MC94	10/7/09	825912.02	26721595.27	4.9	30.0	40.0	35.0	1718.86	1683.86	Shallow	Qal/UMCf	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
MC97	5/11/10	825838.35	26721425.66	1.8	31.0	41.0	36.0	1723.10	1687.10	Shallow	Qal/UMCf	Monitoring
MCF-01A	8/10/09	830905.30	26720244.86	0.0	335.0	355.0	345.0	1754.44	1409.44	Deep	UMCf	Monitoring
MCF-01B	8/7/09	830888.59	26720256.83	0.7	55.0	85.0	70.0	1753.95	1683.95	Shallow	UMCf	Monitoring
MCF-02A	8/21/09	833801.41	26718435.24	0.0	360.0	380.0	370.0	1816.44	1446.44	Deep	UMCf	Monitoring
MCF-02B	8/21/09	833785.68	26718432.16	0.0	215.0	235.0	225.0	1816.36	1591.36	Middle	UMCf	Monitoring
MCF-03A	8/13/09	836835.26	26721058.78	0.0	364.0	384.0	374.0	1783.23	1409.23	Deep	UMCf	Monitoring
MCF-03B	8/17/09	836813.17	26721066.60	0.1	57.0	77.0	67.0	1783.46	1716.46	Shallow	UMCf	Monitoring
MCF-04	8/28/09	837630.23	26723668.56	0.0	379.0	399.0	389.0	1748.35	1359.35	Deep	UMCf	Monitoring
MCF-05	8/28/09	832871.21	26728512.84	0.0	221.0	231.0	226.0	1625.03	1399.03	Middle	UMCf	Monitoring
MCF-06A-R	9/21/09	834815.16	26728802.22	0.0	333.0	373.0	353.0	1630.32	1277.32	Deep	UMCf	Monitoring
MCF-06B	8/28/09	834930.92	26729012.42	4.6	67.0	82.0	74.5	1630.40	1555.90	Shallow	UMCf	Monitoring
MCF-06C	9/9/09	834945.84	26729004.59	4.3	44.0	59.0	51.5	1630.42	1578.92	Shallow	Qal	Monitoring
MCF-07	9/11/09	837113.60	26729569.85	0.1	350.0	370.0	360.0	1576.33	1216.33	Deep	UMCf	Monitoring
MCF-08A	8/31/09	827753.96	26733221.86	0.0	350.0	370.0	360.0	1579.02	1219.02	Deep	UMCf	Monitoring
MCF-08B	7/23/08	827771.70	26733214.25	0.0	107.5	137.5	122.5	1578.43	1455.93	Middle	UMCf	Monitoring
MCF-08B-R	8/21/09	828022.76	26732923.83	0.0	96.5	136.5	116.5	1577.82	1461.32	Middle	UMCf	Monitoring
MCF-09A	8/17/09	831024.27	26723427.11	0.0	270.0	290.0	280.0	1694.26	1414.26	Middle	UMCf	Monitoring
MCF-09B	8/17/09	831019.19	26723449.62	0.0	105.0	125.0	115.0	1693.00	1578.00	Middle	UMCf	Monitoring
MCF-10A	8/31/09	825973.72	26730015.36	0.0	365.0	385.0	375.0	1613.32	1238.32	Deep	UMCf	Monitoring
MCF-10B	8/18/09	825951.40	26730022.81	0.0	84.0	104.0	94.0	1612.38	1518.38	Middle	UMCf	Monitoring
MCF-11	8/17/09	830656.16	26725461.46	0.0	93.5	103.5	98.5	1657.75	1559.25	Middle	UMCf	Monitoring
MCF-12A	8/27/09	840058.76	26727429.27	0.0	349.5	369.5	359.5	1713.68	1354.18	Deep	UMCf	Monitoring
MCF-12B	5/8/08	840046.01	26727441.77	4.1	64.0	84.0	74.0	1712.74	1638.74	Shallow	Qal	Monitoring
MCF-12C	8/19/09	840042.06	26727428.91	0.5	155.0	175.0	165.0	1713.03	1548.03	Middle	UMCf	Monitoring
MCF-16A	10/5/09	835886.90	26726023.31	0.0	364.5	384.5	374.5	1689.67	1315.17	Deep	UMCf	Monitoring
MCF-16B	9/30/09	835867.57	26726026.53	0.0	283.7	313.7	298.7	1689.75	1391.05	Middle	UMCf	Monitoring
MCF-16C	9/30/09	835846.38	26726030.18	11.0	53.0	73.0	63.0	1689.88	1626.88	Shallow	Qal	Monitoring
MCF-17A	9/29/09	825846.55	26732627.07	0.0	347.0	387.0	367.0	1597.65	1230.65	Deep	UMCf	Monitoring
MCF-18A	9/21/09	831913.55	26731555.46	0.0	360.0	400.0	380.0	1574.16	1194.16	Deep	UMCf	Monitoring
MCF-19A	9/3/09	830660.58	26728076.82	0.0	320.0	360.0	340.0	1625.00	1285.00	Deep	UMCf	Monitoring
MCF-20A	9/3/09	833117.06	26728934.11	0.0	340.0	380.0	360.0	1623.53	1263.53	Deep	UMCf	Monitoring
MCF-21A	8/25/09	838079.48	26727846.01	0.0	330.0	370.0	350.0	1663.63	1313.63	Deep	UMCf	Monitoring
MCF-22A	10/9/09	840882.17	26728719.79	0.0	341.5	381.5	361.5	1680.62	1319.12	Deep	UMCf	Monitoring
MCF-23A	10/5/09	830726.53	26726048.99	0.0	342.0	382.0	362.0	1650.00	1288.00	Deep	UMCf	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
MCF-24A	8/28/09	833661.11	26725570.88	0.0	335.0	375.0	355.0	1674.07	1319.07	Deep	UMCf	Monitoring
MCF-25A	8/28/09	830660.58	26722042.79	0.0	325.0	365.0	345.0	1730.00	1385.00	Deep	UMCf	Monitoring
MCF-27	9/14/09	832488.11	26719293.06	0.0	361.5	381.5	371.5	1787.03	1415.53	Deep	UMCf	Monitoring
MCF-28A	9/29/09	830679.60	26732313.65	0.0	370.0	390.0	380.0	1564.73	1184.73	Deep	UMCf	Monitoring
MCF-28B	10/1/09	830661.57	26732313.02	0.0	168.0	188.0	178.0	1565.24	1387.24	Middle	UMCf	Monitoring
MCF-29A	9/29/09	833957.87	26733436.56	0.0	359.5	379.5	369.5	1543.48	1173.98	Deep	UMCf	Monitoring
MCF-29B	10/9/09	833954.70	26733444.92	0.0	155.0	175.0	165.0	1543.52	1378.52	Middle	UMCf	Monitoring
MCF-30A	10/5/09	836135.15	26733724.11	0.0	350.0	370.0	360.0	1527.60	1167.60	Deep	UMCf	Monitoring
MCF-30B	10/5/09	836130.63	26733707.02	0.0	144.0	164.0	154.0	1528.84	1374.84	Middle	UMCf	Monitoring
MCF-31A	9/29/09	838327.15	26733550.26	0.0	361.0	381.0	371.0	1523.82	1152.82	Deep	UMCf	Monitoring
MCF-31B	10/9/09	838313.96	26733552.24	0.0	210.0	230.0	220.0	1523.95	1303.95	Middle	UMCf	Monitoring
MCF-32B	10/2/09	835753.14	26724074.91	0.0	140.0	160.0	150.0	1728.31	1578.31	Middle	UMCf	Monitoring
MCF-BW-11A	10/13/09	824044.54	26718693.95	0.0	57.0	72.0	64.5	1776.18	1711.68	Shallow	UMCf	Monitoring
MC-MW-09	11/12/09	825794.59	26716752.37	0.0	90.0	120.0	105.0	1812.62	1707.62	Middle	UMCf	Monitoring
MC-MW-10	11/13/09	825523.88	26717919.06	0.0	85.0	115.0	100.0	1801.21	1701.21	Middle	UMCf	Monitoring
MC-MW-11	11/12/09	824860.15	26717766.00	0.0	100.0	120.0	110.0	1801.94	1691.94	Middle	UMCf	Monitoring
MC-MW-12	11/17/09	826293.89	26717903.04	0.0	100.0	120.0	110.0	1797.38	1687.38	Middle	UMCf	Monitoring
MC-MW-17	11/16/09	826576.82	26717707.84	0.4	70.5	90.5	80.5	1797.67	1717.17	Shallow	UMCf	Monitoring
MC-MW-18	11/17/09	826495.85	26718439.15	0.0	96.5	116.5	106.5	1784.50	1678.00	Middle	UMCf	Monitoring
MW-08	11/18/09	841021.90	26734440.76	0.0	56.0	71.0	63.5	1581.02	1517.52	Shallow	UMCf	Monitoring
MW-13	9/2/09	838307.02	26734741.23	2.2	38.0	48.0	43.0	1528.36	1485.36	Shallow	Qal	Monitoring
MW-16	5/12/10	826447.64	26719904.41	0.2	24.7	39.7	32.2	1751.99	1719.79	Shallow	UMCf	Monitoring
MW-K4	9/16/10	828994.00	26728410.00	250.0	9.5	50.0	29.8	1615.70	1585.95	Shallow	xMCf	Monitoring
MW-K5	9/16/10	829617.00	26730252.00	2.4	28.5	44.0	36.3	1589.30	1553.05	Shallow	xMCf/UMCf	Monitoring
PC-1	5/8/08	830925.11	26730308.65	12.1	14.7	29.7	22.2	1596.68	1574.48	Shallow		Monitoring
PC-101R	9/15/10	828711.72	26728107.74	170.0	20.0	50.0	35.0	1618.12	1583.12	Shallow	Qal	Monitoring
PC-103	9/16/10	829110.87	26730205.73	13.0	9.0	29.0	19.0	1597.02	1578.02	Shallow	Qal	Monitoring
PC-104	5/8/09	829277.08	26731049.70	2.4	10.0	35.0	22.5	1596.68	1574.18	Shallow	Qal	Monitoring
PC-108	5/10/10	828526.96	26731913.05	0.0	9.7	44.7	27.2	1584.96	1557.76	Shallow	Qal	Monitoring
PC-112	5/10/10	828898.31	26732800.69	0.0	7.0	47.0	27.0	1575.24	1548.24	Shallow	Qal	Monitoring
PC-115R	9/8/10	831148.64	26733131.33	11.0	10.0	50.0	30.0	1554.79	1524.79	Shallow	Qal	Recovery
PC-116R	9/8/10	831348.43	26733203.15	9.9	10.0	50.0	30.0	1552.04	1522.04	Shallow	Qal	Recovery
PC-117	9/8/10	831422.37	26733275.94	4.5	11.0	51.0	31.0	1551.23	1520.23	Shallow	Qal	Recovery
PC-118	9/8/10	831051.99	26733167.39	5.0	9.0	49.0	29.0	1553.65	1524.65	Shallow	Qal	Recovery
PC-119	9/8/10	830951.29	26733188.50	1.0	15.0	45.0	30.0	1554.34	1524.34	Shallow	Qal	Recovery
PC-120	9/8/10	830851.47	26733185.77	0.8	15.0	45.0	30.0	1554.41	1524.41	Shallow	Qal	Recovery
PC-121	9/8/10	830751.31	26733180.39	1.4	6.5	36.5	21.5	1554.70	1533.20	Shallow	Qal	Recovery

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
PC-122	9/16/10	829675.17	26728145.17	15.0	22.5	37.5	30.0	1617.55	1587.55	Shallow	Qal	Monitoring
PC-123	5/3/10	829485.04	26727358.44	380.0	20.0	35.0	27.5	1626.70	1599.20	Shallow	Qal/xMCf/UMCf	Monitoring
PC-124	5/3/10	830132.95	26726741.58	6.3	20.3	35.3	27.8	1636.30	1608.50	Shallow	Qal/xMCf/UMCf	Monitoring
PC-125	5/3/10	829925.95	26726739.82	2.2	18.7	33.7	26.2	1632.41	1606.21	Shallow	Qal/xMCf/UMCf	Monitoring
PC-126	5/3/10	829724.72	26726737.84	16.0	19.5	34.5	27.0	1634.66	1607.66	Shallow	Qal	Monitoring
PC-127	5/3/10	829316.65	26726735.62	420.0	15.0	35.0	25.0	1632.92	1607.92	Shallow	Qal/xMCf/UMCf	Monitoring
PC-128	5/3/10	828953.97	26726732.39	260.0	14.8	34.8	24.8	1633.62	1608.82	Shallow	Qal/xMCf/UMCf	Monitoring
PC-129	5/3/10	828747.28	26726730.81	480.0	12.8	37.8	25.3	1634.36	1609.06	Shallow	Qal	Monitoring
PC-130	5/3/10	828538.19	26726729.31	530.0	14.8	49.8	32.3	1633.50	1601.20	Shallow	Qal/xMCf/UMCf	Monitoring
PC-131	5/3/10	828123.28	26726725.41	6.8	9.8	39.8	24.8	1634.28	1609.48	Shallow	Qal/xMCf/UMCf	Monitoring
PC-132	5/3/10	827913.94	26726723.10	2.2	9.8	39.8	24.8	1635.21	1610.41	Shallow	Qal/xMCf/UMCf	Monitoring
PC-133	9/8/10	831758.00	26733209.00	4.0	5.0	40.0	22.5	1551.84	1529.34	Shallow	Qal/xMCf/UMCf	Recovery
PC-134	8/13/08	828776.17	26728126.42	0.0	59.7	69.7	64.7	1617.43	1552.73	Shallow	UMCf	Monitoring
PC-134A	9/13/10	828775.80	26728143.15	0.2	59.7	69.7	64.7	1618.84	1554.14	Shallow	UMCf	Monitoring
PC-135	8/13/08	828765.25	26728123.18	9.6	19.7	49.7	34.7	1617.52	1582.82	Shallow	Qal	Monitoring
PC-135A	9/14/10	828767.49	26728143.03	12.0	30.7	50.7	40.7	1618.77	1578.07	Shallow	Qal	Monitoring
PC-136	5/14/08	829517.91	26728191.38	169.0	20.7	40.7	30.7	1618.78	1588.08	Shallow	Qal	Monitoring
PC-137	5/11/08	829517.61	26728199.10	0.1	63.7	73.7	68.7	1618.77	1550.07	Shallow	UMCf	Monitoring
PC-141	9/14/10	828446.31	26728106.63	11.0	44.7	54.7	49.7	1617.12	1567.42	Shallow	Qal	Monitoring
PC-142	9/14/10	828436.04	26728106.76	5.5	21.7	31.7	26.7	1617.14	1590.44	Shallow	Qal	Monitoring
PC-143	9/14/10	828698.71	26728238.64	1.6	29.7	64.7	47.2	1619.25	1572.05	Shallow	Qal	Monitoring
PC-144	9/14/10	828903.75	26728223.86	320.0	29.7	39.7	34.7	1618.93	1584.23	Shallow	Qal	Monitoring
PC-145	9/13/10	829536.07	26728324.97	29.0	24.7	39.7	32.2	1618.10	1585.90	Shallow	Qal	Monitoring
PC-148	9/14/10	829249.33	26728124.42	34.0	24.5	44.5	34.5	1617.79	1583.29	Shallow	Qal	Monitoring
PC-149	9/14/10	829117.97	26728122.90	15.0	24.5	44.5	34.5	1618.93	1584.43	Shallow	Qal	Monitoring
PC-150	9/13/10	828915.29	26728104.18	210.0	19.5	39.5	29.5	1618.36	1588.86	Shallow	Qal	Monitoring
PC-17	1/13/09	828732.63	26728089.23	183.0	10.5	50.5	30.5	1617.89	1587.39	Shallow	Qal	Monitoring
PC-18	9/15/10	828636.25	26728079.97	190.0	11.5	51.5	31.5	1618.55	1587.05	Shallow	Qal	Monitoring
PC-2	5/11/10	830443.45	26730209.58	4.1	14.0	29.0	21.5	1593.79	1572.29	Shallow	Qal	Monitoring
PC-21A	5/17/10	829269.53	26721332.72	3.3	14.0	34.0	24.0	1722.20	1698.20	Shallow	Qal/xMCf/UMCf	Monitoring
PC-24	5/10/10	829524.18	26726729.82	24.0	15.0	30.0	22.5	1633.95	1611.45	Shallow	Qal	Monitoring
PC-28	5/10/08	828530.65	26725375.67	509.0	10.0	19.5	14.8	1651.17	1636.42	Shallow	Qal	Monitoring
PC-31	5/10/10	826781.65	26725195.83	7.4	14.5	49.5	32.0	1658.13	1626.13	Shallow	Qal	Monitoring
PC-37	5/3/10	826612.10	26722172.24	370.0	16.8	41.8	29.3	1706.64	1677.34	Shallow	Qal	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
PC-4	5/11/10	831171.80	26730353.42	8.2	17.7	42.7	30.2	1597.13	1566.93	Shallow	Qal	Monitoring
PC-40	5/10/10	826476.78	26723971.04	4.5	15.0	55.0	35.0	1677.05	1642.05	Shallow	Qal	Monitoring
PC-50	5/10/10	828326.94	26726722.30	200.0	11.8	41.8	26.8	1633.49	1606.69	Shallow	Qal/xMCf/UMCf	Monitoring
PC-53	6/16/10	829941.58	26730225.29	3.1	13.0	32.5	22.8	1593.14	1570.39	Shallow	Qal	Monitoring
PC-54	5/3/10	828296.34	26722067.79	250.0	9.5	34.5	22.0	1704.40	1682.40	Shallow	Qal	Monitoring
PC-55	9/15/10	828530.49	26728056.66	0.7	4.0	54.0	29.0	1617.39	1588.39	Shallow	Qal/xMCf/UMCf	Monitoring
PC-56	8/9/10	830645.29	26732289.43	5.6	4.8	54.8	29.8	1568.99	1539.19	Shallow	Qal/xMCf/UMCf	Monitoring
PC-58	9/13/10	831123.78	26732118.20	6.3	7.8	32.8	20.3	1568.24	1547.94	Shallow	Qal	Monitoring
PC-59	9/14/10	830150.30	26732452.69	6.6	4.8	34.8	19.8	1568.34	1548.54	Shallow	Qal/xMCf/UMCf	Monitoring
PC-60	9/13/10	830405.14	26732358.75	6.4	4.5	39.5	22.0	1568.80	1546.80	Shallow	Qal	Monitoring
PC-62	9/14/10	829764.28	26732733.52	2.0	7.6	37.6	22.6	1568.45	1545.85	Shallow	Qal/xMCf/UMCf	Monitoring
PC-64	5/10/10	827916.52	26723702.44	540.0	4.0	19.0	11.5	1675.51	1664.01	Shallow	Qal	Monitoring
PC-65	5/10/10	828386.90	26723682.74	310.0	4.1	18.7	11.4	1676.07	1664.67	Shallow	Qal	Monitoring
PC-66	5/10/10	828779.40	26723966.95	380.0	6.9	26.9	16.9	1674.05	1657.15	Shallow		Monitoring
PC-67	5/10/10	829207.80	26723846.87	72.0	11.0	35.6	23.3	1674.38	1651.08	Shallow	Qal	Monitoring
PC-68	6/15/10	829616.96	26732906.82	0.0	9.9	54.9	32.4	1567.66	1535.26	Shallow	Qal/xMCf/UMCf	Monitoring
PC-71	5/3/10	826805.90	26722687.72	520.0	13.4	28.4	20.9	1696.11	1675.21	Shallow	Qal/xMCf/UMCf	Monitoring
PC-72	5/3/10	826604.72	26722688.82	270.0	15.0	35.0	25.0	1696.89	1671.89	Shallow	Qal	Monitoring
PC-73	5/3/10	826404.90	26722694.93	360.0	20.0	45.0	32.5	1697.56	1665.06	Shallow	Qal	Monitoring
PC-74	5/10/10	829203.52	26734003.52	2.1	39.5	49.5	44.5	1564.54	1520.04	Shallow	Qal	Monitoring
PC-76	5/14/08	829183.79	26734006.74	0.0	15.0	20.0	17.5	1564.51	1547.01	Shallow	Qal	Monitoring
PC-77	5/10/10	829031.63	26733568.07	2.2	29.5	39.5	34.5	1566.63	1532.13	Shallow	Qal	Monitoring
PC-79	5/10/10	829815.15	26733246.70	5.3	34.5	44.5	39.5	1564.53	1525.03	Shallow	Qal	Monitoring
PC-80	4/29/08	829823.82	26733250.46	0.0	19.5	29.5	24.5	1564.49	1539.99	Shallow	Qal	Monitoring
PC-81	4/29/08	829833.40	26733254.77	0.0	9.5	14.5	12.0	1564.27	1552.27	Shallow	Qal	Monitoring
PC-82	5/10/10	830316.93	26733194.96	3.1	47.0	57.0	52.0	1559.40	1507.40	Shallow	Qal	Monitoring
PC-86	9/15/10	830826.99	26733185.76	1.2	17.5	27.5	22.5	1554.08	1531.58	Shallow	Qal	Monitoring
PC-88	12/16/09	831259.41	26733178.42	9.8	40.0	50.0	45.0	1550.91	1505.91	Shallow	Qal	Monitoring
PC-90	9/15/10	831271.92	26733192.63	6.1	4.5	14.5	9.5	1550.53	1541.03	Shallow	Qal	Monitoring
PC-91	9/15/10	831729.99	26733110.85	5.9	26.5	36.5	31.5	1552.42	1520.92	Shallow	Qal	Monitoring
PC-92	8/10/10	831749.30	26733109.85	4.5	11.5	21.5	16.5	1552.12	1535.62	Shallow	Qal	Monitoring
PC-93	12/16/09	832179.60	26733117.81	7.2	27.5	37.5	32.5	1548.86	1516.36	Shallow	Qal	Monitoring
PC-94	8/10/10	832189.05	26733122.48	6.0	9.5	19.5	14.5	1548.84	1534.34	Shallow	Qal	Monitoring
PC-96	5/10/10	830896.56	26733450.83	5.7	29.0	39.0	34.0	1552.69	1518.69	Shallow	Qal	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
PC-97	9/15/10	831565.69	26733441.54	4.2	23.0	33.0	28.0	1548.78	1520.78	Shallow	Qal	Monitoring
PC-98R	6/16/10	829522.58	26730260.53	22.0	20.0	35.0	27.5	1593.46	1565.96	Shallow	Qal	Monitoring
PC-99R2	9/8/10	831258.73	26733155.42	14.0	10.0	50.0	30.0	1552.18	1522.18	Shallow	Qal	Recovery
POD2-R	4/23/08	831955.50	26724825.40	3.7	45.0	65.0	55.0	1673.80	1618.80	Shallow	Qal	Monitoring
POD8	9/3/09	833586.10	26724789.80	0.3	42.5	72.5	57.5	1691.16	1633.66	Shallow	Qal	Monitoring
POU3	9/22/09	831329.98	26721664.71	27.0	35.0	65.0	50.0	1728.00	1678.00	Shallow	Qal	Monitoring
TIMETMW-4	1/26/09	830991.70	26718577.88	0.2	38.0	58.0	48.0	1798.34	1750.34	Shallow	Qal	Monitoring
TIMETMW-5	1/26/09	830319.58	26717935.92	0.4	40.0	60.0	50.0	1813.00	1763.00	Shallow	Qal	Monitoring
TIMETMW-6R	7/23/09	829221.18	26717836.95	1.7	39.7	59.7	49.7	1810.43	1760.76	Shallow	Qal	Monitoring
TMMW-101	2/5/09	829462.76	26715285.26	0.0	65.0	95.0	80.0	1880.61	1800.61	Shallow	Qal	Monitoring
TMMW-102	2/4/09	830371.18	26715433.08	1.6	47.0	87.0	67.0	1880.20	1813.20	Shallow	Qal/xMCf	Monitoring
TMMW-103	2/3/09	831325.82	26715583.05	0.1	57.0	87.0	72.0	1882.68	1810.68	Shallow	xMCf	Monitoring
TMMW-104	2/4/09	832104.88	26715722.71	0.0	57.0	87.0	72.0	1883.64	1811.64	Shallow	xMCf	Monitoring
TMPZ-105	4/16/08	828703.77	26720557.27	33.0	19.0	39.0	29.0	1738.63	1709.63	Shallow	Qal/xMCf	Monitoring
TMPZ-106	4/17/08	829102.42	26720359.15	3.3	19.0	39.0	29.0	1740.24	1711.24	Shallow	Qal	Monitoring
TMPZ-107	4/17/08	829386.70	26720209.59	3.6	19.0	39.0	29.0	1745.00	1716.00	Shallow	Qal/xMCf	Monitoring
TMPZ-108	4/21/08	829756.76	26720032.09	3.2	26.0	46.0	36.0	1750.00	1714.00	Shallow	Qal/xMCf	Monitoring
TMPZ-109	4/21/08	830082.66	26719874.25	1.0	26.0	46.0	36.0	1758.92	1722.92	Shallow	Qal/xMCf	Monitoring
TMPZ-110	4/17/08	830531.86	26719668.76	3.3	25.0	45.0	35.0	1764.76	1729.76	Shallow	Qal/xMCf	Monitoring
TMPZ-111	4/21/08	831186.73	26719015.17	0.3	37.0	57.0	47.0	1784.38	1737.38	Shallow	Qal	Monitoring
TMPZ-112	4/21/08	831559.74	26718652.39	0.2	37.0	57.0	47.0	1796.85	1749.85	Shallow	Qal	Monitoring
TR-1	11/20/09	826168.04	26719957.91	0.0	281.5	311.5	296.5	1749.41	1452.91	Middle	UMCf	Monitoring
TR-10	7/14/09	827562.53	26715739.77	1.9	80.0	100.0	90.0	1851.72	1761.72	Middle	UMCf	Monitoring
TR-11	11/18/09	825422.57	26721918.29	0.0	210.0	230.0	220.0	1714.80	1494.80	Middle	UMCf	Monitoring
TR-12	6/11/10	825286.37	26723271.82	0.0	272.0	292.0	282.0	1693.44	1411.44	Middle	UMCf	Monitoring
TR-2	5/29/09	826156.85	26719954.57	0.0	144.5	174.5	159.5	1749.45	1589.95	Middle	UMCf	Monitoring
TR-3	6/11/10	826342.89	26718941.61	0.0	219.5	249.5	234.5	1770.08	1535.58	Middle	UMCf	Monitoring
TR-4	6/2/09	826342.53	26718951.58	0.0	124.5	144.5	134.5	1770.04	1635.54	Middle	UMCf	Monitoring
TR-5	10/23/09	826595.86	26717592.13	0.0	221.0	251.0	236.0	1797.45	1561.45	Middle	UMCf	Monitoring
TR-6	7/17/09	826594.34	26717608.38	0.2	60.0	80.0	70.0	1797.53	1727.53	Shallow	UMCf	Monitoring
TR-7	11/20/09	826724.99	26716525.47	0.0	260.0	290.0	275.0	1826.56	1551.56	Middle	UMCf	Monitoring
TR-8	7/14/09	826722.81	26716512.15	0.1	63.0	93.0	78.0	1826.54	1748.54	Shallow	UMCf	Monitoring
TR-9	11/21/09	827560.22	26715752.71	0.0	230.0	250.0	240.0	1851.75	1611.75	Middle	UMCf	Monitoring
WMW5.58SD	9/9/09	835091.50	26734645.80	0.1	60.0	80.0	70.0	1525.00	1455.00	Shallow	UMCf	Monitoring

TABLE F-1
Perchlorate Data Used for 3-D Plume

Well Name	Sample Date	Easting (NAD83)	Northing (NAD83)	Result (ppm)	Screen Top (ft BGS)	Screen Bottom (ft BGS)	Screen Mid (ft BGS)	Surface Elevation (ft MSL)	Screen Mid Elevation (ft MSL)	WBZ	Lithology	Well Type
WMW5.58SI	9/3/09	835065.43	26734651.40	0.4	5.0	20.0	12.5	1525.00	1512.50	Shallow	UMCf	Monitoring
WMW5.58SS	9/3/09	835065.43	26734651.40	0.0	4.0	14.0	9.0	1525.00	1516.00	Shallow	Qal	Monitoring

APPENDIX G
RESPONSE TO NDEP COMMENTS ON HYDROGEOLOGIC MODEL INPUT MEMO

northgate

environmental management, inc.

From: Deni Chambers, CEM
Pascual Benito

Date: December 10, 2010

To: Shannon Harbour, NDEP

RE: Response to NDEP's November 30, 2010 Comments on *Technical Memorandum: Hydrogeologic Groundwater Model Inputs,* dated October 29, 2010

---

1. *General comment, the Hydrogeologic Modeling Work Plan (dated April 29, 2010) included a task to evaluate density driven groundwater flow effects. Please include the results of this evaluation.*

Response:

There are a number of factors which serve to minimize the relative impact that density gradients from the higher TDS plumes (i.e. higher density water) may have on the current flow and transport regime around the Tronox Well Field areas:

1. Hydraulic Controls:
    a. Strong upward vertical gradients due to artesian conditions at depth, serve to counteract small vertical density gradients.
    b. Relatively low recharge infiltration rates (so does not contribute further downward migration)
    c. Pumping wells are screened in the Shallow water-bearing zone (WBZ), so do not serve to draw the TDS plumes deeper as would be the case if there was extensive deeper pumping. The pumping wells are also generally situated in or just upgradient of the zones of highest TDS (highest density), and the strong horizontal and vertical gradients generated by active pumping also serve to minimize the effects of density gradients in the region where they would be expected to be greatest.
2. Geologic Controls:
    a. In the vertical direction the large contrast in hydraulic properties between the thin, high conductivity, Qal, overlaying the much lower hydraulic conductivity Muddy Creek formation, serves to attenuate the effects of density gradients which would result in downward driving forces in the

regions of high TDS.

b. Similarly, in the horizontal direction, the heterogeneity created by the presence of the high conductivity paleochannels within the Qal and directly above the UMCf, results in a situation in which horizontal and vertical spreading due to hydrodynamic dispersion are likely much more significant than vertical spreading due to density gradients alone. As the TDS plumes advects horizontally, it becomes more dilute, thus diminishing density gradient effects.

Through these line of analysis (Koch & Zhang, 1992; API, 2006) it was decided that for the purpose of the current capture zone evaluation, based on the current plume configuration, it would not be necessary to explicitly account for variable density flow through the use of a specialized simulator such as SEAWAT. Rather, fresh water head corrections were carried out for all water level measurements well pairs/triplets used for estimating the horizontal and vertical fluxes assigned along the southern and bottom boundaries of the model. Furthermore, all measured water levels chosen as calibration targets were also corrected for density differences based on measured TDS concentrations. At shallow depths, the corrections, even for high TDS values, are relatively minor, given the small water column. The correction however, can be large for deeper wells under artesian conditions, in which the well has a tall water column, over which the density difference can have a big effect on the corrected head. These effects were most pronounced towards the Las Vegas Wash in the region of very high TDS (upwards of 100,000 mg/l) brines that have been associated by BRC with deeper waters in contact with evaporitic deposits. Some of these wells had freshwater head corrections as large as 50 feet. For regions around the Tronox well fields, there were very few water levels in the Shallow WBZ that had freshwater head corrections larger than a tenth of a foot.

After the steady-state model calibration process was complete, a comparison between TDS and the calibration residuals, well as between freshwater head correction (i.e. Observed Corrected Freshwater Head – Observed Head) was carried out to identify if there was any obvious correlation between errors in the modeled head values and locations with high TDS or large freshwater head corrections. For example, were high TDS locations systematically being under or over predicted by the model? If so this could indicate some bias due to density differences. The scatter plots shown in Figure G-1a and Figure G-1b illustrate that there is no readily apparent correlation between the model prediction errors and either TDS or Freshwater head corrections. Residuals appear to be distributed between both high and low TDS values. While not diagnostic, this does add an additional line of evidence in support of the assessment variable density flow may not be significant for the purposes of the capture zone evaluation.

That said, it should be pointed out it is likely that density effects may have played a stronger role in the vicinity of the source areas (and immediately downgradient) during the initial historical release and migration of the TDS plumes, when the relative effects of horizontal hydrodynamic dispersion would have been smaller, vertical gradients may been reversed locally due to significant downward recharge of high TDS water, and when strong local gradients due to pumping had not yet begun. At the early stages, the initial TDS concentrations would also have been much higher and density effects would have added to the downward driving forces. In this regard future studies that simulate the historical releases and evolution of the plumes may need to incorporate variable density flow.

References:

American Petroleum Institute (API), 2006. Downward Solute Plume Migration: Assessment, Significance, and Implications for Characterization and Monitoring of "Diving Plumes", Regulatory Analysis and Scientific Affairs. API Soil and Groundwater Technical Task Force Bulletin 24. April 2006.

Koch, M., & G. Zhang, 1992. "Numerical Simulation of the Effects of Variable Density in a Contaminant Plume", Groundwater, Vol. 30, No. 5, pp. 731-733, Sept.-Oct. 1992.

2. *Section 2.2, page 3, the stated QA process describes identifying records that have ground surface discrepancies as compared to digital elevation model as well as top-of-casing discrepancies as compared to ground surface elevations. Please include a table summarizing the results of identified data errors and resolutions.*

Response:

Response: Initially, ground surface elevations recorded in the "All Wells" spreadsheet were compared with TOC elevations as a first pass at identifying possible errors or typos in the ground surface elevations, and the possible subsequent errors in Qal/UMCf elevations derived from those ground surface elevations. After this initial screening exercise a decision was made to instead compare the recorded ground surface elevations with elevations taken from an interpolated ground surface elevation model derived from the 5 ft contour interval topographic survey map conducted for the entire BMI complex by PBS&J in 2006. This comparison was used as the basis for any ground surface elevation corrections. The identified ground surface elevation data issues and resolutions are presented in Table G-1.

3. *Section 2.2, page 4, NDEP provides the following comments:*
   a. *An ordinary kriging routine is described as used to generate an initial UMCf/Qal contact surface map and "anomalously high or low values" were picked for comparison against well logs to fix errors. Please include a summary of identified errors and resolutions.*
   b. *Advanced routines are described as used to generate a final UMCf/Qal contact surface map. Please include a discussion on what impacts these methods have on the uncertainty of the final model product.*
   c. *Differences are described between the final UMCf/Qal contact surface map and that produced by BRC; please describe any differences that are anticipated to propagate substantively different model results.*

Response:

a. Identified Upper Muddy Creek contact elevation data issues and resolutions are presented in Table G-2.

b. Two "advanced" routines were applied during the interpolation and contouring of the Qal/UMCf lithologic contact. The first routine was the removal of the regional elevation trend prior to establishing the spatial correlation model (variogram), and second was the definition of of an anisotropic variogram model that takes into account the north-south trending anisotropy introduced by the presence of the paleochannels. It was found that this combination of routines produced a better fit between the observed and predicted contact elevations, as compared to the default "bare-bones" kriging routine.

   The regional trend is identified and subtracted from all the elevations prior to kriging. In this case, a plane sloping northward was first fit (via linear regression) to the cloud of Qal/UMCf contact elevations. This northward sloping plane represents the regional topographic slope of the Qal/UMCf contact. This trend can be represented by a mathematical formula and removed from the data. Once the trend is removed, the statistical analysis to determine the variogram parameters is performed on the residuals or the short-range variation component of the surface. The trend is automatically added back before the final surface is created so that the predictions produce meaningful results. By removing the trend, the analysis that follows will not be influenced by the trend, and once it is added back, a more accurate representation of the smaller scale variability of the surface, in this case the paleochannel structure, is produced. The advantage of kriging with regional trend removal is that smaller scale structure of the data is revealed and preserved in areas where data are sufficiently dense, whereas the regional trend provides an indication of the general tendency of the lithologic contact in areas where data are sparse or nonexistent.

   So, the method reduces uncertainty of the final product in terms of both ensuring that the regional trend is faithfully maintained in the interpolated and extrapolated values, and also that the smaller scale variability, such as channel topography,

etc., is also preserved and not overwhelmed by the large scale regional variability represented by the background trend.

In applying the anisotropic variogram model, we also reduce the uncertainty in the modeled surface because when interpolating, the system "knows" that topographic features should generally be more strongly persistent in the north-south direction than in the east-west direction. This is consistent with the geologic interpretation that the paleochannel system represents an ancient drainage system that drained northwards from uplands south of site, and towards the direction of the present day Wash.

Modern day Basin and Range alluvial drainage networks can serve as analogs for the paleochannel network system, and visual comparison of aerial photos of such networks (see Figure G-2) with the kriged Muddy Creek contact map and associated paleochannel network show strong geomorphic similarities.

c. Comparison of the recent Tronox contour map interpretation and BRC's 2009 interpretation of the Qal/UMCf contact reveal some differences. Both paleochannel interpretations are shown on Figure E-4 in Appendix E to Northgate's *Capture Zone Evaluation Report* dated December 10, 2010. For the purpose of identifying differences between the recently revised Tronox and BRC (2009) interpretations of the Qal/UMCf contact surface that could propagate substantive differences in modeling results, we can focus our initial attention on how the contour maps have lead to different paleochannel drainage networks. In general the majority of the paleochannels appear to be interpreted more or less in the same areas by the two companies. However, some important differences are noted. BRC does not identify any paleochannels located in the Tronox industrial area; due to the low water levels in the alluvium in this area, the presence or absence of channels in this area are significant controlling factors to alluvial groundwater flow. BRC does not identify the tributary channel mapped by Tronox that begins southeast of the Athens Road well field (AWF) and merging with the "main channel" downgradient of the AWF, and the absence of this channel would likely lead to different interpretations of the amount of water and mass flux passing through the Athens Road Well Field and towards the wash. Third, while both companies identify a network of channels northeast of the TIMET facility, Tronox interprets these channels as flowing to the northwest and joining the main channel near the Seep Well Field (SWF), whereas BRC interprets these channels flowing towards the north-northeast, across what has been interpreted as a subtle ridge in the Tronox map. Since this set of channels effectively drains from the alluvial sediments from TIMET and from the east-side ponds, the differences in interpretations could have significant effects on the concentrations and magnitude of mass fluxes that arrive to the wash. On a secondary level, there are some noticeable differences in the overall structure of the interpreted contours that could also affect flow, though perhaps in less

dramatic fashion. In particular, the BRC interpretation has some broad areas to the east of the "main channel" that appear to have very gentle slopes, while to the north and south of these plateaus are areas where the slope becomes much more steep, suggesting a "terrace" like topography. The Tronox interpretation of the topography is much more uniform in slope; this may be in part due to the de-trending step in the kriging which preserves the overall regional slope.

4. *Section 2.3, page 5, please provide a reference for the geophysical survey data.*

Response:

Geophysical survey cross-sections of smoothed geoelectric inversion profiles across the BMI Eastside Common Areas (available on the Land Well Company website) were reviewed and compared qualitatively as an additional line of evidence during the definition of the paleochannel network.

Reference:

http://www.landwellco.com/coolscnew/Geophysics_Landwell.html (accessed on October 14, 2010).

5. *Section 2.5, page 7, the range of hydraulic conductivity for alluvium and Muddy Creek is stated to be bounded by the arithmetic and harmonic mean of the data. Please explain how the data range will be implemented in the model (e.g., stochastic inputs, calibration endpoints, etc.).*

Response:

We modeled the hydraulic conductivity field of different lithologic zones through an effective conductivity concept. The most general brackets on the values of the effective hydraulic conductivity, K_{eff}, are given by the Batchelor bounds, in which the lower limit is equal to the harmonic mean (K_H) and the upper limit is equal to the arithmetic mean (K_A) of the hydraulic conductivity (Batchelor, 1974; de Marsily, 1986; Rubin , 2003). With this approach, the upper and lower limits of the effective hydraulic conductivity of each lithologic zone were calculated from the available pump and slug test data. The harmonic and arithmetic means for each lithologic zone were then used as calibration as lower and upper endpoints during the auto-calibration runs.

References:

Batchelor, G K. 1974. *Transport Properties of Two-Phase Materials with Random Structure.* Annual Review of Fluid Mechanics, 6(1), 227–255.

de Marsily, G., 1986. *Quantitative Hydrogeology: Groundwater Hydrology for Engineers.* San Diego. Academic Press.

Rubin, Yoram. 2003. *Applied Stochastic Hydrogeology*. New York, NY: Oxford Univ. Press.

6. *Section 2.7.1, page 10, please note that AMPAC has recently replaced their injection wells with an injection trench capable of higher rates. The replacement was constructed following the steady state model time period. Additionally, AMPAC is in the process of switching to an ex-situ remediation system with surface discharge, thereby eliminating their current injection well field. These considerations should be noted for any future predictive modeling.*

   Response:

   Comment noted.

7. *Section 2.8, page 10, please note that TIMET is in process of construction of a groundwater barrier wall; this consideration should be noted for any future predictive modeling.*

   Response:

   Comment noted.

8. *Section 3.1, page 11, please discuss how dispersion will be accounted for in capture zone evaluation.*

   Response:

   Response: The definition of the Target Capture Zone will be based on isoconcentration contours derived from of a three-dimensional plume model based on interpolation of actual monitoring data. In this regard the effects of both lateral and longitudinal dispersion are implicitly incorporated in the Target Capture Zone definition, since by its very nature, the spatial distribution of concentration exhibited by the monitoring data reflects the process of advection-dispersion. The high-degree of heterogeneity introduced by the presence of the higher permeability paleochannels creates a situation in which the longitudinal dispersion is much greater than the lateral dispersion (i.e., the plume is much "longer" than it is "wide" or "deep"). It is expected that over time there will be some limited additional lateral spreading of the plume beyond its current width, though this would be at the low end of the concentrations that are not thought to be contributing significantly to the mass flux.

   The response above addresses the part of the capture zone evaluation carried out by particle tracking which is advective by definition. However, in addition particle tracking, in order to evaluate the mass of perchlorate extracted by the GWETS, TRX carried out transport modeling using MT3D (Zhang, C 1990). MT3D addresses dispersion explicitly.

   <u>Reference:</u>

   Zheng, C. 1990. MT3D: A modular three dimensional transport model for simulation

of advection, dispersion and chemical reactions of contaminants in ground-water systems. U.S. Environmental Protection Agency and R.S. Kerr Environmental Research Laboratory, Ada, OK.

9. *Table 1, NDEP provides the following comments:*
   a. *TRX should note that hydraulic conductivity values used by McGinley & Associates for Athens Road Modeling (2007) have been superseded by revised values (Ed Krish, personal communication with McGinley and Associates).*
   b. *Please provide a date for the COH Birding Preserve data sent by Brenda Pohlmann. NDEP notes that the reported value is an order-of-magnitude less than that used by DBS&A.*
   c. *TRX should include discussion on how well HEC-RAS water surface elevation data compare to grid cell elevations and whether there are implications for evapotranspiration extinction implementation.*

Response:

a. Noted. TRX will review the revised values for use in future updates of flow model.

b. COH Birding Preserve data was sent by Brenda Pohlmann on 8/18/2010, which summarized inflow data from 2006 to present. The discharge data was averaged for the time period used to calibrate the TRX model (8/2008 – 3/2009), resulting in a discharge rate of 1.15×10^5 cfd (0.86 mgd). Using this discharge rate and accounting the for evaporative loss using the pan evaporation rate of 8.2 ft/yr estimated by Shevenell (1996), a recharge rate of 2.43×10^{-3} ft/d was calculated for the Birding Preserve (footprint of the preserve is approximately 4.65×10^6 ft^2).

   DBS&A used the 2005-06 time period for discharge into the Birding Preserve in their model. The inflow to the Birding Preserve was higher during that period, 2.14×10^5 cfd (1.6 mgd). Using the 8.2 ft/yr evaporation rate and the same estimated footprint, the recharge is 2.35×10^{-3} ft/d, which is an order of magnitude larger than the value used by TRX.

c. The HEC-RAS water surface cross-sections were used to estimate the water surface gradient downstream and upstream of Pabco Rd. We only obtained cross-sections downstream of Pabco Rd and calculated a gradient based on this data. We assumed that the gradient was linear across the portion of the Wash within our model domain, although this is a simplification because of the weirs along the Wash. Therefore, differences exist in the water elevations used in the model and the HEC-RAS water surface elevations. The water surface elevations in the model are above the bottom elevation of the cells in Layer 1 representing the Wash.

   The depths to the water table in the ET regions near the Wash were checked and are consistent with an extinction depth of 5 ft, the value currently used to calculate

ET.

10. *Figure 10, NDEP notes that paleochannels are being simulated using a minimum of 2 grid cells in width (400 feet). Please discuss all factors used to support this geometry.*

Response:

A width of 400 feet for the paleochannels is based primarily on previous work by DBS&A (2008). The widths of many of their paleochannels in their model are also about 400 ft. Note, however, that the two paleochannels that run through the IWF in the TRX model are thinner and have a width of about 200 ft. The narrower width of these channels can be seen as based on the interpretation that these channels represent smaller, "lower order" tributaries of the larger, main Tronox channel that they meet up with further down gradient. Future work may be conducted to examine the sensitivity of the paleochannel width on the results. A more extensive assessment of the range of paleochannel widths would also be performed at that time.

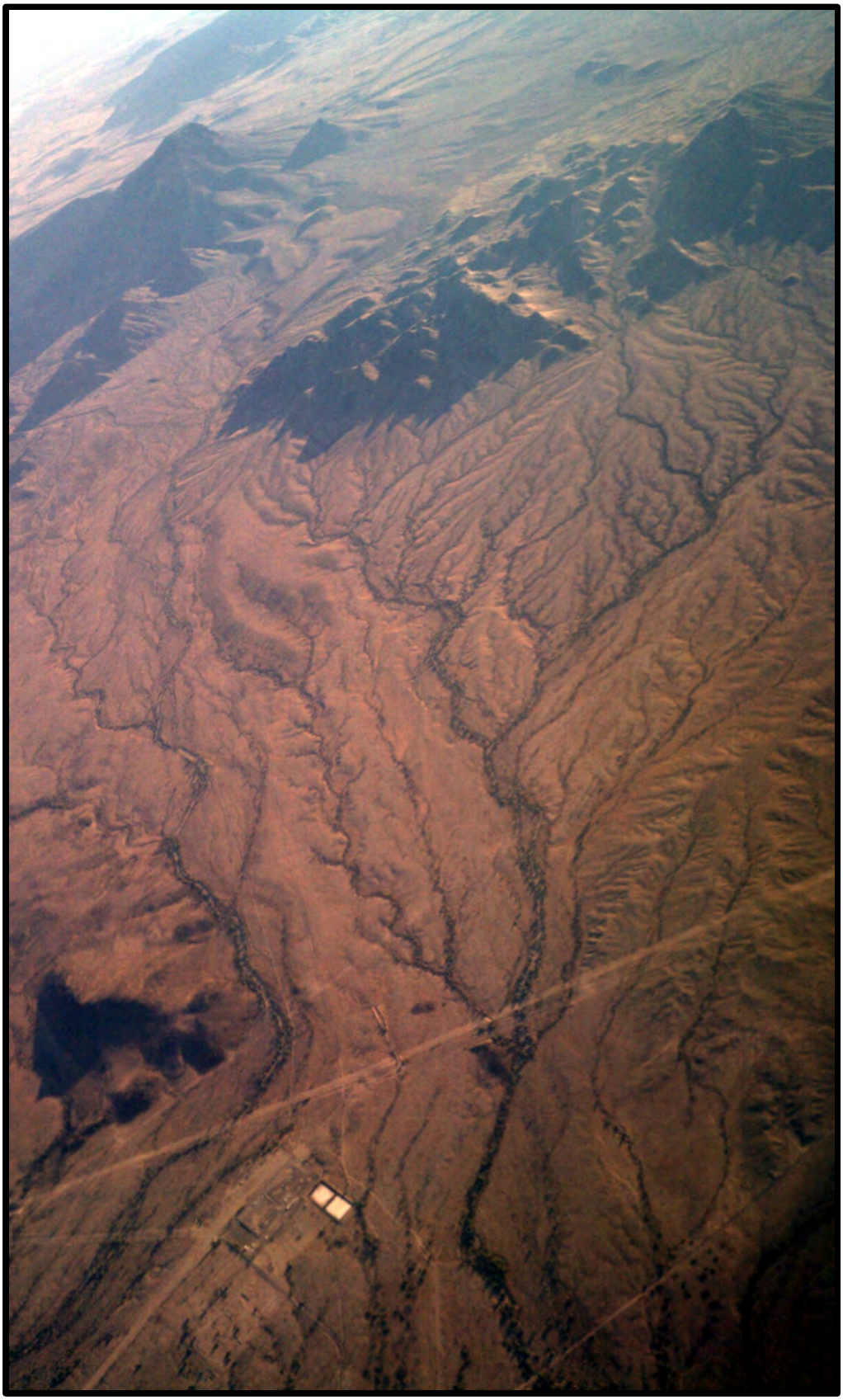
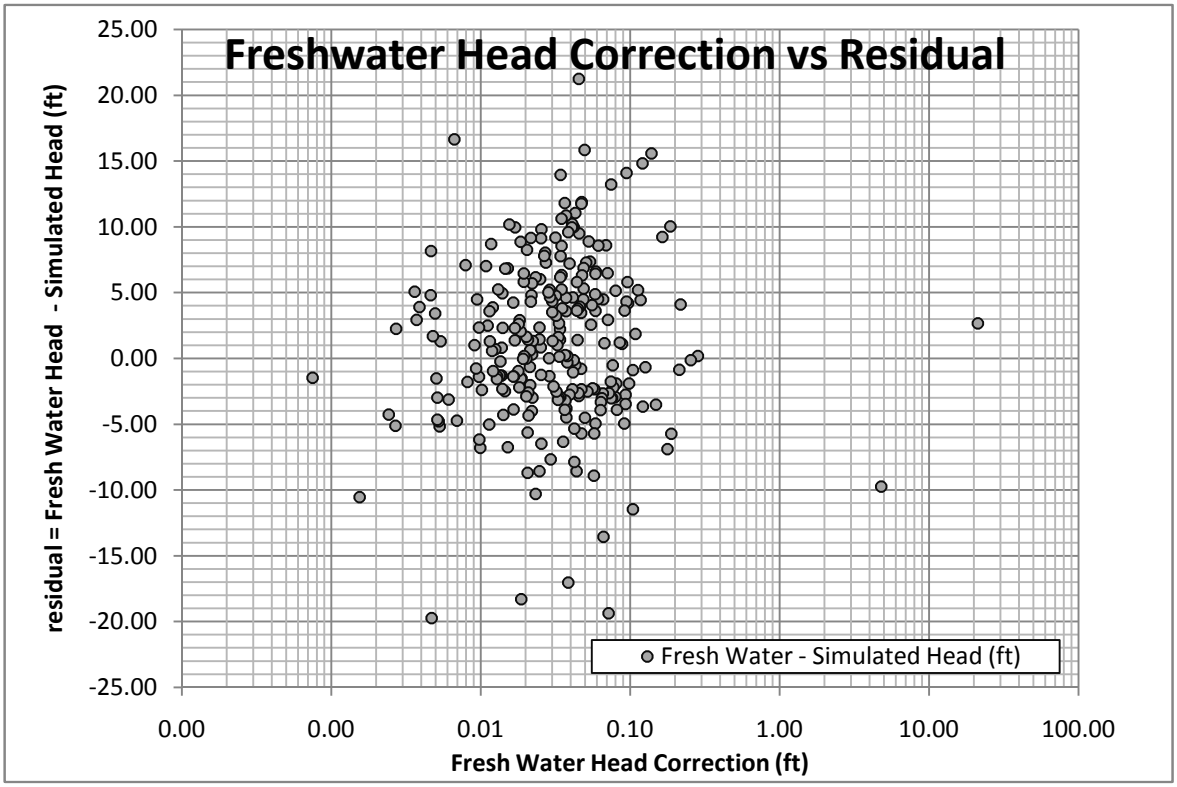


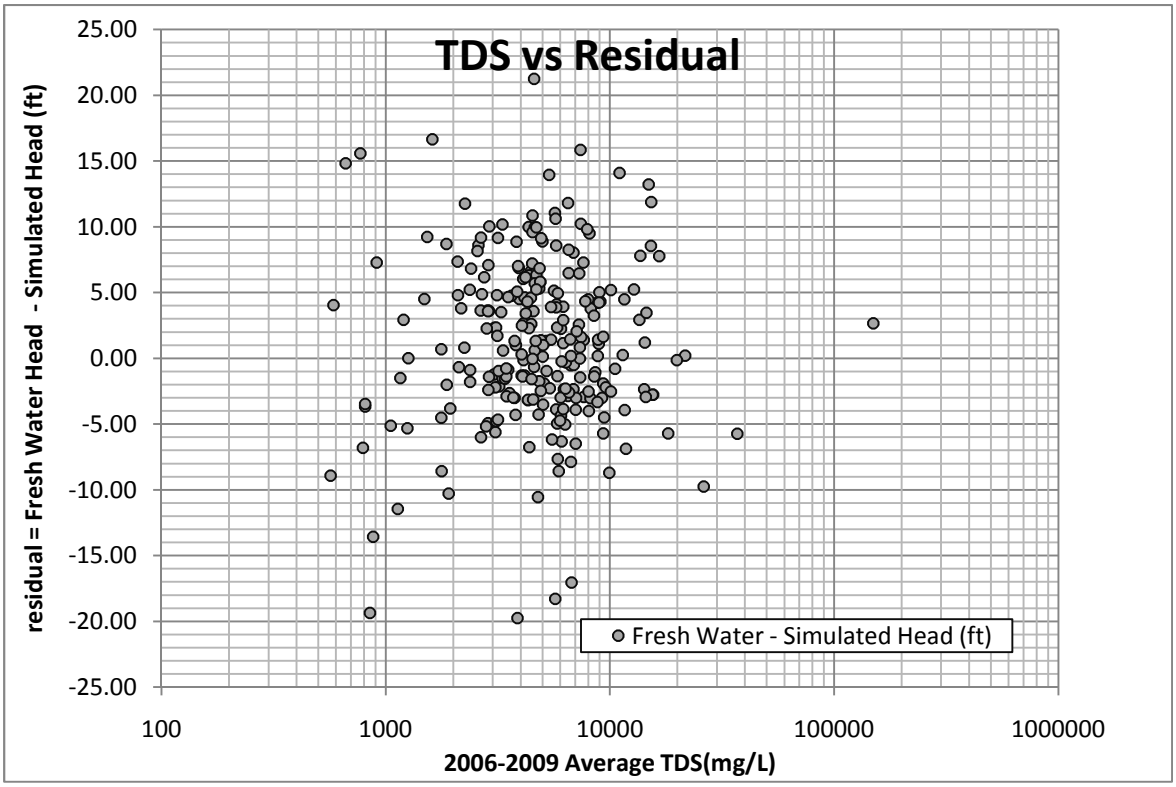
Figure G-2	
Analog Basin & Range alluvial fan drainage network. (photo credit: P. Benito, 2009)	northgate environmental management, inc.

FIGURE G-1

A)


Freshwater Head Correction vs Residual
residual = Fresh Water Head - Simulated Head (ft)
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
0.00
0.00
0.01
0.10
1.00
10.00
100.00
Fresh Water Head Correction (ft)
Fresh Water - Simulated Head (ft)

B)


TDS vs Residual
residual = Fresh Water Head - Simulated Head (ft)
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
100
1000
10000
100000
1000000
2006-2009 Average TDS(mg/L)
Fresh Water - Simulated Head (ft)